AN ANNOTATED BIBLIOGRAPHY OF PIGEONPEA

1900-1977

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1900-1977

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ICRISAT

International Crops Research Institute for the Semi-Arid Tropics
ICRISAT Patancheru P.O.
Andhra Pradesh, India 502 324

May 1980

To those people who are devoted to the improvement of Cajanus cajan *with the aim of upgrading the nutritional standard of the diets of people in the developing countries.*

CONTENTS

FOREWORD

ICRISAT is pleased to publish this annotated bibliography of pigeonpea literature, which results chiefly from the efforts of a close associate, Dr. B. S. Dahiya of Haryana Agricultural University, who was at Punjab Agricultural University when these references were compiled. Our joint effort exemplifies the two-way cooperation that multiplies the effectiveness of the research done by both ICRISAT and the Indian national programs.

Interest in pigeonpea, now grown mostly in India, is increasing on an international basis. A recent report of the U. S. National Science Foundation, for example, recommended research to explore the adaptation of the crop to marginal lands in the USA.

It is our hope that easier access to existing literature on pigeonpea will help all concerned scientists in planning effective research for increasing the supply of a highly nutritive food crop of importance to many millions of people.

L. D. Swindale
Director General

PREFACE

This bibliography is prepared to provide up-to-date information on pigeonpea literature. It contains 1275 citations dating from 1900 through 1977, including all traceable references prior to 1900 and some of 1978. The annotations are the authors' original abstracts or summaries, with some editing. Where the papers or publications do not deal directly with pigeonpea, only the portion relating to pigeonpea is summarized. The abstracts of papers not directly available were taken from sources such as Biological Abstracts, Chemical Abstracts, or CAB Abstracts. Titles are presented only in English translation, with one or two exceptions where the English translation was not available.

The subject index is brief but adequate, I think, to be useful. Since the bibliography is on pigeonpea, the term "pigeonpea" has been omitted from the index. A list of pigeonpea synonymy is given at the end.

In a publication of this nature, omissions and errors are inevitable. I should appreciate having such omissions and errors brought to my attention, in order to improve future supplements.

ACKNOWLEDGMENTS

I am grateful to Drs. L. D. Swindale, Director General, and J. S. Kanwar, Director of Research, ICRISAT, Hyderabad, for providing facilities at ICRISAT, where I could devote myself entirely to this assignment, and to the authorities of Punjab Agricultural University (PAU), Ludhiana, for granting leave from my duties there to work on this project.

I am indebted to my colleagues and postgraduate students at PAU and the staff of the libraries consulted for assistance in compiling the references.

The input of the pigeonpea scientists and secretarial staff of ICRISAT is gratefully acknowledged; I especially appreciate the early interest expressed in the project by Dr. John M. Green, Leader of the Pulse Program at ICRISAT, and his sustained encouragement to complete it.

Special mention must be made of the dedicated effort of A. J. Rama Rao, ICRISAT pulse program secretary, without whom the preparation of the final test of the bibliography would have been much more delayed.

Finally, I am deeply grateful to Vrinda Kumble for her editorial assistance, and to ICRISAT, the publisher, for making the bibliography available to the scientists to whom it is dedicated.

B. S. Dahiya

LIST OF ABBREVIATIONS

Acta Alimen. Hung.
Acta Alimentaria Hungaricae

Acta Phytother.
Acta Phytotherapeutica

Adm. Rep. Dir. Agric. Ceylon
Administrative Report of the Director of Agriculture, Ceylon

Agra Univ. J. Res.
Agra University Journal of Research

Agric. Anim. Husb., Uttar Pradesh
Agriculture and Animal Husbandry, Uttar Pradesh

Agric. Coll. J. Osmania University
Agricultural College Journal, Osmania University

Agric. Exp. Stn Univ. Puerto Rico
Agricultural Experiment Station, University of Puerto Rico

Agric. Gaz. N.S.W.
Agricultural Gazette of New South Wales, Australia

Agric. J. Bihar, Orissa
Agricultural Journal of the Bihar and Orissa Department of Agriculture

Agric. J. India
Agricultural Journal of India

Agric. Meteor.
Agricultural Meteorology

Agric. Res., New Delhi
Agricultural Research, New Delhi

Agric. Situ. India
Agricultural Situation in India

Agricultura, Louvain
Agricultura, Louvain

Agricultura Mod. Habana
Agricultura Moderna, Habana

Agricultura Trop.
Agricultura Tropicale

Agriculture, India
Agriculture in India

Agriculture Live-Stk India
Agriculture and Live-Stock in India

Agronomico Compinas
Agronomico Compinas

Agron. J.
Agronomy Journal

Agron. Trop., Nogent
Agronomie Tropicale, Nogent sur Marne

Allahabad Fmr
Allahabad Farmer

Am. J. Bot.
American Journal of Botany

Analyt. Biochem.
Analytical Biochemistry

Andhra Agric. J.
Andhra Agricultural Journal

An. Esc. Agric. Queiroz.
Annals Escola de Agricultura Luiz de Queiroz, Pirocicaba

An. Fac. Farm. Bioquim. Univ. S. Marcos Lima Peru
Anales de la Facultad de Farmacia y Bioquimica. Universidad Nacional de San Marcos

Annls Amel. Pl.
Annales de l'amelioration des Plantes

Ann. Appl. Biol.
Annals of Applied Biology

Ann. Arid Zone
Annals of Arid Zone

Ann. Biochem. Expl Med.
Annals of Biochemistry and Experimental Medicine

Ann. Bot.
Annals of Botany

Arb. Biol. Anst. Reichsanst. Berl.
Arbeiten aus der Biologischen Reichsanstalt für Land-u-Forstwirtschaft. Berlin

Archos Venez. Nutr.
Archivos Venezolanos de Nutricion

Aust. J. Agric. Res.
Australian Journal of Agricultural Research

Aust. J. Pl. Physiol.
Australian Journal of Plant Physiology

A. Meet. Ind. Sci. Cong., Poona
Annual Meeting of the Indian Science Congress, Poona

A. Rep. Agric. Dept Sierre Leone
Annual Report, Agriculture Department, Sierre Leone

A. Rep. Dept Agric. Tanganyika Territory
Annual Report of the Department of Agriculture Tanganyika Territory

A. Rep. Dept Agric. Kenya
Annual Report, Department of Agriculture, Kenya

A. Rep. Dept Agric. Nyasaland
Annual Report of the Department of Agriculture, Nyasaland

A. Rep. Lands Forest. Dep. Sierre Leone
Annual Report, Lands and Forests Department, Sierre Leone

A. Rev. Biochem. Appl. Res. India
Annual Review of the Biochemical and Applied Research in India

At ICRISAT
At ICRISAT

B.A. Agric. Coll. Mag.
Bansilal Amritlal Agriculture College Magazine

Biet. Ent. Entomol.
Biet. Entomology Entomologie

Bihar Agric. Coll. Mag.
Bihar Agricultural College Magazine

Biochem. J.
Biochemical Journal

Biochim. Biophys. Acta
Biochimica et Biophysica Acta

Biol. Res. Coun. Soc. Biol. Chem., India
Biological Research Council, Society of Biological Chemistry, India

Bol. Min. Agric. Brazil
Boletim do Ministerio da Agricultura, Brazil

Bol. R. Soc. Española Hist. Nat.
Boletin de la Real Sociedad Española de Historia Natural

Bol. Sec. Agric. Pernambuco
Boletim da Secretaria da Agricultura de Pernambuco

Bol. Soc. Bot. Mexico
Boletin de la Sociedad Botanica del Mexico

Bol. Trim. Exp. Agropec.
Boletin Trimestral de Experimentación Agropecuaria, Lima

Bolm Agric. São Paulo
Boletim de Agricultura São Paulo

Bolm Minist. Agric. Ind. Com. Rio de J.
Boletim do Ministério da Agricultura, Industria e Comercio

Bombay Dep. Agric. Leafl.
Bombay Department of Agriculture Leaflet

Botanica
Botanica

Bot. J. Linn. Soc.
Botanical Journal of Linnaean Society

Botanique (Nagpur)
Botanique (Nagpur)

Bothalia
Bothalia

Bragantia
Bragantia

Brasil Acucareiro
Brasil Acucareiro

Bull. Agric. Congo Belge
Bulletin Agricole du Congo Belge

Bull. Bot. Soc. Bengal
Bulletin of the Botanical Society of Bengal

Bull. Calcutta Sch. Trop. Med.
Bulletin of the Calcutta School of Tropical Medicine

Bull. Ent. Res.
Bulletin of Entomological Research

Bull. Estac. Exp. Agric. Univ. P.R.
Bulletin Estación Experimental Agriculture University of Puerto Rico

Bull. Grain Technol.
Bulletin of Grain Technology

Bull. Nat. Inst. Sci., India
Bulletin of the National Institute of Sciences, India

Bull. U.S. Nat. Mus.
Bulletin of the United States National Museum

B.V.J. Agric. Sci. Res.
The Balwant Vidyapeeth Journal of Agricultural and Scientific Research

Cajanus
Cajanus (Jamaica)

Can. J. Biochem. Physiol.
Canadian Journal of Biochemistry and Physiology

Can. J. Genet. Cytol.
Canadian Journal of Genetics and Cytology

Can. J. Pl. Sci.
Canadian Journal of Plant Science

Caribb. Agric.
Caribbean Agriculture

Caribb. Fmr
Caribbean Farmer

Caryologia
Caryologia

Castanea
Castanea

CRRI, Cuttack
Central Rice Research Institute, Cuttack

Cereal Chem.
Cereal Chemistry

Ceres, Minas Gerais
Ceres, Minas Gerais

Commun. Found. NEDERF. Amsterdam
Communication Foundation, NEDERF. Amsterdam

Coton Fibr. Trop.
Coton et Fibres Tropicales, Paris

Crop Sci.
Crop Science

Curr. Res.
Current Research

Curr. Sci.
Current Science

Cytologia
Cytologia

Dep. Agric. Econ. Fm Mgmt Univ. W. Indies
Department of Agricultural Economics and Farm Management, University of West Indies

Dep. Agric. Tech. Rep. Ceylon
Department of Agriculture Technical Reports Ceylon

Dep. Agric. Poona, Bombay
Department of Agriculture, Poona, Bombay

Div. Pl. Path. Dep. Agric. Mauritius
Division of Plant Pathology, Department of Agriculture, Mauritius

E. Afr. Agric. J.
East African Agricultural Journal

E. Afr. Agric. For. J.
East African Agricultural and Forestry Journal

El Salvador Minist. Agric. Ganad. Cire Agric.
El Salvador Ministerio de Agricultura Y Ganaderia, Cire Agriculture

Emp. J. Exp. Agric.
Empire Journal of Experimental Agriculture

Entomologist
Entomologist

Entomologists' Newsletter
Entomologists' Newsletter

Euphytica
Euphytica

Experientia
Experientia

Expl Agric.
Experimental Agriculture

FAO Agric. Studies
Food and Agriculture Organization Agricultural Studies

FAO Pl. Prot. Bull.
Food and Agriculture Organization Plant Protection Bulletin

FAO/SIDA Seminar
Food and Agriculture Organization, Swedish International Development Agency, Seminar

Farmer
Farmer, India

Farmer (Kingston, Jam.)
Farmer. Journal of the Jamaica Agricultural Society Kingston

Fd Fmg
Food and Farming

Fd Fmg Agric.
Food Farming and Agriculture

Fd Res.
Food Research

Fd Technol. Ser. Fac. Engg Univ. W. Indies
Food Technology Series, Faculty of Engineering, University of West Indies

Fertil. News
Fertilizer News

Fertil. Technol.
Fertilizer Technology

Fld Crop Abstr.
Field Crop Abstracts

Fm Factory
Farm and Factory

Fm Fare
Farm Fare

Fm J.
Farm Journal

Fm News
Farm News

Fmg S. Afr.
Farming in South Africa

Fmr Parliam.
Farmer and Parliament

Fruits d'outre Mer
Fruits d'outre Mer

Gaz. Agric. Mozambique
Gazette Agriculture, Mozambique

Genet. Agr.
Genetica Agraria

Genetica
Genetica

Genetics
Genetics

Har. J. Hort. Sci.
Haryana Journal of Horticultural Science

HAU J. Res.
Haryana Agricultural University Journal of Research

Hawaii Agric. Exp. Stn Bull.
Hawaii Agricultural Experiment Station Bulletin

Hawaii Agric. Exp. Stn Prog. Rep.
Hawaii Agricultural Experiment Station Progress Reports

Hawaii Agric. Exp. Stn Tech. Bull.
Hawaii Agricultural Experiment Station Technical Bulletin

Himachal J. Agric. Res.
Himachal Journal of Agricultural Research

Hoppe-Seyler's Z. Physiol. Chem.
Hoppe-Seyler's Zeitschrift für Physiologische Chemie

Hort. Sci.
Horticulture Science

IAEA
International Atomic Energy Agency

IARI Res. Ser.
Indian Agricultural Research Institute Research Series

ICAR
Indian Council of Agricultural Research

ICMR
Indian Council of Medical Research

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics

IDRC
International Development Research Centre

IITA
International Institute of Tropical Agriculture

Imp. Coun. Agric. Res. Pusa
Imperial Council of Agricultural Research, Pusa

Indian Agric.
Indian Agriculturist

Indian Agric. News Digest
Indian Agriculture, News Digest

Indian Cott. Grow. Rev.
Indian Cotton Growing Review

Indian Fmg
Indian Farming

Indian Fmr Digest
Indian Farmer's Digest

Indian Forester
Indian Forester

Indian Inst. Sci. J.
Indian Institute of Science Journal

Indian J. Agric. Chem.
Indian Journal of Agricultural Chemistry

Indian J. Agric. Res.
Indian Journal of Agricultural Research

Indian J. Agric. Sci.
Indian Journal of Agricultural Sciences

Indian J. Agron.
Indian Journal of Agronomy

Indian J. Anim. Sci.
Indian Journal of Animal Sciences

Indian J. Appl. Chem.
Indian Journal of Applied Chemistry

Indian J. Biochem.
Indian Journal of Biochemistry

Indian J. Biochem. Biophys.
Indian Journal of Biochemistry and Biophysics

Indian J. Ent.
Indian Journal of Entomology

Indian J. Expl Biol.
Indian Journal of Experimental Biology

Indian J. Fm Sci.
Indian Journal of Farm Sciences

Indian J. Genet. Pl. Breed.
Indian Journal of Genetics and Plant Breeding

Indian J. Med. Res.
Indian Journal of Medical Research

Indian J. Microb.
Indian Journal of Microbiology

Indian J. Mycol. Pl. Path.
Indian Journal of Mycology and Plant Pathology

Indian J. Mycol. Res.
Indian Journal of Mycological Research

Indian J. Nematol.
Indian Journal of Nematology

Indian J. Nutr. Dietet.
Indian Journal of Nutrition and Dietetics

Indian J. Pl. Physiol.
Indian Journal of Plant Physiology

Indian J. Pl. Prot.
Indian Journal of Plant Protection

Indian Lac Res. Inst. Bull.
Indian Lac Research Institute Bulletin

Indian Phytopath.
Indian Phytopathology

Indian Soap J.
Indian Soap Journal

Indian Vet. J.
Indian Veterinary Journal

Int. Z. Vitamforsch.
Internationale Zeitschrift für Vitaminforschung

Intensive Agric.
Intensive Agriculture

Intern. Bull. Plant Prot.
International Bulletin on Plant Protection

ISI
Indian Standards Institution

J. Agric. Bihar Orissa
Journal of Agriculture, Bihar and Orissa

J. Agric. Res.
Journal of Agricultural Research

J. Agric. Res.
Journal of Agricultural Research, North Caucasus

J. Agric. Sci., Camb.
Journal of Agricultural Science, Cambridge

J. Agric. Soc. Trin.
Journal of the Agricultural Society of Trinidad and Tobago

J. Agric. Trop. Bot. Appl.
Journal d'Agriculture Tropicale et de Botanique Appliquée

J. Agric. Univ. P. Rico
Journal of Agriculture of the University of Puerto Rico

J. Am. Soc. Agron.
Journal of the American Society of Agronomy

J. Assoc. Advan. Agric. Sect. Africa
Journal of the Association of Advances in Agriculture Section, Africa

J. Aust. Inst. Agric. Sci.
Journal of the Australian Institute of Agricultural Sciences

J. Bd Agric. Br. Guiana
Journal of the Board of Agriculture of British Guiana

J. Coll. Agric., Gwalior
Journal of the College of Agriculture, Gwalior

J. Coun. Sci. Indust. Res. Aust.
Journal of the Council of Scientific and Industrial Research, Australia

J. Cytol. Genet.
Journal of Cytology and Genetics

J. Econ. Ent.
Journal of Economic Entomology

J. Empire Expl Agric.
Journal of Empire Experimental Agriculture

J. Fd Sci.
Journal of Food Science

J. Fd Sci. Technol.
Journal of Food Science and Technology

J. Hered.
Journal of Heredity

J. Indian Appl. Chem.
Journal of Indian Applied Chemistry

J. Indian Bot. Soc.
Journal of the Indian Botanical Society

J. Indian Chem. Soc.
Journal of the Indian Chemical Society

J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science

J. Jamaica Agric. Soc.
Journal of the Jamaica Agricultural Society

J. Karnatak Univ.
Journal of the Karnatak University

J. Madras Univ.
Journal of the Madras University

J. Maharaja Sayajirao Univ. Baroda
Journal of the Maharaja Sayajirao University, Baroda

J. Mysore Agric. Expl Union
Journal of the Mysore Agricultural and Experimental Union

J. Nat. Agric. Soc. Ceylon
Journal of the National Agriculture Society of Ceylon

J. Nat. Cancer Inst.
Journal of the National Cancer Institute

J. Nematol.
Journal of Nematology

J. Nutr.
Journal of Nutrition

J. Nutr. Dietet.
Journal of Nutrition and Dietetics

J. Papua N. Guinea Agric.
Journal of Papua New Guinea Agriculture

J. Proc. Inst. Chem.
Journal and Proceedings of the Institution of Chemists, India

J. Postgrad. Sch. IARI, Delhi
Journal of the Postgraduate School, Indian Agricultural Research Institute, Delhi

J. Res. MAU
Journal of Research Maharashtra Agricultural University

J. Res. Ranchi Univ.
Journal of Research Ranchi University

J. Sci. Fd Agric.
Journal of the Science of Food and Agriculture

J. Scient. Ind. Res.
Journal of Scientific and Industrial Research

J. Soil Wat. Conserv. India
Journal of Soil and Water Conservation in India

J. Stor. Prod. Res.
Journal of Stored Products Research

J. Univ. Poona
Journal of the University of Poona

JNKVV Res. J.
Jawaharlal Nehru Krishi Vishwa Vidyalaya Research Journal

Kanpur Agric. Coll. Mag.
Kanpur Agricultural College Magazine

Kew Bull.
Kew Bulletin

Kew Bull. (Misc. Inform.)
Kew Bulletin (Miscellaneous Information)

Labdev J. Sci. Technol.
Labdev Journal of Science and Technology

Leafl. Dep. Agric. U.P.
Leaflet Department of Agriculture, Uttar Pradesh

Madras Agric. J.
Madras Agricultural Journal

Mahatma Phule Agric. Univ. Res. J.
Mahatma Phule Agricultural University Research Journal

Mem. Dep. Agric. India Bot. Ser.
Memoirs of the Department of Agriculture in India (Botanical Series)

Mem. Dep. Agric. India Chem. Ser.
Memoirs of the Department of Agriculture in India (Chemical Series)

Mem. Imp. Coll. Trop. Agric. Trinidad (Mycol. Ser.)
Memoirs of the Imperial College of Tropical Agriculture in Trinidad (Mycological Series)

Mem. Res. Div. Dep. Agric., Uganda
Memoirs of the Research Division, Department of Agriculture, Uganda

Mod. Agric.
Modern Agriculture

Mut. Breed. Newsletter
Mutation Breeding Newsletter

Mycologia
Mycologia

Mycol. Circ. Dep. Agric. Tanganyika
Mycological Circular, Department of Agriculture, Tanganyika

Mycopath.
Mycopathologia

Mycopath. Mycol. Appl.
Mycopathologia et Mycologia Applicata

Mysore Agric. J.
Mysore Agricultural Journal

Mysore J. Agric. Sci.
Mysore Journal of Agricultural Science

Nagpur Agric. Coll. Mag.
Nagpur Agricultural College Magazine

Nagpur Agric. Coll. Mag. (Spec. Res. No.)
Nagpur Agricultural College Magazine (Special Research Number)

Nature
Nature

Naturwissenschaften
Naturwissenschaften

Nematropica
Nematropica

Nutr. Abstr. Rev.
Nutrition Abstracts and Reviews

Nutr. Rep. Intern.
Nutrition Reports International (USA)

Nutrition
Nutrition

PAG Bull.
Procein Advisory Group Bulletin

Pakist. J. Biochem.
Pakistan Journal of Biochemistry

Pakist. J. Scient. Ind. Res.
Pakistan Journal of Scientific and Industrial Research

PANS
Pesticide Articles and News Summaries

Pantnagar J. Res.
Pantnagar Journal of Research

PAU Res. J.
Punjab Agricultural University Research Journal

Pb Hort. J.
Punjab Horticultural Journal

Perf. Essent. Oils Res.
Perfumes and Essential Oils Research

Pesticides
Pesticides

Philipp. Agric.
Philippine Agriculturist

Phytochem.
Phytochemistry

Phytopath.
Phytopathology

Phytopath. Z.
Phytopathologische Zeitschrift

PKV Res. J.
Punjabrao Krishi Vidyapeeth Research Journal

Pl. Biochem. J.
Plant Biochemistry Journal

Pl. Dis. Reptr
Plant Disease Reporter

Pl. Prot. Bull.
Plant Protection Bulletin, New Delhi

Pl. Sci. Letters
Plant Science Letters

Pl. Soil
Plant and Soil

Poona Agric. Coll. Mag.
Poona Agricultural College Magazine

Poult. Sci.
Poultry Science

PRJ Publ. Health Trop. Med.
Puerto Rico Journal of Public Health and Tropical Medicine

Proc. Agric. Soc. Nigeria
Proceedings of the Agricultural Society of Nigeria

Proc. Bihar Acad. Agric. Sci.
Proceedings of the Bihar Academy of Agricultural Sciences

Proc. Bd Agric. India
Proceedings of the Board of Agriculture of India

Proc. Caribb. Soc. Fd Crop Sci.
Proceedings of the Caribbean Society of Food Crop Science

Proc. Eighth Internat. Bot. Congr.
Proceedings of the Eighth International Botanical Congress

Proc. Eleventh Int. Grassland Congr.
Proceedings of the Eleventh International Grassland Congress

Proc. First E. Afr. Hort. Symp.
Proceedings of the First East African Horticulture Symposium

Proc. First Nigerian Grain Legume Conf.
Proceedings of the First Nigerian Grain Legume Conference

Proc. Indian Acad. Sci. (Sect. B)
Proceedings of the Indian Academy of Sciences (Section B)

Proc. Indian General Congr. N. Delhi
Proceedings of the Indian General Congress, New Delhi

Proc. Indian Sci. Congr.
Proceedings of the Indian Science Congress

Proc. Linn. Soc. London
Proceedings of the Linnaean Society of London

Proc. Nat. Acad. Sci., India
Proceedings of the National Academy of Sciences of India

Proc. Ninth Int. Grassland Congr.
Proceedings of the Ninth International Grassland Congress

Proc. North Qd. Agrost. Conf.
Proceedings of the North Queensland Agrostology Conference

Proc. Second Ent. Meet., Pusa
Proceedings of the Second Entomologists' Meeting, Pusa, India

Proc. Seventh Ann. Meet. C.F.C.S., Martinique, Guadeloupe
Proceedings of the Seventh Annual Meeting of Central Food Crop Society, Martinique, Guadeloupe

Proc. Sixth Intern. Congr. Microbio.
Proceedings of the Sixth International Congress on Microbiology

Proc. Soc. Exp. Biol. Med.
Proceedings of the Society for Experimental Biology and Medicine

Proc. Soil Crop Sci. Soc. Fla.
Proceedings of the Soil and Crop Science Society of Florida

Proc. Symp. Fertil. Ind. Soils
Proceedings of the Symposium on Fertility of Indian Soils

Proc. Symp. G.B. Pant Univ. Agr. Tech. Pantnagar
Proceedings of the Symposium, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar

Proc. Symp. Proteins Mysore
Proceedings of the Symposium on Proteins, Mysore

Proc. Twentieth Ann. Meet. Ind. Sci. Congr. Poona
Proceedings of the Twentieth Annual Meeting of the Indian Science Congress, Poona

Prog. Fmg
Progressive Farming

Punjab Fmr
Punjab Farmer

Qd.Agric. J.
Queensland Agricultural Journal

Qual. Plant. Pl. Fds Hum. Nutr.
Qualitas Plantarum, Plant Foods for Human Nutrition

Radiat.Bot.
Radiation Botany

Raj. J. Agric. Sci.
Rajasthan Journal of Agricultural Science

Ranchi Agric. Univ. Res. J.
Ranchi Agricultural University Research Journal

Ranchi Univ. J. Agric. Res.
Ranchi University Journal of Agricultural Research

Rep. Agric. Res. Inst. New Delhi
Report of Agricultural Research Institute, New Delhi

Rep. Dep. Agric. Bermuda
Report, Department of Agriculture, Bermuda

Rep. Dep. Agric. Bihar Orissa
Report, Department of Agriculture, Bihar and Orissa

Rep. Dep. Agric. Bombay
Report, Department of Agriculture, Bombay

Rep. Dep. Agric. Cent. Prov. Berar
Report of the Department of Agriculture, Central Provinces and Berar

Rep. Dep. Agric. Mauritius
Report of the Department of Agriculture, Mauritius

Rep. Dep. Agric. Uganda
Report of the Department of Agriculture, Uganda

Rep. Div. Agric. Br. Guiana
Report, Division of Agriculture, British Guiana

Rep. Div. Plant Ind. Australia
Report, Division of Plant Industry, Australia

Rep. Minist. Agric. Rhod. Nyasald.
Report of the Ministry of Agriculture, Rhodesia, Nyasaland

Rep. P. Rico Univ. Agric. Exp. Stn
Report, Puerto Rico University Agricultural Experiment Station

Res. Bull. MAU
Research Bulletin Maharashtra Agricultural University, Marathwada

Res. J. Ranchi Univ.
Research Journal Ranchi University

Revta Agric. Costa Rica
Revista de Agricultura, Costa Rica

Revta Agric. Guatem.
Revista Agricola Guatemala

Revta Cubana Ciencio Agric.
Revista Cubana de Ciencio Agricola

Revta de la Facultade de Agronomica
Revista de la Facultade de Agronomica

Revta Fac. Agric. Univ. Cent. Venez.
Revista de la Facultad de Agricultura, Universidad Centralde Venezuela

Revta Peru. Ent. Agric.
Revista Peruana de Entomologia Agricola

Rhodesia Agric. J.
Rhodesia Agricultural Journal

Riz Rizic.
Riz et Riziculture

Rur. India
Rural India

Rural Rev. Soc. Rural Bras.
Rural Review Society of Rural Brasil

Science
Science

Scient. Monogr. Coun. Agric. Res. India
Scientific Monograph, Council of Agricultural Research, India

Scientist, Pak.
Scientist, Pakistan

Scient. Rep. Agric. Res. Instt., New Delhi
Scientific Report of the Agricultural Research Institute, New Delhi

Scient. Rep. Imp. Inst. Agric. Res. Pusa
Scientific Reports of the Imperial Institute of Agricultural Research, Pusa

Seed Fm
Seed Farms

Seed Res.
Seed Research

Seed Wld
Seed World

Senckenberg. biol.
Senckenbergiana biologia

Soil Sci. Soc. Am. J.
Soil Science Society of America Journal

Span
Span

Sunshine St. Agric. Res. Rep.
Sunshine State Agricultural Research Report

Surin. Landb.
Surinaamse Landbouw

SABRAO J.
Society for Advancement of Breeding Researches in Asia and Oceania Journal

SABRAO Newsletter
Society for Advancement of Breeding Researches in Asia and Oceania Newsletter

S. Afr. Sug. J.
South African Sugar Journal

Samaru Agric. Newsletter
Samaru Agricultural Newsletter

Sci. Cult.
Science and Culture

Technology
Technology

The Sunday Australian
The Sunday Australian

Toxicon
Toxicon

Tr. Prikl. Bot. Genet. Selek. (USSR)
Trudy Prikladnoi Botanike Genetikei Selektsei, Leningrad (USSR)

Trans. Bose Res. Inst.
Transactions of the Bose Research Institute

Trans. Br. Mycol. Soc.
Transactions of the British Mycological Society, London

Trans. Proc. Bot. Soc. Edinb.
Transactions and Proceedings of the Botanical Society of Edinburgh

Trop. Agric. (Trinidad)
Tropical Agriculturist (Trinidad)

Trop. Agric. Ceylon
Tropical Agriculture, Ceylon

Trop. Agric. Res. Ser., Japan
Tropical Agricultural Research Series, Japan

Trop. Ecol.
Tropical Ecology

Trop. Grain Legume Bull.
Tropical Grain Legume Bulletin

Trop. Grasslands
Tropical Grasslands

Trop. Sci.
Tropical Science

Tropenpflanzer
Tropenpflanzer

Turrialba
Turrialba

USAID
United States Agency for International Development

W. Afr. J. Biol. Appl. Chem.
West African Journal of Biological and Applied Chemistry

Wealth of India
Wealth of India

World Crops
World Crops

Z. Angew. Entomol.
Zeitschrift für Angewandte Entomologie

Z. Angew. Zoo.
Zeitschrift für Angewandte Zoologie

Z. Ernährwiss. Suppl.
Zeitschrift für Ernährwissenschaft Suppl.

Z. Natur.
Zeitschrift für Natur Forschung

Z. pflanzk. pflanzs.
Zeitschrift für pflanzenkrankheiten und pflanzenschutz

Zbl. Bakt.
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AGRONOMY

ABRAMS, R. 1975.
Status of research on pigeonpeas in Puerto Rico. First International Workshop on Grain Legumes, 13-16 Jan, 197[illegible]. ICRISAT, Hyderabad, India. 141-148. 1

Discusses importance of the crop; its cultivation, weed control, lime and fertilizers, date of planting, row width, plant populations, cultural practices. Breeding programs, inheritance, variety-environment interactions, diseases and insects, processing, and other quality aspects are also discussed.

ABRAMS, R., and F.J. JULIA. 1973.
Effect of planting time, plant population, and row spacing on yield and other characteristics of pigeonpeas, *Cajanus cajan* (L.) Millsp. J. Agric. Univ. P. Rico 57(4):275-285. 2

The effect of planting date, population, and row spacing was studied with special reference to mechanized pigeonpea production. Date of planting, row spacing, and plant population had no effect on seed size or number of seeds per pod, but pods per plant increased markedly with increased spacing and with early plantings. Yield tended to be higher at lower spacing between rows and at highest populations, regardless of row spacing.

ABRAMS, R., and F.J. JULIA. 1974.
Effect of mechanical, cultural, and chemical weed control on yield and yield components of pigeonpeas, *Cajanus cajan* (L.) Millsp. Agric. Univ. P. Rico 58(4):466-472. 3

Prometryne (preemergent), paraquat (postemergent), mechanical, and handweeding treatments increased green-pod yield and pod number per plant, in four determinate and four indeterminate lines, with the chemicals giving the greatest increase. The treatments had no effect, however, on plant height, number of days to flower, seed weight, or seed number per pod.

AHLAWAT, I.P.S., C.S. SARAF, and A. SINGH. 1975.
Studies on the performances of pigeonpea varieties to dates of planting and row spacing. Indian J. Agron. 20(3): 245-247. 4

Three *Cajanus* varieties tested during 1972 gave similar seed yields, but in 1973 cv T-21 gave a higher yield than Pusa Ageti and Sharda. In 1973, differences were observed between the varieties in the five yield characters studied. Early planting and 50-cm row spacing were better than late planting and 75-cm row spacing.

AIYER, A.K.Y.N. 1949.
Mixed cropping in India. Indian J. Agric. Sci. 19:439-443. 5

Details of the various crops with which pigeonpea is grown in mixture and of the proportions in which it is sown. The lists are formidable--for example, in the case of *Cajanus indicus*, the reporting states and provinces give a total of 65 types of mixtures.

AIYER, A.K.Y.N. 1949.
Mixed cropping in India. Part II. Mixed cropping with reference to some principal crops: Redgram. Indian J. Agric. Sci. 19(4):524-527. 6

Red gram is grown in mixture with one other crop, or with two or more others, up to six. The total number of mixtures is 65; of these 17 contain more than two crops. Pulses enter into 36 mixtures. The proportions in which seeds of the different components are mixed also vary widely. The different proportions for red gram are listed.

AKINOLA, J.O., and P.C. WHITEMAN. 1975.
Agronomic studies on pigeonpea (*Cajanus cajan* (L.) Millsp.). 1. Field responses to sowing time. Aust. J. Agric. Res. 26(1):43-56. 7

Vegetative and reproductive responses of two early maturing and two late-maturing *C. cajan* accessions to eight sowing dates were investigated. Preflowering to pod-ripening durations varied, depending upon interactions between climatic factors and the photoperiodic responses of the accessions. Quantitative short-day, day-neutral, or nearly day-neutral, and intermediate photoperiodic forms were identified. Relationship between day length, radiation, growing degree-days, and seed yield/ha based on individual monthly harvests and harvest index were established for a sowing density of 2,990 plants/ha. Optimum sowing dates were late November to mid-January for dry seed production in the late-maturing accessions, and not later than December for periodic green-pod picking in the early maturing accessions.

AKINOLA, J.O., and P.C. WHITEMAN. 1975. Agronomic studies on pigeonpea (*Cajanus cajan* (L.) Millsp.). 2. Responses to sowing density. Aust. J. Agric. Res. 26(1):57-66. 8

Vegetative and seed yields in *Cajanus cajan* accession UQ-1 were investigated at nine sowing densities ranging from 6,727 to 215,278 plants/ha. Dry-matter yield/plant declined asymptotically with increasing sowing density, while the dry-matter yield/ha vs. density relationship was described by a parabolic curve. The highest dry-matter yield/ha, 22.95 metric tons, was produced at a spacing of 0.305 x 0.305 m (107,639 plants/ha). At higher densities, increased stand mortality and reduced numbers of pods per plant resulted in severe yield reductions. Reduced pod number per plant was related to significant reductions in the number of pod-producing branches and in the inflorescence-bearing stem length. Interactions of yield component, leaf-area index, and other plant characters are discussed.

AKINOLA, J.O., and P.C. WHITEMAN. 1975. Agronomic studies on pigeonpea (*Cajanus cajan* (L.) Millsp.). 3. Responses to defoliation. Aust. J. Agric. Res. 26(1):67-69. 9

Two early-maturing and two late-maturing accessions of *C. cajan* grown in the field for 161 days were cut to stubbles 90 cm in height every 4, 8, 12, and 16 weeks during a 72-week period. Evidence from total and seasonal dry-matter and nitrogen yields, stand survival, and stubble yield at the end of the trial suggested that 8- and 12-week cutting frequencies could be successfully integrated to incorporate cattle grazing and forage and seed production into a single management system. The late-maturing accessions were better adapted to cutting, provided that basal green leaves always remained on the stubble. Reduction of plant height by defoliation in accession UQ-50 to facilitate subsequent harvesting led to a reduced annual seed yield. The first seed crop was lost, because topping removed the reproductive material.

AKINOLA, J.O., P.C. WHITEMAN, and E.S. WALLIS. 1975. The agronomy of pigeonpea (*Cajanus cajan*). Rev. Sr. Pas. CAB. Fd. Crops 1:57. 10

Information (much of it brief) is reviewed on taxonomy and nomenclature, varieties, cytology, pollination, hybridization, heritability, induced mutations, growth period and sowing dates, yield components, protein levels and quality, and resistance to *Fusarium udum*.

ALLES, W.S. 1958. Some studies on run-off and infiltration. Trop. Agric. Ceylon 114(3):197-206. 11

In Ceylon, run-off permeability of soil profile, infiltration capacity, and soil loss have been studied on plots planted with sorghum/pigeonpea (*C. cajan*) and with cotton, both clean-cultivated and mulched.

AMBIKA, SINGH, and S.K. SHARMA. 1969. Red gram is a paying guest. Intensive Agric. 6(11):18-19. 12

Red gram (Pigeonpea) yields well and fetches good profits. The different aspects of red gram cultivation discussed are mixed cropping with legumes and others, rotation cropping, methods and time of growing and pests and diseases.

ANONYMOUS. 1924. Dholl (*Cajanus indicus*): A Natal farm crop. Notes on its cultivation. S. Afr. Sug. J. 8:239. 13

ANONYMOUS. 1927. Maize and tur in Gokak canal area. Bombay Dep. Agric. Leafl. 13. 14

ANONYMOUS. 1943. *Cajanus indicus* Spreng. Bol. Min. Agric. Brazil. 32(1):95-96. 15

ANONYMOUS. 1945. Shaping the future of Hawaii's agriculture. Report of the Hawaii Agricultural Experiment Station for the Biennium ending June 20, 1944. p. 115. 16

In Hawaii reduced vigor and higher mortality were reported in the *C. cajan* ratoon crop than in the plant crop. A further decline occurred following the second ratoon crop, during which mortality was increased from 12.9% by cutting at 76 cm to 32.6% by cutting at 7.6 cm above ground level. It was found that mechanical harvesting with an oscillating-type cutter bar (instead of a corn binder) caused root snapping, particularly with cutting heights of less than 30 cm.

ANONYMOUS. 1946.
Annual report of the Department of Science and Agriculture, Barbados, for the year 1944-45. 17

In addition to the work summarized on cotton and sugar, the selection of Indian maize and investigations with *Cajanus indicus*, *Phaseolus aureus*, *P. mungo*, and perennial kavironda sorghum are reported.

ANONYMOUS. 1949.
Annual report of the Department of Agriculture, Colony of Sierra Leone for the year 1948. Freetown. 51 pp. 18

Pigeonpea is expanding as a crop; five varieties are under trial and experiments on the effect of fertilizers on different crops include pigeonpea.

ANONYMOUS. 1950.
Cajanus cajan. *In* Wealth of India. (Raw material) 11:6-11. New Delhi: Council of Scientific and Industrial Research. 19

A monotypic genus comprising *C. cajan*, an important leguminous crop, widely distributed in the tropics and cultivated extensively for its edible seeds. Sanskrit: Adhaki, tuvari, tuvarika; Hindi, Bengali and Marakan-Tagore: Mal-Thuvara. An annual or perennial shrub. Plant is probably native of Africa and it is now grown in almost all the tropical countries of the world including Africa, America, India, Australia, Hawaii, East and West Indies. Details of cultivation, pests, diseases, and yield.

ANONYMOUS. 1950.
Tanganyika Department of Agriculture, Annual Report for 1948. Dar-es-Salaam. 173 pp. 20

Investigations reported include the effect of a 3-year rotation of elephant grass, pigeonpea, or continuous maize on a subsequent maize crop.

ANONYMOUS. 1951.
Nyasaland Protectorate. Annual report of the Department of Agriculture for the year 1948. Pt. 2. Experimental work, Zomba. 15 pp. 21

Organic manuring and mulching experiment designed to determine the effect of burying crop residues, to investigate various other methods of adding humus to the soil, and to ascertain the effect of protecting the soil during the dry season, either by means of a cover crop (pigeonpea) or by mulching.

ANONYMOUS. 1953.
Line sowing of arhar and Jaur. Allahabad Fmr 27(3):116-118. 22

Line sowing (sowing in straight lines or rows) does not in itself give crops more plant food or water but it does help each plant to get its share of food and water. Its advantages over broadcast method are given. Also Jowar (*Sorghum vulgare*) can be very successfully grown in combination with arhar. The distance between the lines of arhar should be 6 to 8 ft (1.8 to 2.4 m); between seeds in a row, 2 inches (5 cm). Intercropping of other crops with arhar is also suggested.

ANONYMOUS. 1956.
The Agricultural resources of Mysore State (Tur--*Cajanus cajan*). Mysore Agric. J. 31(4):207-213. 23

ANONYMOUS. 1958.
Annual report of the Department of Agriculture, Ghana. Agronomic Research. 1955-56:8. 24

At Kwadoso, the effect of different fallow crops grown for 3 years was measured by a first test crop of maize. Fallow crops and maize yields (dry grain) were: pigeonpea (*Cajanus cajan*) 1,691 lb/acre (1,896 kg/ha); permanent cropping (no fallow) 1,127 lb/acre (1,243 kg/ha).

ANONYMOUS. 1959.
The work of IRCT during 1957 (French). Coton Fibr. Trop. 1959. 14(2):77-285. 25

In a trial which started in 1956, comparisons were made between maize, *Canavalia* sp., and *Cajanus cajan*, as preceding crop for cotton; maize was considered the best because it yields a large quantity of green matter, which is relatively easy to plow in.

ANONYMOUS. 1961.
Crop production trials and new crops. Rep. Div. Agric. Br. Guiana 1959 (n.d.); 36-37. 26

Cajanus cajan and some other crops were successfully grown on well-drained beds of coastal and pegassy clay. The possibility of including these crops in a rice rotation was also investigated. Dhal (*C. cajan*) grown on well-drained coastal clay which received 0.25 to 0.5 tons (560 to 1,120 kg/ha) of limestone + 0.5 cwt (56 kg/ha) each of sulfate of potash and triple superphosphate/acre yielded 600 to [illegible]0 lb dry

seed/acre (672 to 785 kg/ha) at the first picking, and after ratooning, a further 600 to 700 lb/acre 5 to 6 months later.

ANONYMOUS. 1968.
Green manure. Seed Wld 103(8):22. 27

Pigeonpea (*Cajanus cajan*) cv Norman has been developed as a new green manure crop for N and S Carolina, USA. In trials during 4 years, average yields from Norman were 3.75 tons DM/acre (8,407 kg/ha), compared with 2.5 tons/acre (5,605 kg/ha) from Crotalaria and hairy indigo (*Indigofera hirsuta*). Norman is resistant to the two main root-knot nematodes (*Meloidogyne* spp.) found in N Carolina.

ANONYMOUS. 1971.
Profits triple if arhar is adequately fertilized. Fm J. 12(11-12):14-15. 28

Profits per hectare under the standard practice amounted to Rs. 964.52; this profit increased to Rs. 1,686.40, Rs. 1,947.22, and Rs. 2,341.29 when the crop received low, medium, and high rates respectively of the phosphatic fertilizers. These are about 75, 102, and 143% increases in profit over the standard practice as against the increase of about 24 and 57% in costs incurred.

ANONYMOUS. 1972.
Know your foods: Red gram. Nutrition. 6(4):27-29. 29

Red gram is a popular pulse crop grown throughout India. A very hardy crop, it is grown generally as a mixed crop with jowar, bajra, maize, and cotton. The plant can thrive on all soils; useful as a hedge and prevents soil erosion. The nutritive value of red gram and its use in commercial consumption are tabulated.

ANONYMOUS. 1974.
Arhar has a big role. Fm fare 1(9): 11-13. 30

Researchers have identified quick-growing, compact breeds of this pulse which give it a significant place in the country's food economy. These varieties also avoid frost and fit well in rotations.

ANONYMOUS. 1974.
Symposium on inter and multiple cropping of short duration varieties of pulses for a major advance in the production of biological nitrogen and protein resources. Aug. 13-14, 1974. IARI, New Delhi. 31

Emphasized that specific areas should be identified where cropping intensity can be increased with the use of pulses Formulated a study on ways and means of reducing losses of fixed nitrogen. Though experimental evidence is not conclusive, it is assumed that a small but significant amount of nitrogen is left behind by grain legumes for utilization by the succeeding crop.

ANONYMOUS. 1974.
Report of the Faculty of Agriculture, 1972-73. University of the West Indies, St. Augustine, Trinidad. 186 pp. 32

Trials reported include studies of varietal characters and the effect of sowing date, plant density, fertilizer application, growth regulators, and herbicides on yields of pigeonpea and other crops. Work on agronomic characters and dry-matter production, dry-matter intake, and apparent digestibility of various pasture species (including pangola grass and *Cyanodon dactylon*) is described.

ANONYMOUS. 1975.
New red gram pays with better practices. Fm J. 16(11):5-6. 33

The new red gram, P-4785, is early and high yielding and gave a profit as high as Rs. 1622/ha in as short a time as 150 days. New varieties of red gram with new management practices are bound to give a better return over the old varieties.

ANTICHAN, C. 1952.
Cover crops for Guinea plantations. Fruits d'outre Mer. 7:339-341. 34

A list of 23 erect and 16 creeping leguminous plants suitable for use as cover crops, and amount of seed necessary per hectare, average height, resistance to drought, and tolerance to cutting back. For middle Guinea *Cajanus indicus* was found one of the most satisfactory erect species.

APONTE APONTE, F. 1963.
Pigeonpea cultivation in Puerto Rico. Caribb. Agric. 1(3):191-197. 35

The cultivation is very simple and is mostly conducted on the poorest soils in the southwestern part of the island. Among the three varieties in use, Kaki is the most popular with the canneries. It is an early variety, yielding a first crop in December and a second crop in February.

APPADURAI, R. and K.V. SELVARAJ. 1974.
Note on the groundnut-redgram mixture in lower Bhawani Project area. Madras Agric. J. 61(9):803-804. 36

Three years of trials in both seasons showed significant additional income in mixed crop over the pure crop of groundnut. The red gram variety 1141 (Co-1) can be raised profitably as a mixed crop with groundnut cv TMV-2.

ARGIKAR, G.P. 1968.
Growing of pulses is beset with many problems. Indian Fmg 17(11):15-18. 37

Some causes of low pulse yields in India are discussed, particularly susceptibility to diseases. Drought tolerance; resistance to pod borers, bruchids, and mealy bugs; nutritive quality; cooking, canning, and parching qualities; breeding for heavy manuring, irrigation, and nitrogen fixation are also discussed.

ARIYANAYAGAM, R.P. 1975.
Status of research on pigeonpeas in Trinidad. Proc. First International Workshop on Grain Legumes. 13-16 Jan, 1975. ICRISAT, Hyderabad, India. 131-140. 38

Importance of pigeonpea research organization, microbiology, microclimatology, drought hardening, crop physiology, agronomy, breeding, germplasm collection, problems of agronomic and nutritional quality are discussed.

ARWOOTH, N.L. 1974.
Production and research on food legumes in Thailand. Trop. Agric. Res. Ser. 6:93-100. 39

The main research problems concern varietal improvement, crop management, soil fertility, and seed multiplication of pigeonpea and other legumes.

AYYAR, A.K.Y.N. 1958.
Red gram. *In* Field Crops of India. 5th ed. Bangalore: Govt. Press. 113-118. 40

BADILLO-FELICIANO, J., R. ABRAMS, and R. PIETRI. 1977.
Effect of foliar-applied fertilizers on pigeonpeas (*Cajanus cajan*). J. Agric. Univ. P. Rico 61(2):217-220. 41

Two pigeonpea cultivars were tested: Nutrileaf at a rate of 2.24 kg/ha was foliar-applied at weekly, biweekly, triweekly, and monthly intervals. Equivalent amounts of N and P were applied biweekly, separately and combined as urea and triple superphosphate respectively. Foliar-applied nutrients did not have significant effects on green-pod yield, plant height, seed weight, protein content, or seed-to-pod ratio of the two cultivars. Cv Kaki yielded more green pods with heavier seeds and grew taller than did the experimental line 2B-bushy. The seed-to-pod ratio for 2B-bushy was higher than that for Kaki, but protein content was almost the same in the two cultivars.

BAINS, S.S. 1968.
Pulses are popular for mixed cropping. Indian Fmg 17(11):19-22. 42

Profitable crop mixtures generally comprise a cereal and a pulse and there are good reasons for the popularity of sowing pulses mixed with other crops. Recent developments on intercropping of pulses are summarized.

BALASUBRAMANYAM, R., and SUNDARAM, S. 1947.
A review of experiments with legumes preceding cotton in Madras province. Indian Cotton Grow. Rev. 1:87-95. 43

The review has amply demonstrated that in planning future trials, it would be unwise to go in for pulses other than groundnut, tur (*C. cajan*), gram, and horse gram for seed and pillipesara, indigo, and guara for green manure. Pulses figure in most of the mixtures as a chief component.

BHAN, V.M., M. SINGH, and R.A. MAURYA. 1970.
Weed control in field crops at Pantnagar. Indian Research Report 1968-69. PANS 16(4):690-701. 44

Trifluralin, alachlor (CP 50144), and prometryne were applied at various concentrations to control weeds in *Cajanus cajan*. All three chemicals gave significantly higher yields over control. Pigeonpea in plots receiving prometryne at 1.5 kg/ha and trifluralin at 1.5 kg/ha produced considerably higher yields. Alachlor had some toxic effect on the crop plants. Highest dry matter of weeds at 30th day was shown after application of prometryne at 1.5 kg/ha. However, dry matter of the crop was not affected significantly by application of the three herbicides.

BHATAWADEKAR, P.U., S.S. CHINOY, and K.M. DESHMUKH. 1966.
Response of bajra-tur mixed crop to nitrogen and phosphate fertilization under dry farming conditions of Sholapur. Indian J. Agron. 11:243-246. 45

Nitrogen and phosphoric acid were tried at four levels, each singly and in combination. Bajra responds to both nitrogen and phosphoric acid in the form of single superphosphate. Tur responds to phosphoric acid applied in the form of single superphosphate. Yields tend to decrease with increased dosage of nitrogen.

BRAR, Z.S., J.S. GILL, and MUKAND SINGH. 1976.
T-21, a new arhar for Punjab. Indian Fmg 26(3):28-29. 46

The new arhar (*Cajanus cajan*) cv T-21 gave seed yields of 640 to 1,160 kg/ha at three locations in Punjab. The net profit was higher in arhar/wheat rotation than in maize/wheat rotation.

CARRIERE, E.A. 1874.
Cajanus indicus. Revue Horticole. 191-193. 47

CHANDRA MOHAN, J. 1969.
Effect of limited irrigation on the yield of pulses. Madras Agric. J. 56(2): 85-86. 48

Reports the effect of limited irrigation on yield of red gram (*Cajanus cajan*) and horse gram (*Dolichos biflorus*) grown in the lower Bhawani Project Ayacut, during the main cropping season of 1967-68.

CHOWDHURY, S.L. 1969.
Pulse crops - more productive than you think. Indian Fmg 19(6):23-25. 49

The news of arhar (pigeonpea) yielding over 5000 kgs of grain per hectare may come as a surprise. Suitably spaced and adequately fertilized, the crop produced 5200 kgs at Pantnagar. This is about five times the average yield of arhar in the state. A still higher grain yield (7,990 kgs) of this crop has also been reported from outside India.

CHOWDHURY, S.L., and P.C. BHATIA. 1971.
Profits triple when arhar is adequately fertilized. Indian Fmg 20(12):27-30. 50

In fertilizer experiments on a poor sandy loam soil treated with superphosphate at rates of 33, 67, and 100 kg of P_2O_5/ha and with 15, 30, and 45 metric tons of manure/ha *Cajanus cajan* yielded 2,030, 2,340, and 2,760 kg/ha respectively, on the superphosphate plots and 1,900, 2,360, and 2,840 kg/ha, respectively, on the manured plots, as against 1,290 kg/ha for the control plots. The relatively high yield of the unfertilized plots is attributed to weed and pest control. Examination of costs and returns showed that the use of fertilizer and manure was highly profitable.

CHOWDHURY, S.L., and P.C. BHATIA. 1971.
Ridge-planted kharif pulses: high yield despite waterlogging. Indian Fmg 21(3):8-9. 51

In 1968-69 trials in the kharif (summer monsoon) season, sowing *Cajanus cajan* on ridges increased average seed yields by 30.7% over yield of 2,180 kg/ha when sown in flat. In a second trial in 1968-69, *C. cajan* sown at a spacing of 20, 30, and 40 cm between plants in 50-cm rows gave average yields of 2,870, 2,370, and 2,010 kg/ha, respectively.

CROSS, L.C., and S.M. THOMAS. 1968.
Pigeonpea. Texaco Food Crop Demonstration Farm, University of the West Indies, St. Augustine. 52

DAFTARDAR, S.Y., and N.K. SAVANT. 1971.
Influence of competition between root colloids for cations on K/Ca ratio in plant tops. Pl. Soil 34(1):201-202. 53

Pearl millet and pigeonpea were grown in mixed stands in pots of clay loam soil. The K:Ca ratio in plant tops increased with increasing representation of pearl millet in the mixture.

DAHIYA, B.S., J.S. BRAR, and J.N. KAUL. 1974.
Changes in growth habit of pigeonpea (*Cajanus cajan* (L.) Millsp.) due to late sowing. J. Agric. Sci., Camb. 83(2): 379-380. 54

Four early maturing varieties were sown in mid-June (normal) and mid-July (late). Effect of late sowing was greatest on the highest yielding variety (Pant-A2) for plant width and height, pod number per main branch and per plant, and grain yield. The variety T-21 gave the highest yields under late-sown conditions.

DALAL, R.C. 1974.
Effect of intercropping maize with pigeonpeas on grain yield and nutrient uptake. Expl Agric. 19(3):219-224. 55

Maize cv X-306 and pigeonpea cv G1-274A (dwarf) were sown (i) as pure stands, (ii) in a mixed stand (sown together on the same hill in the same row) and (iii) in alternate

rows. A similar trial was given four levels of N at sowing. Grain yield of maize and seed yield of pigeonpea were lower in (ii) and (iii) than in (i). Maize in (i) produced the highest grain yield/ha per week. Maize/pigeonpea in (iii) gave the highest protein yield/ha per week and absorbed the highest amounts of K, Ca, and Mg. Yields of seed and protein/ha per week and nutrient uptake were lowest with pigeonpea in (i). The problem of intercropping maize and pigeonpea under optimum conditions of fertilizer N application is discussed.

DALAL, R.C., and P. QUILT. 1977.
Effect of N, P, liming, and Mo on nutrition and grain yield of pigeonpea. Agron. J. 69(5):854-857. 56

The main N treatments (0, 12, 20 and 30 kg N/ha), P (0, 50, 100 and 250 kg P/ha), and lime (0, 1,250, 2,500 and 5,000 kg $CaCO_3$/ha) were arranged in blocks in a modified central composite design. The subtreatment Mo was applied at two rates (0 and 0.25 kg/ha). Nitrogen fixation as measured by acetylene reduction assay, nodule weight, dry matter and grain yield, and nutrient uptake by pigeonpea were observed. Although fertilizer N significantly reduced the N fixation, the total K and N uptake, grain yield, and Fe and Cu concentrations in the plant were not affected. Applied Mo had no effect on any of the plant parameters considered, possibly because it was present in sufficient amounts in soil. Liming significantly increased total Ca, Mg, and P uptake by pigeonpea but significantly decreased Mn concentration in the plant by raising soil pH. Fertilizer P significantly increased dry-matter yield (at 7 weeks of crop growth) and total P uptake but significantly decreased Zn concentration in the plant. The tendency for increasing grain yield with higher rates of liming and of P suggested that optimum rates of P and liming should be further studied.

DE, R. 1974.
Development of agronomic practice under unfavourable rainfed conditions. Proc. First FAO/SIDA seminar on improvement and production of field food crops for plant scientists from Africa and the Near East. Cairo, Egypt. 495-504. 57

During the rainy seasons of 1970-1973, red gram (*Cajanus cajan*) cv. Pusa Ageti gave the most stable yield (1,900 kg) and cowpea and grain sorghum were least stable. The different aspects of fertilizer application irrespective of rainfall, the possibilities of drilling aqueous N and P fertilizers, of applying film-forming and reflectant antitranspirants, and of double-cropping without irrigation are discussed.

DERIEUX, M. 1970.
Results of preliminary trials on two legumes used for food: *Cajanus cajan* and *Vigna sinensis*. Proc. 7th Ann. meet. C.F.C.S. Martinique - Guadeloupe. 1969. 164-172. 58

Pigeonpea trials indicated that yields of fresh seeds around 2,750 kg/ha are attainable with a daylength-insensitive and a short-day variety sown in June; later sowing greatly reduced the yield. A plant density of 32,000/ha resulted in somewhat higher yields than lower densities.

DERIEUX, M., C. SUARD, and C. VINCENT. 1971.
Some data on the behaviour of pigeonpea in Guadeloupe (French West Indies). Annls. Amel. Pl. 21:373-407. 59

Compared germination in nine varieties and growth and development in five collected from Trinidad, the West Indies, Pakistan, and Guadeloupe. Variability in morphological and some physiological characters, such as photoperiodism, is described in studies of a large collection including tall and dwarf varieties from 200 sources in the West Indies, Africa, and Pakistan. Trials for fertilizer response and soil adaptation are reported, using the Trinidad cv G-154/32 as standard. The possibility of breeding and selection in Guadeloupe is briefly discussed.

DHILLON, MANMOHAN SINGH. 1972.
Effect of planting dates on the performance of pigeonpea (*Cajanus cajan* (L.) Millsp.) T-21 sown under different row spacings in arhar-wheat rotations. M.Sc. (1972) Thesis. Punjab Agricultural University, Ludhiana, Punjab, India. 60

DORASAMI, L.S. 1940.
The cultivation of pulses in Mysore State. J. Mysore Agric. Expl. Union. 19(1-4): 63-68. 61

The most important pulses grown in the state are *Dolichos biflorus*, pigeonpea (*Cajanus indicus*), *Dolichos lablab*, *Cicer arietinum*, *Phaseolus mungo*, and *Phaseolus aureus*. *C. indicus* occupies 120,000 acres (48,600 hectares) and is grown as a pure

dry crop or in some cases as a mixed crop. It is drought resistant and successful in dry seasons, when other crops have failed. There are many varieties of *C. indicus* but the two main types are: (i) the perennial type, which assumes a tree-like appearance and is allowed to grow more than a year, and (ii) the annual variety which is grown as a field crop. Breeding work to evolve good strains is in progress.

ENYI, B.A.C. 1973.
Effects of intercropping maize or sorghum with cowpea, pigeonpea, or beans. Expl Agric. 9(1):83-90. 62

All intercropping treatments decreased LAI, plant fresh weight at anthesis, and stover and grain yields of the cereals compared with the pure stands. In sorghum, grain yield was decreased more by cowpeas and pigeonpeas than by beans, but in maize, cowpeas and beans decreased yields more than pigeonpeas. Intercropping sorghum with pigeonpeas increased total grain yield by 65.9%.

EVANS, A.C., and H.W. MITCHELL. 1962.
Soil fertility studies in Tanganyika. 1. Improvement to crop and grass production on a leached sandy soil in Bukoba. E. Afr. Agric. For. J. 27(4):189-196. 63

Trials during 1957-60 with N, P, K, Ca, and farmyard manure on maize and pigeonpea on poor grassland. Pigeonpea responded most to K and Ca in the absence of FYM; both crops responded well to FYM even at only 5 tons/ac (5 mt/ha).

FAO. 1961.
Agricultural and horticultural seeds - their production, control, and distribution. FAO Agric. Studies. 55:259-260. 64

FOREMAN, A. 1965.
Pigeonpea trials. Farmer (Kingston, Jamaica) 70:105-108. 65

Comparative trials of the varieties Kaki and Saragateado undertaken from 1963 to 1965 in Jamaica are described. A new white "no-eye" type, smaller than any known variety and believed to be a mutant, is mentioned. It appears to breed true.

FREYMAN, S., and J. VENKATESWARLU. 1977.
Intercropping on rainfed red soils of the Deccan Plateau, India. Can. J. Pl. Sci. 57(3):697-705. 66

In rainfed field trials on a red soil near Hyderabad, India, various intercropping patterns of sorghum, pigeonpea, castor, pearl millet, cowpea, lablab, finger millet, soybean, and black gram were studied for mutual competitive effects. Highest total yields were obtained when sorghum was grown at the highest population tested (220,000 plants/ha) and intercropped with sorghum or with pigeonpea. Reducing the population of sorghum to better accommodate intercrops reduced yield for which the intercrops did not compensate. In both years grain yields of sorghum grown at highest populations (at least 220,000 plants/ha) generally surpassed yields from plots of sorghum intercropped with pigeonpea.

GAHLOT, K.S.N., RAM VISHAL, and S.J. VISHWAKARMA. 1978.
Urd 'T.9' as intercrop with Arhar 'T.21.' Indian Fmg 27(10):7-8. 67

The yield data of arhar and urd and economics of intercropping are presented. One row of T-9 between two rows of arhar planted 80 cm apart produced 27.47 quintals (2,747 kg) of arhar and 6.61 quintals (661 kg) of mash/ha.

GALBAN, E. 1955.
Cajanus indicus - Florida herbs and plants. Acta Phytother. 2(2):1-7. 68

GIDWANI, H.M., M.C. AGARWAL, and L.N. DUBEY. 1967.
Crop rotation for reclaimed ravine lands. J. Soil Wat. Conserv. 15(1-2):55-60. 69

The detailed analysis showed that (i) Bajra + Arhar - Mustard and (ii) Bajra - Cowpea are the best rotations for the tract as compared to Bajra continuously, which is at present the usual practice followed by the cultivator. These rotations also build up soil fertility and cause less soil and water loss than Bajra continuously.

GIRI, R., and R. DE. 1977.
Canopy managements under rainfed conditions. Indian Fmg 27(1):21-22. 70

The seed yields in pigeonpea (*Cajanus cajan*) cv Pusa Ageti grown at a spacing of 50 x 20 cm in pure stands or when intercropped with black gram (*Vigna mungo*) cv T-9 between the rows were 1,700 and 1,580 kg/ha, respectively. Seed yields of *V. mungo* were 700 kg/ha. Similar results were also obtained in the following year.

GOODING, H.J. 1962.
The agronomic aspects of pigeonpeas. Fld Crop Abstr. 15:1-5. 71

This is a review of pigeonpea agronomy, including sowing, spacing, manuring, harvesting, and diseases and pests. The importance of this legume in India and the tropics and subtropics is discussed and information provided on its rotational and green manurial values, and its use as a forage and pasture crop. Gives a brief account of breeding work.

GUPTA, T.N. 1970.
Varietal-cum-row spacing-cum plant population studies on pigeonpea. 86 pp. M.Sc. (1970) Thesis. G.B. Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh, India. 72

HAMMERTON, J.L. 1971.
A spacing/planting date trial with *Cajanus cajan* (L.) Millsp. Trop. Agric. Trin. 48(4):341-350. 73

The effect of spacing and planting date on the growth and yield of two dwarf lines of pigeonpea (*Cajanus cajan*) recently developed in Trinidad was studied. Where time of planting had no effect, yield per plant increased with increasing area per plant from 0.21 to 2.32 m^2. Yield per ha decreased with increasing area per plant. Yield components were not affected by closest spacings (30,000 - 42,000 plants/ha).

HAMMERTON, J.L. 1972.
Weed control work in progress at the University of the West Indies. Part 2. PANS 18(2):173-182. 74

In trials with pigeonpeas, the yield of dry peas from unweeded plots was 1,020 kg/ha and from weeded plots 1,160 kg/ha. Yields were further increased to 1,380, 1,220, and 1,200 kg/ha by pre-emergence applications of 1.1 kg prometryne, 1.1 kg prometryne + 2.2 kg diphenamid, and 1.7 kg chloroxuron/ha, respectively.

HAMMERTON, J.L. 1976.
Effects of planting date on growth and yield of pigeonpea (*Cajanus cajan* (L.) Millsp.). J. Agric. Sci., Camb. 87(3): 649-660. 75

In 19/2 dwarf pigeonpea cv 17 and cv 20 were sown at 4-week intervals at spacings of (i) 0.9 x 0.9 m and (ii) 0.45 x 0.45 m. Plant height at flowering was less in early sown plots. Differences in plant height and number of branches between cultivars and spacings were significant. Fresh-pod yields were 0.5 to 10.0 t/ha. Cv 17 spaced at (ii) averaged 4.96 t/ha, but at (i) yielded < 1.5 t in five sowings and > 4 t in three sowings. Sowing in late May appeared the most efficient, giving a large number of pods per day, per flowering branch, and per meter of height. Daylength had a dominant influence on growth and yield, but part of this effect could have been a response to radiation rather than to photoperiod.

HAMMERTON, J.L., and R.E. PIERRE. 1971.
Cajanus cajan - the pigeon or gungo pea, *Cajanus*. Trinidad 4(2):81-88. 76

In the West Indies, the pigeonpea (*Cajanus cajan*) is a very important protein source in the human diet. General information is given on varieties, variety selection, agronomy, sowing date, spacing, control of weeds, insects and diseases, and yields. A note is included on the possibility of mechanical harvesting of the crop.

HANAGODIMATH, S.B. 1976.
Effect of skip row cultivation and mixed cropping of tur (*Cajanus cajan* L.) on the yield of main and ratoon crop of CSH-1 sorghum (*Sorghum bicolor* (L.) Moench.) Thesis Abstracts. 2(1):16-17. (M.Sc. Thesis). 77

HERRERA, P.G. 1967.
Effect of height of cutting on pigeonpea and kaohaole. Agric. Trop. 23:34-42. 78

Pigeonpea plants cut at 0.15 or 0.75 m after having attained a height of 0.50 to 1.50 m did not vary markedly in protein content. The number of cuts and derived total yields increased as cutting heights rose from 0.15 to 0.75 m, and as plant height before defoliation increased from 0.50 to 1.50 m.

HORTA FERREIRA, A. 1960.
The growing of maize. Gaz. Agric. Mozambique. 12(138):325-331. 79

One of the aspects of maize cultivation discussed is its association with other plants such as *Cajanus cajan* and *Vigna nilotica*.

HORTA FERREIRA, A. 1960.
Fodder plants for ensilage. Gaz. Agric. Mozambique. 12(132):133-136. 80

In Mozambique stock breeders have difficulty feeding cattle during dry months. *Cajanus cajan* and four other leguminous plants have been found suitable for producing enough reserve fodder for these scarce periods.

HUBBELL, D.S. (EDITOR). 1963.
A field guide to tropical agriculture for the Union of Burma. USAID, Burma. 81

ILJIN, W.S. 1954.
Yield and chemical composition of commercially fertilized plants in the tropics. Plant analysis and fertilizer problems. Proc. Eighth Internat. Bot. Congr. 143-150. 82

Cajanus indicus is one of the crops included in use on red lateritic and more fertile clay soils. Tables show the effect of fertilizers on the chemical composition of the crops.

INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI. 1971.
New vistas in pulse production. New Delhi: IARI. 109 pp. 83

The aspects discussed are; plant production: genetic improvement, agronomy of pulse crops, rhizobial inoculation, use of pulse crops in rotations, improvement of nutritional quality, plant protection, diseases and insect pests of pulse crops.

INDIAN CENTRAL COTTON COMMITTEE. 1954.
Thirty-third Annual Report. 1954. 30-63. 84

Intercropping of cotton with groundnut, tur (*Cajanus indicus*), mung, and maize. The most remunerative practice was growing two rows of cotton alternating with ten rows of groundnuts.

INFORZATO, R. 1947.
Note on the rooting system of *Cajanus cajan* and its importance as a green manure. Bragantia. 7:125-126. 85

Cajanus cajan (*C. indicus*) is an Asiatic legume valuable in São Paulo as green feed for cattle and for restoring fertility to exhausted soils. The rooting system was studied in a row of eight representative 2-year-old plants approximately 4.5 m in height. The total root weight was 1,237.04 g, of which 90.67% was found in the top 30 cm; the weight of the aerial parts was 17,200 g. As a green manure it can furnish 14,968 kg roots and 208,124 kg organic matter for plowing in per alqueire (1 alqueire = 24,200 sq.m.).

IRVINE, F.R. (EDITOR). 1963.
A text book of West African agricultural soils and crops (2nd ed). London: Oxford University Press. 86

JOSHI, K.R., and P.M. KULKARNI. 1936.
Bajra (*Pennisetum typhoideum*) and tur (*Cajanus indicus*) in Jaipur State. Proc. Indian Sci. Congr. 23:433. 87

This study tested possibilities of (i) securing supplies of silage cheaply and conveniently and (ii) introducing early Malvi tur, which escapes frost, as a subcrop by spacing adjustments. The row spacing of 8 inches for bajra gave maximum fodder yield but was less profitable than bajra and tur with a spacing of 15" (38 cm) or 21" (53 cm) grown alone or in association. A mixed crop of four rows of bajra and two rows of tur was found suitable both for income and supply of grain and fodder.

KALYAN SINGH. 1972.
Plant density, rhizobial inoculation and fertilization studies in pigeonpea (*Cajanus cajan* Millsp.) under rainfed conditions. Ph.D. (1972) Thesis. Indian Agricultural Research Institute, New Delhi, India. 88

KALYAN SINGH, and R. PRASAD. 1976.
Effect of nitrogen, phosphorus and rhizobium inoculation on protein content and nutrient uptake of pigeonpea. Indian J. Agron. 21(3):266-270. 89

In trials with four *Cajanus cajan* cultivars, increasing the P_2O_5 rates from 0 to 100 kg/ha increased seed N and protein contents and N and P uptake in seeds + stems; seed P contents were not significantly affected. Application of 25 kg N/ha at sowing or seed inoculation with rhizobium strain Arhar-U had inconsistent effects on seed N, P, and protein content and nutrient uptake in different years. On an average, crops took up 115 kg N and 16 kg P_2O_5/ha.

KALYAN SINGH, and RAJENDRA PRASAD. 1975.
It pays to fertilize arhar under rainfed conditions. Fertil. News 20(2): 28-30. 90

Pigeonpea responded well to phosphorus and to bacterial fertilization. The grain yield increased significantly with increasing levels of phosphorus, with the highest

yield obtained from 100 kg P_2O_5/ha. Rhizobium culture treatment was found to be the best among seedling time treatments. The variety P-4785 yielded the highest amount of grain/ha.

KALYAN SINGH, RAJENDRA PRASAD, and S.L. CHOUDHURY. 1975.
Effect of variety row spacing and plant population on pigeonpea. Indian J. Agron. 20(4):331-336. 91

The optimum value of plant rectangularity, associated with the maximum grain yield of the crop, was at a row spacing of 50 cm and a population of 75,000 plants/ha. Variety P-4785 yielded the most grain.

KASASIAN, L. 1964.
Chemical weed control in pigeonpeas. Caribb. Agric. 2(4):721-743. 92

During 2 years, excellent weed control for at least 3 weeks, with no effect on the yield of pigeonpeas, was given by preemergence application of 1 kg prometryne/ha. Subsequent control was maintained by direct applications of 0.5 lb paraquat/ac. (0.6 kg/ha).

KASASIAN, L. 1968.
Chemical weed control in tropical root and vegetable crops. Expl Agric. 4:1-16. 93

Chemical weed control in six root crops and fourteen vegetable crops commonly grown in the tropics is reviewed. Preemergence application of 2 to 4 lb (0.9 to 1.8 kg) Amiben is recommended in West Indies for *C. cajan*; also after emergence, directed sprays of paraquat. In Trinidad, no injury was caused by preplanting applications of 3 to 6 lb (1.3 to 2.7 kg) EPTC if 3 days elapsed between spraying and sowing, whereas sowing after only 1 day retarded emergence and growth of pigeonpeas. In Guyanese experiments a basally directed spray of aliquat gave excellent weed control with little or no crop injury. Fourteen to 35-day-old plants were severely injured by MCPB.

KATYAL, S.L. 1956.
Your crops. No. 17 - Arhar. Fd Fmg 8(12):352-354. 94

KAUL, J.N., and H.S. SEKHON. 1975.
Response of pigeonpea to dates of planting and phosphorus levels. Indian J. Agron. 20(4):376-377. 95

Date of planting significantly influenced yield attributes of the plantings done on June 1 and June 15. Pods/plant and total dry-matter production were reduced by the later sowings. Harvest index increased with delay in planting.

KAUL, J.N., H.S. SEKHON, and B.S. DAHIYA. 1975.
Inter-cropping studies with arhar (*Cajanus cajan*). Indian J. Genet. Pl. Breed. 35(2):242-247. 96

The planting of one row of either mash (*V. mungo*) or mung (*V. radiata*) in between two rows of arhar, spaced 75 cm apart, increased the arhar yield, whereas groundnut and soybean slightly reduced arhar yield. Intercropping with maize reduced the arhar. The intercropping of maize and soybean proved to be a losing proposition.

KHAN, A.R., and B.P. MATHUR. 1962.
Studies on tillage. XIII. Effect of variation in the depth of cultivation with different methods of phosphate application on the yield of pigeonpea (*Cajanus cajan*). Indian J. Agric. Sci. 32:35-38. 97

The results confirm those of previous experiments conducted with different crops. Deep plowing (up to 25 cm) was not conducive to significant increase in pigeonpea yield. The country plow was found to be a suitable implement on weed-free land and the broadcast method of phosphate application was found superior to placement.

KHAN, T.N., and J.M. ASHLEY. 1975.
Factors affecting plant stand in pigeonpea. Expl Agric. 11(4):315-322. 98

Some factors that may influence emergence and establishment of pigeonpea (*Cajanus cajan* (L.) Millsp.) in Uganda include seeding depth, seed dressing, seed grading, seeding rate, variety, and temperature. The effect of seeding rate was dependent on mean germination percentage in the field, but circumstantial observations on other factors of possible consequence in determining plant stand are also discussed.

KILLINGER, G.B. 1958.
New agronomic crops for Florida. Sunshine St. Agric. Res. Rep. 13:3-5. 99

The nonsynchrony of pod-ripening has made mechanical harvesting of pigeonpea difficult. As pigeonpea was a new crop in

Florida, the use of combine harvesters was extended to this crop also, but there were some losses due to harvesting.

KRAUSS, F.G. 1932.
The pigeonpea (*Cajanus indicus*): its improvement, culture, and utilization in Hawaii. Hawaii Agric. Exp. Stn Bull. 64:1-46. 100

The following aspects of pigeonpea are described in detail. Introduction. Botany, history and nomenclature, improvement: breeding, need of classification, suggestions, climatic and soil adaptations, culture: Tillage, planting, fertilizing, irrigation, harvesting, curing, threshing, and milling. Uses of the pigeonpea. Feeding value. Pigeonpeas as a cover green manure and rotation crop. Plowing under pigeonpeas: Insect pests of pigeonpeas. Practical experience of growers.

KULKARNI, L.G. 1969.
Increasing the production of red gram (*Cajanus cajan*) with special reference to Andhra Pradesh. Proc. Indian Sci. Cong. Assoc. 56(4):52. (Abstract). 101

Red gram occupies large areas but its yields are as low as 350 to 375 lbs/ac (392 to 420 kg/ha) in A.P. This is because plant type is bushy, accommodating a population of only about 10,000 plants per acre, and has a duration of 210 to 240 days. Because of its low yield, it is planted as a mixed or border crop, or planted in marginal lands of low water-retentive capacity. Its productive stage coincides with dry periods after rainy season. Thus, neither the crop has been tried as a pure crop nor have attempts been made to raise it under fertilized or irrigated conditions.

KUMAR, P., and N.S. CHAUHAN. 1976.
Problems and prospects of lac-host breeding. Indian Fmg 27(8):31. 102

The wild tree species *Butea monosperma* and *Schleichera oleosa*, the usual hosts of the lac insect *Kerria lacca*, are not considered suitable material for breeding programs because of their long life cycle and large size. Polyploid plants of the shrubby legume *Moghamia macrophylla*, a suitable host, have been obtained and the pulse crop *Cajanus cajan* is also considered a possible host worth developing.

KYNEUR, G.W., and R.W. WALKER. 1962.
The performance of legume introduction at Kairi Research Station, Queensland. Proc. North Qd. Agrost. Conf. 14/4. 103

C. cajan has been found useful as a component in mixed grass/legume stands. In preliminary observations pigeonpea was considered a promising legume in mixed stands. It may also be used as a legume in monsoon environments. Other aspects of mixed cropping have also been discussed.

LAKER, J.S. 1970.
Pigeonpea - *Cajanus cajan* (L.) Millsp. *In* Agriculture in Uganda (Ed.) J.D. Hameson, pp. 245-246. London: Oxford University Press. 104

LAL, R. 1976.
No-tillage effects on soil properties under different crops in Western Nigeria. Soil Sci. Soc. Am. J. 40(5):762-768. 105

In trials in 1973-1974, different crop rotations such as early/late maize, cowpea/cowpea, maize/cowpea, soybean/soybean, maize/soybean and pigeonpea/maize were grown on plots on which no-tillage maize had grown since 1970 and which had then been conventionally tilled or treated with 2.5 kg paraquat/ha 1 week before sowing. During the early season, continuous no-tillage maize yielded higher than plowed maize. Maize in rotation with pigeonpea yielded more than continuous maize.

LAL, S. 1977.
Increasing pulse production. Indian Fmg 27(7):3-5. 106

Some measures based on available technology are suggested for increasing the production of pulses through increasing yields and area under pulses.

LANDRAU, J.R.P., and G. SAMUELS. 1959.
The effects of fertilizer applications on yields of pigeonpea. J. Agric. Univ. P. Rico. 43(7):69-72. 107

Data are provided on the fertilizer responses of *C. cajan* on clay soils in terms of seed yield. Up to 250 kg each of N, P_2O_5, and K_2O/ha gave no favorable green pod yield response (on a unit area basis).

LAXMAN SINGH, S.K. MAHESHWARI, and D. SHARMA. 1971.
Effect of date of planting and plant population on growth, yield, yield components and protein content of pigeonpea (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Sci. 41(6):535-538. 108

Row spacing and planting dates did not influence yields or protein content of pigeonpea significantly. The highest yield of 1,124 kg/ha was obtained with a plant population of 60,000 plants/ha. Plant height was significantly affected by planting dates, the maximum height of 220 cm being obtained with the early planting on May 20, and the minimum of 140 cm with the later planting on July 5. In early plantings height and number of branches were increased, but the effective pod-bearing length was reduced.

LAXMAN SINGH, D. SHARMA, and S.K. MAHESHWARI. 1973.
Pigeonpea does better in mixture with dwarf sorghums. JNKVV Res. J. 7(2): 100-101. 109

The gross profit (sorghum and pigeonpea seed) in mixed cropping with dwarf variety of sorghum was highest. The standard practice of intrarow planting of pigeonpea in sorghum rows was better than interrow. Sorghum was benefitted in the mixture at the cost of pigeonpea. Early and medium varieties of pigeonpea were equally productive in the mixtures.

LAXMAN SINGH, and M.P. SHRIVASTAVA. 1976.
Cultivation systems and varietal adaptation of pigeonpea in Madhya Pradesh. Indian J. Genet. Pl. Breed. 36(3): 293-300. 110

Cultivation systems of pigeonpea (*Cajanus cajan* (L.) Millsp.) were studied in 43 districts of Madhya Pradesh to relate the variation in cultivar adaptation to systems. Seven broad categories of cropping systems were identified, important ones being: sole, intercropping, mixed cropping, mixed-cum-intercropping, bund cultivation, and shifting cultivation. Study of over 900 cultivars revealed nine distinct plant and maturity types as adapted to different cropping systems. Minor variation within each group also existed.

LENKA, D., and R.K. SATPATHY. 1976.
Response of pigeonpea varieties to levels of nitrogen and phosphate in laterite soil. Indian J. Agron. 21(3):217-220. 111

The trials with three pigeonpea cultivars showed that average seed yields were increased from 880 kg/ha without N to 1,070 kg/ha with 20 kg N/ha, were not further increased with 40 kg N/ha and were increased from 830 kg/ha without P to 1,070 to 1,170 kg with 80 and 120 kg P_2O_5/ha, respectively. Cv R-60 gave the highest yield of 1,370 kg/ha.

LOUSTALOT, A.J., and R. FERROR. 1950.
Studies on the persistence and movement of sodium trichloroacetate in the soil. Agron. J. 42:323-327. 112

In greenhouse experiments, as in field experiments, TCA was more toxic to *Zea mays* than to *Cajanus indicus*. Toxicity to these plants decreased with the passage of time; the rate and degree of this decrease was greatest at high temperatures and in soil stored at 45°C. Toxicity entirely disappeared within weeks. At all rates of application TCA toxicity disappeared within 1 month in saturated soil, within 2 months in soil with a medium moisture content, and after a longer period in clay soil. In field trials, plots treated with only 30 lb. TCA per acre remained practically free of perennial grasses and *Cyperus rotundus* for 4 months after treatment.

LOVADINI, L.A.C., and H.A.A. MASCARENHAS. 1974.
Time of planting of pigeonpea (*Cajanus cajan* (L.) Millsp.). Bragantia 33:5-7. 113

Six planting times were compared in Pindorama, São Paulo. Planting in October, November, December, and January initiated flowering in April. Among the first three plantings the difference was only 6 days, whereas for plantings in January, February, and March the difference was 16, 30, and 78 days respectively. Time of planting also affected plant height, with March plantings being shortest (1.11 m). The best time of planting would thus be January.

MAGISTAD, O.C., and O.N. ALLEN. 1933.
Effect of liming on the growth of pigeonpeas in Hawaiian soils. Philipp. Agric. 21:654-664. 114

The following determinations were made on soils from limed and unlimed plots: pH values, replaceable hydrogen, replaceable calcium, total base exchange capacity, and

percentage saturation. Recorded growth of pigeonpea plants, green weights, dry weights, and nitrogen content of the plants in pounds per acre were tabulated. The results warrant the conclusion that lime was beneficial in restoring the crop productivity of the soils, with pigeonpea as an indicator crop. Increases in crop growth were associated with greater soil pH values, more replaceable calcium, and a greater degree of base saturation.

MAHATIM SINGH, B.S. SAUMITRA, KALYAN SINGH, and R.K. SINGH. 1977.
Intercrop arhar for higher profit. Indian Fmg 27(5):9. 115

The highest yield was obtained with arhar alone. Intercropping of soybean, setaria, and sawan delayed the maturity of arhar. Highest net return (42.4%) over pure crop of arhar was obtained when urd was used as intercrop.

MANJHI, S., S.L. CHOWDHURY, and A.G. KANITKAR. 1974.
Influence of varieties, planting dates, row spacings and fertilizer nutrients on the yield and yield components of pigeonpea (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Sci. 43(11):998-1001. 116

Among three varieties, T-21, AS-10, and Sharda (AS-8), grown in 1969-1970 in India, Sharda had the highest mean grain yield (q/ha), T-21 had the most pods per plant, and AS-10 had the highest 1000-grain weight in 1970. Sharda had the highest protein content in both years, and also showed the greatest response to phosphorus application.

MARCUS, A. 1933.
Die straucherbse, *Cajanus indicus*. Tropenpflanzer. 36(6):245-250. 117

MARTIN, JOHN H., and W.H. LEONARD. 1967.
Cajanus cajan: In Principles of field crop production. 2nd Edition. New York: Macmillan. 732 pp. 118

MEHTA, T.R. 1955.
Cultivation of pulses in Uttar Pradesh, Agric. Anim. Husb., Uttar Pradesh 6:8-16. 119

Pigeonpea is the second most important major pulse crop grown in India next to Bengal gram (*C. arietinum*), with nearly 2.5 million hectares sown annually and over 600 kg dry seed/ha produced. The survival of perennial pigeonpea depends on soil depth, texture, and available moisture content. The deep, well-drained, medium rich loamy soils have produced crops with good yield for 5 years or more. The annual types could be grown well on light, loose, dry, and gravelly soils. On heavy and clay soils the crop was sensitive to waterlogging.

MEHTA, T.R. 1968.
Pulses could play a larger role in Indian agriculture. Indian Fmg 17(11):23-25. 120

In spite of low yields, the pulse crops are extensively grown for various reasons, one reason being that many pulses give profitable yields under conditions of moisture stress, with very little cultivation. Mixed cropping of red gram with sorghum and in upland paddy are also discussed.

MELLO, F.A.F. de, and M. deO. C. do BRASIL. 1960.
Chemical composition of some green manures. An. Esc. Agric. Queiroz 17:347-350. 121

Data on chemical composition are given for *Cajanus cajan* and six other legume species.

MENEZES, O.B. de 1944.
Spacing requirements with pigeonpea. Revta Agric. Piracicaba. 19:399-412. 122

Red, yellow, spotted, and black-seeded varieties of pigeonpea were used in spacing experiments. Red- and black-seeded varieties proved inferior. For the others, spacing at 2 m x 1 m and 1 m x 2 m gave higher yields than 2 m x 2 m, especially with the spotted variety, which was the best. The results seem to be of less interest than the manner of arriving at them, much of the paper being taken up with statistical computations.

MILES, J.F. 1939.
The need for a legume in Northern Queensland. Possibilities of *Cajanus cajan* looked into. J. Coun. Sci. Indust. Res. Aust. 12:289-293. 123

MILLS, P.F.L. 1961.
Pigeonpea as a pasture legume in the high rainfall sandveld region of Southern Rhodesia. Rhodesia Agric. J. 58(3): 171-172. 124

Some recommendations are given on the growing of pigeonpea, *Cajanus cajan*. It may be used as a dry-season protein supplement and as green manure.

MISHRA, K.C., H.N. PANDEY, and K.L. MUKHERJEE. 1968.
Crop-weed competition for phosphate nutrition. Trop. Ecol. 9:243-250. 125

Pot experiments were conducted to study intraspecific competition in gram, pearl millet, and pigeonpea by increasing their density. Interspecific competition between these crops and their dominant weed competitors was also evaluated. Results indicate that individual plants suffer badly due to overcrowding but the biomass per unit area steadily increases with increase in density. Crop-weed competition studies have revealed three kinds of interspecific association effects.

MOHAMED ALI, A., and J. CHANDRA MOHAN. 1973.
Water management practices for redgram and horsegram in Tamil Nadu. Indian Fmr Digest 6(2):29-30. 126

The importance of one or two "protective" irrigations when the soil moisture touches the lowest of availability is emphasized. Irrigation at the critical stages, i.e., seeding, flowering, and pod formation should not be avoided. Moisture can be conserved during crop growth by bunding, basin listing, criss-cross ridging, and chisel trenching.

MOREL, R., and P. QUANTIN. 1964.
The influence of fallows on soil regeneration in the Soudan-Guinean climate of Central Africa. Agron. Trop. 19(2):105-136. 127

Regeneration of soil fertility can be accelerated by practicing artificial instead of natural fallow. Among the various legumes tested, *Cajanus indicus* proved to be the most effective in restoring soil fertility.

MORTON, J.F. 1976.
The pigeonpea (*Cajanus cajan* Millsp.), high protein, tropical bush legume. Hort. Sci. 11(1):11-19. 128

One of the oldest of food crops, the pigeonpea ranks fifth in importance among edible legumes of the world and occupies first place in India. In eastern Kenya, it stands sixth among the leading food commodities. In Uganda, the pigeonpea is now declared to be the fastest growing cash crop for canning. This legume has been a staple food in Puerto Rico and the Bahamas for generations. In many other parts of the tropics, it is a neglected crop with an unrealized potential. Various aspects of pigeonpea are discussed. These are: nomenclature, origin and distribution, description, production, trade and economic value, and uses as food stuff, feedstuff, medicine, and for other purposes, including rearing of silkworms (*Boroceras cajani*).

MUKHERJEE, D. 1960.
Studies on spacing of *Cajanus cajan* (L.) Millsp. Indian J. Agric. Sci. 30: 177-184. 129

In a field experiment with pigeonpea, six spacings ranging from 60 x 60 to 120 x 120 cm were compared with broadcast sowing at the rate of 13 kg seed/ha. During 5 successive years, the plots with the 60 x 60 cm spacing (about 30,000 plants/ha) always gave the highest yields. The average increase over broadcast sowing (resulting in a stand of 90,000 to 100,000 plants/ha) was 30%, but in years with unfavorable rainfall distribution, this difference tended to be reduced.

MUKHERJEE, D. 1962.
Pulses in West Bengal. Indian Agric. 6:54-61. 130

The main pulse crops grown in West Bengal are gram, lentils, mung, kalai (Mash) and khesari in the post-monsoon season and arhar, mung, and kalai in the monsoon. The following aspects have been discussed: Area and production under different pulses, production and requirement of pulses in West Bengal, and incidence of pests and diseases.

NAIR, G.G.K., and B.V. MEHTA. 1958.
A note on zinc contents of plants in Goradu soil. Indian J. Agron. 3(2):116-117. 131

Leaves of fruit-trees have the maximum uptake of zinc; grasses the minimum. In decreasing order, zinc contents can be arranged thus: fruit-trees, legumes, cereals, and grasses. Of the four pulses analyzed, tur was found to contain the highest amount of zinc (43.0 ppm).

NANNE, E. 1934.
El gandul (*Cajanus indicus*). Revta. Agric. Guatem. 12(5):311-313. 132

NATARAJAN, M., and T.M. VITTAL. 1975.
Promising pulse varieties for intercropping and multiple cropping in Tamil Nadu. Indian J. Genet. Pl. Breed. 35(2):291-299. 133

Discusses the scope of extending the cultivation of tur (*Cajanus cajan*) as a mixed crop with ragi, groundnut, jowar, and bajra. In the areas where tur is grown as a pure crop, introduction of green gram and black gram as mixtures needs further trials.

NEME, N.A. 1955.
Pigeonpea cultivation. Agronomico Compinas. 7(11-12):24-28. 134

Information is given on the growing of pigeonpea (*Cajanus cajan*) for green manure in Brazil.

NICHOLS, R. 1964.
Studies on the major-element deficiencies of the pigeonpea (*Cajanus cajan*) in sand culture. 1. Foliar symptoms of the major-element deficiencies. Pl. Soil 21(3): 377-387. 135

A full description of foliar symptoms from nodulated and nonnodulated plants grown in sand culture and an analytical key are presented for the diagnosis of N, P, K, Ca, Mg, and Fe deficiencies in pigeonpea.

NICHOLS, R. 1965.
Studies on the major-element deficiencies of the pigeonpea (*Cajanus cajan*) in sand culture. 2. The effects of major-element deficiencies on nodulation, growth and mineral composition. Pl. Soil 22(1): 112-116. 136

Data are given on the mineral composition of the leaves of nodulated and nonnodulated pigeonpeas grown in sand culture at deficiency levels of N, P, K, Ca, Mg, and Fe. The deficiencies affected root growth, which in turn determined the intensity of nodulation, expressed as dry weight of nodules or number/plant. Deficiencies of Ca, P, and Mg had the greatest effect in reducing plant growth and intensity of nodulation.

NYE, P.H., and W.N.M. FOSTER. 1961.
The relative uptake of phosphorus by crops and natural fallow from different parts of their root zone. J. Agric. Sci., Camb. 56(3):299-306. 137

Maize derived 7% and pigeonpea 11% from below 10 in (25 cm) after 80 days. Pigeonpea feeds much closer to its base than the cereals until the 50th day. Pigeonpea in its second year extracted little more phosphorus from the subsoil than it did in the first. The amount of phosphorus derived from below the 10-inch (25 cm) layer corresponded with the proportion of dicotyledonous roots in the subsoil.

OKE, O.L. 1969.
Sulphur nutrition of legumes. Expl. Agric. 5:111-116. 138

Application of sulfur, alone or in combination with P, significantly increased the number, yield, and nitrogen content of root nodules on pigeonpea and guar. Sulfur, applied at different levels with NPK, increased the methionine content and yield of plants significantly but had no significant effect on N content. Sulfur at 20 ppm, alone or in combination with P, increased the methionine content of pigeonpea significantly but the effect decreased at higher levels of S. In general, higher values of methionine were obtained in the presence of S than in its absence.

PALO, A.N. 1972.
Production of food legumes in the Philippines with special reference to leguminous vegetables. Trop. Agric. Res. Ser. 6:189-195. 139

Data are given on the yields, seed protein contents and varieties of *Vigna sinensis, V. radiata, Phaseolus vulgaris, Pisum sativum, Cajanus cajan, Dolichos lablab,* and other legumes grown in the Philippines. Prospects for producing the normally imported dried peas and beans are also discussed.

PANDEY, H.N., K.C. MISHRA, and K.L. MUKHERJEE. 1971.
Phosphate uptake and its incorporation in some crop plants and their associated weeds. Ann. Bot. 35(140):367-372. 140

In pearl millet, pigeonpea, wheat, and chickpea, and in six weed species rate of P^{32} uptake and incorporation into leaves depended on age and species. Rate of uptake increased with time in all species, but incorporation of P was at a maximum during early stages of growth.

PANDEY, R.B. 1977.
Studies on crop mixtures. M.Sc. (1977) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India. 141

PANIKKAR, M.R. 1961.
Growing pulse crops. II. Redgram. Fertil. News 6(5):7-10, 15. 142

Red gram requires more attention than other legumes because it is a multipurpose legume crop that yields nutritious grain and valuable forage and also enriches the soil by its growth. Production could be stepped up by better cultivation practices, particularly manuring; nitrogen and phosphorus applications could double or even triple yields.

PANIKKAR, M.R. 1968.
Grain legumes play a vital role in progressive farming. Indian Fmg 17(11):9-11. 143

Pulses are important in the overall cropping spectrum of Indian farming, either alone or as mixtures, and invariably as the linchpin of crop rotations. Their role in multiple or relay cropping is also significant.

PANKAJA REDDY, R., P.P. TAMHALKAR, and N.G.P. RAO. 1977.
Improved pigeonpea varieties for mono- and intercropping. Indian Fmg 27(4):3-4. 144

The varieties HY-1, HY-2, and HY-4 have been released for general cultivation. Various intercropping systems based on combinations of cereal (sorghum), pulse (arhar and soybean) and oilseeds (groundnut and castor) were compared for total productivity, nutritional efficiency, and economic profitability.

PANNU, J.S., and J.S. SAWHNEY. 1975.
Effect of arhar on the nitrogen requirements of the succeeding wheat in an intensive rotation. Indian J. Genet. Pl. Breed. 35(2):253-256. 145

Residual phosphorus from arhar showed significant beneficial effects on grain yield of succeeding wheat. Comparison of wheat yields from no-phosphorus plots of arhar-wheat and fallow-wheat rotations showed that each level of nitrogen recorded significantly lower wheat yield in the former rotation than in the latter. For late-sown (December 3) wheat succeeding arhar, 100 kg N/ha was adequate.

PANSE, V.G., M.D. DANDAWATE, and S.B. BOKIL. 1947.
Summary of past experimental work on wheat, millets, oil seeds, and pulses. Delhi: Army Press. pp. 117-147. 146

PARSONS, D.J. 1962.
The systems of agriculture practised in Uganda. 3. The northern systems. Pt. 1. The Lango-Acholi system. Pt. 2. The West Nile systems. Mem. Res. Div. Dep. Agric. Uganda 3. 1960. 66 pp. 147

The crops grown in some or all of the several ecological zones include cotton, finger millet, pigeonpea (*Cajanus cajan*), sorghum, sesame, cassava, cowpea, bean, and maize. These districts of Uganda are situated at an altitude of 2,000 to 4,000 ft (609 to 1,218 m) and receive 35 to 60 inches (87.5 to 150 cm) rainfall/year.

PATHAK, G.N. 1970.
Red gram. *In* Pulse Crops of India. P. Kachroo (editor). New Delhi:ICAR. 148

Discussed different aspects of red gram: Importance, area and production, agronomy, genetics, plant breeding, cytogenetics, nutritional quality, and diseases and pests.

PATRO, G.K., and G.C. TOSH. 1973.
Relative efficiency of herbicides on control of weeds in red gram (*Cajanus cajan* (L.) Millsp.). Andhra Agric. J. 20(3-4):65-70. 149

Varitox (Na salt of TCA), Tropotox (Na salt of MCPB), and Enbutox (Na salt of 2,4-DB) were tried at a dose of 2.24 kg a.i./ha, both as preemergence and postemergence sprays. Of the herbicides tried, Varitox (TCA), sprayed preemergence or postemergence, was found the most effective against dominant weeds and recorded maximum grain yields and net profits per hectare.

PAUL, S., and R.P. SINGH. 1977.
Response of arhar varieties to methods of phosphorus application. Allahabad Fmr 48(2):175-177. 150

All arhar varieties exhibited significant yield response to phosphorus application. Not only the number of pods per plant but length of pod (cm), number of clusters per plant, and 1000-grain weight all showed significant increases. The phosphorus placement method gave significantly higher yield (938 kg/ha) than the broadcast method (725 kg/ha).

PAUL, W.R.C. 1951.
Notes on Legumes. Trop. Agric. Ceylon 107:225-228. 151

Notes on legumes under trial both as cover crops and forage plants. Describes varieties of pigeonpea, *Cajanus cajan*, that will seed satisfactorily in Ceylon.

PAUL, W.R.C. 1953.
Notes on legumes. Trop. Agric. Ceylon 109:27-35. 152

Observations are recorded on the behavior of various legumes under trial in Ceylon as green manure and cover crops or as forage crops. Several varieties of *Cajanus cajan* are described for green manuring.

PIETRI, R., R. ABRAMS, and F.J. JULIA. 1971.
Influence of fertility level on the protein content and agronomic characters of pigeonpeas in an oxysol. J. Agric. Univ. P. Rico 55(4):474-477. 153

In a trial, pigeonpea cv Kaki was given either no fertilizer or various levels of N, P, and K, with and without Ca, Mg, and two levels of calcium silicate. Fertilizer treatments had no effect on green pod yield, date of flowering, plant height, 100-seed weight or protein content of the dry seed.

POPENOE, W. 1948.
The pigeonpea (*Cajanus indicus* or *Cajanus cajan*). A discussion of the value of *Cajanus* for cultivation in central America. Rev. Agric. Costa Rica. 20:475-478. 154

PRASAD, M.V.R., and R.P. SINGH. 1975.
Inter-cropping of short duration grain legumes in sown pastures and field crops. Indian J. Genet. Pl. Breed. 35(2): 271-275. 155

Suggests developing suitable systems of intercropping and crop rotation for better retention and utilization of fixed nitrogen. An intercrop of arhar in ragi and mung and arhar in bajra have increased the yield of principal crop to some extent.

PREMSEKHAR, S., and A. SUBRAMANIAM. 1961.
Time of sowing experiments with short duration redgram (*Cajanus cajan*) No. 1141. Madras Agric. J. 48(3):106-107. 156

In trials with the early maturing red gram 1141, grown under irrigation as a short-duration crop, the mid-March sowing gave the highest yield of dry pods (1,354 lb/ac, or 1,516 kg/ha) and seeds (743 lb/ac, or 832 kg/ha).

PUGH, B.M. 1958.
Arhar. Production of field crops in India. Allahabad: Kitabistan. pp. 188-194. 157

PUTTARAJAPPA, P.K. 1943.
Grow more pulses. Togari (*Cajanus indicus*). Mysore Agric. J. 21:106. 158

Togari (pigeonpea), one of the chief pulses, is grown in Karnataka as a mixture with ragi and not as a pure crop. It grows better in stony soil than in black or red soils. Togari takes 12 days from sowing to seedling. At seven and half months the crop is harvested.

PYNAERT, L. 1933.
L'Ambrevade, *Cajanus indicus*. Bull. Agric. Congo Belge. 20:459-474. 159

QUADROS, A.S. de 1950.
Damage by frost to arhar (tur) and how to prevent it. Rur. India 13(3):134-135. 160

On the basis of maturity, all Indian types of arhar can be easily classified into early and late. It is suggested that the initial seed rate in mixtures be reduced to a level below that adopted for single crop, not only to minimize competition for soil moisture between the crops but also to insure arhar against possible damage by frost.

RACHIE, K.O., and R.T. WURSTER. 1971.
The potential of pigeonpea (*Cajanus cajan* Millsp.) as a horticultural crop in East Africa. Proc. First E. Afr. Hort. Symp. Kampala, Uganda. 1970. 161

RAJANI, H.J., and R.B. PATEL. 1956.
Cajanus indicus - approximate composition of manures and fertilizers. Poona Agric. Coll. Mag. 47(2):130. 162

Available information on the plant nutrient contents of various manures and fertilizers is compiled from the data of Bombay State. *Cajanus indicus* (green manure) has N 1.12; P_2O_5 0.36; K_2O 0.72; and CaO 0.48.

RAMANATHAN, G., N. PALANISAMY, and K.K. KRISHNAMOORTHY. 1977.
Response of Co-2 redgram to 'P' application. Madras Agric. J. 64(10): 671-672. 163

Of the different levels of P tested, the maximum level of 76.4 kg P_2O_5/ha gave significant increase in pod and grain yield. It was established that P utilization and crop response were maximum at 76.4 kg/ha.

RAMANUJAM, S. 1972.
Some salient results of pulse research (2). Indian Fmg 21(11):19-21, 24. 164

Summarizes important findings of a comprehensive and concentrated research program on the agronomy of pulse crops in India. Deals with fertilizing, plant density, intercropping, and time of planting of various pulse crops. One of the important findings for pigeonpea is its response to P fertilizing. The highest yields of pigeonpea were obtained with 60,000 plants/ha. Slow seedling growth of pulse crops makes chemical weeding essential for high yields. During the early growth period, cowpea, mungbeans, or soybeans can be interplanted in pigeonpea without affecting its yield.

RAO, K.S. 1976.
Response of pigeonpea (*Cajanus cajan*) varieties to various levels of phosphorus. M.Sc. (1976) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India. 165

RATHI, S.S., D. SINGH, and R.C. MALIK. 1974.
Response of short duration arhar (*Cajanus cajan*) to dates of sowing, row spacing and phosphate application. Fertil. News 19(2):27. 166

Date of sowing, row spacing, and levels of phosphate significantly affected arhar yield. Sowing of June 10 gave the highest yield, and 50-cm row spacing yielded higher than 75- and 100-cm spacings. A significant interaction between dates of sowing and rates of phosphate placement was observed, highest grain yield being obtained when the June 10 sowing was fertilized with 80 kg P_2O_5/ha. Phosphorus application gave consistent and significant increases in grain yield under all dates of sowing.

RAVENZA, M.V.B., and M.A. BARROTA. 1953.
First experiments with *Cajanus indicus*. Rev. Fac. Agric. Univ. Cent. Venez. L. 211-215. 167

REEM, H.W. 1968.
The potential for legumes in tropical agriculture and their role in solving the world food supply. Proc. Soil Crop Sci. Soc. Fla. 27:347-357. 168

The possibilities of legume production to improve world food supply are emphasized. Attention is paid to soybeans, pulses, and groundnuts as food crops in Brazil, India, Iran, Africa and Far East. The use of legumes as a green manure increases the rice yields by 25%, if initial levels of production are low. The importance of maximum yield per unit of land per year is stressed. It is proposed to introduce suitable rotation schedules including edible legumes.

RENARD, M. 1949.
Regeneration of the exhausted soils of the French Sudan. Bull. Agric. Congo Belge. 40:2173-2188. 169

RICHHARIA, R.H. 1948.
Progress report of the research scheme on pulses in Bihar for the year 1947-48. 170

RIOLLANO, A., A. PEREZ, and C. RAMOS. 1962.
Effect of planting date, variety, and plant population on the flowering and yield of pigeonpeas (*Cajanus cajan* L.). J. Agric. Univ. P. Rico 46(2):126-134. 171

Three pigeonpea varieties were sown on the 15th of each month from July 1954 to June 1955. Depending on the date of sowing, the number of days to flowering ranged from 125 to 320 days in the varieties Florido and Kaki and from 174 to 430 days in the late variety Saragateado. Plant height ranged from 0.9 to 4.5 m in the first two varieties and from 1.5 to 4.4 m in Saragateado. All three varieties flowered in the short-day season, irrespective of sowing date. No significant differences in yield were observed between planting distances within the row of 0.6, 0.9, and 1.2 m.

ROCHE, P. *et al.* 1955.
Use of green manures in rice-fields in Lake Alaotra region (Madagascar). Riz. Rizic. 1(4):141-144. 172

Soybean and *Cajanus indicus* are recommended as green manures for increasing rice yields. These legumes are grown as catch crops under irrigation; their place in the rotation is after rice. They are sown in June and plowed under in November, while rice occupies the ground from December to May.

ROCKWOOD, W.G., and R. LAL. 1974.
Mulch tillage: A technique for soil and water conservation in the tropics. Span 17(2):77-79. 173

Systems of mulch-tillage (Zero tillage) cropping on tropical soils are discussed. In plot trials, yields of cowpea, maize, and pigeonpea were similar for mulch

tillage and plowed treatments, except during periods of drought stress, when yields of maize and cowpea were 50 and 25% higher with mulch tillage. Yields of soybean were lower with mulch tillage than with plowed treatments.

SABNIS, T.S. 1943.
Cajanus indicus - Notes on Agricultural Crops (Arhar), Leafl. Dep. Agric. U.P. 174

SAHU, D., and S. PATTNAIK. 1962.
Evaluation of available phosphorus status of Orissa soils by greenhouse tests. Pigeonpea - Fertilization. Proc. Symp. Fertil. Ind. Soils. 78-83. August 3-4, 1962, Madras, India. Also in Bull. Nat. Inst. Sci., India. 26:72-83 (1964). 175

The phosphorus status of twelve soils collected from different parts of Orissa was evaluated by the greenhouse technique. On the basis of the dry matter of test plants (*Cajanus cajan*) obtained under different levels of phosphorus application, the soils have been classified into three groups. Group I: Soils that responded to application of P up to 60 kg/ac. Group II: Soils that responded to application of phosphorus but the yield ceased to increase beyond 45 kg/ac. Group III: Soils that responded to application of P but the yield ceased to increase beyond 30 kg/ac. The data indicated that response to P application is not correlated with any single factor, such as texture, moisture-holding capacity, organic carbon content, or available P_2O_5 contents.

SALETTE, J.E., and J.M. COURBOIS. 1968.
Agronomic aspects of pigeonpea in Marie-Galante. Proc. Caribb. Soc. Fd Crop Sci. 6:32-37. 176

A strain local to Marie-Galante showed a 34 to 45% yield response to 112 kg P_2O_5 and 134 kg K_2O/ha, whereas an introduction from Puerto Rico showed no response. This indicated that varieties differ considerably in nutrient requirements.

SANCHEZ-NIEVA, F. 1963.
Variations in maturity of pigeonpeas during the harvesting period. Bull. Estac. Exp. Agric. Univ. P.R. 170:1-21. 177

The percentage of mature green pigeonpeas (*Cajanus indicus*) fit for processing in the Kaki and Saragateado selections in Puerto Rico is at its highest value during the early stages of the harvesting season, and decreases to a minimum within a period of 27 days. This finding suggests the possibility that a more uniform product could be canned by harvesting the peas only once at a predetermined stage of development.

SANCHEZ-NIEVA, F. 1964.
Application of the shear press to determine the degree of maturity of pigeonpeas. J. Agric. Univ. P. Rico 47(3):212-216. 178

Trials demonstrated that the Lee-Kramer shear press affords a rapid and sufficiently accurate means of assessing the degree of maturity of pigeonpeas for canning. Maturity criteria used were: alcohol-insoluble solids content, starch content, total solids content, and percentage of yellow peas.

SANCHEZ-NIEVA, F., M.M. CANCEL, and J.R. BENERO. 1960.
Maturity indices for pigeonpeas. J. Agric. Univ. P. Rico 40(2):60-69. 179

The following characters could be used as an index of maturity of pigeonpeas (*Cajanus cajan*): content of moisture, starch, alcohol-insoluble solids and total solids; specific gravity; and intensity of green pigmentation.

SANCHEZ-NIEVA, F., and G. COLOMCOVAS. 1964.
Advantages to the farmer of harvesting all the pods of pigeonpeas at the same time. Bull. Estac. Exp. Agric. Univ. P.R. 131:1-13. 180

The commercial method of harvesting by repeated pickings gives higher yields than harvesting all pods at once. However, the wages required for commercial harvesting are much higher than those for the new method. Thus farmer's gross income is higher when he harvests only once.

SANDHU, H.S., S.S. BRAR, and G.S. GILL. 1973.
Arhar-wheat is a good rotation. Prog. Fmg 9(10):8. 181

Sowing arhar T-21 on June 1, a farmer can sow the following wheat crop by November 20, which is not too late for wheat. The results show that the arhar-wheat rotation can be adopted profitably.

SANTON, W.R., J. DOUGHTY, R. ORRACA-TETTEH, and W. STEDE. 1966.
Grain legumes in Africa. Rome: FAO. 191 pp. 182

SARAF, C.S., A. SINGH, and I.P.S. AHLAWAT. 1975.
Studies on intercropping of compatible crops with pigeonpea. Indian J. Agron. 20(2):127-130. 183

Cajanus cajan in pure stands or intercropped with *V. radiata*, *V. mungo*, cowpea, and soybean gave average seed yields of 1,630, 1,720, 1,640, 1,530, and 1,690 kg/ha respectively; the intercrops gave seed yields of 198, 110, 424, and 114 kg/ha, respectively. Intercropping of maize and sorghum in *Cajanus cajan* markedly decreased its yields.

SARDAR SINGH, and V.B. SAHASRABUDHE. 1957.
Effect of organic and inorganics on the yield of jowar (*Sorghum vulgare*), arhar (*Cajanus cajan*) and groundnut (*Arachis hypogaea*) and after-effect on rainfed cotton. Indian J. Agron. 1(3): 151-157. 184

Ammonium sulfate depressed the yield of arhar (*Cajanus cajan*). There was no appreciable effect of superphosphate on the arhar crop. Application of superphosphate or of farm compost to the preceding crop indicated significant residual response on cotton.

SAVILLE, A.H., and W.A. WRIGHT. 1958.
Notes on Kenya agriculture. 3. Oilseeds, pulses, legumes and root crops. E. Afr. Agric. J. 2(1):1-9. 185

Notes on climate, soils, cultivation, and harvesting methods and major uses of a number of legumes, including pigeonpea (*Cajanus indicus*). Spacings, seed rates, yields per acre and time to maturity are also tabulated for each crop.

SAXENA, M.C., and D.S. YADAV. 1975.
Some agronomic considerations of pigeonpeas and chickpeas. Proc. First International Workshop on Grain Legumes. 13-16 Jan 1975. ICRISAT. Hyderabad, India. pp. 32-62. 186

Describes trials on effects of seedbed preparation methods, sowing methods, sowing rates and dates, spacing, fertilizers, trace elements, seed inoculation, weed control, irrigation, growth substances, and mixed cropping on seed yields of chickpea and pigeonpea.

SAXENA, M.C., and D.S. YADAV. 1976.
Parallel cropping of soybeans with pigeonpea under humid sub-tropical conditions of Pantnagar. Indian J. Agron. 21(2): 131-134. 187

When pigeonpea was grown (i) in pure stands in rows 15 cm apart and (ii) with seven soybean cultivars drilled between two rows of pigeonpea, the average seed yields were similar: 2,440 kg and 2,130 to 2,510 kg/ha respectively. Soybean gave an additional seed yield of 760 to 1,160 kg/ha, the highest yield being with cv J-3. Intercropping with pigeonpea reduced soybean yield by 50% over pure-stand yields.

SCHAFFHAUSEN, R.V. 1963.
Economic methods to form and improve pastures with the legumes *Dolichos lablab*, *Cajanus cajan* and *Glycine javanica*. Rural Rev. Soc. Rural Bras. 43:16-17. 188

This paper deals with the problem of how to grow green fodder economically during dry winter months on poor soils, under conditions similar to those prevailing in the State of São Paulo, Brazil.

SELLSCHOP, J., and H.M. MULLER. 1953.
The pigeonpea or dhal bean. Fmg S. Afr. 28:159-160. 189

General notes are given on *Cajanus cajan*, which in South Africa does best in the warm lowveld where frosts seldom occur.

SEN, A.N. 1956.
Nitrogen economy of soil under rahar. J. Indian Soc. Soil Sci. 6(3):171-176. 190

Studies were conducted on nitrogen uptake of a crop of rahar (*Cajanus cajan*), the nitrogen status of the soil after harvest, and the effect of fertilizers on both. The observations recorded for 3 years with a late variety of rahar (NP-51) showed that the uptake of nitrogen and nitrogen fixation by rahar was greatly increased by the application of N and P fertilizers, singly as well as in combination. Rahar was found to be an exhaustive crop rather than a recuperative one. Nitrogen content of the soil under rahar could be increased if its leaves are allowed to be incorporated with the soil. Rahar did not derive as much benefit from root nodule organisms as other legumes. Nodules were found to remain on the plant only up to 8 to 12 weeks growth and the amount of nitrogen fixed by rahar during 36 to 40 weeks totaled 100 to 250 lb/ac (112 to 280 kg/ha).

SEN, S., K. SENGUPTA, S.C. SUR, and D. MUKHERJEE. 1966.
A study on mixed cropping of arhar (*Cajanus cajan* (L.) Millsp.). Indian J. Agron. 11:357-362. 191

Arhar grown in lines (62 cm x 62 cm), in association with *aus* paddy sown broadcast at 69.21 kg/ha, brought the highest yield of grain and the maximum net profit per hectare. Yield of arhar and *aus* each suffered in the mixed crop, but the total grain yield was higher. Losses were incurred when two leguminous crops were grown in mixture, and arhar grown as a pure crop brought very little profit.

SEN, S., S.C. SUR, K.C. GUPTA, and T.K. DE. 1970.
A further study on spacing requirement of *Cajanus cajan* (L.) Millsp. Allahabad Fmr 44(3):153-157. 192

An experiment with *Cajanus cajan* showed that: (i) at Berhampore a spacing of 30 x 30 cm was best; (ii) at Kalyani a spacing of 30 x 90 cm was best; (iii) heavy precipitations in September/October reduced the number of pods, and (iv) uniform total rainfall during the growing period from May to August, was responsible for uniform growth.

SEWA RAM, and GAJENDRA GIRI. 1973.
A note on response of redgram (*Cajanus cajan* L.) varieties to varying fertility levels. Indian J. Agron. 18(1):103. 193

Different fertility levels significantly influenced both arhar growth and grain yield. The optimum level of fertility for arhar was 25:50:0 (N:P:K). Varietal differences were not significant.

SHARMA, N.L. 1976.
Effect of nitrogen, phosphorus and sulphur on protein content of arhar (*Cajanus cajan* (L.)). Seed Fm 2(5):37-39. 194

The protein content of the grain increased significantly with additions of nitrogen, phosphorus, and sulfur. The protein content increased from 21.78% to 23.96% with nitrogen, from 22.35% to 23.98% with phosphorus, and 20.89% to 24.00% with sulfur levels. Combinations of two or three nutrients also resulted in grain with a higher protein content. A positive and significant correlation was observed between protein content of the grain and the levels of N, P, and S.

SHERIFF, N.M., and C.K. RAJAGOPALAN. 1970.
A study on the seedling mortality in redgram in relation to the mode of application of fertilizers. Madras Agric. J. 57:439-441. 195

Sowing of seeds and applying fertilizer in a separate small furrow as close as possible is the best method for uniform population stand of red gram. Direct application of fertilizers under dryland conditions not only reduces germination but also induces higher seedling mortality.

SINGH, D., and A.A. SHAH. 1950.
Arhar as a green manure. Punjab Fmr 2:15. 196

SINHA, K.S., and M.P. SINGH. 1956.
Mixed cropping of maize (*Zea mays*). Proc. Bihar Acad. Agric. Sci. 5:134-137. 197

In some parts of India crops such as arhar and groundnut are grown along with maize. In this practice arhar (pigeonpea) and maize are sown in the same row and groundnut is sown in between two rows of maize and arhar. Early maturing arhar varieties suit this practice well.

SINGH, L., S.K. MAHESHWARI, and D. SHARMA. 1971.
Effect of date of planting and plant population on growth, yield, yield components and protein content of pigeonpea (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Sci. 41(6):535-538. 198

Pigeonpea cv T-21 was sown on four dates at plant populations of (i) 40,000 (ii) 50,000 and (iii) 60,000/ha in rows 75 and 100 cm apart. Seed yields were highest (1.38 t/ha) in the crop sown on May 20 and declined with successive later sowings. Plant population (iii) gave higher seed yields (1.21 t/ha) than (i) or (ii). Seed protein content was not affected by any of the treatments. Plants were taller in the crop sown first than in crops sown later. The number of primary and secondary branches were highest in early sown crops and at the lowest plant population. The number of pods per plant was higher with plant population (i) than with (ii) or (iii).

SINGH, S.B. 1947.
A new and lucrative rotation for sugarcane. Indian Fmg 8:181-182. 199

The rotation is groundnut - arhar - sugarcane. The first two are sown together "with the break of the monsoon" the *Cajanus* 2½ to 3 ft. (76 to 92 cm) apart in lines 9 ft. (2.7 m) apart, with groundnut between in lines 18 in. (45 cm) apart. After the groundnut has been harvested in November, its place is taken by sugarcane planted in February. The *Cajanus* is harvested in March, by which time the sugarcane has begun to grow. Some advantages claimed for this rotation are: the two leguminous crops, one deep-rooted and the other shallow-rooted, fertilize the soil for the sugarcane and the farmer harvests two cash and food crops, without irrigation or manure, and a good sugarcane crop over a period of 2 years.

SMARTT, J. 1976.
Tropical Pulses. Tropical Agriculture Series. London: Longman. 200

Includes chapters: Origin and history of pulse crops. Botany of Pulse Crops. Pulses in human nutrition. Physiology of growth, development and reproduction. Mineral nutrition and productivity, cultural practices and crop handling. Pests and pest control. Breeding and improvement of pulses. The economic importance of pulse crops.

SOHAN SINGH. 1976.
Arhar shelters young litchi plants. Prog. Fmg 12(6):16. 201

Arhar, besides protecting litchi plants against hot winds, frost, and cattle, minimizes weeding and, being a legume crop, enriches the soil as well.

SOLOCOTZI, E.H. 1947.
The beans and others of the leguminosae cultivated in Chiapas. Bol. Soc. Bot. Mexico. 5:4-6. 202

Phaseolus is the legume most commonly grown in the Mexican State of Chiapas. It is represented by many species. *Cajanus indicus* is also found in the tropical parts of the State. *Vigna* and *Crotalaria* are also found.

SOLOMON, S., and G.P. ARGIKAR. 1956.
Perennial tur. Farmer 7(12):13-15. 203

SOUSA, J.A., and C.A. GENTIL. 1959.
Green manuring of sugarcane fields. Brasil Acucareiro 54(5):12-15. 204

The advantages of green manuring for sugarcane soils are enumerated. *Cajanus cajan* is one of the green manures most indicated for São Paulo conditions.

SUGAWE, G.T.R. 1974.
Response of pigeonpea (*Cajanus cajan*) to various levels of phosphorus and spacing. M.Sc. (1974) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India. 205

SUAREZ, J.J., and D. HERREARA. 1971.
Response of pigeonpea (*Cajanus cajan* Millsp.) at different populations submitted to different heights of cutting. Revta. Cubana Ciencio Agric. 5(1): 71-75. 206

Pigeonpeas were sown at 90, 105, and 120 cm between rows and 45, 60, and 90 cm between plants and cut after the first harvest at 30 or 60 cm. Seed yields were higher and times of flowering and maturity 3.5 months less for the first than for the ratoon crop. Spacing did not affect yield. Cutting at 30 cm reduced plant number and yield in the ratoon crop.

SURINDER SINGH, and R.C. SINGH. 1976.
Economics of mixed cropping in pigeonpea (arhar) under Haryana conditions. HAU J. Res. 6(3-4):171-175. 207

The yield of mid-maturing arhar was not reduced when it was sown with short-duration and dwarf intercrops, whereas the yield of early maturing arhar varieties was adversely affected. Arhar + mung gave the highest returns.

THOMPSTONE, E. 1920.
Cultivation of "Pesingon" *Cajanus indicus*. Burma cultivators Leaflet-55. Rangoon: Govt. Printing Press. 208

TIWARI, A.S., L.N. YADAV, L. SINGH, and C.N. MAHADIK. 1977.
Spreading plant type does better in pigeonpea. Trop. Grain Legume Bull. 7:7-10. 209

In mixed cropping, a spreading type of pigeonpea does better and appears more adaptable to different plant spacings, showing a higher yield.

TRIVEDI, K.A. 1963.
Effect of (i) spacing and (ii) NPK on the yield and quality of pigeonpea. M.Sc.(1963) Thesis. B.A. Agric. Coll. Mag. 16:88. 210

UKIRDE, R.H. 1975.
Response of pigeonpea (*Cajanus cajan*) varieties to various levels of phosphorus and spacing. M.Sc. (1975) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India. 211

UPPAL, B.N. 1952.
Tur - Progress of agricultural research and development in Bombay State. Dep. Agric. Poona. 21. 212

VEERASWAMY, R., V.P.A. RAJASEKARAN, G. SELVAKUMARI, and N. MOHAMED SHERIFF. 1972.
Effect of phosphoric acid and organic manures on redgram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 59(5): 304-305. 213

The results indicated that a basal dressing with 22.4 kg of P_2O_5 in the form of superphosphate and 5 mt/ha of compost will increase the yield of rainfed red gram by about 13%.

VEERASWAMY, R., R. RATHNASWAMY, G. SELVAKUMARI, and P. BADRI NARAYANAN. 1972.
Studies on the spacing of redgram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 59(8):435-436. 214

A spacing of 90 cm between rows and 30 cm between plants within the row appears to be the optimum spacing. Nine different spacings varying from 90 x 20 cm to 150 x 40 cm were tried and a broadcast sowing was used as a control. The optimum spacing gave a yield increase of 51.78% over the control and required only 9 kg/ha of seed as compared with the 12.50 kg/ha usually used in broadcast sowing.

VEERASWAMY, R., R. RATHNASWAMY, and G.A. PALANISWAMY. 1974.
Studies on the mixed cropping of redgram and groundnut under irrigation. Madras Agric. J. 61(9):801-802. 215

The experiment has shown that a mixed crop of groundnut TMV-2 and red gram Co-1 in the ratio of 6:1 is more profitable than a pure crop of either groundnut or red gram.

VERMA, G. 1955.
Mixed cropping with arhar (*Cajanus cajan*). Agric. Anim. Husb., Uttar Pradesh. 6(2-3):42-53. 216

VERTEUIL, L.L. 1962.
The pigeonpea scheme. J. Agric. Soc. Trin. 62(2):252-255. 217

VERTEUIL, L.L. 1963.
Some observations on the pigeonpea industry. J. Agric. Soc. Trin. 63(2): 227-229. 218

Problems to be solved include the presence of insect larvae in the peas and fluctuations in the supply; the possibility of utilizing the shells and the breeding of more suitable varieties should receive attention. Yields up to 4 tons of pods/ha have been attained.

VOELCKER, JOHN AUGUSTUS. 1893.
Cajanus cajan. Report on the improvement of Indian agriculture. London: Eyre and Spottiswood. pp. 26, 46-47, 119, 198, 233-235. 219

WALLIS, E.S. 1976.
Agronomy of pigeonpea (*Cajanus cajan*). Proc. Tropical Grassland Soc. of Australia. Trop. Grasslands 10(3):230-240. 220

C. cajan cv UQ-50 was sown on 15 October and 14 December 1973, and 4 March 1974, to give plant densities of 10,000 to 110,999/ha. Dry seed yields ranged from 1,030 kg/ha with 10,000 plants sown on 4 March to 4,480 kg with 33,333 plants sown on 14 December.

WALLIS, E.S., P.C. WHITEMAN, and J.O. AKINOLA. 1975.
Pigeonpea (*Cajanus cajan* (L.) Millsp.) research in Australia. Proc. First International Workshop on Grain Legumes, 13-16 Jan 1975. ICRISAT. Hyderabad, India. 149-166. 221

Describes the agronomic aspects of pigeonpea, including response to photoperiod, dry-matter production under different conditions, production trials, and aims and objectives.

WATKINS, J.M., and J.M. CANO. 1950.
Improve your soils by sowing legumes. El Salvador Minist. de Agric. y Ganaderia. Circ. Agric. No. 23. 222

A number of legumes are recommended as green manure, including pigeonpea (*Cajanus cajan*). Seeding rates for growing pigeonpea as a seed crop and for green manure are given.

WATSON, K.A., and P.R. GOLDSWORTHY. 1964. Soil fertility investigations in the middle belt of Nigeria. Emp. J. Exp. Agric. 32(128):290-302. 223

Experiments with different types and lengths of fallow have shown that where only a short fallow can be allowed, *Cajanus cajan* or *Andropogon gayanus* as planted covers were more efficient than natural regeneration. There is evidence that fertilizers are as effective as manure in maintaining fertility under continuous cropping.

WATT, SIR GEORGE. 1889. *Cajanus cajan*. Dictionary of the Economic Products of India. pp. 12-15. Calcutta: Supdt. Govt. Printing. 224

WATT, SIR GEORGE. 1908. The commercial products of India - An abridgment of, "Dictionary of the Economic Products of India." London: John Murray. 1189 pp. 225

Pigeonpea is known in India as Cadjan, tuvar (Tuver), tur, thor, arar (uror), rahar dhal, Jahar, oroha, gelamah, togari, kanalu, and peh-yen-klyung. Watt also notes that *C. indicus bicolor* is referred to as the Congo or Angola pea, and *C. indicus flavus*, as the no-eyepea in the West Indies. The plant was probably introduced by slave traders into the West Indies and North America from Africa. In northern Bengal and Assam the arhar is specially grown as a food plant for the lac insect. Silk was produced in Madagascar by silkworm fed on the pigeonpea.

WHYTE, R.O., G. NILSSON-LEISSNER, and H.C. TRUMBLE. 1953. Legumes in Agriculture. Rome: FAO. 21: 367 pp. 226

The scientific and practical information at present available on members of leguminosae is surveyed. Problems of agronomists and others engaged in research are reviewed. Part I contains thirteen chapters dealing with economic botany of legumes, ecological and biotic relationship, legumes in tropics and subtropics, etc. The centers of origin of the chief leguminous genera and species are defined according to Vavilov's proposals. Part II provides information on the chief characters and uses of the different genera and species, and for important crops, also on types and varieties. The survey concludes with tabulated information on plant characters, climatic and soil adaptation, number of seeds per pound, seedling rates, and suitable spacings.

WILLIAMS, S.J.A., and J.A. SPENCE. 1971. Dwarf pigeonpeas as a row crop. Caribb. Fmr 3(1):19. 227

In Trinidad, preliminary results of field trials with dwarf pigeonpea (*Cajanus* spp.) showed that the early flowering and the dwarf habit of the plants allowed dense planting and mechanization. A density of 165,000 plants/ha in rows and mechanical harvesting yielded 2,500 kg/ha after a cropping period of 111 days as compared with 4,500 kg/ha and a cropping period of 210 days for conventional methods of cultivation. Mechanical harvesting cost was 20% of the cost of traditional manual picking.

WILSIE, C.P. 1935. Seed production studies with legumes in Hawaii. J. Am. Soc. Agron. 27: 784-790. 228

This study of the response of *C. cajan* to spacing observes that each plant tries to fill the available space surrounding it, the rate of filling for a given cultivar depending on the sowing density. But the limitations imposed by spacing have not been established. The plant-space relationship is the potential ability of a given cultivar to exploit the environment. Spacing more widely than 1.52 x 2.29 m resulted in a progressive decline in yield, which was lowest at a spacing of 3.05 x 3.05 m.

YADAHALLI, Y.H. 1973. Intercropping of redgram with maize and ragi is profitable. Curr. Res. 2(6):37. 229

Intercropping red gram with maize, ragi (*Eleusine coracana*), groundnut, and soybean gave total yields (seed, grain, unshelled nuts) of 1.86, 1.19, 1.13, and 1.11 t/ha, respectively, compared with 0.57 t/ha for pure stands of red gram.

YADAHALLI, Y.H., G. JAYARAM, and G. SHIVASHANKAR. 1976. Redgram variety Hyd-3C with higher plant population yields more than double that of variety Co-1. Curr. Res. 5(3): 133-134. 230

Increasing the density from 50,000 to 75,000 plants/ha increased seed yields from 1.88 to 2.08 t/ha in the new *Cajanus*

cajan cv Hyd-3C and from 0.95 to 1.04 t in the standard cv Co-1.

YADAV, D.S. 1976.
Be careful to take bumper harvest of arhar this kharif. Fmr Parliam. 11(8): 31-32. 231

The cultivation of arhar as a paying proposition is emphasized. The different aspects of its cultivation discussed are: selection of promising varieties, production package, land and its preparation, fertilization, sowing, weed control, mixed cropping, plant protection, and harvesting.

YADAV, D.S., and M.C. SAXENA. 1975.
All about arhar cultivation. Indian Fmr Digest 8(6):7-8. 232

The essential components of production technology for arhar, such as selection of promising variety, suitable land, fertilization, sowing, weed control, irrigation and drainage, plant protection, mixed cropping, and harvesting are briefly described.

BIBLIOGRAPHIES

BARRIOS, G.A., and V.D. RAMOS. 1973.
Venezuelan bibliography of leguminous seed crops. Maracay, Venezuela, Ministerio de Agricultura y Cria. 44 pp. 233

The bibliography covers *Vigna sinensis*, *Phaseolus aureus*, *Ph. mungo*, *Dolichos lablab*, *Cicer arietinum*, *Vicia faba*, *Lens esculenta*, *Cajanus cajan*, *Glycine max*, and *Ph. lunatus* and includes sections on diseases and varieties.

CHAPMAN, T., and E. HERRERA. 1961.
List of completed research work carried out at the Imperial College of Tropical Agriculture on crop husbandry. I. Short term crops. J. Agric. Soc. Trin. 61(4): 489-503. 234

The list includes published and unpublished work (Student theses deposited in the library of the ICTA) dating from 1921. The crops covered include cotton, groundnut, cowpea, pigeonpea, maize, sorghum, and millets.

DHARAMPAL SINGH. 1955.
Bibliography of research work done in India on major pulse crops - principally on genetics, breeding, and diseases. Agric. Anim. Husb., Uttar Pradesh 6(2-3): 84-89. 235

JADHAV, P.S., T.C. JAIN, and S. PRASANNALAKSHMI. 1975.
Sorghum, millets, peas. A bibliography of the Indian literature. 1969-1973. Hyderabad: ICRISAT. 116 pp. 236

A nonannotated bibliography scanned from 44 Indian periodicals and dealing with general aspects (196 titles), sorghum (207), pearl millet (112), *Eleusine coracana* (46), *Pisum sativum* (31), chickpea (91), and pigeonpea (20). Title index; author index.

BIOCHEMISTRY AND NUTRITION

ABDI, H., and M.K. SAHIB. 1976.
Distribution of lysine in different legumes and some species of Amaranthus seeds. J. Fd Sci. Technol. 13(5):237-239. 237

Protein and lysine content of seven commonly occurring leguminous seeds have been determined. Protein of horse gram seed has highest lysine content. Black gram, pea, and red gram proteins are also rich in lysine. Leguminous seedcoats contain nonprotein nitrogen and some bound lysine. Most of the lysine of the seed is present in albumin fractions; a small portion is found in the globulin and glutelin fractions; and very little lysine is contained in the prolamine.

AHMAD, S.U., F.H. SHAH, and M.S. CHAUDHRY. 1975.
Effect of cooking on the essential amino acid content and net protein utilization (NPU) of common pulses. Pakist. J. Scient. Ind. Res. 13(3-4):175-178. 238

Five commonly grown pulses were evaluated for their total amino acid content, available essential amino acids (cooked and uncooked), and NPU (cooked and uncooked). Tabulated results showed 23.9 to 25.3% crude protein and adequate amounts of EAA except for methionine (0.02-0.17%) and tryptophan (0.19-0.28%). Cooking by conventional methods caused varying losses of amino acids but increased the NPU. The

following results were obtained for percent NPU of cooked and uncooked pulses: black gram 43.85 and 50.30; Bengal gram 57.90 and 61.90; lentil 40.70 and 43.10; green gram 42.70 and 55.20; red gram 32.30 and 57.30.

AHMED, BASHIR, S.L. MEHRA, and G. BHARIHOKE. 1948.
Thiamin content of common Punjab food stuffs in the raw and cooked state (Arhar). Ann. Biochem. Exp. Med. 8(3-4):89-92. 239

Vitamin B_1 was estimated in cereals, pulses, vegetables, fruits, and a few other foods. Most vegetables and fruits were very poor sources, but pulses and cereals contained 2 to 6 µg vitamin B_1/g. The usual methods of cooking are described with some notes on the probable losses of vitamin B_1. The percentage loss in making wheat into chapati was 20 to 30, in making rice pulao 60 to 68, in making pulses into curry 35 to 53, and in making vegetables into curry 25 to 28.

AHSAN, R., F. RIAZ, B.K. ZAIN, and M. ZAIN-UL-ABEDIN. 1968.
Nutrition studies on some pulses commonly consumed in Pakistan. Pakist. J. Biochem. 1:16-20. 240

The nutritive value of *C. cajan* seed is quite high at the 20% protein level, but the seed produced digestive disturbances when fed to mice over a long period as the major dietary constituent.

AKHBAR, S., N.A. KHAN, and T. HUSSAIN. 1973.
Amino acid composition and nutritive value of arhar (*Cajanus indicus*) grown in Peshawar region. Pakist. J. Scient. Ind. Res. 16(34):130-131. 241

Analysis of arhar seeds gave the following results: 21.4% crude protein containing 7.05% lysine; 2.27% histidine; 0.88% methionine; 8.36% leucine; 1.73% fat; and 2.94% ash. Net protein utilization, true digestibility, and biological value were 46.0, 85.8, and 53.7% respectively.

ANONYMOUS. 1936.
Sulfur content of globulins from pigeonpeas. Hawaii Agric. Exp. Stn Report for the year 1935. 25 pp. 242

ANONYMOUS. 1973.
P.A.G. statement (No. 22) on upgrading human nutrition through the improvement of food legumes. PAG Bull. 3(2):1-4. 243

The food legumes, which are major sources of protein and other important nutrients in many developing countries, have been seriously neglected in terms of research necessary to improve their low productivity and to correct defects in nutritional and food acceptance characteristics. This comprehensive statement identifies such deficiencies in the most prevalent food legume crops and proposes to legume breeders desirable procedures for achieving increased yield and improved nutritional and food-use qualities in these staple foods.

AXTMAYER, J.H., and D.H. COOK. 1933.
Nutrition studies of food stuffs used in Puerto Rican dietary 5. The vitamin A contents of arracacha, eggplant, squash, chayote, pigeonpea, chickpea, string beans, mamey, red pepper, boiled green plantain, okra and cassava. PRJ Publ. Health Trop. Med. 8:407-412. 244

The vitamin A content--in units per g of edible portion-- of native food stuffs as detected by the Sherman and Munsell method are reported (in the order in which the food stuffs appear) to be 4.00, 0.33, 2.00, too small to measure, 3.00, 0.5, 10.0, 40.0, 33.0, 20.0, 6.0, and 0.5.

AXTMAYER, J.H., and S. SILVA. 1932.
Nutrition studies of food stuffs used in Puerto Rican dieta / 3. The vitamin G (B_2) content of ripe plantain (*Musa paradisiae* L.) and pigeonpea (gandul) (*Cajanus cajan* L.). PRJ Publ. Health Trop. Med. 8:1-4. 245

Ripe plantain and pigeonpeas contained 0.5 and 2 Bourquin units of vitamin G (B_2) per gram, respectively.

BACHARACH, A.L. 1941.
The distribution of nicotinic acid in human and animal foods (*Cajanus cajan*). Nutr. Abstr. Rev. 10:454-465. 246

The nicotinic acid content of red gram is 5.3 mg/100 g. The biological importance of nicotinic acid or its amide is that it is indispensable for normal growth and health of pigs and dogs and can also prevent or cure some disease in these species.

BAGCHI, K., and S. CHOUDHURY. 1949.
Copper content of some Indian food stuffs (Red gram). Ann. Biochem. Exp. Med. 9(2): 107-112. 247

The copper (Cu) content of 75 Indian food stuffs was determined by a colorimetric method with diethyl-dithiocarbamate reagent. Possibilities of Cu deficiencies in the diets of Indians are discussed.

BANERJEE, B.M., and V.B. TANDON. 1970.
Carotenoids: precursors of vitamin A in precooked Indian lady's finger, greenpea and dal arhar. Labdev. J. Sci. Technol. 8-B(2):76-79. 248

Spectrophotometric studies with precooked accelerated freeze-dried food products showed that lady's finger, green pea, and dhal arhar contain α- and β-carotenes as precursors of vitamin A, licopene, and other biologically inactive isomers, α-carotene making the major contribution towards the vitamin A potency in all the three foods.

BANERJEE, S. 1961.
Biological value and essential amino acid composition of the proteins of some pulses. Proc. Symp. on Proteins. Mysore, India: 355-356. 249

The ten essential amino acids in seven pulses were estimated microbiologically. Amino acid content per 100 g protein was, in descending order: *Phaseolus radiatus, Pisum sativum, Lathyrus sativus, Ph. mungo, Cajanus cajan, Lens esculenta,* and *Cicer arietinum.* Protein ranged from 17% in *Ph. radiatus* to 25% in *L. sativus.* Biological values were estimated with rats. The protein efficiency ratios of five pulses ranged from 1.16 for *L. esculenta* to 1.87 for *Ph. radiatus.*

BASSIR, O., and F.I. IKEGWUONU. 1975.
The in-vivo effects of phytochem agglutinins on atpase and fumarase enzymes in the rat: *Vigna unguiculata, Arachis hypogaea, Cajanus cajan, Phaseolus lunatus, V. umbellata* and *Glycine max.* Toxicon 13(5): 371-374. 250

BASU, K.P., and M.C. MALAKAR. 1939.
Calorific value of Indian foodstuffs. J. Indian Chem. Soc. 16:427-432. 251

A comparative study of the biological value of proteins of *Cicer arietinum* and *C. cajan* was conducted for the maintenance of nitrogen balance and for the promotion of growth in young rats. A detailed analysis of these crops is given. It was concluded that the proteins of *Cajanus* are somewhat inferior to the proteins of Bengal gram at low levels (5% and 10%) of intake, whereas at 15% level, they are superior to the proteins of Bengal gram in promoting growth.

BASU, K.P., and M.K. HALDAR. 1939.
Biological values of proteins of *Cicer arietinum* (Bengal gram) and *Cajanus indicus* (Arhar) by the balance sheet and growth methods. J. Indian Chem. Soc. 16: 209-218. 252

The biological value of proteins of *C. arietinum* and *Cajanus indicus* was determined by the balance-sheet method and by the growth of young rats. In the balance-sheet experiments, *C. arietinum* has a higher biological value than *Cajanus indicus.* In the growth methods, the growth rate per gram of protein intake produced by *C. arietinum* at 15% concentration of protein is less than the corresponding value for *Cajanus indicus*, while at lower concentrations of proteins, *C. arietinum* produces more growth.

BASU, N.M., G.K. RAY, and N.K. DE. 1947.
Cajanus indicus. On the vitamin C and carotene content of several herbs and flowers used in Ayurvedic medicine (*Cajanus indicus*). J. Indian Chem. Soc. 24: 358-360. 253

Of the various herbs examined, mature neem leaves are very rich; tender neem leaves, vesak, dhania, and babla thorn leaves quite rich, both in carotene and vitamin C. The arhar (*Cajanus indicus*) leaves have free vitamin C 50 mg/100 g, and carotene in μ per 100 g = 3,100.0. The study was undertaken to throw light on the possible relationship between the medicinal properties of these herbs and their vitamin C and carotene contents.

BISWAS, H.C. 1943.
Investigations on the saponin content of the Indian pulses. Sci. Cult. 9:165. 254

A comparative test of the saponin content of the pulses, including red gram was made. The method of extracting and purifying the saponin is given. All the available dhals, or pulses, contain saponin to an appreciable extent.

BOSE, R.D., P.M. GANGULI, and S.N. UMAR. 1938.
Cooking tests with Pusa types of pigeonpeas (*Cajanus cajan* (L.) Millsp.). Proc. Indian Sci. Congr. 25(3):214. 255

The ultimate test of all food crops is their cooking value; hence, all improvement programs should include cooking tests. Eighty-six Pusa types of arhar (*Cajanus*) and six hybrids were tested for their cooking quality and classified into three main groups. Some correlation was present between taste and adherence of husk to dhal, color of raw and cooked dhal, and cooking time. No relationship was observed between the taste of dhal and the habit, maturity, or flowering of plant, pod color, size and shape of grain, yield, percentage of husk, and consistency of cooked dhal.

BRAHAM, J.E., M.N. ROLANDO, B. RICHARDO, and J. ROBERTO. 1965.
The effect of cooking and of amino acid supplementation on the nutrient value of the protein of the gandul or pigeonpea (*Cajanus indicus*). (Spanish/English summary). Archos Venez. Nutr. 15:19-32. 256

Studies showed that pigeonpea meal 20-minute autoclaved at 121°C, supplemented with 0.1% tryptophan and 0.3% methionine, was comparable to casein in rat diets fed at 10% protein level. *Cajanus* seeds and meal were found deficient in sulfur, amino acids, and tryptophan.

BRESSANI, R., and L.G. ELIAS. 1977.
The problem of legume protein digestibility. pp. 61-72. *In* Nutritional standards and methods of evaluation for food legume breeders. International Working Group on Nutritional Standards and Methods of Evaluation for food legume breeders. IDRC Publ. TS7e. 257

An analysis of the low protein-digestibility of legume grains and possible reasons for it. If these are identified and could be eliminated, beans will make a better nutritional contribution than they have made during the 4,000 years since their consumption began. The paper discusses the problem of legume protein digestibility and the role played in it by each of these factors: anti-physiological factors, heat treatment, water-soluble nitrogen fractions of cooked beans, proteins resistant to enzymatic hydrolysis, seedcoat pigments, and rate of passage of food residues.

CHATTOPADHYAYA, H., and S. BANERJEE. 1951.
Studies on the choline content of some common Indian pulses. Fd Res. 16(3): 230-231. 258

Estimates the choline content of some common food stuffs in Bengal. The choline content, expressed as choline chloride on dry basis (mg/100 gm), was 201 (± 2.2). Variations in chemical composition are attributed to soil and climatic factors.

CHOUDHURY, KAMAL, and M.M. RAHMAN. 1973.
Fatty acids in different pulses produced and consumed in Bangladesh. J. Fd Sci. Technol. 24(4):471. 259

The total fat ranged from 1 to 1.7% of dry weight in musuri (*Lens esculenta*), arhar (*Cajanus indicus*), matar (*Pisum sativum*), khesari (*Lathyrus sativus*), and mash-kalai (*Phaseolus mungo*). The fat from musuri, arhar, matar, and khesari had 18 to 28% palmitic acid and 54 to 57% linoleic acid. The unsaturated:saturated fatty acid ratios in the fat extracts ranged from 2.3 for arhar to 4.4 for musuri.

CUBAS, A.C. 1950.
Nutritional study of pigeonpea (*Cajanus indicus*). An. Fac. Farm. Bioquim Univ. S. Marcos (Lima, Peru) 1:87. 260

DAKSHINAMURTHI, K. 1955.
Choline content of some South Indian food stuffs (dhal arhar). Curr. Sci. 24(5): 194. 261

Cereals and common vegetables are low in choline, an important nutritional element, dhal arhar (*Cajanus indicus*) contains appreciable amounts of choline.

DANIEL, V.A., B.L.M. DESAI, R. SUBRAMANYA, T.S. URS, S. VENKATARAO, M. SWAMINATHAN, and H.A.B. PARPIA. 1968.
The supplementary value of Bengal gram, red gram, soybean, as compared with skim milk powder to poor Indian diets based on ragi, kaffir corn, and pearl millet. Indian J. Nutr. Dietet. 5(4):283-291. 262

Soybean at 5 to 6% levels was found as effective as Bengal gram or red gram at 15 to 16% level as a supplement to the poor Indian diets based on ragi, kaffir corn, and pearl millet.

DANIEL, V.A., R. LEELA, R. SUBRAMANYA, T.S. URS, S. VENKATARAO, RAJALAKSHMI, M. SWAMINATHAN, and H.A.B. PARPIA. 1965.
The supplementary value of proteins and soybean as compared with those of Bengal gram, red gram and skim milk powder to poor Indian diets based on rice and wheat. Indian J. Nutr. Dietet. 2(3):128-133. 263

The supplementary value of soybean (at 5.5 to 6.0% level), Bengal gram, and red gram (at 15.0 to 16.0% level) to poor Indian diets based on rice (PRD) and wheat (PWD), providing about 2.5% extra protein in the case of rice diets and 2.2% in the case of wheat diets, has been studied by growth

experiments using albino rats. It was concluded that soybean at 5.5 to 6.0% level has the same supplementary value as Bengal gram or red gram at 15.0 to 16.0% level.

DANIEL, V.A., D. NARAYANASWAMY, B.L.M. DESAI, S. KURIEN, M. SWAMINATHAN, and H.A.B. PARPIA. 1970.
Supplementary value of varying levels of red gram (*Cajanus cajan*) to poor diets based on rice and ragi. Indian J. Nutr. Dietet. 7(6):358-362. 264

The incorporation of 8.5% red gram dhal in poor rice diet and 16.7% red gram dhal in poor ragi diet, along with vitamins and minerals, markedly improves the overall nutritive value of the diet as judged by the growth of young rats.

DANIEL, V.A., P. RAJAN, K.V. SANJEEVARAYAPPA, K.S. SRINIVASAN, and M. SWAMINATHAN. 1977.
Effect of insect infestation on the chemical composition and the protein efficiency ratio of the proteins of Bengal gram and red gram. Indian J. Nutr. Dietet. 14:70-74. 265

Bengal gram and red gram were subjected to infestation with *Callosobruchus chinensis* for a period of 5 months. The uric acid content of the infested Bengal gram and red gram was 211 mg/100 g and 205 mg/100 g, respectively. A significant reduction in threonine content of infested Bengal gram and lysine and threonine contents of red gram was observed. The PER values of uninfested and infested Bengal gram were 1.80 and 1.16 and those of red gram were 1.23 and 0.68, respectively.

DEVADAS, R.P., EAPEN MARY, and A. SUSHEELA. 1968.
Effect of supplementation of skim milk and its combination with multipurpose food or red gram dhal on the nutritional status of children. Indian J. Nutr. Dietet. 5(3):206-214. 266

The nutritional status and physical development were higher for E1, receiving skim milk multipurpose food (MPF) payasam, than E2 receiving skim milk-red gram dhal payasam, although the differences were not significant. A combination of red gram dhal and skim milk in the protein ratio of 1:1 can be an efficient substitute for an equal quantity, by protein content, of skim milk. The use of red gram dhal in this manner can help to reduce Indian dependence on imports of skim milk from abroad.

DEVADAS, R.P., R. GIRIJA BAI, and N. SNEHLATA. 1967.
Effect of methionine and tryptophan supplementation to two improved strains of red gram on protein utilization by albino rats. Indian J. Nutr. Dietet. 4(4):300. 267

Even after the protein of the selected strains of red gram (1141 and SA-1) was supplemented with the amino acids methionine and tryptophan, the protein quality did not equal that of skim milk powder. This might be due either to the insufficient quantities in which the amino acids were supplemented, or to other limiting amino acids, such as lysine, in the diet.

DEVADAS, R.P., R. SAMBAMURTHY, and R. ROWLANDS. 1964.
Nutritive value of the proteins of blends of red gram dhal, milk, rice and peas. Indian J. Nutr. Dietet. 1(3):182-183. 268

Groups of four male rats were given diets with about 8% protein derived from skimmed milk; red gram dhal; and a mixture of skimmed milk and red gram dhal 1:5. The protein efficiency ratio (PER) of the skimmed milk diet was 2.6, that of the dhal diet was only 0.58. The replacement of 1 part in 6 of the red gram by skimmed milk increased the PER to 1.6.

DEVI, L.S. 1954.
Bio-assay of heavy metals by *Aspergillus niger*--sensitivity of a new strain. Proc. Indian Acad. Sci. (Sect.B) 40(1):1-7. 269

The standard 'M' strain of *Aspergillus niger* van Teigh, which is used in laboratories as a biological test to detect minute traces of some heavy metals has been compared with a new strain of the same fungus, isolated from the rhizosphere of *Cajanus cajan*, and designated as M.U.B.L.I. This new strain appeared to be less sensitive to traces of manganese, and more sensitive to copper, and perhaps molybdenum, than the 'M' strain.

DHINGRA, P.K., and N.B. DAS. 1959.
Nutritive values of pure strains of Indian Pulses. Ann. Biochem. Exp. Med. 19: 245-248. 270

The chemical composition of two strains each of Bengal, black, green, and red grams; lentil; and pea was estimated. The total protein ranged from 20.11 to 32.37%; phytin P ranged from 22.63 to 50.23% of the total P. Marked variation among strains was noted in total protein content, ether extracts, crude fiber, Fe, total P,

and phytin P. The PER of the pulses was lower than that of casein.

ELIAS, L.G., F.R. CRISTALES, R. BRESSANI, and H. MIRANDA. 1976.
Chemical composition of nutritive value of some grain legume seeds. Turrialba 26(4):375-380. 271

The chemical composition and nutritional value of the seeds of 15 cultivars of common bean (6), cowpea (7), pigeonpea (1), and soybean (1) were investigated in El Salvador. The results show that: (i) protein contents of all samples, except soybean, varied from 20.6 to 27.9%; (ii) protein content of soybean was 41.5%; (iii) lysine content was relatively high, while methionine content was relatively low; and (iv) common bean cultivars showed the lowest values for protein efficiency ratio (0.11-0.46), followed by pigeonpea (0.89), cowpea (1.40), and soybean (2.15).

ELIAS, L.G., M. HERNANDEZ, and R. BRESSANI. 1976.
The nutritive value of precooked legume flours processed by different methods. Nutr. Rep. Intern. 14(4):385-403. 272

Three species of legumes (*Phaseolus vulgaris, Vigna sinensis,* and *Cajanus cajan*) were processed under various conditions to test effect on nutritive value. Whole and ground beans, soaked for 18 hours in 3 liters water/kg of beans, were autoclaved at 16 lb pressure (121°C) for 15, 30, and 45 minutes. Digestibility coefficient of pigeonpea was 47%; at 15 minutes cooking time, PER value of whole grains was 1.94 and protein digestibility was 80.4%. PER value decreased with increased cooking time; thus, 15 minutes was considered enough cooking time.

EVANS, I.M., and D. BOULTER. 1975.
S-methyl-L-cysteine content for various legume meals. Qual. Plant Pl. Fds Hum. Nutr. 24(3-4):257-261. 273

S-methyl-L-cysteine content of seed meal per 16 g N was: *Ph. vulgaris,* 0.87 g; *V. radiata,* 0.5 g; cowpea, 0.56 g; *Ph. lunatus,* 0.43 g; pea, 0.044 g; pigeonpea, 0.033 g. The nutritional significance and the interference in methionine determination of this amino acid are discussed.

GAUR, Y.D., and A.N. SEN. 1973.
Role of legumes and *Rhizobium* in solving the protein problem in India. Qual. Plant Pl. Fds Hum. Nutr. 22(3-4):285-306. 274

Legumes are important sources of proteins in the developing countries. For increasing legume production, *Rhizobium* inoculation and other improved agricultural practices are recommended. Also improving processing methods and improving digestibility of legumes will automatically increase consumption, thus meeting the need for proteins in Indian diets.

GHOSE, S.N. 1922.
The examination of some Indian food stuffs for their vitamin content. Biochem. J. 16(1):35-41. 275

The lentils examined included arhar (small size, yellow-ochre variety). *Cajanus indicus* Spreng., along with other lentils examined, showed good content of vitamin B.

GOPALAKRISHNA, T., R.K. MITRA, and C.R. BHATIA. 1977.
Seed globulins of '*Cajanus cajan*'. Qual. Plant Pl. Fds Hum. Nutr. 27(3-4): 313-326. 276

Seed globulins of *Cajanus cajan*, a widely cultivated legume, were purified and characterized. Of the 78% salt-soluble seed proteins, 61% were globulins; these were further separated into three fractions. The α-fraction was insoluble at pH 4.7 and consisted of two subfractions. Fractions β and γ were soluble at pH 4.7. All the fractions were characterized as glycoproteins by cesium chloride centrifugation. The proteins consisted of subunits held together by covalent disulphide linkages. Amino acid analysis of the different globulin fractions showed that the γ fraction was comparatively rich in sulfur amino acids.

GOPALAN, C., and S.C. BALASUBRAMANIAM. 1966.
The nutritive value of Indian foods and the planning of satisfactory diets. New Delhi: ICMR. 277

GUPTA, G.L., S.S. NIGAM, S.D. SASTRY, and R.L. CHAKRAVARTI. 1969.
Investigations on the essential oil from *Cajanus cajan* (Linn) Millsp. Perf. Essent. Oils Res. 60(11-12):329. 278

Preliminary studies showed that essential oil present in different parts of *Cajanus cajan* was as follows: Seeds 0.002; fruits 0.03; flowers 0.05; leaves 0.16; and tender stems 0.11%. The oil distilled from leaves and soft stems (yield 0.15%) showed:

Copaene 21.3; alpha-selinene 20.4; beta-selinene 16.3; gamma-selinene 24.5; alpha-beta and gamma-endesmol 8.1; sesquiterpene (unidentified), 1.9; and others (Ketene, esters, alcohols, and menoterpenes) 7.6%.

HABIB, F.G.K., G.H. MAHRAS, S.H. HILAL, G.N. GABRIAL, and S.R. MORCOS. 1976.
Phytochemical and nutritional studies on pigeonpea and kidney beans cultivated in Egypt. Z. Ernährwiss Suppl. 15(2): 224-230. 279

Pigeonpeas (*Cajanus indicus* Spreng.) and Kidney beans (*Ph. vulgaris* L. var. Guiza III) were either left raw or cooked in boiling water for 1 hr. Samples were air dried, ground, and subjected to various studies. Raw pigeonpea and kidney bean contained (DM basis):25.2 and 23.2% protein; 4.12 and 3.49% ash; 1.85 and 1.32% ether extract; and 68.78 and 71.99% carbohydrates. Phytochemical studies revealed that both the species contained carbohydrates and/or glycosides; flavonoids, unsaturated sterols, and/or saponins and trypsin inhibitor. Extraction with NaOH gave the highest yield of protein N for both species. Amino acid analysis indicated both species were deficient in methionine, cystine, and tryptophan. Cooking increased the contents of leucine, isoleucine, and threonine, contents of other amino acids decreased or were unchanged. Cooking destroyed the trypsin inhibitors and haemoglutinins.

HANUMANTHA RAO, K., and N. SUBRAMANIAM. 1970.
Essential amino acid composition of commonly used Indian pulses by paper chromatography. J. Fd Sci. Technol. 7(1):31. 280

The essential amino acid contents of Bengal gram, black gram, red gram, green gram, and lentils were 33.5, 40.6, 37.0, 39.1, and 39.3 respectively and their protein scores were 32, 29, 32, 26, and 19 respectively. Pulse proteins are mainly deficient in tryptophan and total sulfur amino acids.

HARTMAN, C.P., N.G. DIVAKAR, and U.N. NAGARAJA RAO. 1973.
Qualitative studies on differentiation of pulses. J. Fd Sci. Technol. 10(4): 195-196. 281

It is feasible to identify different pulses by chromatography of phenolic constituents present. This helps in detecting food adulteration by identifying *Lathyrus sativus* in red gram and Bengal gram.

HERIWA, R.N., and N.G. MAJOR. 1951.
Effect of autoclaving on the nutritive value of Bengal gram, dhal arhar and lentil. Curr. Sci. 20(2):40. 282

The flour was autoclaved and tried on albino rats. Rats fed on raw arhar dhal diet gained more weight than those on autoclaved dhal but the differences were not significant, whereas with autoclaved Bengal gram dhal diet the gain in weight was more than with raw Bengal gram.

HULSE, J.H. 1975.
Problems of nutritional quality of pigeonpea and chickpea and prospects of research. Proc. First International Workshop on Grain Legumes 13-16 Jan 1975. ICRISAT. Hyderabad, India. 189-208. 283

Gives data on chemical and amino acid composition of chickpea and pigeonpea, concluding that both legumes, especially chickpea, represent valuable but considerably under-exploited sources of edible protein.

HULSE, J.H., K.O. RACHIE, and L.W. BILLINGSLEY. 1977.
Nutritional standards and methods of evaluation for food legume breeders. pp. 7-28. International Working Group on nutritional standards and methods of evaluation for food legume breeders. IDRC Publ. TS7e. 284

The food legumes are important and economical sources of protein and calories as well as certain vitamins and minerals essential to human nutrition. Topics discussed in this book include (i) nutritional objectives to which legume breeders should give attention; (ii) recommended physical and chemical methods of analysis; (iii) recommended methods of biological evaluation, (iv) related background material.

HULSE, J.H., K.O. RACHIE, and L.W. BILLINGSLEY. 1977.
Biological evaluation of protein quality of legumes. *In* Nutritional standards and methods of evaluation for food legume breeders. International Working Group on nutritional standards and methods of evaluation for food legume breeders. IDRC Publ. TS7e. 29-34. 285

The amino acid score is a useful guide to the potential nutritive value of the protein. The aspects discussed are rat bioassays, preparation of samples, relative NPR, calculation of NPR. RPV modified (or slope ratio assay), dry matter and protein digestibility, and test for gross toxicity.

IKEGWUONU, F.I., and O. BASSIR. 1976.
The toxicity of phytochemical agglutinins to chick embryos: *Glycine max, Phaseolus lunatus, Cajanus cajan, Arachis hypogaea, Vigna unguiculata*. Hepatocyte fatty infiltration. Toxicon 14(2):139-141. 286

JAFFE, W.G. 1950.
Biological value of some legumes important in Venezuelan diet. Archos. Venez. Nutr. 1:107-126. 287

Data are presented for moisture, protein, ash, fiber, fat, carbohydrates, digestibility of proteins by rats, and *in vitro* biological value of protein for rats, with or without addition of methionine and/or tryptophan. Based on these data, the legumes are arranged in the following order of values, soyanegra (*Glycine soja*), chickpea (*Cicer arietinum*), hyacinth bean (*Dolichos lablab*), kidney bean (*Phaseolus vulgaris*), cowpea (*Vigna sinensis*), garden pea (*Pisum sativum*), lentil (*Lens esculenta*), and pigeonpea (*Cajanus cajan*). In all the legumes except pigeonpea, methionine was the limiting amino acid; in pigeonpea, tryptophan also was deficient.

JAFFE, W.G. 1950.
Protein digestibility and trypsin inhibitor activity of legume seeds. Proc. Soc. Exp. Biol. Med. 75:219-220. 288

No significant difference was found between the digestibilities of raw and autoclaved pigeonpeas, cowpeas, or lentils, and trypsin inhibitor activities of three legumes were only between 1.78 and 2.77 x 10^{-4} units per g.

JAFFE, W.G., M. GROSS, S.A. MOSQUEDA, S. GARCIA, H. OLIVARES, C. EMBDEN, B. NOLBERGA, and H. SARANZ. 1957.
Nutritive content of legumes widely eaten in Venezuela. Archos. Venez. Nutr. 8:97-106. 289

Intake of legumes is high, especially in lower social groups. The average annual intake per head is 13 kg, providing a daily protein intake of 8 g per person. The 34 samples examined were rich in proteins and vitamin B complex but poor in carotene, and their vitamin C would be lost in prolonged cooking. In relation to physiological requirements vitamin B_1, nicotinic acid, and riboflavin were most important. No appreciable quantity of B_{12} was found. Fe content was high, P was fair, but Ca was low. Amounts of methionine and cystine were small except in chickpeas. Tryptophan content was over 1%, except in garden peas, lentils, and pigeonpeas (*Cajanus indicus*). Lysine was relatively high in all, fluctuating between 6.82 and 7.99%.

JERMYN, M.A., and Y.M. YEOW. 1975.
A class of lectins present in the tissues of seed plants. Aust. J. Pl. Physiol. 2:501-531. 290

In legume seeds the major part of the specific glycoprotein lectin is concentrated in the intercellular spaces as distinct globular bodies. The purification and analysis of the glycoprotein from a selection of species is described. Hydroxyproline and glucosamine are present and the major sugars are galactose and arabinose. Neither the function of lectin nor the reasons for its extraordinary evolutionary stability is known. Lectins from *C. cajan* have been studied in more detail by physiochemical techniques.

JOHNSON, R.M., and W.D. RAYMOND. 1964.
The chemical composition of some tropical food plants. 2. Pigeonpeas and cowpeas. Trop. Sci. 6:68-73. 291

A review of literature on the chemical composition of seeds of pigeonpea (*Cajanus indicus*) and cowpea (*Vigna sinensis*). Data are provided on the contents and nature of carbohydrates, proteins and amino acids, vitamins, fats, and some other components.

KADWE, R.S., K.K. THAKARE, and N.N. BADHE. 1974.
A note on the protein content and mineral composition of twenty-five varieties of pulses. Indian J. Nutr. Dietet. 11(2): 83-85. 292

Seeds of varieties of six species were analyzed. The following varieties had the highest protein contents within each species. Sindkheda-1-1 (*Vigna mungo*), Kopergaon (*V. radiata*); EB-3 and Hyderabad (*Cajanus cajan*); K-33 (*Dolichos biflorus*); 88 (*Phaseolus aconitifolius*) and S-19-4-2 (*V. sinensis*). Tabulated data show the calcium, phosphorus, magnesium, and iron content in each variety. In general, the varieties Sindkheda-1-1, Kopergaon, Hyderabad, 148 (*C. cajan*), K-33, 2-4, and S-19-4-2 had the best nutritional value.

KAUL, A.K., and S.P. SHARMA. 1971.
Research on combining nutritive quality with high yield. *In* Recent research on the improvement of protein and nutritive properties of foods and feed plants. IARI Res. Ser. 6:7-32. 293

Colorimetric methods were used to determine sulfur and methionine in a number of pulses. With 295 samples, crude sulfur and methionine contents were not correlated, r = -0.04.

KOLI, BHARATI, DIPALI ROY, and S.P. NETKE. 1973.
Effect of incorporation of soybean meal on protein quality of diets composed of cereals and red gram (*Cajanus cajan*). JNKVV Res. J. 7(3):120-126. 294

Substitution of AGSB (autoclaved ground soybean) for RGD (Red gram dhal) in 10.1% and 12.5% protein diets did not improve the protein quality as judged by the gain in weight and PER. However, marked improvement in protein quality was obtained when AGSB was substituted for 50% RGD protein in 14.4% protein diet. The substitution of entire RGD in 14.4% diet with AGSB improved the nitrogen retention by 41%.

KROBER, O.A. 1968.
Nutritional quality in pulses. J. Postgrad. Sch. IARI, Delhi. 6(2):157-160. 295

The first objective of this nutritional work on pulses is the identification of high-protein genetic material. From this material high-protein varieties of good yield potential are to be developed. Protein quality as measured by amino acid balance is also important. Pulse proteins tend to be high in lysine. Cereal proteins in general tend to be low in lysine. The pulses are a natural high-lysine supplement to the cereal grains with which they are usually eaten. The pulse proteins tend to be low in the sulfur amino acids and in some cases low in tryptophan.

KUPPUSWAMY, S., M. SRINIVASAN, and V. SUBRAMANIAN. 1958.
Protein in foods: pp. 35-60. New Delhi: ICMR. 296

LAXMAN SINGH, NEELAM SINGH, M.P. SHRIVASTAVA, and A.K. GUPTA. 1977.
Characteristics and utilization of vegetable types of pigeonpeas (*Cajanus cajan* (L.) Millsp.). Indian J. Nutr. Dietet. 14(1):8-10. 297

Of four varieties tested, JNAL-530 has the highest oil content. The two vegetable-type varieties, JNAL-139 and JNAL-530, had a higher total polysaccharide and a lower crude fiber content than the two seed-type varieties, JNAL-394 and JNAL-148.

LAXMAN SINGH, D. SHARMA, A.D. DEODHAR, and Y.K. SHARMA. 1973.
Variation in protein, methionine, tryptophan and cooking period in pigeonpea (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Sci. 43(8):795-798. 298

Fourteen genotypes of *C. cajan* were evaluated for phenotypic and genotypic variation in two seasons for protein content of seed methionine, and tryptophan (limiting amino acids); and cooking time. None of the quality characters were associated with seed size or days to maturity.

LOCSIN, A.M. 1935.
Nitrogen partition in three native varieties of pigeonpeas. *Cajanus cajan* (L.) Millsp. Philipp. Agric. 24:481-487. 299

The diamino fraction of the three varieties contains relatively high amounts of arginine and lysine, the differences among the three varieties being slight, and fair amounts of histidine. The percentage nitrogen in the monoamino fraction of the three varieties is about one-half of the total amino acids present. A comparison of the amino acid content of pigeonpea with that of soybean and cowpea shows certain peculiarities such as the apparent absence of cystine in pigeonpea and its presence in soybean and cowpea, the absence of histidine in cowpea and its presence in pigeonpea varieties.

LOMBARD, J.H., and D.J. de LANGE. 1965.
The chemical determination of tryptophan in foods and mixed diets. Analyt. Biochem. 10:260-265. 300

A sample of food containing 600 mg protein was mixed with 25 ml 0.05 NaOH, 10 ml enzyme solution freshly prepared by shaking 2 g papain with 100 ml water for 2 minutes and filtering, and adding 10 drops 5% NaCN. The mixture kept at 70° overnight was cooled, water was added to 100 ml, and 5-ml proportions were mixed with 5 ml 0.1 N KOH and 3 ml CCl_4, shaken for 10 minutes, and then centrifuged for 10 minutes. Supernatant fluid, 1 ml, was mixed with 1 ml 5% p-dimethylaminobenzaldehyde in HCl and 5 ml HCl and after 10 minutes, 2 drops 0.2% $NaNO_2$ were added. The color intensity was

measured at 590μ. The recovery of tryptophan ranged from 96.7 to 101.6%.

LUSE, R.A. 1976.
Screening legume germplasm and field trials for protein content and quality. Proc. IITA Collaborators Meet on Grain Legume Improvement. Seed quality/Biochemistry. 9-13 June 1975. IITA, Ibadan, Nigeria. 110-114. 301

A report on the screening of the 5,000-entry world cowpea collection, soybeans, and other grain legumes at IITA, and the variation in sulfur, nitrogen, and protein in cowpea lines in uniform and advanced yield trials: data are tabulated for 100-grain weight, protein content, and sulfur, nitrogen ratio (average values and range for each trait) for cowpea (113 lines), lima bean (31), pigeonpea (35), soybean (74), *Psophocarpus tetragonolobus* (13), and *Sphenostylis stenocarpa* (36).

MILLER, C.D. 1928.
The vitamin A and B content of the pigeonpea (*Cajanus cajan*). J. Agric. Sci. Camb. 6:8-16. 302

C. cajan seed is deficient in the essential amino acids; further analysis for vitamin content showed that it is also deficient in vitamin A but contains a large amount of vitamin B. In terms of vitamin B, *C. cajan* is an excellent food.

MILLER, C.D., B. BRANTHOOVER, N. SEKIGUCHI, H. DENING, and A. BAUER. 1956.
Vitamin values of foods used in Hawaii. Hawaii Agric. Exp. Stn Tech. Bull. 30. 303

Detailed analysis of both raw and cooked green seed of pigeonpea indicated that at moisture content of 66 to 69% the shelled raw and cooked pea contained respectively, 0.398 and 0.412 mg thiamine, 0.256 and 0.226 mg riboflavin, and 2.43 to 2.33 mg niacin per 100 g of edible food. In terms of vitamin B, carotene, and ascorbic acid, *C. cajan* ranked among the highest out of 285 food items used in Hawaii.

MILLER, C.D., and R.C. ROBBINS. 1936.
Nutritive value of the proteins of *Cajanus indicus*. J. Agric. Res. 53:281-293. 304

First-generation rats made good growth but second-generation rats made only fair growth when fed pigeonpea seed meal at a level to provide 18% of protein in the diet. First-generation rats fed pigeonpea seed meal were able to reproduce; second-generation rats fed with the same diet were not. When the meal was fed at a level to furnish 8% of protein, the addition of cystine did not improve the growth of rats; the addition of cystine, however, markedly improved growth when the seed meal furnished 11% of the protein. The first growth-limiting factor of prepared pigeonpea globulins appears to be tryptophan.

MITRA, C.R., and M.M. CHAKRAVARTHY. 1956.
Fixed oil obtained from some Indian pulses; the component fatty acids of *Cajanus cajan*. Indian Soap J. 21:143-144. 305

The oil extracted from the seeds with petroleum ether (yield 1.4%) had the following characteristics: Iodine value (Wijs, ½ hr) 103.6 sapon. equiv. 318.3, n_{40} 1:4754 per fatty acids (as oleic acid) 0.2%, and unsaponifiable 6.1%. The mixed fatty acids had iodine value 114.2 and sapon. equiv. 277.0 and were made up of linolenic 5.56, linoleic 51.4, oleic 6.33, and saturated acids 36.7%. The fatty acid component is similar to that of other legumes. The high percentage of unsaponifiable matter is rather striking, but this has also been noted in some other fats derived from Leguminosae.

MITRA, S.N., and B.R. ROY. 1960.
Further studies on the detection of Metanil yellow in pulses (dal). Sci. Cult. 25(9):539-540. 306

Metanil yellow is a nonpermissible coal-tar dye in pulses, mainly arhar (*Cajanus cajan*). The presence of large amounts of starch in pulses sometimes prevented the full extraction of the dye in aqueous solution and also hampered the process of wool-dyeing. These difficulties are removed entirely by extraction with alcohol. The method of extraction is described here along with a simple chromatographic test for the identification of metanil yellow.

MITRA, S.N., and S.C. ROY. 1957.
Detection of Metanil yellow in pulses (Dal). Curr. Sci. 26(3):89. 307

Metanil yellow, a harmful coal-tar dye, is sometimes used to color certain types of pulses, mainly arhar (*Cajanus cajan*); its detection in routine analysis of pulses is of considerable importance. Three tests were found useful: preliminary test, wool-dyeing test, and chromatographic test. The chromatographic method can be used to detect metanil yellow in pulse products such as *besan* (chickpea flour) and sweetmeats.

MODI, J.D., and P.R. KULKARNI. 1976.
Studies on the starches of ragi and red gram. J. Fd Sci. Technol. 13(1): 9-10. 308

Starches isolated from ragi and red gram had iodine affinity of 3.08 and 3.13% respectively. The gelatinization temperatures ranged from 56 to 72°C; when tested in an amylograph, both these starches were found to be stable to heat up to 90°C.

MTENGA, L.A., and T. SUGIYAMA. 1974.
A note on the amino acid composition of some legume seeds grown in Tanzania. E. Afr. Agric. For. J. 39(3):307-310. 309

Amino acid contents of cowpea, groundnut, *Ph. vulgaris*, *Cajanus cajan*, and soybean seeds grown in Tanzania are presented.

MUNSELL, HAZEL E. 1949-50.
Composition of food plants of central America. I and VII. Honduras. II, III, and VIII. Guatemala. IV. El Salvador. V. Nicaragua. VI. Costa Rica. Fd Res. 14:144-164. 15:16-33. 310

The composition of various food plants from Honduras, Guatemala, El Salvador, Nicaragua, and Costa Rica set out in tabular form with brief notes on each plant. Analyses are given for the following, among others: *Vigna unguiculata*, *Cajanus cajan*, *Ph. limensis*, *Ph. vulgaris*, *Pisum sativum*, *Cicer arietinum*, *Lens culinaris*, and *Dolichos lablab*.

NENE, S.P., U.K. VAKIL, and A. SREENIVASAN. 1975.
Improvement in the textural qualities of irradiated legumes. Acta Alimen. Hung. 4(2):199-209. 311

Gamma-irradiation of pulses reduced their cooking time by varying degrees (8.39% reduction with 1 Mrad), as measured by a texture-meter. Initially high hydration rate on soaking and cooking stabilized during prolonged cooking and resulted in better and more uniform texture in irradiated red gram. Better vitamin B retention observed in irradiated cooked red gram, is attributed to the reduced cooking time.

NENE, S.P., U.K. VAKIL, and A. SREENIVASAN. 1975.
Effect of gamma irradiation on red gram (*Cajanus cajan*) proteins. J. Fd Sci. 40(4):815-819. 312

Irradiation of pigeonpea seed with 1 to 3 Mrad doses at a γ-irradiation flux of 15 Krad/min increased the level of tyrosine in total amino acids, increased free amino acid content, increased digestibility of protein *in vitro* by pepsin and trypsin, changed the distribution of protein among peaks obtained on elution from a Sephadex G-200 column, and did not affect the trypsin inhibitor activity.

NENE, S.P., U.K. VAKIL, and A. SREENIVASAN. 1975.
Effect of gamma radiation on physico-chemical characteristics of red gram (*Cajanus cajan*) starch. J. Fd Sci. 40(5):943-947. 313

The total reducing sugars of irradiated pulse showed no significant increase over the control. This suggests that the breakdown of starch in red gram was probably limited to higher maltodextrins. Though the quantity of total nonreducing sugars was not affected by irradiation, cooking significantly decreased raffinose and stachyose contents. Degradation of red gram starch has also been observed in terms of a decrease in gelatinization viscosity and an increase in solubility on heating.

NENE, S.P., U.K. VAKIL, C. BANDHYOPADHYAY, and A. SREENIVASAN. 1975.
Effect of gamma-irradiation of redgram (*Cajanus cajan*) lipids. Acta Alimen. Hung. 4(4):373-380. 314

No changes in the total or neutral lipid composition were observed in red gram irradiated at 1 Mrad dose levels. Similarly, saturated and unsaturated fatty acids were not affected by radiation treatment. Radiation prevented development of rancidity and off-flavors during storage for 8 months. Prevention of oxidation under such conditions can be attributed to the synergistic effect of phospholipids in the presence of tocopherols as well as to low moisture content. However, polar lipids seemed to undergo decomposition on irradiation.

NICAM, V.N., and K.V. GIRI. 1961.
Sugar in pulses. Can. J. Biochem. Physiol. 39:1847-1853. 315

Ethanol extracts of ground seeds of red gram (*C. cajan*) and other pulses were analyzed by circular paper chromatography. About 10% of dry weight was saccharides; sucrose 1.3 to 2.7, raffinose 0.4 to 1.1,

stachyose 1.8 to 2.7 and verbascose 3.0 to 4.2%. Sucrose was most variable. Germination tests showed that fructose is liberated, oligosaccharides disappear, and sucrose, which probably forms the intermediary breakdown product, remains more or less constant. Hydrolase activity remained low for the first 3 days of germination.

NIYOGI, S.P., N. NARAYANA, and B.G. DESAI. 1931.
Studies on nutritive value of Indian vegetable food stuffs. I. Nutritive value of pigeonpea (*Cajanus indicus*) and field pea (*Pisum arvense* Linn.). Indian J. Med. Res. 13:1217-1229. 316

The most important protein fraction of the pulses is a globulin moiety. The percentage composition of amino acids in pulse globulin expressed as percent of protein was estimated. The amino acid composition of common Indian pulses is listed on a comparative basis.

NORTON, G. 1976.
Plant proteins. Canada: Butterworths. 156 pp. 317

The three sources of plant proteins, namely, cereals, oilseeds, and legumes, have been considered under the headings of production and demand. The world production of pigeonpeas from 1965 to 1974 was almost static, except for 1967 and 1974, when the production was lower. The production of legumes is very difficult to deal with statistically because of confusion over nomenclature. Different aspects of plant proteins have also been discussed.

OKE, O.L. 1967.
Chemical studies on some Nigerian pulses. W. Afr. J. Biol. Appl. Chem. 9:52-55. 318

Cowpea (*V. unguiculata*), groundnut, lima bean (*Ph. lunatus*), pigeonpea (*C. cajan*), and soybean were analyzed. In soybean Ca was 0.30, in others 0.05 to 0.10%; P was 0.04, in others 0.31 to 0.54%. Values of N and five major and eight minor mineral elements are tabulated. Oxalic acid was 0.1 in cowpea, in others 0.4 to 0.6%. Phytin and P ranged from 30 in soybean to 133 mg % in cowpea or, percent of total P, from 13 in pigeonpea to 33 in groundnut. HCN was 1 in cowpea, 30 mg % in lima bean, none in other pulses.

PAL, R.K. 1939.
A review of literature on the nutritive value of pulses. Indian J. Agric. Sci. 9(1):133-137. 319

Bengal gram has proved to be the best of all the pulses. Green gram is also very good, especially when combined with rice and milk products. Black gram has high nutritive value as a protein. Other pulses such as lentil or red gram may be taken only occasionally. Red gram also acts better than Bengal gram or any other variety when it is eaten with rice.

PANT, R., and A.S. KAPUR. 1963.
The soluble carbohydrates of some Indian legumes. Naturwissenschaften. 50:95. 320

Total soluble carbohydrates in g per 100 g were in *Cajanus indicus* 8.0, *Cicer arietinum* 6.7, *Phaseolus mungo* 6.5, *Crotalaria medicaginea* 7.4, *Cassia obtusifolia* 5.56, *C. occidentalis* 5.52. The last two contained maltose, lactose, and raffinose and all had glucose and sucrose.

PANT, R., and A.S. KAPUR. 1963.
A comparative study of the chemical composition and nutritive value of some common Indian pulses and soybean. Ann. Biochem. Exp. Med. 23:457-460. 321

Cajanus cajan contained per 100 g, moisture 11.20%, protein 22.31%, fat 1.45%, ash 3.21%, Ca 0.128 g, P 0.205 g, Fe 7.62 mg and in mg, riboflavin 138, thiamine 48, and nicotinic acid 49. Amino acid compositions were similar in pigeonpea and soybean. Diets containing 10% of the respective proteins were steamed; biological values were 64.8 (pigeonpea) and 57.5 (soybean) and digestibility coefficients 86.2, 91.4, protein efficiency ratios were 0.82 and 0.50. Although pulses contained less protein than soybeans, they were considered superior because they did not need processing to destroy antigrowth factors.

PANT, R., and A.S. KAPUR. 1964.
Free amino acids in some edible and inedible Indian legumes. Hoppe-Seyler's Z. Physiol. Chem. 333:39-41. 322

Free amino acids were detected by paper chromatography in *Cajanus cajan, Cicer arietinum, Ph. mungo, Ph. radiatus, L. esculenta, Pisum sativum* (green and white varieties), *Vigna catjang, Glycine max*, and in three nonedible wild legumes. No legume contained all the essential amino acids but *Cajanus cajan, Cicer arietinum*, and *Lens esculenta* each had seven.

PREMA, L., and P.A. KURUP. 1973.
Hypolipidaemic activity of the protein isolated from *Cajanus cajan* in high fat cholesterol diet fed rats. Indian J. Biochem. Biophys. 10(4):293-296. 323

Marked reduction in the total and free cholesterol, phospholipid, and triglyceride contents of all the three tissues was observed at all the levels studied. The animals receiving 10% level show lipid levels very similar to those in the animals fed normal diet. The protein fraction is heterogeneous and contains 7.8% carbohydrates. About 85% of the protein is precipitated at 75% saturation with $(NH_4)SO_4$; the precipitate contains all the hypolipidaemic activity of the protein.

PUSHPAMMA, P. 1975.
Evaluation of nutritional values, cooking quality and consumer preferences of grain legumes. Proc. First International Workshop on Grain Legumes, 13-16 Jan 1975. ICRISAT. Hyderabad, India. 213-220. 324

Data on chemical composition of seeds of pigeonpea and chickpea and of subcellular fractions of groundnut cotyledon obtained in nonaqueous solution, and on the cooking qualities of these legumes.

RAI, KALPANA, DIPALI ROY, and S.P. NETKE. 1973.
Effect of incorporation of soybean meal on protein quality of diets composed of cereals and red gram (*Cajanus cajan*). Part II. JNKVV Res. J. 7(3):146-151. 325

The substitution of AGSB (autoclaved ground soybean) in 10.1% and 12.0% protein diets did not cause any improvement in protein quality. In 14.2% protein diet, the substitution by 25% caused significant increase in nitrogen retention. The beneficial effects of substitution of AGSB for RGD (Red gram dhal), could only be obtained in diets containing 14% protein, in which more than half the protein was provided by RGD.

RAJAMMAL, P.D., R. SAMBAMURTHY, and R. RAJESWARI. 1964.
The nutritive value of the proteins of blends of redgram dhal, milk, rice and peas. J. Nutr. Dietet. 1:182-183. 326

The protein efficiency ratio (PER) of a mixture of red gram dhal and skim milk powder and rice and peas was determined at 8% level of protein intake over a period of 4 weeks. The PER of a mixture of three parts of red gram protein and one part of milk proteins was 1.6, as compared with a value of 0.58 obtained for red gram alone. The PER of a mixture of 3.6 parts of rice proteins and 4.4 parts of pea proteins was 1.80, as compared with 2.60 for skim milk powder.

RAMA RAO, M.V., M.R. TARA, and C.K. KRISHNAN. 1974.
Colorimetric estimation of tryptophan content of pulses. J. Fd Sci. Technol. 11(5):213-216. 327

The colorimetric procedure developed by Spies and Chambers (1948, 1949) has been applied to determine tryptophan content of proteins of pulses. It is observed that the amount of sodium nitrite to be added for the reaction needs to be increased to 0.1 ml of 0.02% solution as against the recommended 0.1 ml of 0.05% solution. This brings out more color. With this modification, the tryptophan content of pulses investigated was in the range of 0.7 to 1.78 g/16 g N as against the literature values of 0.5 to 0.8 g/16 g N.

RAMASASTRI, B.V., and P. SRINIVASA RAO. 1968.
Some studies on the nutritive value of rice varieties and pulses. J. Postgrad. Sch. IARI, Delhi. 6(2):113-122. 328

The digestibility of the carbohydrate content of four of the commonly used pulses -- green gram, red gram, black gram, and Bengal gram -- was studied. *In vitro* amylolysis with the use of ground raw and cooked pulses and with the isolated starches revealed differences in the rates of hydrolysis of the starch present in these pulses.

RAMIAH, P.V., and P. SATYANARAYANA. 1938.
Studies in the quality of crops. II. Nutritive values of proteins of different varieties of red gram (*Cajanus indicus*). Madras Agric. J. 26(4):134-136. 329

Different varieties of red gram obtained locally and from the hills were compared for their nutritive values, and it was found that the local variety has a high protein content and digestibility value.

RANGANATHAN, S. 1938.
The available iron in some common Indian food stuffs determined by the α-α-dipyridine method. Indian J. Med. Res. 25(3): 677-684. 330

One hundred common Indian foodstuffs have been analyzed for their available iron by

a chemical method involving the use of α-α-dipyridine. The method evolved by Kohler *et al* has been improved. The food stuffs analyzed were found to vary widely in percentage of total iron available. Leafy vegetables and condiments and spices, usually considered good source of iron, show a low percentage availability, while the other groups of foodstuffs contain iron of which about 30 to 40% is available. Pigeonpea has 23.3% of total iron available.

RANGANATHAN, S., A.R. SUNDARARAJAN, and M. SWAMINATHAN. 1937.
Survey of the nutritive value of Indian food stuffs. Indian J. Med. Res. 24(3):689-706. 331

Pulses are a good source of protein, containing on an average 24.47%. They are somewhat richer than cereals in most chemical constituents and, on the average, more than twice as rich in proteins. Detailed analyses of various chemical constituents of different food stuffs are tabulated. More emphasis should be laid on biological value of proteins, and on the concentrations and availability of mineral salts.

RAO, P.S. 1969.
Studies on the digestibility of carbohydrates in pulses. Indian J. Med. Res. 57(11):2151-2157. 332

In vitro digestibility studies of raw and cooked Bengal gram, green gram, red gram, and black gram and their starches with commercial α-amylase indicated that carbohydrates of green gram are better digested than any other pulses investigated.

RATHNASWAMY, R., R. VEERASWAMY, and G.A. PALANISWAMY. 1973.
Studies on red gram (*Cajanus cajan* (L.) Millsp.) seed characters, cooking quality and protein content. Madras Agric. J. 60(6):396-398. 333

An assessment was made of the seed characters, cooking quality, and protein contents of the annual and perennial types of red gram. The perennial types MS-9537, PLS-362, and PLS-363 had bigger and heavier seeds than those of the annuals and SA-1. The annual types, which were richer in protein (21.1%),also cooked more easily.

ROYES, W.V., and A.C. FINCHAM. 1975.
Grain quality in *Cajanus* and *Cicer*. First International Workshop on Grain Legumes. 13-16 Jan 1975. ICRISAT. Hyderabad, India. 209-212. 334

Means for estimating protein quality, amino acid profiles, breeding for amino acid contents, problems and other considerations of nutrition are discussed.

RUDRA, M.N., and L.M. CHOWDHURY. 1950.
Methionine content of cereals and legumes. Nature 166:568. 335

Methionine was estimated colorimetrically and the percentage value obtained for red gram was 0.15. It was considered that lathyrism in animals fed on vetch pea is connected with the low methionine content of this plant.

SANKARAN, S., and V. SRINIVASAN. 1963.
Evaluation of red gram types for cooking quality. Madras Agric. J. 50(1): 470-472. 336

The cooking quality of nine introduced cultivars of red gram (*Cajanus cajan*) was poorer than that of cultivar SA-1. Since there is evidence of a significant negative correlation between cooking time and protein content, these types were presumably inferior to the standard also in quality.

SEVILLA-EUSEBIO, J., J.C. MAMARIL, J.A. EUSEBIO, and R.R. GONZALES. 1968.
Studies on Philippine leguminous seeds as protein foods. I. Evaluation of protein quality in some local beans based on their amino acid patterns. Philipp. Agric. 52(4):211-217. 337

Amino acid compositions of (i) mungo (*Phaseolus aureus*) (ii) paayap (*Vigna sinensis*) (iii) kadyos (*Cajanus cajan*) and (iv) tapilan (*Phaseolus calcartus*) bean determined by a modified ion-exchange method after hydrolysis were compared with the amino acid composition of whole egg.

SEVILLA-EUSEBIO, J., R.R. GONZALES, J.A. EUSEBIO, and P.F. ALCANTARA. 1968.
Studies on Philippine leguminous seeds as protein foods. II. Effect of heat on the biological value of mungo, paayap, tapilan, and kadyos beans. Philipp. Agric. 52(4): 218-232. 338

To assess the quality of proteins in (i) mungo (*Phaseolus aureus*) (ii) paayap (*Vigna sinensis*) (iii) kadyos (*Cajanus cajan*) and (iv) tapilan (*Phaseolus calcartus*), feeding

experiments were conducted on pigs. Milk protein proved superior to all beans studied. Toasting the beans for 30 min. at 80 ± 5°C improved protein efficiency and apparent digestibility. To a lesser degree, heating also improved total weight gains of the baby pigs. Feed efficiency and apparent biological value of beans (iii) proteins proved inferior.

SHARDA, D.P., K. PRADHAN, and PRAHLAD SINGH. 1976.
A note on the effect of damaged pulses in the diet on the performance and carcass quality of growing-finishing pigs. Indian J. Animal Sci. 46(12):677-679. 339

Damaged pulses (*C. indicus* and *V. mungo*) used for groundnut and maize (10%) in pig standard diets, showed that average daily gain, feed efficiency, and protein efficiency ratio tended to be greater on the pulse diet. Carcass yield was not affected. Carcass length, proportion of lean cuts, and total lean tended to be greater and back-fat less in pigs given 10% pulses.

SHARMA, Y.K., A.S. TIWARI, K.C. RAO, and A. MISHRA. 1977.
Studies on chemical constituents and their influence on cookability in pigeonpea. J. Fd Sci. Technol. 14(1):38-40. 340

Estimation of eight chemical constituents in 22 cultivars of pigeonpea revealed significant differences among cultivars for most of the constituents studied. None of these constituents was found associated with cooking period, except phytic acid content, which showed positive association of appreciable magnitude. The varieties requiring minimum time for cooking were S-7, EB-38-70, JA-3, NP(WR)-15, and UPAS-120.

SINGH, S., H.D. SINGH, and K.C. SIKKA. 1968.
Distribution of nutrients in the anatomical parts of common Indian pulses. Cereal Chem. 45:13-18. 341

Values are tabulated for proximate constituents, P, Ca, and Fe in whole pea, lentil, pigeonpea (*Cajanus cajan*), mungbean (*Phaseolus aureus*), french bean (*P. vulgaris*), cowpea (*V. sinensis*) and guar (*Cyamopsis tetragonoloba*). The embryo, the richest part, was only 1.0 to 2.3% of the whole seed. Cotyledons (83.0 to 90.4% of seed, except for guar, 42.8%) account for almost the entire nutritive value and milling to remove seedcoat and embryo would have little effect.

SIVARAMAN, E., and MAGGIE MENACHERY. 1967.
Studies on the nutritive values of cowpea (*Vigna catjang*) and tur dhal (*Cajanus cajan*). Indian Vet. J. 44(2):162-169. 342

The nutritive value of tur dhal (*Cajanus cajan*) and cowpea was investigated using albino rats. Cowpea flour fed for 28 days in a diet at an 18% protein level on nitrogen basis, promoted a significantly higher growth response in the rats than tur dhal supplied through an isoproteimic diet. No difference was noticed between the diets in their ability to support the formation of red cells, hemoglobulin, and plasma protein in the normal growing rats. Assessment of the hemopoietic response in adult animals by the phenylhydrozinc anaemia technique showed that for promoting hemoglobin formation, the two pulse protein diets are less efficient than the control diet containing casein. The significance of these observations is discussed briefly.

SRIKANTIA, S.G. 1975.
Chickpea and pigeonpea: Some nutritional aspects. First International Workshop on Grain Legumes. 13-16 Jan 1975. ICRISAT. Hyderabad, India. 221-223. 343

Production, nutritional quality, attempts to improve nutritional quality, limiting amino acids, variation in protein and amino acids. Other nutrients, trypsin inhibitors, and flatus formation are described.

SUNDARAM, P.S., R.V. NORRIS, and V. SUBRAMANIAM. 1929.
Studies on the protein of Indian food stuffs. II. The protein of the pigeonpea (*Cajanus indicus*). Indian Inst. Sci. J. 12(A):193-205. 344

The seeds of arhar contain two globulins, Cajanin and cajani, which account for 58% and 8%, respectively, of the total nitrogen, differing from each other in their sulfur and tryptophan contents. The globulins appear to be characteristic of the genus and independent of the differences in types and varieties. They are rich in tyrosine and moderately rich in cystine, arginine, and lysine. The principal protein of *Cajanus*, cajanin, is deficient in essential diamino acids.

SUNDARARAJAN, A.R. 1938.
Phytin-phosphorus content of Indian food stuffs. Indian J. Med. Res. 25(3): 685-691. 345

The phytin-phosphorus content of 67 food stuffs has been determined. In cereals a high percentage of total phosphorus is present as phytin, while in vegetables, with certain exceptions, the phytin percentage is small or absent. The condiments and species investigated in general occupy an intermediate position. A large proportion of the phosphorus in pulses also exists as phytin.

SUSHEELAMMA, N.S., and M.V.L. RAO. 1974. Surface-active principle in black gram (*V. mungo*) and its role in the texture of leavened foods containing the legume. J. Sci. Fd Agric. 25(6):665-673. 346

A surface-active fraction with the characteristics of a globulin and an arabinogalactan type polysaccharide were shown to occur in *V. mungo*. These two components appeared to be responsible for the characteristic texture of leavened foods containing the legume. Lower foam-forming activity was found in *C. arietinum*, *V. radiata*, and *C. cajan*.

SWAMINATHAN, M. 1938. The relative amounts of the protein and non-protein nitrogenous constituents occurring in food stuffs and their significance in determination of the digestibility coefficient of proteins. Indian J. Med. Res. 25(4):847-855. 347

The relative amounts of protein and nonprotein nitrogenous constituents occurring in certain cereals, pulses, nuts, oilseeds, condiments, vegetables, and milk have been determined by the Stützer method. The average amounts of nonprotein nitrogen expressed as percent of total nitrogen occurring in the different groups of foodstuffs, were as follows: cereals 5; pulses 9; nuts and oilseeds 5; condiments 6; vegetables 14; and milk 9%. If the protein content of a food is determined by multiplying the nitrogen content by 6.25, the digestibility coefficient of proteins may be underestimated, owing to the presence of varying amounts of nonprotein nitrogen, which may be poorly available in digestion.

TARA, M.R., C.W. LEE, J.F. MORTON, T.J. KAPADIA, and L.J. DUNHAM. 1974. Sarcoma induced in rats by extracts of plants and by fractionated extracts of *Krameria ixina*. J. Natl Cancer Inst. 52:445-448. 348

Eight plant species were tested on rats for production of esophageal cancer. *Cajanus indicus* was not effective in causing cancer. Cancers were caused by *Acacia villosa* root, *Melochia tomentosa*, *Heliotrophum angiospermum* and *Krameria ixina*. Extracts of *K. ixina* with tannins removed did not cause cancer.

TARA, M.R., and M.V. RAMA RAO. 1972. Changes in essential amino acid content of arhar dal (*Cajanus cajan*) on dehydration. J. Fd Sci. Technol. 9(2):76. 349

Tryptophan and glutamic acids were higher, and isoleucine, valine, and tyrosine in arhar dhal were lower than that reported in literature. Precooking and drying of the dhal with or without Papain treatment was found to have no significant effect on the protein scores. Methionine followed by isoleucine was the limiting amino acid in the proteins of the dhal, raw or processed.

TARA, M.R., and M.V. RAMA RAO. 1975. Changes in free amino acids of arhar dhal (*Cajanus cajan*) in processing. J. Fd Sci. Technol. 12(2):71-74. 350

Nearly 40% of the ninhydrin positive constituents were comprised of peptides, mostly glutamyl peptides, of phenylalanine. All natural amino acids were found to be present, glutamic acid being highest, with asparagine and glutamine next. During processing of the dhal, a slight increase in peptides was found. Part of the alanine appears to be bound to proteins in such a way that it is released by the mild hydrolytic conditions of processing. Arginine (7.5 μ mole/g) was found in higher amounts than other amino acids.

TARA, M.R., T.N. RAWAL, and M.V.R. RAO. 1972. Effect of processing on the proteins of arhar dhal (*Cajanus cajan*). Indian J. Nutr. Dietet. 9:208-212. 351

Percentage of proteins extracted by various solvents was determined, and was 28.6 for water and 65.9 for NaCl solution. Percentage extracted by water was 33.3 for precooked and dehydrated dhal (PD); 44.2 for papain-treated dhal (PTD); by NaCl solution 20.0 and 24.1 respectively. Free amino acid content decreased with processing but was higher for PTD than for PD. Extracts of processed dhal were autoclaved for 30 min at 15 lb pressure. Percentage soluble proteins remaining in solution was 80 to 100 showing that heat denaturation had

taken place to the fullest extent during the preliminary processing. Further experiments showed that the decrease in soluble proteins in the solvents occurred in the first 6 minutes of steaming.

TAWDE, S. 1961.
Isolation and partial characterization of red gram (*Cajanus indicus*) trypsin inhibitor. Ann. Biochem. Exp. Med. 21: 359-366. 352

Red gram trypsin inhibitor has a typical protein-like UV absorption ranging between 252 and 278μ. It resembles glycoprotein in nature; reacts stoichiometrically with crystalline trypsin; is quite active over a pH range of 2.5 to 10.1; and is fairly heat-stable. The various normal acid extracts of red gram meal analyzed for trypsin inhibition showed maximum activity with 0.05 N HCl extract with a pH value of 4.4. The amino acid composition of this inhibitor showed the absence of histidine and presence of low amounts of tryptophan, cystine, and methionine, and larger amounts of leucine, threonine, proline, and lysine compared to that of lima bean, pancreatic, and ovomucoid trypsin inhibitors.

TAWDE, S., and H.R. CAMA. 1960.
Fractionation and isolation and electrophoretic characterization of red gram globulins. Symposium on proteins. Biol. Res. Coun. Soc. Biol. Chem., India. 1:8-13. 353

The fractionation of red gram proteins was carried out by (i) extraction with different solvents, (ii) dialysis of sodium chloride extract against water, (iii) fractional precipitation with ammonium sulfate. All the fractions were tested for their homogeneity electrophoretically. The dispersibility characteristics of these proteins studied by successive extraction in various solvents -- water, 10% NaCl, 0.25 M NaOH -- and separately in 75% alcohol, showed the absence of prolamine nitrogen and a low content of gluten nitrogen. Though NaCl solution extracted the major portion of the globulins, water also extracted globulins to some extent. Dialysis of NaCl extract against water yielded a fairly homogeneous fraction, while the fractions obtained with 20, 40, and 60% ammonium sulfate saturation were all found to be heterogeneous. Of all the methods used, dilution and fractional precipitation was found to be the best for isolation of red gram globulins, yielding a major globulin fraction that was homogeneous between pH 3.0 and 12.0, with isoelectric point at pH 4.65.

TAWDE, S., and H.R. CAMA. 1962.
Physico-chemical studies on indigenous seed proteins. 5. Amino acid composition of red gram (*Cajanus indicus*) meal and globulin fractions. J. Sci. Indust. Res. 21C: 162-163. 354

Amino acids were estimated by circular paper chromatography in red gram meal and its three globulin fractions. Except that proline and tryptophan were about twice as high, values for meal agreed fairly well with those of others. Methionine and cystine, 0.20 and 0.89% of the meal, were measurable in only one fraction, 0.42 and 3.02%. This fraction had most of the essential amino acids but was poor in lysine, threonine, and tryptophan. No histidine was found.

TAWDE, S., and K.V. GIRI. 1960.
Physico-chemical studies on indigenous seed proteins. 4. Peptization of red gram (*Cajanus indicus*) proteins and their characterization by electrophoresis. J. Sci. Indust. Res. 19C:190-194. 355

Cajanus indicus contains 23.81% protein. A meal-to-water extractant ratio of 1:5 solubilizes 80% of proteins in 120 min. The isoelectric (percent) points of these proteins have been found to be about pH 4.0. Alkaline salts are found to be better extractants of proteins. Sodium bicarbonate solution at a concentration of 0.001 M proved to be the most effective extractant. Maximum electrophoretic separation of the protein components, one major and two minor, occurs between pH 7 and 8.6, ionic strength 0.1.

TRIPATHI, R.D., G.P. SRIVASTAVA, M.C. MISRA, and S.C. SINHA. 1975.
Comparative studies in the quality characteristics of early and late varieties of red gram (*Cajanus cajan* L.). Indian J. Agric. Chem. 8(1):57-61. 356

When grown under identical conditions, eight late-maturing *C. cajan* cultivars were superior to eight early-maturing cultivars in seed yields; 1000-seed weight; dhal (split seeds) recovery percentage; and dhal, protein, and methionine yields. The early-maturing cultivars had higher seed protein contents (20.62 to 25.5%) than late-maturing ones (19.95 to 21.75%); methionine contents were similar.

VANGALA, R.R., and E. MENDEN. 1969.
The amino acid composition of some African legumes. Int. Z. Vitamforsch. 39: 203-209. 357

Amino acids were estimated in pigeonpea (*Cajanus cajan*), blackeyed pea (*Vigna sinensis*), cowpea (*V. unguiculata*), lima bean (*Ph. lunatus*), and *Centrosema pubescens*. There was little difference between raw and cooked products. Except for cooked pigeonpeas, there was poor agreement between calculated values and values obtained by animal experiment. It was concluded that protein quality depends not only on amino acid composition but also on such heat labile factors as enzyme inhibitors and hemaglutinin.

VIJAYALAKSHMI, D., S. KURIAN, D. NARAYANASWAMY, S.V. RAO, and M. SWAMINATHAN. 1972.
Blood amino acid studies in the weaning rat on diets containing raw and cooked red gram. Indian J. Nutr. Dietet. 9(3): 129-134. 358

Amino acid content and trypsin inhibitor activity of raw and cooked red gram were determined. Plasma amino acid scores indicated that methionine and tryptophan were the first limiting amino acids in red gram; lysine and threonine were easily available from the proteins. Enzymatic digestion studies showed lysine, methionine, threonine, and tryptophan to be equally available from raw and cooked red gram, indicating that the trypsin inhibitor of red gram did not affect liberation of amino acids during digestion of the proteins. PER of raw red gram was low (0.68), but improved with cooking (to 1.43) and with supplementation with methionine and tryptophan (to 1.93).

VIJAYARAGHAVAN, P.K., and P.R. SRINIVASAN. 1953.
Essential amino acid and composition of some common Indian pulses. J. Nutr. 51:261-271. 359

The essential amino acid composition of five common Indian pulses and *Vigna catjang* has been reported. Unlike lysine, which is a limiting amino acid for cereals, the limiting amino acids for pulses were found to be methionine, cystine, and tryptophan. The relationship between the chemical score essential amino acid index and biological value is discussed.

VISWANATH, B., R.J. LAKSHMANA, and P.A. RAGHUNATHASWAMI AYYANGAR. 1916.
Some factors affecting the cooking quality of dhal (*Cajanus indicus*). Mem. Dep. Agric. India Chem. Series. 4(5): 149-163. 360

The study has been limited to the following: (i) the effect of the composition of the water upon the rate of cooking, (ii) the influence of the fat content on the rate of cooking, (iii) differences in the rate of cooking due to variety, (iv) differences in the rates of cooking due to methods of preparing dhal, (v) the influence of various salts on the liquefaction of starch. The dissolved salts found in natural waters exert a marked influence on the time taken to cook dhal. The addition of sodium bicarbonate or sodium carbonate to a hard water materially hastens the cooking. The fat content of dhal plays a very important part in rate of cooking. Dhals from different localities have varying rates of cooking.

BOTANY

AKINOLA, J.O., and P.C. WHITEMAN. 1972.
A numerical classification of *Cajanus cajan* (L.) Millsp. accessions based on morphological and agronomic attributes. Aust. J. Agric. Res. 23:955-1005. 361

Ninety-five accessions from eleven countries were field-grown and studied throughout a year. Using the MULTCLAS hierarchical program and a version of Burr's Euclidean system, the accessions were classified into 15 groups on the basis of 31 attributes.

ANONYMOUS. 1960.
News and Notes. Africa: Edible African legumes. Riz. Rizic. 1960. 362

Cajanus cajan and a number of legumes are illustrated with notes on popular names and botanical characteristics.

BASUDEV, R. 1933.
Studies in the development of the female gametophyte in some leguminous crop plants of India. Indian J. Agric. Sci. 3(6): 1098-1107. 363

The development of the female gametophyte was studied in *Cajanus indicus* and other

legumes. The curvature of the ovules is towards the apex of the ovary. Ovules are more or less camylotropous. The synergids of *Cajanus* possess well-defined filiform apparatus. The polar nuclei migrate towards each other and fuse to form the primary endosperm nucleus. The haploid number of chromosomes is eleven.

BROUK, B. 1975.
Plants consumed by man. London: Academic Press. 479 pp. Pigeonpea: p. 125. 364

Pigeonpea or *Cajanus cajan* (family Leguminosae) is probably a native of Africa. It was cultivated in ancient Egypt at least 2,000 years B.C., as is proved by the seeds found in the tombs of the Seventh Dynasty. It is also probable that pigeonpea was brought to India in prehistoric times, and it diversified there into many types. Two varieties can be recognized: *C. cajan* var. *flavus* which has green glabrous pods usually with three seeds and includes the Tur cultivars extensively cultivated in India, and *C. cajan* var. *bicolor* which has hairy, dark maroon pods usually containing four to five seeds and including arhar cultivars, grown in northern India.

COBLEY, L.S. 1956.
An introduction to the botany of tropical crops. Pigeonpea (*Cajanus cajan*). London: Longman , Green. pp. 158-160. 365

Pigeonpea is cultivated throughout the tropics, especially in the more arid areas, since it is a deeply rooting, perennial plant and fairly drought resistant. The seeds are used throughout the tropics as a pulse. The plant is of ancient origin and its home was presumably in the African subcontinent. The African types are fairly uniform. The Indian types differ in many characters. The young stems are angled and hairy. The leaves are alternate trifoliate structures, petioles are grooved. The leaflets are oval, entire, and slightly hairy, the terminal leaflet considerably larger than the laterals. The inflorescences are shorter than the leaves. Each flower has a hairy four-lobed calyx. The stamens are diadelphous and the ovary is tapering structure, covered with shiny brown silky hairs. The pods are straight, constricted. The seeds are roundish, reddish-brown in color but varying from fawn to purple. There is a white elliptical hilum, and germination is hypogeal.

CONFODONTIS, V.G. 1957.
Cajanus cajan L. Senckenberg. Biol. 38(5-6):405-415. 366

DATTA, P.C., and ARATI DEB. 1970.
Floral biology of *Cajanus cajan* (Linn) Millsp. var. *bicolor*. D.C. (Papilionaceae). Bull. Bot. Soc. Bengal. 24(1-2): 135-145. 367

In the two varieties studied, flowering period appeared to be influenced by weather conditions. Many flowers fall off by abscission in the 4 days between anthesis and fruit setting. A high percentage of cleistogamous flowers were found early in the flowering period. Fertilization occurs 5 hours after pollination and this long period may explain the large proportion of flowers failing to form fruits.

DE, D.N. 1976.
Origin, evolution and distribution of Cajanus and Phaseolus: Western Ghats as a microcentre (Abstract). Indian J. Genet. Pl. Breed. 36(1):141-142. 368

A study of *Cajanus* and its morphologically and taxonomically closest relative *Atylosia* indicated that an erect form of *Atylosia* has given rise to the cultivated *Cajanus*. A study of the distribution of the 25 known species of *Atylosia* indicated that the forest of the Upper Western Ghats in India is the center of origin of *Cajanus*.

DE CANDOLLE, A.P. (EDITORS). 1886.
Origin of cultivated plants (2nd ed). New York: Hafner. 1959. 369

DURGA PRASHAD, M.M.K., and B.L. NARASIMHA MURTHY. 1963.
Some observations on anthesis and pollination in red gram (*Cajanus cajan*). Andhra Agric. J. 10:161-167. 370

Flower buds attained full development into flower in 19 days. Flowers opened between 35° and 44°C, the maximum number opening between 43° and 44°C. The maximum dehiscence of anthers was between 38° and 40°C. Thrips seem to be the agent for self-pollination in this crop; insects such as blister beetles and honey bees visiting after the flower opens are responsible for cross pollination to a limited extent. After pollination it took 35 days for maturation of the pod.

DUTHIE, J.F., and J. FULLER. 1883.
Field and garden crops of the North Western provinces and Oudh, 2. Roorkee, India. pp. 20-22. 371

The form *Cajanus flavus* is known under the name tur and is commonly cultivated in Madhya Pradesh, while *C. bicolor* is the arhar of Uttar Pradesh.

F.A.O. 1959.
Tabulated information on tropical and subtropical grain legumes. Rome: FAO. pp 45-62. 372

Includes information on different aspects of pigeonpea, such as origin, common names, and uses.

GANGULI, D.K., and D.P. SRIVASTAVA. 1969.
Variability studies in arhar (Pigeonpea). Ranchi Agric. Univ. Res. J. 4:13-16. 373

In trials with 10 pigeonpea cultivars, there was a wide range of phenotypic variation in the number of leaves, pods, and seeds per plant and in plant height and seed yield per plant; a narrow range in the number of total and fruiting branches per plant, pod length, number of seeds per pod, and 100-seed weight. Environmental factors had the greatest influence on seed yield/plant.

GOPINATH, D.M. 1945.
Cleistogamy in some of the flowers of *Cajanus indicus* L. Curr. Sci. 41:74. 374

The flowers of *Cajanus* are considered to be chasmogamic, having such insect visitors as *Megachile lanata* and *Apis florea*. Anthesis takes place 24 hours before the opening of the flowers. From September to November the percentage of ecological cleistogamic flowers goes up to 80 . The exact edaphic factors responsible for such a feature have not been determined.

HECTOR, J.M. 1936.
Introduction to the botany of field crops. Vol. II. Noncereals Johannesburg: Central News Agency. 709 pp. 375

Described *Cajanus* as a monotypic genus.

HOSAKA, E.Y., and J.C. RIPPERTON. 1944.
Legumes in the Hawaiian ranges. Hawaii Agric. Exp. Stn Bull. 93:7-79 (24-25). 376

The following aspects of pigeonpea are described briefly: Habit, stem, leaf, stipules, flower, seed, pod, seed distribution and habitat, importance, and uses.

A number of strains of pigeonpea occur in the islands. The flower color of the seven common strains is yellow, but that of other strains is reddish. The seed color varies from nearly white to dark brown. The strains also differ greatly in their growth habits and seed production. Development of a strain better adapted to grazing would be most advantageous.

HUTCHINSON, J.B. (EDITOR). 1967.
Key to the families of flowering plants of the world. London: Oxford University Press. 377

HUTCHINSON, J.B. (EDITOR). 1974.
Evolutionary studies in world crops. Diversity and changes in the Indian subcontinent. London: Cambridge Univ. Press. 175 pp. 378

This book, developed from a symposium held at IARI, New Delhi in 1970, is an account of the evolution of crops in the Indian subcontinent and consists of five parts. Part 3, "Crops of South Asia and Africa," includes a chapter on pigeonpea (*Cajanus cajan*) by D.N. De. Part 5, entitled "Review," includes two chapters by J.B. Hutchinson on "Crop Plant Evolution in the Indian subcontinent" and on "The Challenge of the New Agriculture."

KAUL, C.L., and S.P. SINGH. 1969.
Validity of stain tests in determining pollen viability of some papilionaceous plants. Indian J. Agric. Sci. 39: 1050-1055. 379

Pollen grains of eight species belonging to seven genera of Papilionaceae were studied and scored for viability. Nitro-BT-stained, germinated, and acetocarmine-stained pollen samples were compared, because the validity of the acetocarmine test has been questioned in recent years. A highly positive correlation between the three tests suggests that all of them are reliable if fresh samples are used. But with stored pollen the three tests sometimes showed marked variations.

KRAUSS, F.G. 1911.
Leguminous crops for Hawaii. Hawaii Agric. Exp. Stn Bull. 23:1-30. (21-30). 380

Pigeonpea, commonly called the Porto Rican pea, after the source from which it was first introduced. Its general plant morphology is described. Its uses as cattle forage, soil improver (due to its long strong tap roots), cover crop, and green

manure are also discussed. Two varieties, old type No. 218 and new type No. 219, are described.

LACKEY, J.A. 1977.
A revised classification of tribe *Phaseoleae, Leguminosae, Papilionideae* and its relation to canavanine distribution. Bot. J. Linn. Soc. 74:163-178. 381

NAIR, P.K.K.K., and A. SEN. 1964.
On the tissues in the petals of *Cajanus cajan* Spreng. Curr. Sci. 33(12): 376-377. 383

The distal parts of all petals are membranous and are composed of elongated rectangular cells. Before the petal comes out of calyx, the spongy tissue in the wing is uniform and no banding occurs. The spongy banded tissue on the abaxial side of the wings may possibly be the seat of nectar in *Cajanus cajan*, providing easy access to honey bees.

OCHSE, J.J. 1931.
Vegetables of the Dutch East Indies. English ed. Buitenzorg. Java. 384

Ochse gives the Malayan name of pigeonpea as Katjang, or Katjang Kayoo; the Javanese and the Maduresi name as Goode, or Katjang goode; and the Sudanese name as Heeris or Katjang heeris. He further notes that one becomes sleepy upon eating too many of the raw seeds, which may have slightly narcotic properties.

OZA, G.M. 1972.
What is the native home of the pigeonpea? Indian Forester: 98(8):477-478. 385

This note shows that *Cajanus cajan* probably originated in India.

PURSEGLOVE, J.W. 1968.
Cajanus cajan L. *In* Tropical crops, dicotyledons. 2. London: Longman. pp. 236-241. 386

RANGASAMY, P., R. VEERASWAMY, and C. RAMALINGAM. 1975.
Studies on flowering and pod set in redgram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 62(5):295-298. 387

Five varieties were studied. S-41 gave the highest pod set and Co-1 the highest yield. The pod-to-grain-weight ratio of S-31 was 13:1; that of S-42 was 1.8:1. S-42 had the highest 100-grain weight.

ROYES, W.V. 1976.
Pigeonpeas: *Cajanus cajan* (Leguminosae: papilionaceae). *In* Evolution of crop plants. N.W. Simmonds, Ed. London: Longman pp. 154-156. 388

SEN, N.K., and I. MUKHOPADHYAY. 1961.
Studies in embryo culture of some pulses. Indian Agric. 5:43-56. 389

The embryonic axes of gram, arhar, and horse gram seeds could be cultured in different nutrient media. Randolph's and White's media proved to be equally good for the culture of arhar embryos. Supplementation of the different media with vitamin B containing 1 ppm thiamin, 5 ppm nicotinic acid, and 1 ppm pyridoxine, markedly increased the number of rootlets in all the species and gave stouter seedlings in arhar and horse gram. Addition of nutrient solution to the soil mixture at the time of transplantation is highly beneficial.

SHAMA RAO, H.K., and S. NARAYANASWAMY. 1976.
Anatomical anomalies in tissue culture-induced roots of *Cajanus cajan* (L.) Millsp. Proc. Indian Acad. Sci. (Sect. B). 83(5):207-209. 390

Internal perturbation as a result of irradiation was marked in 10 Kr-treated roots in which each xylem group was reduced to a single metaxylem vessel with few or no protoxylem elements, secondary growth was absent consequent on loss of cambium, and the phloem was transformed into fibrous tissue.

SHARMA, D., LAXMAN SINGH, H.K. SHARMA, and R.R. PARASHAR. 1971.
Plant types in arhar (*Cajanus cajan* (L.) Millsp.) and their bearing on varietal improvement. SABRAO Newsletter 3(2): 109-112. 391

Pigeonpea varieties with different growing durations can be classified into tall compact, tall open, medium height compact, medium height open, and dwarf bushy types. Early to medium-maturing varieties are generally medium height open type, while in the late group tall compact types predominate. Yield was significantly correlated with the spread of the plant, number of secondary branches, effective pod-bearing length, and pod number/plant. The adaptability of plant types in different growing conditions is discussed from the viewpoint of selection.

SHAW, F.J.F. 1934.
Improved varieties of crops produced at Pusa (Tur). Agriculture Live-Stk, India. 4(5):471. 392

Eighty-six types of tur (*Cajanus cajan*) were isolated at (old) Pusa, India, and tested for yielding ability and resistance to wilt disease. Seven promising types from them were released for distribution. Of these seven, yielding 1,300 to 1,900 lb/ac (1,456 to 2,128 kg/ha), three (type 15, 16, and 51) were erect late types, and the rest (type 24, 64, 80, and 82) were spreading late. Types 16, 51, and 80 were wilt resistant. Morphological characters of the seven types are described.

SHAW, F.J.F., A.R. KHAN, and H. SINGH. 1933.
Studies in Indian pulses. (3). The types of *Cajanus indicus* Spreng. Indian J. Agric. Sci. 3:1-36. 393

General information on the possible origin and cultivation precedes a note on pollination (including the extent of natural crossing) as observed under conditions in Bihar and a full description of the morphological characters with a key to the various types and also a descriptive list of 86 of them. The question of wilt resistance is touched upon.

SHUKLA, S.P. 1967.
On polyembryony in *Cajanus cajan* (L.) Millsp. Sci. Cult. 33(2):80-81. 394

The occurrence of more than one embryo in a single seed and their subsequent growth into established seedlings was noticed in *Cajanus cajan*. On the basis of seed germination, the frequency of polyembryony recorded was as much as 1.66%. Frequency of bi- and tri-embryonate seeds was also recorded. There were indications that the middle seedling always dominates over lateral ones.

SUBRAMANYAM, K. 1950.
Anthesis in *Cajanus indicus* Spreng. Curr. Sci. 19:215. 395

It is pointed out that information on anthesis is of importance in crop breeding. Observations on anthesis in the *C. indicus* variety 216-061 are reported.

VENKATESWARA RAO, P. 1973.
Development and anatomical studies in *Cajanus cajan* (Linn.) Millsp. Ph.D. (1973) Thesis. Sardar Patel University, Vallabh Vidyanagar, Gujarat, India. 118 pp. 396

WENHOLZ, H. 1920.
Pigeonpea. Agri. Gaz. N.S.W. 31(12): 888. 397

Pigeonpea is a perennial summer legume that grows quickly and reaches a height of 6 or 7 ft (1.8 to 2.1 m) at maturity. The morphology of the plant is described. The seed is similar in appearance to the grey field pea, which is in favor for pigeons, but which is only about half the size. Only the young growth and the leaves are suitable for fodder. The best use can be to plant a hedge along a poultry or pigeon-yard, and allow the seed to fall and be picked up by birds. Owing to the succulence of the young shoots and leaves the crop as a fodder is best used for grazing. A fair crop of seed is from ½ to 3/4 ton per acre (1.12 to 1.7 mt/ha).

WESTPHAL, E. 1974.
Pulses in Ethiopia, their taxonomy and agricultural significance. Centre for Agricultural Publishing and Documentation, Wageningen. 263 pp. ISBN. 90. 220 0501-1. 398

Cajanus derived from the Malay plant name Katjang by which some pod or bean is meant. In foreign ears the word Katjang sounded like Cajan and this vernacular name thus spelled was Latinized as *Cajanus*. Its taxonomy, ecology, husbandry, and uses are described.

WHYTE, R.O. 1976.
An environmental interpretation of the origin of Asian food legumes. Indian J. Genet. Pl. Breed. 35(1):61-68. 399

It is suggested that in continental Asia the change of leguminous herbs from a formerly predominantly perennial state to communities containing a high proportion of annuals originally occurred as an expression of the physiological stress caused by environments unfavorable to the persistence of the perennial species. The operative factors that would have been involved in such a change are considered.

BREEDING

ABODUNDE, S.O. 1965.
Introduction of pulses from India to Northern Nigeria. Samaru Agric. Newsletter. 7(3):40-42. 400

Pigeonpea selection 1141, introduced from Madras state (India) into Nigeria, was grown in observation plots. The strain is different from the common Nigerian variety, with a duration of 4 to 5 months. Crops of this variety could be grown in April or in July. Indian methods of processing the seed into split peas (Dhal) are described.

ABRAMS, R. 1967.
Studies on natural cross pollination in pigeonpeas (*Cajanus cajan*). J. Agric. Univ. P. Rico. 51(1):1-21. 401

An average of 5.8% cross-pollination took place between rows 8 ft. (2.44 m) apart in Puerto Rico. No natural hybrids resulted from plants artificially selfed and bagged.

ABRAMS, R., and J. VELEZ-FORTUNO. 1961.
Radiation research with pigeonpeas (*Cajanus cajan*): results on X_1 and X_2 generations. J. Agric. Univ. P. Rico. 45(4): 197-204. 402

Irradiation with gamma rays exceeding 16,000 roentgens or exposure to neutrons for more than 2 hours impaired the viability of pigeonpea (variety Kaki) seeds and reduced plant height in the X_1 generation. The X_2 generation was considerably more variable than the parent variety with respect to plant height and time of flowering.

ABRAMS, R., and VELEZ-FORTUNO. 1962.
Radiation research with pigeonpeas (*Cajanus cajan*): results on X_3 and X_4 generations. J. Agric. Univ. P. Rico. 46(1): 34-42. 403

Radiation by means of gamma rays and neutrons produced mutations in pigeonpeas, showing earlier and later flowering dates than the parent variety. This could result in an extension of the production season in Puerto Rico. Yield improvement was large enough to be detected in trials with modern designs. Some of the genetic characteristics could be fixed by repeated single-plant selection.

ABRAMS, R., J. VELEZ-FORTUNO, and J. GARCIA LOPEZ. 1969.
The interaction of variety and environment in pigeonpea (*Cajanus cajan*) trials. J. Agric. Univ. P. Rico. 53(1):61-66. 404

Statistical analysis of field trials with 20 varieties of pigeonpea (*Cajanus cajan*), over 3 consecutive years at two locations showed a considerable effect of varieties on yield, date of flowering, plant height, and seed weight. Data indicated that performance of varieties may be significantly dependent on years, whereas no effect was observed for the locations. This suggests that varietal introduction of this crop should be preceded by replication of tests over at least 3 years to obtain reliable information.

ANONYMOUS. 1935.
The gungo or pigeonpea. J. Jamaica Agric. Soc. 39:330. 405

The home of gungo or pigeonpea was in the East, probably in India, where it is extensively grown. It is now found throughout the tropics. In Jamaica, although never grown on a large scale, it is an article of the diet. As a fairly high percentage of cross fertilization takes place naturally, the isolation of pure varieties is less simple than for other leguminous crops. Some superior strains exist in Jamaica, for example, varieties No-eye, Popus, Tamarind, and Minto.

ANONYMOUS. 1939.
Changes in the nomenclature of improved varieties of crops bred at the Imperial Agricultural Research Institute. Nagpur Agric. Coll. Mag. 14(1-2):147-148. 406

A list of the old and new names of the varieties of crops under distribution is given. For Rahar (*C. cajan*) the old and new names are as follows:

Old name	New name
Pusa Type 15	I.P. 15
" 24	" 24
" 51	" 51
" 64	" 64
" 80	" 80

ANONYMOUS. 1943.
Annual report of the Imperial Council of Agricultural Research for 1942-43, New Delhi. 407

Improvement of pigeonpea studied; selection for wilt resistance was made and work started in Madras for selecting high-

yielding strains.

ANONYMOUS. 1943.
Progress report of the Institute of Plant Industry, Indore, Central India for the year ending 31st May 1943. 408

Cajanus indicus: The improved strain IP-15 has been developed, suitable for Malwa, and further work is being carried out to develop a better strain.

ANONYMOUS. 1946.
Progress report of the Institute of Plant Industry, Indore, Central India, for the year ending 31st May, 1944. 32 pp. 409

Cajanus indicus: Samples of local tur (pigeonpea) collected from various localities in central India were tested against Indore Selection No. 5 and E.R. 38 from the Central Provinces; Indore Selection No. 5 showed a general superiority. Indore No. 5 is being multiplied for distribution.

ANONYMOUS. 1947.
India, United Provinces, Annual Administration Report of the Agriculture Department, for the year ending 30th June, 1945. Allahabad. 86 pp. 410

Work on pulses involved *Cajanus cajan* also. About 600 selections, representing an all-India collection of *C. cajan* varieties, were studied and some types promised special wilt resistance, hardiness, and high yield.

ANONYMOUS. 1948.
Annual Administration Report of the Department of Agriculture, United Provinces, for the year 1946-47: 83 pp. 411

Varietal trials with different pulses have enabled certain improved seed types to be recommended and distributed to various research stations in India and abroad.

ANONYMOUS. 1954.
Administration Report of the Director of Agriculture, Trinidad and Tobago, for the year ended 30th June, 1952. 54 pp. (Mimeographed). 412

Other crops: Selection of rice and pigeonpea is in progress.

ANONYMOUS. 1965.
Improved crop varieties and their yields. Indian Fmg 15:35-38. 413

Some improved varieties of crop plants evolved by the IARI are given. In pigeonpea the varieties listed are NP(WR)15 and NP(WR)18; both are late maturing, high yielding, and wilt resistant.

ANONYMOUS. 1966.
New variety of pigeonpea. Farmer, Kingston, Jam. 71(9-10):213-215. 414

Pigeonpea growing in Jamaica is being promoted through the introduction and development of better varieties. The Puerto Rican variety Kaki proved to be the highest yielder, another promising variety being No-eye from St. Thomas, which commands a premium because of excellent flavor and high suitability for canning. One of the locally found varieties is a very large-seeded type and the other is capable of producing pods throughout the year.

ANONYMOUS. 1971.
Pulse varieties developed at IARI. Indian Fmg 21(10):47. 415

Three arhar varieties, Pusa Ageti, Mukta, and Sharda are released. Pusa Ageti has dwarf plants, clustered pods. Its seeds are shiny brown, bold, and attractive. Being early maturing, it escapes frost. Mukta matures in about 170 days, has fairly wide adaptability, and is resistant to wilt. Sharda is medium tall, semi-spreading, matures in about 165 to 170 days. It is best suited as a high-yielding rainfed crop.

ANONYMOUS. 1971.
Particulars of new strains of crops approved for release by the fifth meeting of the State Seed Committee on 24 [illegible].1970. Madras Agric. J. 58(2):51-53. 416

The red gram selection 1141, since proposed for release as CO-1, is nonseason bound, with a short duration of 4½ months. It is suitable for growing either as a pure or a mixture crop both under irrigated and unirrigated conditions. As an unirrigated crop, it equals SA-1 in yield but is shorter in duration. It is suited to the whole of Tamil Nadu for growing all through the year.

ANONYMOUS. 1972.
New redgrams yield more in less time. Intensive Agric. 10(3):6. 417

Pusa Ageti, Sharda, and Mukta are better varieties of red gram than the existing ones. Their cultivation, fertilization, weeding, and pest control are discussed.

ANONYMOUS. 1973.
A note on required legume research. PAG Bull. 3(4):11-14. 418

The importance of grain legumes is emphasized. For increasing their productivity the following aspects are discussed: (i) increasing the genetic potential of seed yield, (ii) improving photosynthetic efficiency, (iii) improving the sink potential, (iv) improving the nutrition of pulse crops, (v) improving the nutritive value of pulse crops, (vi) agronomic management and plant protection, (vii) collection, assessment, and maintenance of germplasm.

ANONYMOUS. 1974.
Co.1 redgram - a new short-duration and high-yielding variety. Fm News 2(2): 21. 419

This variety yields up to 1,600 kg/ha and is ready for harvesting in 135 to 140 days after sowing, which is 6 to 10 weeks earlier than many other varieties. Co.1 is suitable for growing with *Arachis hypogaea*, is relatively high in protein, and has an attractive flavor when cooked.

ANONYMOUS. 1974.
Improved arhar evolved at JNKVV Campus, Jabalpur. Mod. Agric. 5(1):94. 420

Most available arhar varieties are late maturing, with low yield potential. To eliminate these shortcomings, an attempt was made at JNKVV, Jabalpur, India, during 1971-1972 to isolate a desired mutant from radiation treatment. The mutant recovered had much bigger pods, larger flowers, and larger seeds as compared to the normal diploid, T-21. The mutant, besides maturing earlier, gave higher yields than T-21.

ANONYMOUS. 1975.
U.S. Agency for International Development, Office of Agriculture. Technical Assistance Bureau. International Agricultural Research Network in Grain Legumes. 6:11. 421

The different aspects of improvement in grain legumes are discussed.

ANONYMOUS. 1976.
Pantnagar University develops early maturing varieties of arhar. Indian Fmr Digest. 9(8):7-8. 422

The early strains, Pant A-1, A-2, A-3 and UPAS-120 are also high-yielding, escape frost damage, and can be harvested by the first week of November. Suitable for arhar-wheat rotation under normal weather conditions.

ARIYANAYAGAM, R.P. 1976.
Out-crossing and isolation in pigeonpeas. Trop. Grain Legume Bull. 5:14-17. 423

Using marker plants, the degree of outcrossing was measured in a pigeonpea population. Outcrossing was likely to occur with a 3% probability beyond 43 ft (13 m); seeds harvested from within this distance should conform to standard purity requirements. It was recommended that in adjacent plots of two cultivars, 27 ft (8.2 m) of guard rows in each adjoining plot would provide an adequate barrier.

BADAMI, V.K. 1936.
Improvement of crops in Mysore (A review of twenty-five years' work). J. Mysore Agric. Expl. Union 17:113-137, 190-207. 424

The present area under togari (*Cajanus indicus*) needs to be tripled or the yield raised by 300%, to meet the requirement of pulses of the state. Pusa selections have given high yields. T-51 has given the highest yield of 800 lbs per acre (896 kg/ha); T-41 and T-16 come next with yields of 666 and 533 lbs per acre (745 and 597 kg/ha), respectively. The other types T-80, T-82, and T-50 have also been tested. Some of these produce heavy tonnage of green matter and are well suited as green manures, especially where the sannhemp crop is badly attacked by moth.

BHARGAVA, R.N. 1975.
Two new varieties of arhar for Bihar. Indian Fmg 25(1):23. 425

Cajanus cajan Kanke-9, derived from a cross between BR-60 and perennial *C. cajan*, is a semierect, medium-maturing, high-yielding variety of good cooking quality. It is resistant to *Fusarium udum*. Kanke-3 is a selection from a cross between BR-183 and perennial *C. cajan* and has a bushy, spreading habit. It matures slightly earlier than Kanke-9 and is of go d cooking quality. It is high-yielding and moderately resistant to *F. udum* and frost.

BHASKARAN, K. 1954.
Crops and crop improvement in Hyderabad. Agric. Coll. J. Osmania Univ. 1: 60-63. 426

Tur (*Cajanus cajan*) which is believed to have originated in Africa, has been under large-scale cultivation for a long time.

Two wilt-resistant strains of tur, C-11 and C-26, have been released for distribution to farmers.

BRESSANI, R., and L.G. ELIAS. 1977.
Tentative nutritional objectives ir the major food crops for plant breeders pp. 51-61. *In* Nutritional standards ard methods of evaluation for food legume breeders. International Working Group on nutritional standards and methods of evaluation for food legume breeders. IDRC Publ. TS7e. 427

Selection of good crops must be based on production/hectare as the first component of productivity, modified by the nutritional quality, and finally by a technological index. The aspects discussed include: variability in nutrient content, food consumption patterns, nutritional characteristics of cereal grains and legume foods, approach to arriving at nutritional standards, the increased intake of legume grains at the expense of cereal grains, and proposed protein and amino acid levels in some basic foods.

BURNETT, F. 1949.
Report on Agriculture in Malaya for the year 1947. Kuala Lumpur, 1949. 86 pp. 428

Plant introductions included *Cajanus cajan*. These are descriptions of entomological and pathological investigations.

CAMPBELL, J.S., and H.J. GOODING. 1962.
Recent developments in the production of food crops in Trinidad. Trop. Agric. Trin. 39:261-270. 429

A review of selection and breeding work on pigeonpea, dasheen, yam, and other food crops.

CHANDRA, T., B.K. TRIPATHI, and R.P. KATIYAR. 1975.
Genetic variability, heritability and genetic advance of yield and its components in Arhar (*Cajanus cajan* (L.) Millsp.). Mahatma Phule Agric. Univ. Res. J. 6:95-99. 430

Among 23 strains of arhar, a wide range of phenotypic variability was observed in all the plant characters except pod length and number of seeds per pod. A high genotypic coefficient of variability was exhibited by yield per plant, number of primary and secondary branches, and number of days to flowering. Heritability estimates were high for all the characters except number of seeds per pod. Number of days to flowering and number of primary and secondary branches with high heritability were also linked with high genetic gain, probably due to additive effects.

CHATURVEDI, S.N., and R.P. SHARMA. 1978.
EMS-induced sterile mutants in redgram. Curr. Sci. 47(5):173-174. 431

Six male-sterile mutants obtained in the M_2 generation from 0.2% EMS treatment were classified into two groups: TSM (Tall sterile mutant) and SSM (Spreading sterile mutant). The flowering on these mutants was late by nearly two months. The flower structures were modified into a cone. None of these mutants produced any fruit due to the high degree of pollen sterility (78.06 to 92.13%).

CHAVAN, V.M., N.B. KAJJARI, F.B. KURTAKOTI, and V.K. ANGADI. 1957.
Improved tur strains for Dharwar District. Poona Agric. Coll. Mag. 47(4): 251-253. 432

Cultures T-136-1 and 24 have given 33% higher grain yield than the local check. The stand, branching, and bearing habit of the new strains were good. Besides height, number of branches are also tabulated.

CHOPDE, P.R. 1969.
Mutagenic effects of X-ray irradiation on *Cajanus cajan* (L.) Millsp. MKV Agric. Coll. Parbhani. 433

DECORY, R. 1963.
Plants introduced into Madagascar and local toponymy. (French). J. Agric. Trop. Bot. Appl. 10(5-7):204-218. 434

This annotated list of plants includes: rice, maize, *Colocasia antiquorum*, *Cannabis indica*, *Voandzeia subterranea*, groundnut, *Cajanus indicus*, *Lablab vulgaris*, *Manihot utilissima*, and *Ipomoea batatas*.

DESHPANDE, R.B., L.M. JESWANI, and A.B. JOSHI. 1963.
Breeding of wilt resistant varieties of pigeonpea. Indian J. Genet. Pl. Breed. 23:57-63. 435

The variety NP-51, which is large-seeded and resistant to *Fusarium udum*, was crossed with the high-yielding NP-24; this resulted in four promising hybrids of which NP(WR)-15 gave high yields at six stations. In order to incorporate earliness with wilt resistance, NP-51 was crossed with T-132

and Brazilian and Jamaican varieties were also crossed with NP-41 and NP(WR)-15, and promising lines have been obtained.

DHARMAPAL SINGH, and J.M. SAHAI. 1958.
A new gram and a new arhar for U.P. farmers. Indian Fmg 8(1):15-16. 436

Type 105 (arhar) is a tall, spreading variety, late maturing and taking 140 days to flower. The seed is medium-sized and brown. Yields 1,800 to 2,200 kg/ha. Matures 10 days earlier than Type 17.

ESH, G.C., T.S. DE, and U.P. BASU. 1959.
Influence of genetic strain and environment on the protein content of pulses. Science 129:148-149. 437

Investigations on *Cajanus cajan, Cicer arietinum, Phaseolus aureus, Ph. mungo, Vigna sinensis, Lens esculenta, Lathyrus sativus* and *Pisum sativum* at the Bengal Immunity Research Institute, Calcutta, showed both strain and locality to be important factors influencing protein content.

F.A.O. 1975.
Report of the TAC working group on the biology of yield of grain legumes. Rome: FAO. 438

Discusses productivity of grain legumes, plant architecture and yield, photosynthesis, factors affecting nitrogen fixation, and other related aspects.

FENNELL, M.A. 1963.
Present status of research on edible legumes in Western Nigeria. Proc. First Nigerian Grain Legume Conf. 1963:16-29 pp. 439

Progress in the evaluation of local and introduced varieties of *Vigna capensis*, groundnut, *Cajanus cajan, Phaseolus coccineus, Ph. lunatus* and soybean is reported. Hope 5989 is a variety of *Cajanus cajan* from the United States with tolerance to *Meloidogyne*.

GOODING, H.J. 1960.
Some problems of pigeonpea improvement. J. Agric. Soc. Trin. 60(3):321-328. 440

The work done in Trinidad on pigeonpea (*Cajanus indicus*) improvement before 1937 is reviewed. In 1956, a fresh start was made, the program being directed towards the production of green pods. It aims at obtaining dwarf and semidwarf strains which are early bearers and produce all their pods within a short interval, and which are to a marked extent independent of the sowing date. The paper represents the text of a lecture.

GOUD, J.V., and R.V. LAKSHMI. 1972.
S.5 a promising variety of red gram for dryland. Curr. Res. 1(6):44. 441

S-5 gave a yield of 839 kg/ha. It is a bushy, dwarf plant type, suited to high population density, maturing earlier than the local variety. It could be used for both pure crop and mixed crop and still be adjusted to a multiple cropping sequence even in drylands.

GOVANDE, G.K. 1950.
New strains of pulses and millets in Baroda State. Indian Fmg 11:153-154. 442

The pulses and lesser millets improvement scheme for Baroda in the year 1948-1949 obtained no conclusive results on *Cajanus indicus*. Selections Dehgam 35 and Vijapur 49 were promising.

HANDIQUE, L.K. 1951.
Annual report of the Department of Agriculture, Assam, for the year ending 31st March, 1950. Part 1. 357 pp. 443

Cajanus cajan: Many cultivars introduced from nearby Indian States for inclusion in the breeding program proved susceptible to *Fusarium* wilt. From some 100 promising selections, several true-breeding pure lines were isolated; these combine desirable yield capacity and quality with wilt resistance.

HAWTIN, G.C., K.O. RACHIE, and J.M. GREEN. 1977.
Breeding strategy for the nutritional improvement of pulses. pp. 43-50. *In* Nutritional standards and methods of evaluation for food legume breeders. International Working Group on Nutritional Standards and Methods of Evaluation for Food Legume Breeders. IDRC Publ. TS7e. 444

The following aspects are discussed: breeding objectives, nutritional objectives, screening methods, genetic considerations, genetic variation, environmentally-induced variation, genotype x environment interactions, heritability, major genes, minor genes, linkage, transgressive segregation, correlation, breeding methods for nutritional improvement, population improvement, and future trends in nutritional improvement.

HOWARD, A., G.L.C. HOWARD, and A.R. KHAN. 1919.
Studies in the pollination of Indian crops. I. Mem. Dep. Agric. India. (Bot. Ser.) 10:195-200. 445

At the Pusa Agricultural Research Institute, it was observed that natural crossing in pigeonpea occurs to the extent of 14%.

HUTCHINSON, J.B., and V.G. PANSE. 1936.
The introduction of improved strains of crop plants in central India, Rajputana: *Cajanus indicus*. Agriculture Live-Stk India. 6:397-432. 446

Summarizes results of 195 randomized replicated trials with 106 strains of different crops, including tur (pigeonpea), in the seasons 1932-1935, at 42 centers in Central India and Rajputana (Rajasthan). The tur (Arhar) strain Malvi is recommended for Jaipur, Alwar, and Datia. It is concluded that local adaptation is strong in most, if not all, of the crops studied, and that the maximum crop improvement can be achieved by local breeding work.

ICRISAT. 1974.
Pigeonpea. At ICRISAT. July/Aug/Sept. 2-3. 447

The breeding-line collection maintained at ICRISAT contains 3659 entries. In 21 crosses with up to 1,000 pollinations per cross a maximum pod set of 42.1% was recorded. Interactions between planting date and days to flower suggest that other factors are involved in the photoperiod-flowering response.

ICRISAT. 1974.
Pigeonpea improvement. *In* ICRISAT Annual Report 1973-1974. Hyderabad, India. 35-40. 448

IITA. 1973.
Grain legume improvement program. *In* IITA Report. Ibadan, Nigeria. 78 pp. 449

Cajanus: Of seven *C. cajan* lines tested, 3D-8111 (UC 5543-1), 3D-8127 (UC 1381-1), and 3D-8104 (UC 5103-1) are proposed for release. They are high-yielding, semidwarf (120-150 cm), of short duration (106-140 days), and resistant to most diseases in Ibadan.

IITA. 1975.
International Institute of Tropical Agriculture (IITA) Annual Report 1974. Ibadan, Nigeria. 199 pp. 450

Three high-yielding, early, semidwarf bush lines are described. CITA-1 was mass-selected from TUC-5543 and has yellow flowers and green pods. CITA-2, derived from TUC-5103, has dark maroon-blotched pods and good disease resistance. CITA-3 derived from TUC-1463-1 is erect, bearing red-veined flowers and maroon-blotched green pods. A family of soy types has been bred with few or no branches, profuse fruiting on the main stem, and a highly determinate and basipetalous habit.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1931.
Work on *Cajanus cajan* at Pusa. Scient. Rep. Imp. Inst. Agric. Res. Pusa, 1929-30, Calcutta. 451

The imperial Economic Botanist reports on the attempt to obtain wilt-resistant strains of rahar (*C. cajan*) and on the study of the inheritance of various characters such as flower, seed, and pod color; pod habit; growth habit, and immunity to wilt disease in this species.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1946.
Scientific reports of the Indian Agricultural Research Institute, New Delhi for the year ended 30 June, 1946. 109 pp. 452

Cajanus cajan: Work on wilt (*Fusarium udum*) resistance was continued. Hybrid C 38-3-1, from the cross between IP-24 and IP-51, appeared to be completely immune to artificial infection in the field. IP-80 and IP-41 showed only 1% loss. The existence of duplicate genes governing the characters of the "Cawnpore" mutant was confirmed.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1947.
Scientific reports of the Indian Agricultural Research Institute, New Delhi for the year ended 30 June, 1947. 131 pp. 453

Cajanus cajan: The F_3 of a cross between NP-69 and Cawnpore-132 was selected for early maturity, *Fusarium* wilt resistance, and bold-seededness. NP types and other material were tested for wilt resistance. The inheritance of the Cawnpore, bunchy, and sepaloid mutants was studied. The sepaloid character depends upon single pairs of recessive genes, and is closely linked with simple leaf.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1948.
Scientific reports of the Indian Agricultural Research Institute, New Delhi for the year 1947-48. 182 pp. 454

Cajanus cajan: Cultures of the pigeonpea were further selected on the basis of resistance to wilt (*Fusarium udum*), maturity and other characters. Some of the material derived from the crosses between NP-69 and NP-132 showed no wilt infection. In the Burma collection, New Era 40-6 was free from wilt disease as in the previous year. Data from the cross between normal plants and a mutant with simple leaves and sepaloid flowers indicate that leaf type and floral character depend upon a single gene pair.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1954.
Scientific reports of the Indian Agricultural Research Institute, New Delhi for the years ended 30th June, 1952 and 1953. 108 and 114 pp. 455

Cajanus cajan: Wilt-resistant but, in most cases, late-maturing, selections have been developed, crosses are to be made with an early maturing Brazilian strain to combine earliness and wilt resistance.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1956.
Scientific reports of the Indian Agricultural Research Institute, New Delhi for the year ended 30th June, 1956. 142 pp. 456

Pigeonpea-wilt incidence in 64 early high-yielding lines from NP-51 x UP-type 132, Brazil x NP-41, NP-51 x Jamaica 40-28B, and NP(WR)-15 x NP-51 ranged from 0.0 to 10.2%. Some lines yielded 30 to 100% more than the best control. Lines from Brazil x NP-41 and NP-51 x Jamaica 40-28B equalled EB-3 and EB-38 in earliness.

INDIAN COUNCIL FOR AGRICULTURAL RESEARCH. 1967.
Regional Pulse Improvement Progress Report. 5:169-170. New Delhi: ICAR. 457

Experiments on different aspects of pigeonpea are described.

JAIN, H.K. 1971.
New plant types in pulses. Indian Fmg 21(8):9-10. 458

Developments in the improvement of growth habit and harvest index (economic yield: total yield) are reported in *Cajanus cajan*, *Phaseolus aureus*, *Vigna sinensis*, *Ph. mungo*, and *Lathyrus sativus*.

JAIN, H.K. 1972.
Genetic improvement and production prospects of food legumes. Trop. Agric. Res. Ser. 6:33-42. 459

New *C. cajan* varieties have been developed for cultivation at 72,000 plants/ha--as against 35,000/ha for older varieties--with growth periods of 5 to 6 months and yields of 2,700 kg/ha. These include Pusa Ageti, Sharda, and Mukta. The yields and growth periods of recently developed varieties of *Cicer arietinum*, *C. cajan*, *Vigna mungo*, *V. radiata*, *V. sinensis*, and *Lens esculenta* are tabulated.

JAIN, H.K. 1972.
The philosophy and social purpose of some recent plant breeding research. Indian Fmg 22(4):5-8. 460

Summarized breeding research and new varieties of several crops developed at the Indian Agricultural Research Institute. Three recently released varieties of *Cajanus cajan*, maturity 5 to 6 months, are Pusa Ageti, Sharda, and Mukta.

JAIN, H.K. 1976.
Induced mutations and improved plant types in pulses. Evaluation of seed protein alterations by mutation breeding. Part 3. Vienna: IAEA. p. 209. 461

Mutation studies using ionizing radiations and chemical mutagens have been in progress for pigeonpea and *Vigna mungo*. These have resulted in the production of a number of plant types, mutants, and also variability of yield components such as pod number, pod size, seed size, and number of fruiting branches.

JAIN, H.K. 1977.
Development of high-yielding varieties of pulses: Perspective, possibilities, and experimental approaches. Proc. First International Workshop on Grain Legumes. 13-16 Jan 1975. ICRISAT. Hyderabad, India. 177-188. 462

Discusses the concept of harvest index in grain legumes. New varieties of pigeonpea and their maturity aspect are also described.

JESWANI, L.M. 1968.
Pulse production in India - Impact of research programs. J. Postgrad. Sch. IARI, Delhi. 5(2):196-201. 463

Outlines the importance of pulses, their area, and production in the country. The basic objective of the coordinated project for the pulses is to create genotypes superior to those now being grown by cultivators in different agroclimatic areas of the country. The general and specific problems in different pulse crops are also discussed. The immediate objective of the pulse improvement project in India is to enhance considerably the present low yields per hectare of pulse crops.

JESWANI, L.M. 1970.
Some considerations on reorientation of research work on genetic improvement of pulse crops. Indian Agric. News Digest 2(4):127-130. 464

Identification of problems in pulse crop improvement has been stressed. The problems are well defined and the solutions can be found through well-planned experimental approaches. High-yielding, short-duration, disease-resistant varieties that fit well in accepted cropping patterns are to be developed.

JESWANI, L.M. 1975.
Varietal improvement of seed legumes in India. *Cicer arietinum. Cajanus cajan. Ph. aureus. Ph. mungo.* pp. 9-18. *In* Pirie, N.W. (Ed.). International Biological Programme. No. 4. Food protein sources. Cambridge: Cambridge University Press. 260 pp. 465

JESWANI, L.M., and P.H. VAN-SCHAIK. 1968.
Coordinated pulse project - its prospects. Indian Fmg 17(11):5-6. 466

Various aspects of the project discussed are: Coordinated research scheme, improved varieties, quality factors, and reasons for poor grain yields of legumes. Emphasizes that solutions to these difficulties can be found through a well-planned, well-coordinated, and well-financed research effort.

JOSHI, S.N. 1968.
Research in States: Gujarat. Indian Fmg 17(11):34-36. 467

Pigeonpea occupies 16% of the area under pulses in the State of Gujarat. Tur 15-15, a white-seeded medium early variety has been developed.

KADAM, B.S., R.M. KULKARNI, and S.M. PATEL. 1945.
Natural crossing in *Cajanus cajan* (L.) Millsp. in the Bombay-Deccan. Indian J. Genet. Pl. Breed. 5:60-62. 468

Data are given on the extent of natural crossing in *C. cajan*. Under conditions at the cereal-breeding station, Niphad, 15% cross-pollination occurred on the average.

KAUL, C.L., and S.P. SINGH. 1967.
Staminal and functional male sterility induced by chemical treatment in papilionaceous plants. Indian J. Agric. Sci. 37(4):264-269. 469

Nondehiscence of anthers was observed in *Cajanus cajan* and other pulses treated with 0.5 and 1.0% FW 450. Spraying of *C. cajan* and *Crotolaria juncea* with 0.25 to 0.5% dalapon or 0.5 to 10% FW 450 resulted in exudation of pollen cytoplasm in-situ. Such treatments may replace hand emasculation.

KELKAR, S.G., and P.S. PANDYA. 1934.
A new method of selfing "tur" (*Cajanus indicus*) flowers. Poona Agric. Coll. Mag. 26:108-111. 470

After various methods were tried and rejected, a new technique for selfing *Cajanus indicus* by smearing the bud from the calyx to the tip of the standard with melted candle wax was found best and is described here.

KHAN, T.N. 1973.
A new approach to the breeding of pigeonpea (*Cajanus cajan* Millsp.): formation of composites. Euphytica 22(3):373-377. 471

It is suggested that the high potential for cross pollination be utilized in the formation of random-mating composites. A simple breeding scheme based on such composites is proposed.

KHAN, T.N., and K.O. RACHIE. 1972.
Preliminary evaluation and utilization of pigeonpea germplasm in Uganda. E. Afr. Agric. For. J. 38(1):78-82. 472

In trials in 1969-1970, seed yields of pigeonpea ranged from 0.89 t/ha for the local cv CIVEI to 1.225 t and 1.228 t/ha for lines 16 and 959, respectively. Seed yield was positively correlated with plant width, length of main branch, number of pods per main branch and per plant, threshing factor, and grain:straw ratio.

KHAN, W.M.A., N. SIVASWAMY, and K.R. RAMASWAMY. 1973.
Sensitivity of the red gram (*Cajanus cajan* (L.) Millsp.) strains to different mutagens. Madras Agric. J. 60(6): 406-407. 473

Seeds were subjected to X-rays, ethyl methane sulfonate (EMS) and diethyl sulfonate (DES). Strain SA-1 seems to be more tolerant to the mutagens than Co-1. DES beyond 0.25% killed the seeds completely. There were genetic differences between the two strains as shown by their sensitivity to the mutagens.

KILLINGER, G.B. 1968.
Pigeonpea (*Cajanus cajan* (L.) Druce), a useful crop for Florida. Proc. Soil Crop Sci. Soc. Fla. 28:162-167. 474

Pigeonpea is used for human food, livestock feed, and shade for coffee trees in many parts of Central and South America and other tropical areas throughout the world. Norman, a new variety, shows promise of producing sufficient seed in Florida to make it a profitable machine-harvestable seed crop. Pigeonpea can be used in Florida as a seed, cover, grazing, hay, or windbreak crop.

KRAUSS, F.G. 1921.
The pigeonpea - its culture and utilization in Hawaii. Hawaii Agric. Exp. Stn Bull. 46:1-23. 475

The pigeonpea was introduced into Hawaii from Puerto Rico. The following aspects of pigeonpea crop are discussed: introduction, botany and agricultural history, climatic and soil adaptations. Planting: the hay crop, harvesting, cutting; the seed crop, harvesting, threshing. Pigeonpea as feed: feeding value, milling and mixing feeds, suggested feeding rations. Plowing under of pigeonpeas. Pigeonpeas as a cover and green manuring crop and for rotations. Pests and diseases.

KRAUSS, F.G. 1927.
Improvement of the pigeonpea, genetic analysis of *Cajanus indicus* and creation of new varieties through hybridization and selection. J. Hered. 18:227-232. 476

The heritability of a number of quantitative characters and their genetic behavior as dominance and recessiveness has been demonstrated.

KRISHNAN, R.H. 1968.
Research in States: Madras. Indian Fmg 17(11):37-39. 477

The improved pulse strain of red gram, SA-1 released, pure-line selection from a local strain. Average yield was 750 kg/ha; when sown mixed crop, 370 kg/ha.

KROBER, O.A., M.K. JACOB, R.K. LAL, and V.K. KASHKARY. 1970.
Effect of variety and location on the protein content of pulses. Indian J. Agric. Sci. 40(12):1025-1030. 478

Samples of different pulses, including pigeonpea, from the All-India Coordinated Varietal Trials were analyzed for protein content. Significant varietal differences were found in five of the seven crops. There were significant differences due to location in all the crops. Pulse samples from Hyderabad are among the lowest in protein content.

KULKARNI, U.G. 1973.
Mutagenic effects of EMS, MMS and Colchicine in tur, *Cajanus cajan* (L.) Millsp. Variety C-1. M.Sc. (1973) Thesis. Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. India. 479

KUMAR, L.S.S. 1957.
Pulses - History and development of the Economic Botanist's Section, 1908-58. Poona Agric. Coll. Mag. 48(2-3):7-14. 480

Selection was continued in tur. The production of intergeneric cross between *Atylosia* and *Cajanus* resulted in evolving a few hybrids resistant to wilt.

LAL, M.S. 1968.
Research in States: Madhya Pradesh. Indian Fmg 17(11):26-31. 481

The aspects discussed are: area under pulses, production, and development of high-yielding varieties of different pulses. Three varieties of pigeonpea are listed: Tur IPI-5, Khargone-2, and Gwalior-3.

LAL, S. 1976.
Improved varieties of arhar. Indian Fmg 26(7):3-7. 482

Agronomic characters of eight early maturing, six midseason, and six late maturing cultivars of arhar (*Cajanus cajan*) are described, with information on their seed yield potential and adaptability regions in India.

LAL, S., and S.C. SINHA. 1972.
"Prabhat" - an extra early variety of red gram. Fmr Parliam. 7(7):18-24. 483

Emphasizes the importance of an early maturing variety for successful arhar cultivation. Prabhat, which arose as a segregant from variety T-21, matures in 110 to 115 days. The plant type is determinate, bunchy, flat-topped. The botanical characters of Prabhat, its agronomic requirements, and its role in multiple cropping are also described.

LAWANI, S.M., and K.O. RACHIE. 1975.
Announcing pulse cultivars and germplasms for the hulotrops. Trop. Grain Legume Bull. 1(1):12. 484

Grain legume germplasms for the humid lowland tropics available for distribution are announced in this bulletin. Three outstanding cowpea and three pigeonpea cultivars are described.

LAXMAN SINGH, D. SHARMA, and A.D. DEODHAR. 1974.
Effect of environment on protein content of seeds and implications in pulse improvement. Proc. 2nd General Cong. SABRAO. New Delhi, India. 731-808. 485

From this review, which is mainly concerned with information on soybean and pigeonpea, it is concluded that sampling techniques, methods of protein and amino acid estimation, and genotype x environmental interactions considerably influence the speed and effectiveness of selection programs for high protein content among segregating or pure-line populations of pulse crops.

MAESEN, L.J.G. van der. 1975.
Germplasm collection and evaluation in *Cicer* and *Cajanus*. First International Workshop on Grain Legumes. 13-16 Jan 1975. ICRISAT. Hyderabad, India. 229-238. 486

Classification of *Cicer* and *Cajanus*, collection of primitive species, origin and distribution of *Cajanus*, obtaining germplasm, exploration and collection, methods of collection, documentation, maintenance of germplasm, and evaluation for a number of characters are described.

MANE, S.S. 1975.
Genetic variability in M_3 progenies of C-11 and varieties of pigeonpea (*Cajanus cajan* (L.) Millsp.). M.Sc. (1975) Thesis. Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. 487

MANN, HAROLD, H. 1947.
Cajanus indicus - pulse grain crops in the Middle East. J. Empire Expl Agric. 15(6):258. 488

Pigeonpea, one of the most extensively grown pulses in India, is nowhere more than a curiosity in the Middle East, though it would seem to have a possible future in many parts of the area. It is suggested that pigeonpea might be usefully introduced into Iran (Persia).

MBOWE, F.F.A. 1975.
Grain legume research in Tanzania. Trop. Grain Legume Bull. 2:2-3. 489

Research from 1972 to 1974 on groundnut (varietal improvement, spacing, and fertilizer trials), cowpea (variety and fertilizer, spacing, and sowing data trials) and pigeonpea (local cultivar evaluation) is briefly described.

MEHTA, D.N., and B.B. DAVE. 1931.
Studies in *Cajanus indicus*. Mem. Dep. Agric. India (Bot. Ser.). 19:1-25. 490

Includes morphological descriptions of the various types in cultivation, the duration of the flowering period, methods of pollination, data on the extent of natural crossing, and a classification in which two forms are distinguished, one short and ripening early, the other tall, ripening late.

MENEZES, O.B. De. 1943.
Studies on the genetics of pigeonpea. Bolm Minist. Agric. Ind. Com. Rio de J. 32(10):69-83. 491

The species *Cajanus indicus* Spreng. is described and the history of its introduction into cultivation is outlined. An account is given of the floral biology of the plant and the method of artificial pollination. The correct chromosome number is regarded as n = 11 and not n = 9 as reported by Basudev. The plant grows extensively in a semi-wild state in the Baixada Zones.

MILES, J.F. 1949.
Plant introduction trials in central coastal Queensland. 1936-46. Rep. Div. Plant Ind. Australia. 6:134 pp. 492

Studies were made of the climate and soils of the area and of the natural pastures. The best species among the supplementary protein crops was *Cajanus bicolor*. Various small-scale trials indicate the suitability

of crops from India and other monsoon countries for tropical Australia.

MOHAMED SHERIFF, N., and R. VEERASWAMY. 1977.
Genotypic and phenotypic variability of mutants in red gram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 64(1): 44-45. 493

Fifteen red gram mutants (13 from gamma irradiation and two from EMS treatments of the strain Co-1) in M_5 generation were studied. There were significant differences for all the characters. The genetic advance was high for pod weight, number of pods per plant, and plant height. The mutants showed a positive shift in their mean values.

MOHAMED SHERIFF, N., W. MOHAMED ALI KHAN, and R.S. ANNAPPAN. 1977.
Red gram Co.3 - an economic mutant strain for Tamil Nadu. Madras Agric. J. 64(9): 561-564. 494

Mutation breeding research in red gram (*Cajanus cajan* (L.) Millsp.) has resulted in the development of a high-yielding mutant S-18 (Co-3) suitable for cultivation under both rainfed and irrigated conditions. Its duration is 130 days. On an average it records 1,300 kg/ha and 1,200 kg/ha under irrigated and rainfed conditions, or 9.8 and 9.1 kg/ha/day respectively. A special advantage of Co-3 is its resistance to root rot and tolerance to wilt and pod borers.

MUKHERJEE, D., and S. SEN. 1965.
B-7 is the arhar for West Bengal. Indian Fmg 14(11):11, 28. 495

B-7, selected from material obtained from various sources, is superior in yield to commonly grown types of *Cajanus indicus*. The grains are silver white and the variety is recommended for the districts of Malda, Murshidabad, and Nadia; for the first two of these districts T-7 is also recommended.

NADARAJAN, N. 1976.
Induced mutagenesis in redgram (*Cajanus cajan* (L.) Millsp.). Micro and macro mutations. M.Sc. (1976) Thesis. Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. 496

NANJAPPA, B. SHIVARAJ, and R.V. PATIL. 1976.
Co-1 variety performs well in black soils in transitional tract of North Karnataka. Curr. Res. 4(3):40-41. 497

Among five lines of *C. cajan* with a maturation period of 150 to 155 days, Co-1 (height 104.8 cm) gave the highest mean yield (1,298 kg/ha) and had the highest number of pods per plant and pods containing three seeds. S-8 (height 130.5 cm) gave the next highest yield (1,232 kg/ha) and T-21 (height 126.0 cm) had the highest number of pods containing five seeds.

PAL, B.P. 1934.
Recent progress in plant breeding at Pusa - Rahar. Agriculture Live-Stk India 4(5): 511-512. 498

In an investigation undertaken to produce types of rahar (*Cajanus cajan*) resistant to wilt (*Fusarium vasinfectum* Atk.), 80 types that proved very resistant to the disease were isolated. The resistance is not correlated with any important morphological characters. Types 16, 41, 50, and 51 were identified as high yielding. Type 51 is erect, wilt-resistant, with large yellow-brown seeds, yielding well and should prove to be of much economic value. Type 5 is extremely susceptible to wilt. The inheritance of flower color depends upon two factors and is linked with seed color. The factors for disease resistance are not linked with those for morphological characters. Inheritance of resistance depends upon multiple factors.

PANKAJA REDDY, R., DALJIT SINGH, and N.G.P. RAO. 1975.
Character association in pigeonpea. Indian J. Genet. Pl. Breed. 35(1): 119-122. 499

Four characters were studied in 877 lines from four maturity groups. The data indicated that as the maturation period increased, pod number, yield, and seed size also increased. Pod number and seed size were the most important components of yield. It is considered that hybridization between different maturity groups may be effective in combining earliness with high yields and larger seeds.

PANTON, C.A., L.B. COKE, and R.E. PIERRE. 1972.
Seed protein improvement in certain legumes through induced mutations: Pigeonpea, kidney beans, soybeans. *In*: Nuclear techniques for seed protein improvement. Proc. Research

Coordination Meet. Neuherberg, 1972, 1973. 500

PATHAK, G.N., and JAIMANGAL SAHAI. 1960. Type 7: A new arhar for mixed cropping in kharif. Indian Fmg 10(2):37. 501

Selected from material from Lucknow, *Cajanus cajan* Type 7 is a late-ripening, erect, brown-seeded variety suitable for all districts in Uttar Pradesh. It has a 1000-seed weight of 120 g, as against 74 g for T-17 and 81 g for T-105.

PATHAK, G.N., and K.P. SINGH. 1961. Type 21 arhar (pigeonpea) outdoes Type 1. Indian Fmg 11(8):15. 502

The new *Cajanus cajan* variety T-21 is early maturing (6 months), profusely branched, tall, and semispreading. It has more seeds per pod than T-1 and the brown seeds cook and taste better. The 1000-seed weight is 76 g. Over 2 years, it yielded 57% more than T-1.

PATIL, J.A. 1957. T-84 - An improved tur strain. Farmer 8(12):29-30. 503

The morphological characters of T-84, a newly developed pigeonpea strain, and a package of practices for obtaining highest yield from it are given. Its reaction to diseases is described and yield comparisons made with local strains.

PATIL, M.K., and M.N. KAMAT. 1950. Control of plant disease through disease resistance in Bombay. Poona Agric. Coll. Mag. 40(4):6-11. 504

A general discussion on breeding for disease resistance is presented and the technique used in India for obtaining crop plants resistant to *Fusarium* wilt is outlined. In tur (*Cajanus cajan*) much reliance was previously placed on field resistance to wilt, but the results of pot test under uniform conditions at Poona have demonstrated the need for standardization of the breeding technique.

POKLE, Y.S., and L.C. MOHATKAR. 1976. Path analysis of yield components in pigeonpea (*Cajanus cajan* (L.) Millsp.). Nagpur Agric. Coll. Mag. 48:23-24. 505

Path analysis in 40 varieties of pigeonpea revealed that the pods/plant had higher direct effect than shown by its correlation with yield and also indirectly influenced all the correlations. Among all the yield components, pods/plant is the most effective yield determinant and should be given weightage in selection programs.

PRASAD, S.N. 1958. Segregation of characters in arhar (*Cajanus cajan*). Allahabad Fmr 32:305-308. 506

The percentage of natural cross-pollination in *C. cajan* ranges from 0.09 to 48 , as reported by different workers. The species is also included in the class of often cross-fertilized plants. In spite of all precautions controlling mechanical mixture, segregation of characters has been observed in plots of different varieties. The main cause of variety deterioration in this crop is natural cross-pollination. Methods to maintain varietal purity are suggested.

RACHIE, K.O. 1976. Goals and progress in GLIP. June 1975. Proc. IITA Collaborators Meet. on Grain Legumes Improvement. 9-13 June, 1975. IITA. Ibadan, Nigeria. 1-5. 507

Topics briefly covered in this progress report on the grain legume improvement program (GLIP) include (i) the utilization of additive gene effects, linkage breaking, and male sterility to produce many crosses in a single growth season; (ii) the development of elite strains of cowpea, soybean, pigeonpea (four each), and lima beans (three); (iii) the development of a pigeonpea family with a wide range in height (60 to 220 cm); and (iv) improved resistance to pests and diseases.

RACHIE, K.O. 1976. Pigeonpeas and miscellaneous beans. Proc. IITA Collaborators Meet. on Grain Legumes Improvement. Seed Quality/Biochemistry. 9-13 June, 1975. IITA, Ibadan, Nigeria. 21-26. 508

Six high-yielding, early maturing *C. cajan* varieties were grown in trials at 20 sites in Africa, Asia, and the Americas. Brief data are also presented from varietal trials of the other grain legumes.

RACHIE, K.O., and W.D. ROCKWOOD. 1973. Research in grain legume improvement. Span 16(1):9-12. 509

Work at the International Institute of Tropical Agriculture has included a preliminary evaluation of about 6,178 accessions of 20 genera and species. Breeding work in *Cajanus cajan* is mentioned.

RAJ, D., L. ANAVARADHAM, K. MUNWAR BASHA, and A. RAJAMANI. 1977.
Performance of redgram (*Cajanus cajan* (L.) Millsp.) varieties under black soil conditions. Madras Agric. J. 64(9): 570-572. 510

Co-1 was found adaptable for the rainfed black soil area of the southern districts of Tamil Nadu. On the basis of equal yield, duration, and per-day production capacity, coupled with bigger seed size, varieties Khargone-2 and S-8 may also be popularized to provide diversification of genotypes as an insurance against the vagaries of the monsoon.

RAMANUJAM, S. 1971.
Some salient results of Pulse Research 1. Indian Fmg 21(10):17-19. 511

In arhar high performing varieties T-21 (U.P.), P-4785, P-4587 maturing in a period of 150 to 160 days and giving high yields were identified. Some other genotypes like S5 (Ageti) and S8 (Sharda) capable of giving 2,000 to 2,500 kg/ha and maturing in 160 days were selected at IARI from crosses involving N.P. varieties and varieties introduced from Brazil. With early maturing varieties arhar-wheat rotation is possible.

ROHEWAL, S.S., B.C. JOSHI, and S.P. SINGH. 1966.
Arhar S-103, an erect type yielding high. Indian Fmg 16(3):31. 512

S-103 is a tall and erect variety of *Cajanus cajan*, with profuse pod formation. The seeds are large and brown and the plants are highly tolerant of *Fusarium udum*.

RUBAIHAYO, P.R., and C.L.A. LEAKEY. 1973.
Protein improvement in beans and soybeans by mutation breeding. *In* Nuclear Techniques for Seed Protein Improvement 631. 52/UN. pp. 291-296. 513

SAXENA, K.B., D. SHARMA, and J.M. GREEN. 1976.
Pigeonpea ratooning - an aid to breeders. Trop. Grain Legume Bull. 4:21. 514

It was found that ratooning pigeonpea plants facilitated cross-pollination between early and early x medium-flowering cultivars. Less flower drop was observed on ratooned plants than on nonratooned, especially with early maturing types. The effect of ratooning on seed and forage yield is being investigated.

SAXENA, M.C., D.S. YADAV, and N.P. SINGH. 1973.
Grow new varieties of arhar. Indian Fmr Digest 6(7):17-20. 515

The high-yielding and early maturing varieties of pigeonpea, Pant A-2 and Pant A-3, developed by Pantnagar University are described, with methods of cultivation. Agronomic requirements for obtaining higher yields are also given.

SAXENA, S.S. 1968.
Research in States: Uttar Pradesh. Indian Fmg 17(11):32-33. 516

Area under pigeonpea remains static. Average yield is 1,300 kg/ha; the aim of current research is to double the average. Important varieties of pigeonpea are T-21, T-17, and T-7.

SEN, S.K., and S.C. SUR. 1964.
A study on vicinism in pigeonpeas (*Cajanus cajan* (L.) Millsp.). Agricultura Louvain. 12:421-426. 517

The extent of natural crossing between two varieties, separated by a distance of 4 ft (1.2 m) was 3.2%. This figure fell below 1% when the distance was increased to 16 to 32 ft (4.8 to 9.7 m). No crossing occurred at distances of 36 ft and 40 ft (11 and 12 m). *Taeniothrips distalis* appears to be the most important cross-pollinating agent.

SHAMBULINGAPPA, K.G., G. SHIVASHANKAR, and R. SREEKANTARADHYA. 1976.
HY-3a and HY-3c new promising varieties of redgram for Bangalore and surrounding regions. Curr. Res. 5(3):41-42. 518

The variety HY-3c with 2,100 and 2,200 kg/ha and HY-3a with 1,900 kg/ha were highest yielders in 2 years' trials. Both are bold-seeded, with 4 to 7 seeds per pod, sweet, and suited for canning purposes. Different characters of the varieties are given.

SHARMA, D., and J.M. GREEN. 1975.
Perspective of pigeonpea and ICRISAT's breeding program. First International Workshop on Grain Legumes, 13-16 Jan 1975. ICRISAT. Hyderabad, India. 19-30. 519

Provides data on pigeonpea production and discusses special problems in pigeonpea breeding. The ICRISAT breeding program is outlined.

SHARMA, D., and M.P. SHRIVASTAVA. 1974.
An induced useful mutant of *Cajanus cajan* (L.) Millsp. JNKVV Res. J. 8(3-4): 263-266. 520

Following irradiation of tetraploid seeds of T-21, 148 seedlings were grown, of which 30 had reverted to the diploid state (2n = 22) and 54 were aneuploid. Among the diploids was a plant designated No. 9, which had numerous primary branches and pods, and larger flowers, pods, and seeds than its parent. The mutant flowered and matured earlier than the parent, displayed high pollen fertility, and was characterized by pods streaked green at the base.

SHIVAPURI, T.N. 1943.
Selection of strains in arhar (pigeonpea). Proc. Indian Sci. Cong. 30(3):104. 521

SIDHESWAR PRASAD, RAM PRAKASH, and M.A. HASSAN. 1972.
Natural crossing in pigeonpea (*Cajanus cajan* (L.) Millsp.). Mysore Agric. J. Sci. 6:426-429. 522

Studies in seven varieties showed that natural cross pollination ranged from 3.79 to 25.66%, depending on variety and site. BR-15 and BR-13 showed highest cross pollination with 26.66 and 24.74% respectively, and BR-10 showed least with 3.79%.

SIL, S.N. 1914.
Improvement of rahar by selection. J. Agric. Bihar Orissa. I:25-29. 523

SINGH, B.B. 1973.
Effect of gamma-irradiation on growth and yield of pigeonpea. Har. J. Hort. Sci. 2(3-4):83-87. 524

Pigeonpea seeds were irradiated with Cobalt 60 gamma ray 8, 10, 20, and 30 Kr. Radiation-induced changes in the length of shoot, number of branches, number of pods per plant, 1000-grain weight, and grain yield per plant, indicated that length of shoot was negatively, whereas other characters were positively, correlated up to radiation dose of 10 Kr. There was significant increase in grain yield at 10 Kr irradiation dose over control and other dosages.

SINGH, B.B., S.C. GUPTA, and B.D. SINGH. 1974.
Note on 'UPAS-120' an early-maturing mutant of pigeonpea. Indian J. Agric. Sci. 54(4):233-234. 525

Discusses the planting of the newly developed pigeonpea variety (*Cajanus cajan*) UPAS-120, which takes only 150 to 190 days to mature against 250 to 300 days for traditional varieties. This allows farmers in India to grow high-yielding wheat varieties after a pigeonpea crop.

SINGH, H.P., and M.C. SAXENA. 1977.
Challenges in arhar production. Indian Fmg 27(4):9-10, 13. 526

There is need of developing varieties responsive to production inputs, identification of high efficiency legume bacteria. Some of the factors for increasing production are discussed.

SINGH, K.B. 1973.
Punjab can take on Arhar in a big way. Indian Fmg 22(10):19. 527

The acreage under arhar is very small in the Punjab. The main reason is late maturity, which causes high frost mortality. T-21 variety developed from a cross T_1 x T-190 in U.P. gave the highest yield and also matured earliest, under the Punjab conditions. This variety gave on an average of 2,500 kg grain yield/ha.

SINGH, K.B., R.S. MALHOTRA, and R.P. JAIN. 1973.
Arhar is a potential kharif pulse of Punjab. Prog. Fmg 9(10):6. 528

The availability of early maturing varieties of arhar has opened the possibility of cultivation on a large scale in the state. Amongst the early maturing varieties, T-21 is the earliest to mature and has the highest yield potential under Punjab conditions. Important hints for the cultivation of arhar are given.

SINGH, L., A.S. TIWARI, and B.R. SINGH. 1976.
Yield gains by selection for seed characteristics in an adapted local cultivar of pigeonpea (*Cajanus cajan* (L.) Millsp.). Trop. Grain Legume Bull. 5:18. 529

Progeny of local bold- and brown-seeded pigeonpea types gave an increased seed yield of 18.29 and 14.4%, respectively, compared with the unselected population. Progeny of small and light-brown-seeded selections showed a significantly reduced yield. Increased yield in the brown-seeded types was partly due to reduced levels of seed-borne infection. Plant height, pod-bearing length, and days to maturity were

similar in the selected and nonselected populations.

SINGH, S.P. 1955.
Improved varieties of pulse crops in Uttar Pradesh. Agric. Anim. Husb. Uttar Pradesh. 6(2-3):58-60. 530

Information on improved varieties of *Cajanus cajan, Ph. mungo, Ph. aureus, Vigna sinensis, Glycine max, Cicer arietinum, Pisum sativum,* and *Lens esculenta.*

SRINIVASAN, V., and K. JAYABHIMA RAO. 1952.
Progress of Pulses Improvement work in Madras. Madras Agric. J. 39(9): 478-484. 531

Eight years' research isolated a few high-yielding cultivars of different pulses suitable for general cultivation. These pulses are zonal in performance and in any program of improvement this aspect should be considered.

SWAMINATHAN, M.S., and H.K. JAIN. 1972.
Food legumes in India's agriculture. Proc. Symp. nutritional improvement of food legumes by breeding. 3-5 July 1972. PAG (FAO). Rome, Italy. 532

Importance of grain legumes in Indian agriculture, reasons for their low yields and the strategy of bringing the grain legumes to a respectable level of production are discussed.

SWAMINATHAN, M.S., M.S. NAIK, A.K. KAUL, and A. AUSTIN. 1971.
Choice of strategy for the genetic upgrading of protein properties in cereals, millets and pulses. Indian J. Agric. Sci. 41:393-406. 533

Suggests an approach for improving the protein content and quality of cereals, millets, and pulses. The variability for protein content in chickpea and pigeonpea can be induced through mutagens as it is not prevalent in the present collections.

TER HORST, K. 1961.
Selection of pulses in Surinam. 6. Miscellaneous pulses new crops. Surin. Landb. 9(3):75-80. 534

Of five species of pulses tested, pigeonpeas grew well, but set good seed only in dry weather. Among nonleguminous crops, sorghum and sesame appeared to be suitable crops to follow rice.

TURNER, F. 1892.
New commercial crops for New South Wales. The cultivation of the pigeonpea or Catjang. Agric. Gaz. N.S.W. 3(6): 6-8. 535

Pigeonpea or Catjang was introduced into Australia during the 1890s and grows well in the warmer parts as a suitable crop for fodder and also as a vegetable for cultivation in the northeastern area of New South Wales.

VAHEEDUDDIN, S. 1958.
Evolving wilt resistant strains in red gram. Andhra Agric. J. 5:163-164. 536

Out of a large number of red gram strains tested, C-11, C-28, and C-36 proved superior in yield and wilt resistance. The names of these strains have been changed from C-11, C-28, and C-36 to ST-1, ST-2, and ST-3, respectively.

VEDA, O. 1971.
Evaluation of genetic stock of arhar (*Cajanus cajan* (L.) Millsp.) for resistance against its important insect pests in M.P. M.Sc. (1971) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. 537

VEERASWAMY, R., and N. MOHAMED SHERIFF. 1973.
Artificial crossing in *Cajanus cajan* (L.) Millsp. Madras Agric. J. 69(9-12): 1826-1827. 538

To assess the success of red gram hybridization at different hours of the day, artificial cross pollinations were made from 9 a.m. to 5 p.m. at intervals of half an hour. The crosses made during 10 a.m. to 10.30 a.m. gave maximum success. A very low pod set was recorded from 1 p.m. to 2 p.m. There was a visible reduction in the length of pods and number of seeds per pod in the crossed pods as compared with the parents.

VEERASWAMY, R., G.A. PALANISWAMY, and R. RATHNASWAMY. 1973.
Natural cross-pollination in *Cajanus cajan* (L.) Millsp. and *Lablab niger* Medikus. Madras Agric. J. 69(9-12):1828. 539

Co-1, with red-veined yellow flowers and green pods with purple streaks, and P-315 with yellow flowers and green pods were selected. When red gram was grown in alternate rows, 13.7% natural crossing was observed.

VEERASWAMY, R., P. RANGASAMY, and N. MOHAMED SHERIFF. 1975.
Co-2 redgram - a new strain with early maturity and improved plant type. Madras Agric. J. 62(9):541-543. 540

Co-2 is a compact, erect plant type suited for mixed cropping with groundnut. It matures in 110 to 115 days and is capable of yielding 1,500 kg/ha under irrigation and 750 kg/ha under rainfed conditions. Per day productivity is also high. The strain is photoinsensitive and fairly tolerant to *Fusarium* and *Rhizoctonia* wilt and root-rot diseases under field conditions.

VEERASWAMY, R., and R. RATHNASWAMY. 1972.
Red gram Co.1 - an improved short-term strain for Tamil Nadu. Madras Agric. J. 59(3):177-179. 541

Selected from local *Cajanus cajan* material, Co-1 gives high yield of good-quality grain and shows some tolerance of drought.

VIDHYASEKARAN, P., and G. ARJUNAM. 1976.
A new redgram variety resistant to root-rot. Madras Agric. J. 63(3):175-176. 542

S-18 was completely free of the disease while S-5 and Co-2 showed 45% and 20% incidence respectively. Thus S-18 appears to be a promising type with high root-rot and wilt resistance.

WAKANKAR, S.M., and P.S. SANGWAN. 1955.
Madhya Bharat's new pulse strains yield more. Indian Fmg 4:11-12. 543

The pigeonpea strain recommended for cultivation is Gwalior-3, a strain selected from Ambah tehsil of northern Madhya Pradesh. Vigorous, late-maturing (240 days), with bold, fawn-colored seeds, it yields an average 1,000 lb/ac (1,123 kg/ha), 25% more than the local variety. Another strain is Ujjain-7, a selection from Ujjain, which is early maturing, with bold seeds, taking about 170 days to ripen.

WILSIE, C.P., and M. TAKAHASHI. 1934.
Natural crossing in the pigeonpea. J. Agric. Res. 49:923-927. 544

Three strains of *Cajanus indicus* Spreng., breeding true for the recessive pure yellow flower and self green pod when planted in alternate rows with strains bearing the dominant red or red-veined yellow flowers and red- or black-blotched pods, yielded percentages of heterozygotes or natural hybrids ranging from 13.98 to 15.86 in a total production of 24,883 plants. Progenies from 5,201 bagged plants contained only nine natural hybrids, probably due to faulty technique. Comparisons with the results of previous investigators definitely suggest that much more natural crossing occurs when different varieties are grown in adjacent rows. Since the anthers dehisce a day before the flower opens, a high percentage of natural crossing must be due to either a differential growth rate of the pollen from various sources or some inhibiting physiological or morphological factor that prevents selfing before the flower opens. The flowering stage at which fertilization normally occurs should therefore be investigated.

WOODFORD, R.C. 1948.
Annual report of the Department of Agriculture, Assam, for the year ending 31st March, 1948. 352 pp. 545

Legumes: Varietal trials of pulses were carried out at the Jorhat farm. Improvement of *Cajanus indicus*, *Phaseolus mungo* var. Roxb. and *Ph. radiatus* is receiving attention. Several high-yielding selections of *Cajanus indicus* have been made.

CYTOGENETICS

AKINOLA, J.O., A.J. PRITCHARD, and P.C. WHITEMAN. 1972.
Chromosome number in pigeonpea (*Cajanus cajan* (L.) Millsp.). J. Aust. Inst. Agric. Sci. 38:305-308. 546

Cytological studies of 95 introductions from 11 countries show that 2 n = 2 x = 22. Information is included on variation in eleven morphological and agronomic characters.

BENDALE, V.W. 1972.
Studies on autotetraploids in C_2 generation of perennial tur, *Cajanus cajan* (Linn.) Millsp. and Gokarna (*Clitoria ternatea* Linn.). M.Sc. (1972) Thesis. Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. 547

BHATTACHARJEE, S.K. 1956.
Study of autotetraploid *Cajanus cajan* (Linn.) Millsp. Caryologia 9:149-159. 548

Tetraploid obtained from the seed of a colchicine-induced 4n plant had significantly fewer branches and nodes on the main stem than the diploid controls. The 4n and 2n plants showed only slight differences in leaf and leaflet measurements and in leaf number. The tetraploids were in general more variable in growth rate and in other characters studied than the diploids. Multivalent formation and irregularity in disjunction in the 4n plants resulted in 62.4 $\pm$ 11.01% of abortive pollen grains. The average sizes of the fertile pollen grain of 2n and 4n plants were 47.17μ and 50.34μ, respectively.

BHATTACHARYYA, SUNILKUMAR. 1976.
Cytogenetics of Indian pulses. Ph.D. (1976) Thesis. University of Calcutta, Calcutta, West Bengal, India. 549

DAFE, G.A. 1966.
Some studies in C_2 generation of autotetraploids pigeonpea (*Cajanus cajan* (L.) Millsp.). Nagpur Agric. Coll. Mag. (Spec. Res. No.). p. 107. 550

Induced polyploids-tetraploids (n = 22) were studied and varying degrees of sterility observed. They were usually later in maturity, shorter in height, more erect, and had longer and thicker leaves, more branches, and thicker stems. Flower parts were also larger. Seeds contained more nitrogen than their parents. Wide variation in fertility was observed.

DARLINGTON, C.D., and A.P. WYLIE (EDITORS). 1955.
Chromosome atlas of flowering plants. Allen and Unwin: London. 551

DATTA, P.C., and N. SAHA. 1972.
A few trials of hybridization in Euphaseoleae and Cajaneae. Castanea 37(4): 294-297. 552

D'CRUZ, R., and A.S. JADAV. 1972.
Aneuploidy in tur (*Cajanus cajan* L. Millsp.). Mahatma Phule Agric. Univ. Res. J. 3(1):61-62. 553

A tall plant with larger leaves and flowers than normal was found with 2x = 22 and these formed 11_{II} at metaphase I. One plant with 23 chromosomes appeared to have extra vigor of plant and seed.

DE, D.N., and L.J. REDDY. 1972.
Homology between *Cajanus* and *Atylosia* genomes: Origin of *Cajanus*. *In*: Advance Notes of Symposium on Genome Concept - Eukaryota. 59th Indian Sci. Cong. (Sect. Bot.). pp. 10-11. 554

The two genera *Cajanus* and *Atylosia* are separated only on the basis of presence or absence of strophiole. The chromosome number of *Cajanus* is 2n = 22, the same as that of *A. lineata*, *A. sericea*, and *A. scarabaeoides*. There is broad similarity between their chromosomes. The pachytene chromosomes of a *Cajanus* x *A. lineata* hybrid exhibit complete pairing of all the chromosomes except a few terminal and interstitial regimes of homologues. Pachytene karyology indicated that *Atylosia lineata* is closest to *Cajanus cajan*. *Cajanus* is a monotypic genus and it moved from India to other parts of the world. The greatest differentiation and greatest abundance of both *Cajanus* and *Atylosia* are found in the Western Ghats and the Malabar coast. The conclusion was drawn that the broad-leaf evergreen forest area on the Western coast of India is the center of origin of *Cajanus*.

DE, D.N., and L.J. REDDY. 1972.
Centric fusion and star formation at pachytene of *Cajanus-Atylosia* hybrids. *In*: Proc. Symposium on Cytogenetics in the Evolution and Improvement of Plants, October, 1972. Srinagar, Kashmir, India. 555

The cultivated crop *Cajanus cajan* (Tur, Arhar, Pigeonpea) has been successfully hybridized with three species of *Atylosia*, viz. *A. lineata*, *A. sericea*, and *A. scarabaeoides*. The pachytene analysis indicated a high degree of chromosomal homology between the two genera. The centromeres of the bivalents fuse together to form a typical star-shaped configuration during pachytene, which varies from cell to cell in different hybrids. Such star formation is extremely rare in the parents. The implications of star formation are discussed.

DEODIKAR, G.B., and C.V. THAKAR. 1956.
Cyto-taxonomic evidence for the affinity between *Cajanus indicus* Spreng. and certain erect species of *Atylosia* W. & A. Proc. Indian Acad. Sci. (Sect. B). 43:37-45. 556

Morphological, taxonomic, and cytological evidence, homology of normal with mutant characters, and the high degree of fertility of intergeneric hybrids indicate a close affinity between *C. indicus* and

certain erect species of *Atylosia*, particularly *A. lineata* and *A. sericea*. According to observations on chromosome morphology, *A. sericea* is more closely related to *C. cajan* than *A. lineata*. Structural changes in the chromosomes may have played a major role in the differentiation of two genera. *Atylosia* spp. may be useful as a forage legume and also in breeding varieties of *C. cajan* combining hardiness, perennial habit, tolerance to drought, and resistance to pests and diseases. *A. lineata* and *A. sericea* have shown a high degree of resistance to pod borer (*Exelastis atomosa*) and *Fusarium udum*. Taxonomic incorporation of the erect species of *Atylosia* in *Cajanus* is suggested.

JOSHI, K.S. 1966.
Studies on the autotetraploids of tur (*Cajanus cajan* (L.) Millsp.) with special reference to their utilization in breeding. Nagpur Agric. Coll. Mag. (Spec. Red. No.). p. 111. 557

The autotetraploids were late in maturity and showed varying levels of sterility. Considerable variation in fertility occurred in both natural and induced autotetraploids. The possibility of increasing the fertility through appropriate breeding methods such as recurrent selection is discussed briefly.

KHAMANKAR, Y.G. 1966.
Induction of polyploidy by colchicine treatment in some of the crop plants. Nagpur Agric. Coll. Mag. (Spec. Res. No.): 101-102. 558

KRISHNASWAMY, N., and G.N.R. AYYANGAR. 1935.
Chromosome number in *Cajanus indicus* Spreng. Curr. Sci. 3:614-615. 559

The chromosome number of dhal, *Cajanus indicus* Spreng., an important Indian pulse, had not been determined before. The method of bud fixation is described. The metaphase plate gave 11 pairs; this number 11 is the basic number of the *Phasioleae*, of which *Cajanus* is one. A number of secondary nuclei were also seen.

KUMAR, L.S.S., A. ABRAHAM, and V.K. SRINIVASAN. 1945.
Preliminary note on autotetraploidy in *Cajanus indicus* Spreng. Proc. Indian Acad. Sci. (Sect. B). 21:301-306. 560

Colchicine-induced tetraploids were compared with diploids for morphological and other characters. With the exception of leaf and flower size, the tetraploid characters showed an increase in comparison with the diploids. An investigation of meiosis in the tetraploid showed that the number of multivalents formed is fairly high, resulting in partial sterility.

KUMAR, L.S.S., H.K.S. RAO, and M.V. THOMBRE. 1966.
Interspecific and intergeneric hybridization in the breeding of crop plants. Indian J. Genet. Pl. Breed. 26A: 114-120. 561

Twenty-one true triploid F_1 hybrids derived from diploid *Pennisetum typhoides* X tetraploid *P. purpureum* were completely sterile and backcrossing to either parent was unsuccessful. An analysis of the cytological and morphological characters of intergeneric hybrids between *Cajanus* and *Atylosia* is also presented.

KUMAR, L.S.S., and M.V. THOMBRE. 1958.
An intergeneric hybrid of *Cajanus cajan* (L.) Millsp. X *Atylosia lineata* W. and A. J. Univ. Poona 12:13-16. 562

KUMAR, L.S.S., M.V. THOMBRE, and R. D'CRUZ. 1958.
Cytological studies of an intergeneric hybrid of *Cajanus cajan* (Linn.) Millsp. and *Atylosia lineata* W. & A. Proc. Indian Acad. Sci. (Sect. B) 47:252-262. 563

Details are presented of the chromosome morphology and microsporogenesis of *C. cajan*, *A. lineata*, and the F_1 hybrids between these two species; in each case the chromosome number was found to be 2 n = 22. The parents were thought to be closely related because of the similarity between their chromosome complements. However, structural differences between chromosomes of the two species may have accounted for the partial abortion of seed and the low percentage of pollen germinating in the hybrid, in which also some quadrivalents, bridges, and fragments were seen during meiosis. *C. cajan* had been crossed with *A. lineata* in order to combine the wilt resistance of the latter with the desirable agronomic characters of the former.

NAITHANI, S.P. 1941.
Cytological studies on Indian pulses, Part 1. The somatic chromosomes and the prochromosomes of *Cajanus*. Proc. Nat. Acad. Sci. India 11:67-73. 564

The chromosomes and their bahavior in *Cajanus* (2n = 22) are described. Somatic pairing is found. Prochromosomes showing a numerical correspondence to the chromosomes are formed in the resting nucleus, and it is concluded that they represent the spindle attachment regions of the chromosomes.

PANDE, V.N. 1966.
Cytological studies in *Cajanus* and *Atylosia*. DIIT (1966) Thesis. Indian Institute of Technology, Kharagpur, West Bengal, India. 565

PANKAJA REDDY, R., and N. GANGA PRASADA RAO. 1975.
Somatic variation in *Cajanus cajan*. Curr. Sci. 44(22):816-817. 566

The outcrossing in this species is estimated at less than 10%. Off types in true-breeding varieties frequently range from 10 to 30%. Experiments were therefore carried cut on true-breeding varieties in which several plant characteristics were observed on individual plants as well as on each shoot on each plant. Most variations observed appear to be somatic, although further studies are required.

PATHAK, G.N. 1948.
Cytological studies of a spontaneously originated tetraploid *Cajanus cajan* Millsp. Indian J. Genet. Pl. Breed. 8:68-71. 567

A naturally occurring tetraploid (n= 22) of *C. cajan* is described. Its cytological behavior in the pollen mother cells was characterized by the formation of 0 to 11 quadrivalents and irregular distribution of the chromosomes at anaphase I and II; the pollen grains showed up to 80% sterility.

PATHAK, G.N., and R.S. YADAVA. 1951.
Spontaneously originated hexaploid and tetraploid plants in *Cajanus cajan* Millsp. Curr. Sci. 20:304. 568

Naturally occurring tetraploids (n=22) and hexaploids (n= 33) have been observed. The hexaploids set no seed. Out of the nine tetraploids, five produced some seed. It is suggested that chromosome doubling may have occurred in diploids and some natural triploids, possibly as the result of cold conditions during a hail storm.

PHIRKE, T.S. 1966.
Some studies on polyploids in tur (*Cajanus cajan* (L.) Millsp.) with special reference to their utilization in breeding. Nagpur Agric. Coll. Mag. (Spec. Res. No.): 101. 569

Seeds of varieties EB-3 and EB-38 were treated with HNO_3, HCl, and chloral hydrate. Progenies showing gigas characters were studied and all showed 2n = 22 chromosomes. Some were significantly different in height, pod size, yield, and grain weight, and were crossed successfully with normal types.

REDDY, L.J. 1973.
Interrelationship of *Cajanus* and *Atylosia* species as revealed by hybridization and pachytene analysis. Ph.D. (1973) Thesis. Indian Institute of Technology, Kharagpur, West Bengal, India. 570

REDDY, L.J., and D.N. DE. 1978.
Somatic caryotypes of *Cajanus cajan* and three species of *Atylosia*. Genetica (In Press). 571

The somatic chromosomes of *Cajanus* and of *Atylosia lineata*, *A. sericea*, and *A. scarabaeoides* are small and come under the same length groups. *Cajanus* possesses three metacentric chromosomes as against four in all the *Atylosia* species. *A. sericea* possesses two satellited chromosome pairs in contrast to one satellited chromosome pair in *Cajanus* and the other two *Atylosia* species. Detailed analysis showed that five pairs of chromosomes are common to all the species of both the genera. Besides, *Cajanus* and *A. lineata* possess seven identical chromosome pairs and *Cajanus* and *A. sericea* and *Cajanus* and *A. scarabaeoides* exhibit six pairs of identical chromosomes each. Thus on the basis of somatic karyology, of the three species of *Atylosia* studied, *A. lineata* is closest to *Cajanus*.

ROY, ASHOK. 1964.
Intergeneric hybridization of *Cajanus* and *Atylosia*. DIIT (1964) Thesis. Indian Institute of Technology, Kharagpur, West Bengal, India. 572

ROY, ASHOK, and D.N. DE. 1965.
Intergeneric hybridization of *Cajanus* and *Atylosia*. Sci. Cult. 31:93-95. 573

The existence of a close relationship between the two genera is indicated by the similarity in chromosome number (2n = 22),

morphology, and certain anatomical features, and by the success of the cross *C. cajan* FC 9334 x *A. scarabaeoides*. It is therefore proposed that *Atylosia* be incorporated into the genus *Cajanus*, with cytotaxonomic revision of the latter.

SHARMA, C.N. 1967.
Studies on the *Cajanus* and *Atylosia* hybrid. DIIT (1967) Thesis. Indian Institute of Technology, Kharagpur, West Bengal, India. 574

SHRIVASTAVA, M.P. 1975.
Effect of gamma irradiation on diploid and tetraploid seeds of *Cajanus cajan* (L.) Millsp. Curr. Sci. 44(5):167-168. 575

Normal diploid and colchicine-induced tetraploid seeds were treated at five doses of γ-rays and studied for germination, percentage survival, seedling height, and number of leaves. In diploids, increasing doses, 15 to 60 Krad, resulted in a decrease for all these characters. In the tetraploids, 15 Krad resulted in increased germination, height, and number of leaves compared with untreated seeds. At higher doses, germination remained similar to that of the diploids except at the highest dose of 60 Krad, when it was less. Survival in all cases was higher than that of the diploids; height was greater at all doses except 60 Krad, when it was the same as in the diploids; and the number of leaves in all cases was higher than in the diploids.

SHRIVASTAVA, M.P., and R.K. JOSHI. 1972.
A smear technique for root tip chromosome preparation of *Cajanus cajan*(L.) Millsp. JNKVV Res. J. 6:59-60. 576

Of six chemicals tested, α-bromonaphthalene was most successful in pretreatment for Feulgen staining. At somatic metaphase, 2n = 22 was observed.

SHRIVASTAVA, M.P., LAXMAN SINGH, and R.K. JOSHI. 1972.
Induction and cytomorphological study of autotetraploidy in *Cajanus cajan* (L.) Millsp. JNKVV Res. J. 6:47-50. 577

All 13 tetraploids induced by colchicine treatment showed reduced seed set and yield. Cytological studies showed meiotic irregularities but physiological imbalances were also apparently involved in causing sterility.

SHRIVASTAVA, M.P., D. SHARMA, and LAXMAN SINGH. 1973.
Karyotype analysis in 15 varieties of *Cajanus cajan* (L.) Millsp. and *Atylosia lineata* (W. and A.). Cytologia 38(2): 219-227. 578

A chromosome number of 2n = 22 was found in 15 varieties of *C. cajan* and in *A. lineata*. One pair of satellited chromosomes was observed in 13 out of the 15 varieties; P-958 did not have the satellites and NP-69 had a heteromorphic pair with one member of the pair possessing a satellite. Karyotype analysis revealed considerable intervarietal variation regarding arm ratio, total length, and ratio of longest and shortest chromosomes. This variation is not associated with any morphological and agronomic characters of the varieties, although P-458, the variety without satellites, was distinguished from the other varieties by its obovate trifoliate leaves. The chromosome morphology of *A. lineata* closely resembled that of *C. cajan* T-21.

SIKDAR, A.K. 1965.
Cytological investigation on *Atylosia* and its hybridization with *Cajanus*. DIIT (1965) Thesis. Indian Institute of Technology, Kharagpur, West Bengal, India. 579

SIKDAR, A.K., and D.N. DE. 1967.
Cytological studies of two species of *Atylosia* and *Cajanus cajan*. Bull. Bot. Soc. Beng. 21(1):25-28. 580

SINGH, S.P. 1947.
A new method of application of acenaphthene. Sci. Cult. 12:593-594. 581

A method of treating seeds with acenaphthene in lard is outlined. The effects of acenaphthene treatment on *Cajanus* cells are described. It is thought that chromosome doubling might be induced by varying the concentration of the acenaphthene and the duration of the treatment.

SINGH, VEDPAL. 1959.
Retardation in the rate of germination of *Cajanus cajan*(Linn) Millsp. seeds treated with colchicine. Agra Univ. J. Res. (Sci.) 8(1):35-38. 582

SINHA, S.S.N., and S.B. AKHAURY. 1969.
Effect of gamma-radiation and E.M.S. on *Cajanus cajan*. Proc. Indian Sci. Cong. Assoc. 56(3):348-349. (Abstract). 583

Dry dormant seeds of *C. cajan* were treated with γ-rays at 5 and 10 Kr and with EMS of 0.5% and 1% strength. Gamma-rays produced more marked effects than EMS in reducing percentage of germination, increasing time taken for germination, and retarding seedling growth. Gamma rays also produced more breaks in chromosomes than EMS. Shoot growth suffered more than root with both mutagens. Various cytological abnormalities were observed in roots grown from treated seeds. There appear to be similarities in the trend and pattern of abnormalities caused by both the mutagens.

SINHA, S.S.N., and S.B. AKHAURY. 1971.
Radiation studies in *Cajanus cajan* dose response: chromosome aberrations and their eliminations. J. Res. Ranchi Univ. 6,7:247-255. 584

SIVASAMY, N. 1975.
Studies on induction of mutation in *Cajanus cajan*. M.Sc. (1975) Thesis. Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. 585

THOMBRE, MADHUKAR VASUDEO. 1960.
Cytogenetics and inheritance studies on the genera *Cajanus* (L.) Millsp. and *Atylosia* W. and A. Ph.D. (1960) Thesis. University of Poona, Poona, Maharashtra, India. 586

TIDKE, P.M. 1961.
Studies on the induced tetraploids of pea, pigeonpea and water hyacinth. M.Tech. (1961) Thesis. Indian Institute of Technology, Kharagpur, West Bengal, India. 587

VENKATESWARLU, S., R.M. SINGH, R.B. SINGH, and B.D. SINGH. 1976.
Induced variation for inflorescence in *Cajanus cajan*. J. Cytol. Gen. 11: 134-135. 588

ECONOMICS

CHOPRA, K., and G. SWAMY (EDITORS). 1975.
Pulses: an analysis of demand and supply in India 1951-71. New Delhi: Sterling. 589

Demand for pulses in India is explained in terms of total expenditure as well as of price relationships with other foods. One chapter is devoted to the geographical distribution of the production of pulses, and another to agricultural practices, and area response of pulses.

HENDERSON, T.H. 1965.
Some aspects of pigeonpea (*Cajanus cajan*) farming in Trinidad. Occas. Ser. 3. Dep. Agric. Econ. Fm Fgmt Univ. W. Indies. 40 pp. 590

Mainly on the economics of pigeonpea farming, but based on 1964 survey of 439 growers. Some agronomic data are included. The yields ranged from 200 to 5000 lb fresh green pods/ac.

HENDERSON, T.H. 1966.
Practice and reference among pigeonpea growers in Trinidad. Proc. Caribb. Soc. Fd Crop Sci. 1966. 591

In the Americas, pigeonpea is mostly harvested in the form of green pod (unripe pod + seed) to meet the demand for green vegetables and canning. In a survey of growers in Trinidad, green pod production ranged from 224 to 5600 kg/ha, about 80% of yields being less than 2240 kg/ha.

MISHRA, S.D. 1967.
Marketing of arhar in Khajwan market, Varanasi. Agric. Situ. India. 21(10): 855-858. 592

It is interesting to know how a wholesale produce market catering both to urban and rural customers functions. The sources of supply, the difficulties of the cultivators in raising and marketing the crop, and the answers to these difficulties are discussed.

MITRA, R.N. 1959.
Land and labour necessary for caloric and protein requirements in India. Agric. Situ. India. 14(9):958-970. 593

Attempts to determine land and labor cost of nutrients (calories and protein) in different states of India. It was found that pulses, especially red gram, are much more economical sources of proteins than cereals. Khesari (*Lathyrus sativus*) and red gram are the most economical sources of calorie requirements in terms of both human and bullock labor.

MOLLISON, J. 1901.
Pigeonpea (*Cajanus indicus*). *In*: Field and Garden Crops of Bombay Presidency. 70-73 pp. Bombay: Supdt. Govt. Printing. 594

MUTHAIAH, C., and M.P. RAO. 1962.
Shifting of area under tur. Agric. Situ. India. 17(4):337-341. 595

A detailed study made in 10 selected districts in Madhya Pradesh, India showing reasons for a trend in which pigeonpea (*Cajanus indicus*) and its associated crops are being replaced by whe to a considerable extent. Extension of irrigation facilities is the main reason.

RODRIGUEZ, G.O., and J.B. CANDELAS. 1959.
Estadisticas agricolas de Puerto Rico. 1935-1958. E. and R.S., 53. Agric. Exp. Stn Univ. P. Rico. 596

Pigeonpea is also a major crop in Puerto Rico. During 1957-58 a total production of 655,000 kg green peas was reported, which at farm value was worth 1,665,000 US dollars.

SILVESTRE, P., and M. SOITOUT. 1965.
First technical meeting on vegetable and grain legume improvement and production in Africa. Dakar, 18-28 Jan 1965. Agron. Trop. 20(3):747-768. 597

Madagascar produced 2,300 metric tons of beans and 500 metric tons of *Cajanus*. Kenya cultivates *Cajanus* over 16,000 hectares.

ENTOMOLOGY

AHMAD, D. 1976.
Effect of phosphine fumigation on the germination of edible legume seeds. J. Stor. Prod. Res. 12(3):211-212. 598

Fumigation of seeds of *Vigna radiata*, *V. mungo*, *V. aconitifolia*, cowpea, soybean, *Phaseolus vulgaris*, chickpea, lentil, pigeonpea, *Vicia faba*, and *Cyamopsis tetragonoloba* with PH_3 at a concentration four times higher than the normally used maximum for 7 days had no effect on subsequent germination, compared with unfumigated seeds.

AHMAD, T. 1938.
The tur pod fly, *Agromyza obtusa* Mall., a pest of *Cajanus cajan*. Indian J. Agric. Sci. 8:63-76. 599

Red gram *Agromyza*, discovered in 1906, has been identified as *Agromyza obtusa* Mall. Its life cycle, favorable environmental conditions, infestation period, and severity of damage are described. A chalcid larval parasite of this pest has been investigated which is yet awaiting identification.

AHMAD, T. 1940.
On the biology of *Euderus lividus* (Ashm), a parasite of *Agromyza obtusa* Mall. Indian J. Ent. 2:59-64. 600

In nature the larval stage of the *Agromyza* is parasitized by the Chalcid *Euderus lividus* (Ashm) to a sufficiently large extent; therefore, a detailed study of the biology and morphology of the parasite has been made, the results of which are summarized.

ANONYMOUS. 1951.
Annual report of the Department of Agriculture, Mauritius, 1949. pp.64-65. 601

Experiments on the control of insect pests of pigeonpea (*Cajanus indicus*). A spray of 4% DDT reduced insect attack.

ANONYMOUS. 1959.
Pests of pigeonpea. Rep. Dep. Agric. Mauritius, 1959. 602

The pests of pigeonpea (*Cajanus cajan*) were greatly reduced, and a record crop obtained in 1959, following the successful introduction of the parasites *Bracon cajani* and *Eiphosoma annulatum*.

ANONYMOUS. 1961.
Annual report of the Department of Agriculture of the Colony of Mauritius for the year 1959. 78 pp. 603

Review of agricultural activities and results in Mauritius during 1959. Several insect-parasites were introduced, inter alia, against the pests of the pigeonpea (*Cajanus indicus*).

ARGIKAR, G.P., and V.V. THOBBI. 1957.
An estimate of the damage caused by the tur pod caterpillar, *Exelastis atomosa* W., to pigeonpea gram. Poona Agric. Coll. Mag. 48(1):25-26. 604

Twenty-five cultivars of *Cajanus cajan* were grown in a small-scale replicated trial to test comparative susceptibility to the pod caterpillar. Loss in grain weight ranged from 0.30% in strain NP-69 to 19.56% in Borsad-1. The study indicated the differential behavior of the pest towards different types. The necessity of control

measures is emphasized and the possibility of getting comparatively resistant lines in the germplasm is discussed.

ATHWAL, A.S. 1970.
Insect pollinators of crops. Biology, ecology and utilization of insects other than honeybees in the pollination of crops (Final Research Report 1965-70). PL-480 Project (A7-Ent-19), Punjab Agricultural University, Ludhiana, India. 115 pp. 605

Pollinators of *Cajanus indicus* given with detailed biology, habits, photographs etc. *Megachile* spp. *Cerulina* sp. and *Xylocopa* sp. are referred to as pollinators.

ATHWAL, A.S. 1976.
Agricultural pests of India and South-East Asia. *In*: Pests of Pulse Crops. Ludhiana: Kalyani Publishers. 175 pp. 606

About 150 insects have been recorded feeding on 10 important pulse crops grown in different parts of India. Of these, about one dozen insects, including pod borers, stem borers, leaf miners, foliage caterpillars, cut worms, jassids, aphids, and white flies are important. The life-cycles of the plume moth (*Exelastis atomosa*) and red gram pod fly (*Agromyza obtusa* M.), the extent of damage, and control measures to be taken are discussed.

BALASUBRAMANIAN, G., R. RABINDRA JEBAMONI, P.P. VASUDEVA MENON, and T.R. SUBRAMANIAN. 1976.
Control of red gram pod borers with spray formulations. Madras Agric. J. 63(4): 251-252. 607

Endosulfan 0.07% was superior to others in controlling pod borers. The treatments monocrotophos, malathion + fenitrothion, dimethoate, and fenthoate were equally effective in reducing the incidence of pod borers and getting higher yields. Carbaryl both at 0.1% and 0.25% registered less pod borer damage.

BARROW, R.M. 1968.
Bionomics of a leaf-eating beetle (*Diphaulaca* n. sp.) on pigeonpea (*Cajanus cajan*) in Trinidad. Proc. Caribb. Fd Crops Soc. 6th Annual Meeting, Trinidad. 6: 38-41. 608

A high level of host specificity was demonstrated by the leaf-eating flea-beetle species of *Diphaulaca*. Only *Cajanus cajan* and no other legume was consumed. The peak incidence of thi pest coincides with the peak rainfall periods in Trinidad.

BASANT SINGH, RAMESHWAR PRASAD, and Y.K. MATHUR. 1976.
Effect of insecticide combination on the incidence of *Melanagromyza obtusa* Mall. and on yield of arhar crop. Pesticides 10(1):42-43. 609

Spraying of 0.03% phosphamidon mixed with 0.03% endosulfan (1:1) at the rate of 1,135 liters per hectare can be recommended for the control of *M. obtusa* on arhar crop and for realizing appreciable yield.

BENNET, F.D. 1960.
Parasites of *Ancylostomia stercorea* (*Pyralidae*; *Lepidoptera*) a pod borer attacking pigeonpea in Trinidad. Bull. Ent. Res. 59(4):737-757. 610

In Trinidad, the only serious pod borer attacking pigeonpea is *Ancylostomia stercorea* Zell., which breeds throughout the year. The eggs are laid on the young pods and the larvae feed on the developing seeds and later pupate in the soil. The complete life cycle requires 26 to 32 days. Eight species of parasites were reared from the larvae of *Ancylostomia*. Life history studies and rearing techniques for the six commonest species are presented.

BINDRA, O.S. 1965.
Biology and bionomics of *Clavigralla gibbosa* Spinola, the pod bug of pigeonpea. Indian J. Agric. Sci. 35:322-334. 611

There was considerable overlapping of generations and six generations were possible from November to May. The pest could be collected only from *Cajanus cajan*. An effective parasite, *Hadronotus antestiae* Dodd, was found for the first time parasitizing the eggs.

BINDRA, O.S. 1968.
Insect pests of pulse crops. Indian Fmg 17(11):12-14. 612

More than 150 species of insects are known to attack pulse crops in India and of these about 25 cause serious damage. Red gram suffers serious losses from attack not only by caterpillars but also pod fly, plume moth, and pod bug. A large number of other insects which are not serious pests individually also cause appreciable damage collectively.

BINDRA, O.S., and HARCHARAN SINGH. 1971. Tur pod bug, *Clavigralla gibbosa* Spinola (*Coreidae*: *Hemiptera*). Pesticides 5(2):3-4, 32. 613

Clavigralla includes two species, *C. gibbosa* Spin, and *C. horrens* Dohrn., which infest leguminous crops and suck their juice. The former is more commonly prevalent and is of greater economic importance in India. The following aspects of this pest are discussed: various stages of development; distribution of host plants, primarily pigeonpea; life history, seasonal history, and number of generations; nature and extent of damage; natural enemies; and control measures.

BINDRA, O.S., and HARCHARAN SINGH. 1972. Tur pod fly, *Melanagromyza obtusa* Malloch. (*Diptera*: *Agromyzidae*). Pesticides 6(7):11-12, 22. 614

Tur pod fly, *Melanagromyza* (*Agromyza*) *obtusa* Malloch. was first recorded in 1906 under the name "Tur-pod fly" on *Cajanus cajan* (L.). It has also been described under the name "Red-gram agromyza" but this name has not become widely accepted. The identification of the insect, its distribution and host plants, life history, seasonal history, nature and extent of damage, natural enemies, and control measures are summarized.

BINDRA, O.S., and S.S. JAKHMOLA. 1967. Incidence of and losses caused by some pod-infesting insects in different varieties of pigeonpea (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Sci. 37(3):177-196. 615

In a 2-year study of 50 varieties of pigeonpea, the incidence of the pod fly (*Melanagromyza obtusa*) in freshly harvested pods varied considerably from variety to variety; percentages of the affected grains averaged 11.2 and 15.8 in the first and second year respectively. In a subsequent trial with 11 varieties, the incidence on grain basis proved to be only 50% of that on pod basis. The average yield loss was 8.35% while that caused by attacks of the plume moth (*Exelastis atomosa*) the pulse beetle (*Bruchus bacticus*), and three other pests (*Heliothis armigera*, *Catochrysops cnejus*, and *Cosmolyce bacticus*) amounted to 4.02, 0.28, and 3.62% respectively.

CHARI, M.S., and H.K. PATEL. 1970. Studies on phytotoxic action of carbaryl on pigeonpea (*Cajanus cajan* (L.) Millsp.). B.A. Agric. Coll. Mag. 23:47-48. 616

CHAUDHARY, R.R.P., and A.K. BHATTACHARYA. 1974. Keeping pests of arhar at bay. Indian Fmr Digest 7(7):23, 33. 617

Arhar is liable to attack by a number of insect pests, the red gram pod fly and tur pod fly and tur pod caterpillar being the most serious. Others, the tur pod butterfly (*Catochrysops cnejus*) and arhar leaf webber or leaf roller (*Eucosma critica*) are not so serious. Control measures are described.

CRUZ, CARLOS. 1975. Observations on pod borer oviposition and infestation of pigeonpea varieties. J. Agric. Univ. P. Rico. 59(1):63-68. 618

Thirteen varieties of pigeonpea (*Cajanus cajan* (L.) Millsp.) were planted to determine pod borer oviposition preferences and infestation percentages. *Etiella zinckenella* and *Heliothis virescens* were the predominant species. Oviposition of *Heliothis* began on flower buds but pods were preferred where available, except for varieties Florido, Trinidad 5690, and Trinidad 6222, where a similar preference for bud and pods was recorded. Variety Guama particularly was less attractive for oviposition. Varieties Saragateado, Florido, and Totiempo showed highest infestation rates throughout the season.

DAVID, B.V., and T. SANTHANARAMAN. 1964. First record of the green nettle slug caterpillar, *Thosea asperiens* Wlk., in India. Madras Agric. J. 51(12): 499-502. 619

The seasonal occurrence and life history of the green nettle slug caterpillar, *Thosea asperiens* Wlk., a new pest of cholam (*Sorghum* spp.) that also attacks red gram are reported. The larvae defoliate the plants and their poisonous hairs also inflict severe pain if they happen to come in contact with the human body.

DAVID, S. KANAKARAJ. 1964. Note on *Heliothis armigera* H. and *Agromyza obtusa* M. affecting redgram pods and their control. Madras Agric. J. 51(2):90. 620

There was significant reduction of pod borers with DDT formulations giving the best results in the first year. DDT in the first year and Methyl demeton followed by Dipterex in the second year recorded the highest yield.

DAVIES, J.C., and S.S. LATEEF. 1975.
Insect pests of pigeonpea and chickpea in India and prospects for control. Proc. First International Workshop on Grain Legumes. 13-16 Jan 1975. ICRISAT. Hyderabad, India. 319-331. 621

Losses in seed yields of pigeonpea and chickpea due to the incidence of different pests are described, control measures against them are suggested, and the pests are listed in two appendices.

DESHPANDE, B.V. 1966.
Studies on the varietal susceptibility of arhar to *E. atomosa* W. and *A. obtusa* M.: the bionomics and external morphology of *E. atomosa* W. M.Sc. (1966) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India. 622

EGWUATU, R.I., and T.A. TAYLOR. 1976.
Aspects of the spatial distribution of *Acanthomia tomentosicollis* Stal. (Heteroptera: Coreidae) in *Cajanus cajan* (Pigeonpea). J. Econ. Ent. 69(5):591-594. 623

To design an integrated pest management program for the control of the bug *Acanthomia tomentosicollis*, a serious pest of pigeonpea (*Cajanus cajan*) in Nigeria, the spatial distribution of this insect was studied. The species was found to be highly aggregated, with indices of aggregation ranging from 1.61 for eggs to 2.30 for second instar nymphs. Indices of aggregation from the second to the fifth nymphal instar decreased as the nymphs became more mature.

FLETCHER, T.B. 1917.
Leguminous field crops: pests of *Cajanus indicus* (Red gram). Proc. Second Ent. Meet. Pusa. pp. 41-79. 624

Records the occurrence of *Exelastis atomosa* W. on arhar and gives an account of its life history and the damage it causes. The red gram plume moth, a typical borer, cuts through the pod and feeds on the developing seed inside. The caterpillar on hatching, first scrapes the pod surface, cuts a hole and thrusts the head into it to feed on the seeds from outside. Other major pests of pigeonpea are also listed.

GAEKWAD, B.B., V.M. PAWAR, and G.G. BILAPATE. 1977.
Effect of food plants on growth and development of *Heliothis armigera* Hub. Res. Bull. MAU. 1(8):123-124. 625

There were no significant differences between pupal weights of arhar-fed and gram-fed larvae. There appears to be positive correlation between amount of food consumed and pupal weight.

GANGRADE, G.A. 1961.
Tur pod bug, *Clavigralla gibbosa* Spin. in Madhya Pradesh. Sci. Cult. 27(2): 101-102. 626

The duration of the insect's life cycle varies from 39 to 56 days. The eggs are parasitized by *Hadronotus* sp. no. *antestiae* Dodd. (Scelinoidae: Hymenoptera). A red Reduviid bug was observed in the field feeding on an adult bug.

GANGRADE, G.A. 1963.
Assessment of damage to tur (*Cajanus cajan*) in Madhya Pradesh by the tur-pod fly. *Agromyza obtusa* Malloch. Indian J. Agric. Sci. 33(1):17-20. 627

Observations on the extent of the damage to pods and grains of five varieties of pigeonpea revealed that the damage to pods ranged from 29 to 100% in Shahdol, 45 to 54% in No. 148, 40 to 54% in Hyderabad, 30 to 60% in Nizamabad and 27 to 58% in local; whereas in grains of the same varieties the damage ranged from 11.4 to 86.8%, 23.3 to 29.8%, 21.3 to 29.0%, 13.1 to 32.3%, and 13.2 to 37.2%, respectively. A new parasite, *Euderus agromyzae*, parasitized the full-grown maggots in Madhya Pradesh, the extent of parasitism being 11.3 to 18.7%.

GANGRADE, G.A. 1965.
Losses to tur (*Cajanus cajan*) by *Melanagromyza obtusa* Malloch. Indian J. Ent. 26:364-365. 628

The range of percentage loss in weight due to infestation is quoted for each of the four varieties tested. No. 148 was least affected, with maximum loss of 1.17%.

GHOSH, C.C. 1937.
The pulse beetles (*Bruchidae*) of Burma. Indian J. Agric. Sci. 7:395-412. 629

Of four bruchids, the two most injurious are *Bruchus chinensis* on pigeonpea (*pesinngon*) specially and also on cowpeas (*Vigna catajang*) and *Bruchus albocallosus*, which occurs in small numbers in the fields on pigeonpeas (*Cajanus indicus*). *Bruchus chinensis* is the most common pest on pigeonpea both in the field and store.

GIRISH, G.K., K. SINGH, and K. KRISHNAMURTHY. 1974.
Studies on the oviposition and development of *Callosobruchus maculatus* (Fab.) on various stored pulses. Bull. Grain Technol. 12(2):113-116. 630

The oviposition and development of *Callosobruchus maculatus* on a few stored pulses were studied in India. Main factors related to oviposition were smoothness of the seedcoat and size of the grain.

GOKHALE, V.G. 1973.
Developmental compatibility of several pulses in the *Bruchidae*. 1. Growth and development of *Callosobruchus maculatus* (Fabricius) on host seeds. Bull. Grain Technol. 11:28-31. 631

The growth index of the insect proved that moth bean (*Vigna aconitifolia*) was of maximum food value, followed by green gram, pigeonpea, and other legumes. The insect, however, completely failed to develop on soybean, lima bean, french bean, and lentil. An appreciable difference was also recorded in the mean weight of the adults emerging from different seed species.

GOVINDAN, R., H.R. RANGASWAMY, K.C. DEVRAJ, M.C. DEVAIAH, and B.N. VISWANATH. 1977.
Biology of the red gram bud weevil (*Ceuthorhynchus asperulus* Fabricius) (Coleoptera: Curculionidae). Mysore J. Agric. Sci. 11(2):191-194. 632

The percentage of infestation varied from 10 to 80, the maximum being in December. The grubs and adults caused damage to flower buds and flowers. The life cycle was completed in 10 to 22 days with an average of 14.5 days during January-February (incubation period 1.92 days; larval period 4.20 days; prepupal period 3.0 days; pupal period 5.83 days). The adult survived for 5 days without food and 15 days with food under confinement.

GUPTA, S.K., MANJIT SINGH DHOORIA, and A.S. SIDHU. 1971.
Varietal resistance of pigeonpea in the Punjab to pest *Schizotetranychus* sp. Sci. Cult. 37:484-485. 633

In tests of 13 varieties of *Cajanus cajan*, P-1141 was the least susceptible.

HAZARIKA, S.H., and S. ABDUS. 1961.
Insects associated with arhar (*Cajanus indicus* Spreng) in East Pakistan. Scientist (Pak.). 4:18-20. 634

In East Pakistan (Bangladesh), the pod was the most severely attacked plant part. The likelihood of economically important damage was ascribed to *Maruca testulalis* and *Zonabris pustulata*.

HEINRICH, C. 1956.
American moths of the subfamily Phycitinae. Bull. U.S. Nat. Mus. No. 207, 581 pp. 635

The pigeonpea (*Cajanus cajan*) was found to be the commonest host plant but specimens were also collected as larvae from chickpea (*Cicer arietinum*) and black-eyed pea (*Dolichos*).

HEINRICH, W.O. 1966.
"Verruga," a scale pest of coffee in Brazil. World Crops 18(1):38-42. 636

The other host plants of the scale (*Cerococcus catenorius*) include *Cajanus cajan*. The typical symptom is the breaking of the stem some 25 cm below the apex. Spraying with 0.9% malathion or 0.2% diazinon is recommended.

IPE, I.M. 1964.
Anatomy of the final instar larva of *Melanagromyza obtusa* (Malloch) a pest on the developing seeds of *Cajanus indicus* (*Agromyzidae*: Diptera). Agra Univ. J. Res. 13(3):59-72. 637

The larval head of the final instar is followed by three thoracic and eight abdominal segments. Segmental boundaries are marked by muscle scars and cuticular process. Mandibles, labial sclerites, and the paraclypeal phragma constitute the cephalopharyngeal skeleton. The study also describes anatomical peculiarities of digestive and respiratory systems. Salivary apparatus and the histology of the salivary glands, the nervous and excretory systems are also included.

IPE, I.M. 1966.
A detailed morphological study of the external and internal genital organs of a female *Melanagromyza obtusa* (Malloch) a serious pest of *Cajanus indicus* L. (Agromyzidae: Diptera). Indian J. Ent. 28(3):287-298. 638

The details of the functional morphology of internal and external genital organs of the female fly are described. The anatomical studies include the genitalia - genital segments, ovaries, ovarioles, oviducts, vagina, genital chamber, spermathecae, accessory glands, and histology.

IPE, I.M. 1974.
Morphological, behavioural, and biological studies of *Melanagromyza obtusa* (Diptera: Agromyzidae) on *Cajanus indicus*. Z. Angew. Entomol. 75:89-98. 639

The behavior and biology of *M. obtusa*, along with description of various instars, and a key for their identification are given.

JANARTHANAN, R., G. NAVANEETHAN, K.S. SUBRAMANIAN, and G. SATHIABALAN SAMUEL. 1972.
Method of assessment of *Eriophyid* mites on pigeonpea leaves. Madras Agric. J. 59(8):437. 640

A safe method for estimation of *Eriophyid* mites has been developed. This method can also be used for estimating other *Eriophyid* mites in a population as well as for virus vector relationship studies.

JOPLIN, C.E. 1975.
Pulse crops of the world and their important insect pests. Pest Management Papers No. 1. May 1975. Simon Fraser University, (Canada). 134 pp. 641

Summarizes agronomic, economic, and nutritional data on 14 major species of pulses. Identifies the insect genera and species that are important pests of pulses. Three common species of pests are described thoroughly in terms of their biology, ecology, and control. Also discusses the status and possibilities of pest management on pulse crops and several internationally important institutions that are conducting such work.

JOSHI, G. 1976.
Studies on the larvae of rice moth, *Corcyra cephalonica* (Stainton) in some of their characteristic attitudes. Z. Angew. Zoo. 63(4):451-456. 642

The author describes experiments with larvae of *C. cephalonica* (Stnt.) infesting half seeds of *Cajanus cajan* (*indicus*). The larvae were seen to bind the half seeds together with silken threads and later to cement them so that they appeared like whole decorticated seeds, and feeding occurred in both halves. Observations on their pupation and spinning threads are also recorded.

KAPADIA, M.N. 1975.
Some studies on bionomics and control of blue butterfly (*Euchrysops cnejus* Fab.) as a pest of tur (*Cajanus cajan* Millsp.). M.Sc. (1975) Thesis. Gujarat Agricultural University, Junagadh, Gujarat, India. 643

KAPOOR, K.N. 1966.
Bio-ecological studies on *Clavigralla gibbosa* Spin (Coreidae: Hemiptera) the tur pod bug. 76 pp. M.Sc. (1966) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. 644

KHAN, M.Q., and K. RAMASUBBAIAH. 1959.
Bionomics and control of gram caterpillar. Andhra Agric. J. 6(2):68-69. 645

The gram caterpillar, *Heliothis armigera*, is a serious pest of red gram, causing crop damage up to 50%. Insecticidal trials with BHC and DDT showed that 0.16% DDT is effective and economical treatment against *Heliothis armigera*.

KOEHLAR, C.S., and K.O. RACHIE. 1971.
Notes on the control and biology of *Heliothis armigera* (Hub) on pigeonpea in Uganda. E. Afr. Agric. For. J. 36(3):296-297. 646

Observations showed that pods and seeds of pigeonpea (*Cajanus cajan*) were damaged by the larvae of *H. armigera*. The adult insect oviposited on the flower buds; while the young larvae fed exclusively on the buds, the older ones fed on the seeds of immature pods. The insect did not damage more than 50% of the seeds in any pod. Effective control was obtained by spraying with DDT or DDT + dimethoate. Fenitrothion was less effective, and carbaryl produced severe phytotoxic effects.

KOONER, BANTSINGH., HARCHARAN SINGH, and K.B. SINGH. 1972.
Relative susceptibility of germplasm of pigeonpea against tur pod fly, *Melanagromyza obtusa* Malloch under field conditions. Pl. Prot. Bull. 23(1-2):7-18. 647

Of 205 lines, H-90, H-69, C-4240, H-107, CC-4229, H-111, N-165, H-290, H-250, H-254, CC-3444, CC-2851, CC-3342, and L-13 were most resistant on the basis of percentage of infested pods and grains and weight reduction of grains in pods. The individual reaction of each line to attack is tabulated.

KORYTKOWSKI, C., and M. TORRES. 1966.
Insect damaging cultures of pigeonpea (*Cajanus cajan*) in Peru. Revta Peru. Ent. Agric. 9:3-9. 648

The pod borer *Elasmopalpus rubedinellus* (Zell.) *Ancylostomia stercorea* (Zell) and *Heliothis virescens* (F) are serious pests attacking this crop in Peru. There are fourteen pests reported which attack the pigeonpea crop and yield losses in some years are quite high.

KUPPUSWAMY, S., and T.R. SUBRAMANIAN. 1976.
Studies on the impregnation of gunny bags with certain organophosphorus insecticides. Bull. Grain Technol. 14(1):45-50. 649

Of four insecticides tested against *Callosobruchus chinensis* incidence on red gram (*Cajanus cajan*) seeds in gunny bags during storage for 4 months the spraying of phoxim on one side of gunny bags was the best in terms of pest mortality and prevention of penetration by beetles.

LATEEF, S.S. 1977.
A new hymenopteran pest *Taraostigmodes* sp. (Hymenoptera: Taraostigmodae) recorded on pigeonpea (*Cajanus cajan* (L.) Millsp.) at ICRISAT, Hyderabad, India. Trop. Grain Legume Bull. 7:6. 650

Taraostigmodes sp., a new insect pest of pigeonpea, is described.

LAURENCE, G.A. 1971.
Insect pests of pigeonpea and their control. J. Agric. Soc. Trin. 71(4): 501-504. 651

Brief notes are presented on the morphology of and damage caused by various insect pests infecting pigeonpea (*Cajanus cajan*) in Trinidad and Tobago. Among the most important insects are the green leaf hopper (*Empoasca fabilis*), black aphid (*Aphis craccivora*), the beetle *Oncideres amputator*, the phycitid *Ancylostomia stercorea*, and the spider mite *Tetranychus* spp. Control measures are briefly outlined.

MOHAMED HANIFA, A., G. BALASUBRAMANIAN, and A. LEELA DAVID. 1974.
Granular insecticides for the control of pod borers in red gram. Madras Agric. J. 61(10-12):970-972. 652

Two field trials were conducted in India to evaluate the effect of several soil-applied granular insecticides on borer attack in pigeonpea (*Cajanus cajan*). The results suggest that granular mephosfolan (10%), disulfoton (5%) and bux (10%) can be safely adopted for package programs for red gram production.

MOHAMED HANIFA, A., G. BALASUBRAMANIAN, R.J. RABINDRA, T. SURULIVELU, and P.P. VASUDEVA MENON. 1977.
Comparative efficacy of dust, spray, and granular formulations of insecticides in controlling the pod borers of red gram (*C. cajan*). Indian J. Pl. Prot. 5(1): 83-86. 653

Two field experiments were conducted to study the comparative efficacy of certain granular, spray, and dust formulations in controlling the pod borers of red gram cv SA-1. Soil application of aldicarb granules (once) 45 days after sowing at 1.25 kg ai/ha or spraying of chlorphenamidine 0.1% or dusting of carbaryl + BHC (Sevidol), carbophenothion and trichlorphon at 1 kg ai/ha twice at 15 days interval from the pod-formation stage increased the yield of red gram and considerably reduced the pod borer damage.

MOHAMED SHERIFF, N., and C.K. RAJAGOPALAN. 1971.
A comparative study of the intensity of infestation of the pod fly, *Melanagromyza* (Agromyza) *obtusa* Malloch on different varieties of red gram (*Cajanus cajan* (Linn.)). Madras Agric. J. 58(11):842-843. 654

Infestation was severe during the month of November in this tract. Late varieties generally escaped infestation. Maximum infestation of pods and grains was 38.6% in No. 1141, an early maturing variety; in late varieties it ranged from 2.5% to 19.5%.

ODAK, S.C., B.V. DESHPANDE, and S.V. DHAMDHERE. 1968.
Estimate of the damage caused by the plume moth (*Exelastis atomosa* W.) and pod fly (*Melanagromyza obtusa* M.) to tur. J. Coll. Agric., Gwalior 8:1-3. 655

Studies at Gwalior (M.P., India) during 1965-66 with 10 varieties of pigeonpea (Types-1, -87, -114, -157, -176, Gwalior 3, Altair, Khargone-2, Hyderabad and Pusa) indicated that Type T-87 recorded no infestation by plume moths but had maximum loss in weight of grains due to podfly. Highest losses due to these two pests were 6.7 and 7.8 percent of seed weight and there was no apparent relationships with larval populations, possibly due to the interaction by varying levels of host resistance.

ODAK, S.C., S.V. DHAMDHERE, and B.V. DESHPANDE. 1968.
New record of *Demarchus pubipennis* Jacoby, feeding on *Cajanus cajan* (L.). Indian J. Ent. 30(4):323. 656

This beetle was recorded for the first time during 1966 at Gwalior (M.P.), India. The immature stages of the beetles are found feeding on roots and the adults damaging the leaves by making a large number of irregular homes on the leaves. Due to the injury caused by the grubs, the plants start drying at an early stage.

ORIAN, A.T.E. 1962.
Pest control recommendations made by the Division of Entomology of the Department of Agriculture, Mauritius. Rev. Agric. Suc. Maurice. 41(2):87-116. 657

The following crops are considered: beans and other leguminous plants, sugar-beet, cabbage, cassava, pigeonpea, English potato, and sweet potato.

PAL, S.K. 1972.
A note on leaf weevil. *Cyrtozemia cognata* Marshall (Curculionidae: Coleoptera) infesting kharif crops of dryland farming. Ann. Arid Zone. 11(1-2):132. 658

The leaf weevil *Cyrtozemia cognata* Marshall was also noticed on *Cajanus cajan*, a new host for this pest. The activity of the pest was maximum during morning and evening hours. Two sprays, at 10 days' interval, of 0.03% Phosphamidan were effective in controlling the pest.

PANCHABHAVI, K.S., G. THIMMAIAH, and K.S. MUTALIK DESAI. 1972.
Report on the incidence of *Alcides collaris* Pascoe. (Curculionidae: Coleoptera) on red gram at Dharwar. Sci. Cult. 38(7): 325-326. 659

The insect was identified as *Alcides collaris*, which is dirty white in color with a pale brown head; a detailed description is given. This grub, scratching the stem portion just below the ground level, enters the stem and feeds on the tender stem inside; as a result, a gall is formed at the ground level. There is no sign of damage above the ground level. The damage ranges from 95 to 98%.

PANDIT, P.V. 1965.
Effect of time of sowing and varieties of tur on the incidence of its major insect pests, bio-ecological studies on *Exelastis atomosa* Wlsm. (Pterophoridae: Lepidoptera), the tur plume moth. 83 pp. Ph.D. (1965) Thesis. Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur, Madhya Pradesh, India. 660

PARMANIK, L.M., and A.C. BASU. 1968.
Record of two insect pests of pigeonpea (*Cajanus cajan*) in West Bengal. Indian Agric. 11(2):145-147. 661

The life cycle is described of *Eucosma critica*, a serious pest of pigeonpea (*Cajanus cajan*) and of *Oxyrhachis tarandus*, a pest of pigeonpea and of the shade trees *Albizzia odorotissima* and *A. lebbeck*. Damage of *E. critica* is highest in July and August, and of *O. tarandus* at the end of October. Parasites associated with *E. critica* were reared in the laboratory and identified as *Apanteles taragamal*.

PAWAR, A.D., and O.P. BHALLA. 1975.
Occurrence of *Heliothis armigera* (Hubner) as a serious pest of 'arhar' in Himachal Pradesh. Entomologists' Newsletter 5(4):24. 662

The caterpillars on *Cajanus cajan* were observed during August-October. They defoliated the tender part of the plant in the earlier stages but later bored the pods. In some fields the infestation of this pest was so much that hardly a few pods on a plant were left unattacked.

PAWAR, V.M., and M.D. JAWALE. 1977.
A note on the performance of early maturing varieties of arhar against damage by pod borers. Res. Bull. MAU. 1(8): 127-128. 663

Type-21 showed lowest percentage incidence of pod borers. Pant A-3 was damaged most by all the borers. Prabhat showed lowest damage by pod fly. At dry-pod stage the varieties with determinate plant type such as Prabhat and Pant A-3 suffered heavily from pod borers.

PUTTARUDRAIAH, M. 1947.
Some observations on the biology and habits of red gram (*Cajanus indicus*) flower bud borer (*Euproctis scintillans*). Mysore Agric. J. 24:20-24. 664

A serious pest on red gram, *Euproctis scintillans* W., is a moth belonging to the group of tussock moths of the family

Limantridae. Unlike the other leaf-eating caterpillars of this group, this one was found to bore in and feed mostly upon buds and flowers of red gram. A study of the biology and life history of this insect on the red gram crop has revealed certain marked peculiarities.

RAINA, A.K. 1971.
Observations on bruchids as field pests of pulses. Indian J. Ent. 33:194-197. 665

It was observed that the beetles of *Callosobruchus chinensis*, after developing inside the pods, failed to find their way out and consequently died inside the pods.

RAJAGOPALAN, C.L.K., and J.P. DEVAKUMAR. 1965.
Preliminary studies on the infestation of *Agromyza obtusa* Mall. in red gram (*Cajanus cajan* (Linn.) Millsp.). Madras Agric. J. 52(8):345-346. 666

Of 15 varieties tested, late-maturing varieties had the lowest pod and seed infestation.

RAMAKRISHNAN, C., and P.S. NARAYANASWAMY. 1964.
Insecticidal control of the pulse beetle, (*Bruchus theobromae* L.) on red gram. Madras Agric. J. 51(1):30-31. 667

For effective control of the pulse beetle on red gram, treatment with toxaphene 10% dust three times at triweekly intervals commencing from the time of flowering, is best for increased yields and total monetary return from the crop.

RANE, A.E., and Y.M. TALEY. 1973-74.
Field trial with insecticides for the control of pests of tur (*Cajanus cajan*). Nagpur Agric. Coll. Mag. 46:20-21. 668

All the treatments tested were significantly superior to the check and all of them gave good control of *Exelastis atomosa*, *Catochrysops strabo*, *F.* and *Heliothis armigera*; Trithion and Aldrin were found to be comparatively less effective against *Heliothis* damage and *Catochrysops strabo* F. respectively.

RAWAT, R.R., and S.S. JAKHMOLA. 1967.
Estimation of losses in grain yield in different varieties of tur (*Cajanus cajan*) by pod fly, plume moth, pulse beetle and other means. Madras Agric. J. 54(11): 601-602. 669

The grain loss as a result of damage by *Melanagromyza obtusa*, *Exelastis atomosa*, and *Bruchus* sp. was estimated in eight varieties. The total loss was lowest in Type 148.

RAWAT, R.R., ZILE SINGH, and S.S. JAKHMOLA. 1969.
Effect of infestation of blossom-thrips on pod setting in pigeonpea, *Cajanus cajan*(L.) Millsp. Indian J. Agric. Sci. 39(9): 623-625. 670

In comparison to the pod formation in plants treated twice at weekly intervals with a 1:1 mixture of dimethoate 0.03% and endrin 0.02% at the rate of 750 liters per hectare, a reduction of 36.0% in pod formation was observed in the untreated plants as a result of infestation by blossom-thrips.

REGUPATHY, A., and R. RATHNASWAMY. 1970.
Studies on comparative susceptibility of seeds of certain red gram (*Cajanus cajan* (L.) Millsp.) varieties to pulse beetle, *Callosobruchus chinensis* L. (Bruchidae: Coleoptera). Madras Agric. J. 57(2): 106-109. 671

Of 18 varieties studied, P-653, PLS-201, P-642, P-1066, T-17, and MS-9537 were comparatively resistant though not immune. Resistance was associated with large seeds. Seed color, seed volume, seed hardness, and earliness were not associated with resistance.

SAHARIA, D., and B. DATTA. 1975.
Control of *Helicoverpa armigera* HB; a serious pest of Arhar (*Cajanus cajan* L.) in Assam. Pesticides 9(8):34-35. 672

The efficacy of endosulfan, carbaryl, and malathion, each at three concentrations against *H. armigera* infesting pigeonpea var. Ageti (S-5) was studied. The least mean percentage infestation of pods and the maximum yields were obtained with endosulfan. However, because endosulfan is highly toxic, a control schedule consisting of three sprays, first with endosulfan (28 g a.i./100 L water), the second with malathion (50 g a.i./100 L water) and the third with carbaryl (50 g a.i./100 L water), applied at 15-day intervals, has been suggested.

SANGAPPA, H.K., and E.S. BALARAJU. 1977.
A note on *Callosobruchus chinensis* Linnaeus as field pest of red gram (*Cajanus cajan* Sprengal.). Curr. Res. 6:105-106. 673

It was observed that the green and yellow pods are the main source of field infestation. Highest number of eggs were laid on the green pods, followed by yellow, dry, and tender pods. The emergence of beetles through a circular hole was also observed.

SAVALIA, B.M. 1971.
Some studies on bionomics and control of Tur plume moth (*Trichoptilus congrualis* Waller) under Junagadh conditions. M.Sc. (1971) Thesis. Gujarat Agricultural University, Junagadh, Gujarat, India. 674

SAXENA, H.P. 1974.
Severe and widespread occurrence of *Maruca testulalis* Geyer in redgram, *Cajanus cajan*. Entomologists' Newsletter 4(3):21. 675

This is a first record of the occurrence in northern India of *Maruca testulalis* Geyer, a severe pest of legumes in peninsular states. Red gram varieties were severely attacked. All early maturing varieties suffered badly due to this pest; varieties with a large number of flowers and compact inflorescence forming a canopy suffered more than those with fewer flower buds or more spread inflorescence. Hybrid lines having either S-5 (Ageti) or Prabhat as a donor, were very severely damaged by *Maruca* larvae. Two other insects that were also observed webbing the buds, flowers and developing pods of red gram were *Anarsia epiphippias* Meyrick and *Adisura atkinsoni* Moore.

SAXENA, H.P. 1976.
Harvest a rich crop of arhar through pest control. Fmr Parliam. 11(6):19, 29-30. 676

Emphasizes the importance of arhar and the need for pest control to obtain higher grain yields. Lists three main pests: stemfly, jassids, and borers. Groups arhar varieties into early, medium, and late-maturing types and notes that with the introduction of early maturing varieties the incidence of pod-borers is increasing.

SETH, M.L. 1962.
Transmission of pigeonpea sterility by an *Eriophyid* mite. Indian Phytopath. 15:225-227. 677

The *Eriophyid* mite, belong to the order Acarina and occurring on pigeonpea, acts as a vector of the virus causing sterility mosaic disease. The mite remains buried in between the hairs on the under surface of the leaves. It is minute in size -- invisible without the aid of a binocular microscope -- and is pale flesh to orange in color. Virus-vector relationship and host range is further investigated.

SINHA, M.M., R.P. YADAV, and A. KUMAR. 1977.
Evaluation of some insecticides for the control of plume moth (*Exelastis atomosa* Walshe) and pod fly (*Melanagromyza obtusa* Malloch) on red gram (*Cajanus cajan*). Pesticides 11(3):29-30. 678

The red gram crop suffers heavy losses from the attacks of the pod borers *E. atomosa* and *M. obtusa*. In field trials conducted to evaluate some insecticides, two rounds of treatments were given, one at the beginning of pod formation and another 14 days later. Monocrotophos (Nuvacron) at the rate of 0.5 kg a.i./ha effectively checked the incidence of *E. atomosa*, while quinalphos (Ekalux) at 0.6 kg a.i./ha dimethoate (Rogor) at 0.5 kg a.i./ha and endosulfan (Thiodan) at 0.8 kg a.i./ha proved equally efficacious in reducing pod fly damage on early and late varieties of red gram, respectively.

SRIVASTAVA, A.S., S.S.L. KATIYAR, and K.M. SRIVASTAVA. 1971.
Damage of *Agromyza obtusa* Malloch (Dipter Agromyzidae) to *Cajanus cajan* Linn. crop. Labdev. J. Sci. Technol. 9(1):71-73. 679

The tur pod fly, *Agromyza obtusa* M. is a serious pest of arhar crops. The percentage infestation of pods and grains of *C. cajan* L. damaged by this pest varied from 31.83 to 44.25 and 12.59 to 28.83 on T-21 variety; 28.16 to 30.50 and 7.97 to 12.90 on T-7 variety; 26.33 to 34.75 and 10.20 to 13.70 on T-27 variety, respectively. The results of the survey indicated clearly that all three varieties -- T-21, T-7, and T-27 -- are heavily attacked by *A. obtusa* M., causing considerable crop loss.

SRIVASTAVA, A.S., and J.L. SRIVASTAVA. 1966.
Insecticidal trials against *Agromyza obtusa* M. (Diptera: Agromizidae). Labdev. J. Sci. Technol. 4:133-135. 680

Trials with different insecticides carried out against Arhar (*Cajanus cajan*) pod borer (*Agromyza obtusa*) indicated that endrin (0.16%) at 900 liters per hectare was found effective in controlling this pest.

SRIVASTAVA, A.S., and J.L. SRIVASTAVA. 1971.
Incidence of *Agromyza obtusa* M. in different varieties of arhar. Biet. Ent. Entomol. 21:243-244. 681

The maximum incidence of *A. obtusa* (pulse crop pest) was recorded during December in early varieties and during March in late varieties of *Cajanus cajan*.

SRIVASTAVA, B.K. 1964.
Pests of pulse crops. *In*: Entomology in India. New Delhi: ESI. 83-91. 682

A review of Indian work on pests of different pulse crops including pigeonpea.

SRIVASTAVA, O.S. 1972.
Estimation of loss in T-21 variety of arhar (*Cajanus cajan* Linn.) due to tur pod fly (*Melanagromyza obtusa* Malloch). Indian J. Ent. 34(1):82-83. 683

The average percentage of infestation of pod and grain and of loss in weight at medium maturity was 34.5, 29.8, and 63.4, and at harvest 29.1, 30.8, and 43.7, respectively. The percentage pod infestation and loss in weight was higher at medium maturity than at harvest, whereas the grain infestation was higher at harvest.

SRIVASTAVA, O.S. 1974.
Chemical control of the tur leaf caterpillar, *Eucelis critica* Meyr. Indian J. Entomol. 36(4):359-360. 684

Spraying with either dimethoate or endosulfan and dusting with carbaryl provided effective control of tur leaf caterpillar.

STOCKDALE, F. 1911.
An insect pest of pigeonpea. J. Bd Agric. Br. Guiana. 4(4):239. 685

SUBRAMANIAN, T.R. 1958.
Glyricidia maculata as an alternate host for *Ceuthorhynchus asperulus* Faust. Madras Agric. J. 45(11):419. 686

The first record of an alternate host for this pest, commonly known as red gram bud weevil and found only on red gram. Biology of the insect was studied.

SUBRAMANIAN, T.R., and S. VENUGOPAL. 1959.
A note on the occurrence of *Colobodes dolichotis* Marchall, on red gram at Coimbatore. Madras Agric. J. 46(4): 139. 687

Plants showed huge galls at the base of stems. A new record on this crop. Damage very severe, plants remained stunted in growth. Characteristics of the insect are also given.

SURULIVELU, T., G. BALASUBRAMANIAN, P.P. VASUDEVA MENON, and R.J. RABINDRA. 1977.
Efficacy of certain insecticides in the control of redgram pod borers. Madras Agric. J. 64(1):54-56. 688

Among all the treatments endosulfan recorded the minimum pod borer damage under Coimbatore, India conditions, while monocrotophos, fenitrothion, endosulfan, and phosalone registered high yields.

TAYLOR, T., and AJIBOLA. 1973.
Crop protection and legume production in West Africa. J. Assoc. Advan. Agric. Sect. Africa. 1(Suppl):5-8. 689

The significance of crop protection in legume production in West Africa is reviewed and discussed. Cowpea, pigeonpea, and soybean yields have been considerably increased by the effective use of pesticides and management methods to control an array of insects attacking various plant parts. Present results are satisfactory but further economy in productivity and increases in yield may be realized by pest/crop management programs and use of improved cultivars. Future strategy for pest control should be based on a fundamental knowledge of the phenology of the cultivars of grain legumes, their plant/pest relationships, and a combination of pesticide application and crop improvement and management.

THAKUR, D. 1964.
Study of the biology and control of tur plume moth, *Exelastis atomosa* Wals. (Lepidoptera: Pterophoridae). M.Sc. (1964) Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. 690

THEVASAGAYAM, E.S., and L.S.C. CANAGASINGHAM. 1960.
Some observations on the insect pests of dhal (*Cajanus cajan*) and their control. Trop. Agric. Ceylon 116(4):287-298. 691

The major pest occurring during the maha (wet) season and of the yala (dry) season are discussed. Trials on the control of pests revealed that dieldrin and endrin

were very effective, particularly during the wet season.

VAISHAMPAYAN, S.M., and Z. SINGH. 1969.
Comparative effectiveness of some modern insecticides against the blossom thrips of redgram (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Sci. 39(1):52-56. 692

Comparative experiments with insecticides for the control of thrips, *Frankliniella sulphurea* and *Taeniothrips nigricornis*, infesting flowers of pigeonpeas, were carried out in India. Of the emulsion sprays evaluated, the treatments with dimethoate, endrin, and endosulfan were the most effective.

VARMA, B.K., and MANGALASAIN. 1977.
Dasychira mendosa and Hb. (*Lepidoptera : Lymantridae*) a pest of *Cajanus cajan* (L.) Millsp. in Hyderabad. Indian J. Pl. Prot. 5(1):95-98. 693

A survey of tur (*C. cajan*) revealed high infestation of caterpillars of *Dasychira mendosa* feeding on the leaves of this crop. The caterpillars of *D. mendosa* made their first appearance on the tur crop at the beginning of October and continued until the end of November. The life history of the pest, nature of damage it causes, and control measures are discussed.

VEDA, O.P., M.L. PUROHIT, and N.K. SOOD. 1975.
Varietal susceptibility of arhar (*Cajanus cajan* (L.) Millsp.) to *Melanagromyza obtusa* Mall.; *Exelastis atomosa* Wlsm. and *Heliothis armigera* Hub. JNKVV Res. J. 9(1-2):7-9. 694

Of 164 entries evaluated on pod basis, no strain was completely free from infestation by these insects. Pod fly was observed as the most serious pest, causing the maximum percentage of damaged grains (38.95). Based on pod and grain infection, the line P-54(b) was found least susceptible to pod fly.

VEERASWAMY, R. 1959.
Influence of early sowings on the incidence of "Red gram pod fly" (*Agromyza obtusa* Mall.) on red gram (*Cajanus indicus* Spreng). Madras Agric. J. 46(3): 99-100. 695

The extent of damage by red gram pod fly can be effectively reduced by introducing certain suitable modifications in the red gram cropping program.

VENKATA SESHU REDDY, K. 1973.
Studies on the gram caterpillar, *Heliothis armigera* (Hubner) (Lepidoptera: Noctuidae) with special reference to its biology, host preference and estimation of loss in red gram. 120 pp. Ph.D. (1973) Thesis. University of Agricultural Sciences, Bangalore, Karnataka, India. 696

VERMA, B.K., and M.K.H. SIDDIQUI. 1977.
Control of storage pests through inert dust. Indian Fmg 27(5):21. 697

Several inert dusts, such as attapulgite, benotonite, kaolinite, and silicious earth collected from various places of India were tested against storage pests including beetle (*Callosobruchus chinensis*). Pulses treated with 0.3% attapulgite powder were free of pulse beetle attack.

VERMA, SHASHI. 1975.
Determination of the residues of phorate (systemic insecticide) and endosulfan (contact insecticide) during the development of moong and arhar plants. Entomologists' Newsletter 5(2):7-8. 698

The laboratory experiments showed that phorate had slight horizontal movement in soil but its uptake by the plants from the treated soil was very fast. Toxicity against jassids persisted for 40 to 50 days and against thrips for 33 and 43 days on mung and arhar crops respectively. Basal leaf was slightly more toxic than the top leaf of both plants.

VERMA, SHASHI, and N.C. PANT. 1968.
Dissipation of endosulfan on mung and arhar crops. Indian J. Pl. Prot. 4(1): 24-31. 699

The importance of assessing residues of toxic materials is emphasized. The persistence of endosulfan in descending order was winter arhar, summer mung, and monsoon mung. Variety had no effect on the dissipation of endosulfan.

VERMA, SHASHI, and N.C. PANT. 1975.
Persistence of phorate on mung and arhar crops. Entomologists' Newsletter 5(3):21. 700

Phorate was significantly effective against galerucid beetle, *Madurasia obscurella*, infesting leaves, and stem fly, *Melanagromyza phaseoli* Tyron, infesting stems, in the early stage of the crops.

VERMA, SHASHI, and N.C. PANT. 1975.
Persistence of endosulfan on 'mung' and 'arhar' crops. Entomologists' Newsletter 5(4):25. 701

Persistence of endosulfan residues has been studied to evaluate the chemical from the crop-protection and safety angles. Endosulfan at 0.7% was applied at 500 to 700 litres/ha. at the pod formation stage. The residues of endosulfan in leaves and pods were below tolerance limit (0.5 ppm) in about 10 and 8 days in arhar and below detectable limit at harvest. The persistence of endosulfan in descending order was arhar, summer mung, and monsoon mung. Endosulfan gave 50% kill of jassids for about 3 to 5 days on mung and arhar and was significantly effective against pod borers.

VERMA, SHASHI, and N.C. PANT. 1975.
Effect of phorate and endosulfan treatments on growth parameters of mung and arhar crops. Entomologists' Newsletter 5(8-9):41-42. 702

Phorate was applied at 1.5 kg a.i./ha in soil at sowing time and 0.07% endosulfan was applied at 500 to 800 L/ha at pod-formation stage. The combination of phorate and endosulfan when applied according to schedule gave better protection against *Heliothis armigera* Hubner and *Exelastis atomosa* Walsingham and significantly more pods than with the insecticides individually.

VERMA, SHASHI, and N.C. PANT. 1976.
Persistence of phorate in soil and in plants during the development of mung and arhar crops. Indian J. Pl. Prot. 4(1):15-23. 703

Phorate was more persistent in summer than in the monsoon. Varieties of mung had no effect on the dissipation of phorate in soil and in plants during both the seasons. Different crops of mung and arhar have affected the persistence of insecticide both in soil and plants.

VISHAKANTAIAH, M., M. JAYARAMAIAH, and B.L. VISWESWARA GOWDA. 1973.
Observations on tur pod fly, *Melanagromyza obtusa* Malloch. (Diptera: Agromyzidae) in Mysore. Curr. Res. 2(8):62. 704

The pest appeared in severe form causing substantial damage to the grains. The average infestation of pod fly was 89.28%. A maximum of six pupae were observed in a single pod. The damage to the grains and loss in grain weight were 68.03 and 66.23%, respectively.

WALTON, R.R. 1961-62.
Control of tur plume moth *Exelastis atomosa*. Report of Agresco. 1961-62. 705

WILLIAMS, I.H. 1977.
Behavior of insects foraging on pigeonpea (*Cajanus cajan* (L.) Millsp.) in India. Trop. Agric. 54:353-363. 706

The behavior of insects visiting the flowers of *Cajanus cajan* (L.) Millsp. is described. Although insects of many orders were captured on the flowers, bees and, in particular, *Megachile* spp. were probably responsible for most cross-pollination that occurred. *Megachile* spp. and *Apis dorsata* Fab. discriminated between a cultivar with flowers of normal structure and one with flowers of a modified structure.

YADAV, D. 1967.
Field evaluation of different insecticides against thrips, *Taeniothrips distalis* Karny of red gram (*Cajanus cajan* (L.) Millsp.). M.Sc. (1967) Thesis. Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur, Madhya Pradesh, India. 707

YADAV, H.S., G.A. GANGRADE, and S.S. JAKHMOLA. 1974.
Note on the relationship between thrips and pod-setting in the flowers of pigeonpea. Indian J. Agric. Sci. 44(8):555-556. 708

Two species of thrips, *Frankliniella sulphurea* Schmutz, and *Taeniothrips nigricornis* Schmutz were noted visiting flowers of pigeonpea when the buds began to unfold, deserting them only after the initiation of pod development. Significant differences were noticed in the development of pods in relation to different levels of thrips population. Absence of thrips was not conducive to pod-setting. A moderate population of thrips (23 to 150/10 flowers) was probably beneficial to fertilization and pod-setting.

YASEEN, M. 1975.
A further note on the introduction of *Heliothis* parasites into the lesser Antilles. PANS 21(2):155-157. 709

Trichogrammatoidae armigera, Compolitis chlorodaea and *Eucelatoria* spp. were sent to the lesser Antilles in an effort to establish biological control of *Heliothis*

armigera. The success or otherwise of the release has not yet been established. The importance of the pest warrants further introductions.

ZALAVADIA, R.V. 1971.
Some studies on bionomics and control of Pulse beetle (*Callosobruchus maculatus* Fabricus) under storage conditions of Saurashtra area. M.Sc. (1971) Thesis. Gujarat Agricultural University, Junagadh, Gujarat, India. 710

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AHIRRAO, S.N. 1973.
Genetic studies in pigeonpea (*Cajanus cajan* (L.) Millsp.). 145 pp. M.Sc.(1973) Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 711

BAINIWAL, CHAJU RAM. 1972.
Studies on the quantitative characters of arhar (*Cajanus cajan* Millsp.). V, 56. vi p. M.Sc. (1972) Thesis. Haryana Agricultural University, Hissar, Haryana, India. 712

DEOHAR, A.B.L., and P.K. NIGAM. 1972.
Correlation studies in arhar, *Cajanus cajan* (L.) Millsp. JNKVV Res. J. 6(1):58. 713

In trials with high-yielding late-maturing pigeonpea cv Gwalior-3, seed yield per plant was highly correlated (positively) with the number of branches per plant. There was a positive correlation between number of branches and number of pods per plant.

BHANGARE, A.D. 1971.
Genetic studies in pigeonpea (*Cajanus cajan* (L.) Millsp.). 141 pp. M.Sc.(1971) Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 714

BHATIA, C.R. 1977.
Mutation breeding of groundnut, rice, and pigeonpea. Mut. Breed. Newsletter 9:6-7. 715

Brief information is presented on trials with high-yielding mutant lines of these crops.

BHATNAGAR, P.S. 1955.
Breeding improved arhar (*Cajanus cajan* Millsp.) in Uttar Pradesh. Agric. Anim. Husb. Uttar Pradesh 6(2-3):38-41. 716

A historical account of *C. cajan* improvement by selection, initiated in 1932, with headquarters at the Government Research Farm, Kanpur. Hybridization to develop varieties combining high yield and large seeds was to be undertaken.

BHATNAGAR, P.S., P.K. SENGUPTA, L.C. GANGWAR, J.K. SAXENA, and KUMAR, V. 1967.
A fasciated mutant in pigeonpea. Sci. Cult. 33:120-121. 717

This mutant of *Cajanus cajan* has purple coloration and curved stems; the branches are fused with the main stem at the point of emergence. Some plants showed fasciation of stem and branches and some of the main stem only. Many flower buds were produced but there was 11% pollen sterility in the flower. Selfing fasciated plants and crosses with normal D-419-2 and T-163 showed fasciation to be recessive.

CHAUDHARI, A.N. 1973.
Genetic studies in pigeonpea (*Cajanus cajan* (L.) Millsp.). 112 pp. M.Sc.(1973)Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 718

CHAUDHARI, A.N., and M.V. THOMBRE. 1975.
Genetic studies in pigeonpea. Creeping 3-2-8 x purple grained. Mahatma Phule Agric. Univ. Res. J. 6(1):10-14. 719

Inheritance of different morphological characters in pigeonpea such as habit of growth (3:1), raw pod color (49:15), vein color (21:43), and seedcoat color (3:1) has been reported. The factor for growth habit (Egh) and raw pod color (Blpdl) was found to assort independently. Linkage values between the genes Drv (vein color) and Plsd (seedcoat color) have been worked out and a single linkage group has been suggested.

CHAUDHARI, A.N., and M.V. THOMBRE. 1977.
Genetic studies in pigeonpea. Round leaf x N.P. 51. J. Res. MAU. 2(1):17-20. 720

The inheritance of growth habit (54:10), leaflet shape (39:25), vein color (9:7), and seedcoat color (9:7) has been reported in the cross of Round leaf x NP-51 of pigeonpea (*Cajanus cajan* (L.) Millsp.). The studies of joint segregation indicated that the genes of different characters

assorted independently except in three cases. The complementary factor of vein color showed a linkage with the basic factor of leaflet shape with a crossover value of 24%. The basic factor of leaflet shape is linked with complementary factor of seedcoat color, with a crossover value of 7.9%, whereas the vein color and the seedcoat color were found to be linked with crossover value of 29%.

CHAUDHARI, B.B., and J.A. PATIL. 1953. 'Creeping', a mutant in Millsp. Curr. Sci. 22:153. 721

A true-breeding mutant with a prostrate habit of growth has been observed. The form arose spontaneously in the F_3 of a cross between two normal varieties. The mutant is likely to be useful as a cover crop, and in soil conservation and strip cropping.

DAHIYA, B.S., and J.S. BRAR. 1976. The relationship between seed size and protein content in pigeonpea (*Cajanus cajan* (L.) Millsp.). Trop. Grain Legume Bull. 3:18-19. 722

In 220 lines of pigeonpea, the highest seed protein contents (> 24%) were found in lines P-1862, P-3761, P-978, H-12, and H-18 with 100-seed weights of 6.5, 8.0, 8.0, 9.75, and 10.00 g, respectively. Cv Prabhat and Pant A-9 with lowest 100-seed weights of 5.5 and 5.75 g, respectively, had protein contents of 17.15 and 22.32%. Hy-3A and Hy-3C genotypes with the highest 100-seed weights of 19.5 and 20.0 g had protein contents of 20.56 and 19.58%. There was no evidence of a general significant correlation between 100-seed weight and seed protein content.

DAHIYA, B.S., and J.S. BRAR. 1977. Diallel analysis of genetic variation in pigeonpea (*Cajanus cajan*). Expl Agric. 13(2):193-200. 723

Four characters were studied in a diallel cross of six cultivars. Additive inheritance was important in determining flowering time, but the dominance component was greater than the additive component, and overdominance was observed for pod number, 100-seed weight, and yield. Heritability estimates for all traits except flowering time were low, and the bulk population method of breeding was suggested for early segregating generations. It is suggested that, to improve earliness, the best cross would be between parents with low general combining ability for flowering time and high general combining ability for other traits.

DAHIYA, B.S., J.S. BRAR, B.L. BHARDWAJ, and R.K. BAJAJ. 1978. Studies on the heritability and interrelationship of some agronomically important characters in pigeonpea (*Cajanus cajan* (L.) Millsp.). Genet. Agr. (In Press). 724

Six cultivars of pigeonpea were evaluated for seven variables in a diallel experiment using regression coefficients, correlations, and combining ability estimates. Regression coefficients were high, indicating large additive effects for flowering time and plant height. Yield was significantly correlated with number of pods per plant, number of grains per pod, and 100-grain weight, but negatively correlated with plant height. Plant height was positively correlated with yield and its components. The best index of yield among the traits studied was number of pods per plant. GCA variances were larger than SCA variances, except for yield and pods per plant, suggesting predominance of additive gene effects.

DAHIYA, B.S., J.S. BRAR, and B.S. BHULLAR. 1977. Inheritance of protein content and its correlation with grain yield in pigeonpea (*Cajanus cajan* (L.) Millsp.). Qual. Plant Pl. Fds Hum. Nutr. 27(3-4):327-334. 725

The F_2 mean protein contents were generally between the parents, but slightly closer to the low-protein parent. Reciprocal differences in protein of F_1 seeds and the absence of these differences in protein of F_2 seeds showed that the maternal genotypes controlled protein content. The broad-sense heritability estimates varied from 34 to 62% in different crosses, indicating environmental influence on protein content and relatively low additive genetic variance. A minimum of three or four genes control protein content. Low protein was partially dominant over high. Grain yield and protein content were negatively correlated in F_2 plants, but grain yield and protein yield were highly correlated. It is suggested that for total protein production/unit area, efforts should be directed towards increased yield while maintaining percent protein near average levels rather than selecting for high protein in grains alone.

DAHIYA, B.S., J.S. BRAR, and R. KAPUR. 1976.
A preliminary observation on the protein content of pigeonpea crosses. Trop. Grain Legume Bull. 5:22. 726

In crosses between two high-protein (H-18 and C-4784) and two low-protein (H-13 and H-384) lines of pigeonpea, there was a strong maternal influence on seed protein content in the F_1 hybrid. Seeds of C-4784 x H-13 had a protein content of 27%, compared with 18.3% in H-13 x C-4784.

DAHIYA, B.S., and D.R. SATIJA. 1978.
Inheritance of days to maturity and grain yield in pigeonpea (*Cajanus cajan* L. Millsp.) Indian J. Genet. Pl. Breed. (In Press). 727

The inheritance of days to maturity and grain yield was studied in six generations of two crosses of pigeonpea. Partial dominance was observed for early maturity. Heritabilities, both (B.S) and (N.S), were close to each other, indicating the importance of additive gene effects in the expression of days to maturity. Dominance interaction components were greater than the additive component for the inheritance of grain yield. There was considerable level of nonadditive effects for these traits. It was observed that lines with high yield and early maturity can be isolated which can best fit into multiple cropping patterns.

DASAPPA, and M. MAHADEVAPPA. 1970.
Investigations on grain yield and related characters of some tur varieties. Mysore J. Agric. Sci. 4:212-215. 728

Observations were recorded on plant height and spread, number of branches per plant, number of pods per plant, weight of 100 grains and seed yield per plant. Phenotypic and genotypic correlations revealed that plant spread and number of pods per plant may be regarded as effective attributes of grain yield.

DAVE, B.B. 1934.
Inheritance of characters in *Cajanus indicus*. Indian J. Agric. Sci. 4: 674-691. 729

The mode of inheritance of flower, pod, and seedcoat colors was studied. In the F_2 different segregations such as 3:1, 9:7, 12:3:1 were obtained. The results are explained as being due to the action and interaction of five factors, P, A, C, E, and V. The factors P and R are responsible for purplish black spotting and brown color respectively, their concurrent presence giving purplish black; in the absence of both P and R, the seedcoat is white. There is a complete linkage between orange-yellow flowers and purplish black seeds and between yellow flowers with purple veins and green pods.

D'CRUZ, R., and A.B. DEOKAR. 1970.
Genetic studies in pigeonpea. I. N. Green x Red grained. Mahatma Phule Agric. Univ. Res. J. 1:44-53. 730

A single gene, designated Sbr, controlled spreading branching habit, which is dominant to erect. Single genes control purple stem (Pst), dominant to green; lanceolate leaflets (Llt), dominant to short (Lst), long petiole (Lpt), dominant to short; and yellow ventral surface of the standard petal (Yvs), dominant to pale yellow. Two genes, $Gppd_1$ and $Gppd_2$ controlled maroon-blotched pod, which is dominant to green, and Brsda and Brsdb have a complementary action on the red-brown seedcoat. The genes Sbr, Pst, Llt, Lst, and Lpt form one linkage group, while Gppd and Brsda form another. The gene Yvs is independent.

D'CRUZ, R., S.B. MANKE, and A.B. DEOKAR. 1970.
Genetic studies in pigeonpea. IV. Rahar x Red grained. Poona Agric. Coll. Mag. 60:23-26. 731

This investigation showed that the three morphological characters studied are under independent genetic control. Branching is controlled by the genes $Rdvds_a$ and $Rdvds_b$. Brown seedcoat is dominant to white and controlled by Brsd, an inhibitor BrsdI and an antiinhibitor BrsdIA. One of the Rdvds genes, Brsd, and BrsdI are in the same linkage group as the genes for leaflet shape, Llt, and unripe pod color Blpd.

D'CRUZ, R., L.S. PACHPOL, and A.B. DEOKAR. 1974.
Genetic studies in pigeonpea. IX. N.P.51 x Prostrate. PKV Res. J. 2(2):77-81. 732

Inheritance of growth habit (54 erect: 10 prostrate), stem color (3 purple: 1 green), vein color (3 purple: 1 yellow), pod color (39 dark: 25 streaked), and seedcoat color (3 brown: 1 white) has been reported. Interrelationship of the characters showed that one of the genes of prostrate growth habit was linked with that of seedcoat color and one of stem color with that of vein color. The crossover values obtained in the two cases were 15.19 and 33.19%,

respectively. Combinations of other characters showed that their genes assorted independently.

D'CRUZ, R., P.S. PATIL, and A.B. DEOKAR. 1971.
Genetic studies in pigeonpea. XII. Purple grained x Obcordifolia (N. Green). Mahatma Phule Agric. Univ. Res. J. 2(2): 99-106. 733

The gene controlling branching habit, Sbr is independent from the genes for stem color Pst; leaflet shape, Llt; leaf thickness, Tnlt; flower color, Oydsa, Oydsbl, and Oydsb2; pod color, Gppd; and testa color Brsd and Wpsd. One linkage group involving Pst, Tnlt, and Llt was identified.

D'CRUZ, R., P.S. PATIL, and A.B. DEOKAR. 1973.
Genetic studies in pigeonpea. XIII. Leaflet shape, flower and seed color. Botanique (Nagpur) 4(2):117-124. 734

The inheritance of leaflet shape, flower color, and seedcoat color was studied in two crosses of *Cajanus cajan*. In the cross Obcordifolia (D) X Round leaf, ratios of 3 round : 1 obcordate leaflet; 9 yellow purple-veined : 7 yellow flowers; and 9 brown : 7 white were obtained. In the cross Round leaf X Purple grained, ratios of 3 lanceolate : 1 round leaflet; 9 orange-yellow flowers with purple spots : 1 white have been recorded. The ratio of 3 round : 1 obcordate for leaflet shape is reported for the first time.

DEOKAR, A.B., and R. D'CRUZ. 1972.
Genetic studies in pigeonpea. II. N. Black x Purple grained. Mahatma Phule Agric. Univ. Res. J. 3(1):12-20. 735

Single genes control branching habit (Sbr), leaflet shape (Llt), petiole length (Lsta), and color of the dorsal surface of the standard petal (Oyvsa). Stem color is controlled by one complementary and two duplicate complementary genes, Psta, Pstb, and Pstc respectively. Stipule length segregated 9 long : 7 short, suggesting two complementary genes, Lsta, and Lstb, and the color of the ventral surface of the standard petal segregated 9 orange-yellow : 7 yellow, suggesting another two complementary genes, Oyvsa and Oyvsb. Testa color is controlled by two interacting factors, Oyvsa and Brsd, the first with incomplete dominance responsible for white seeds with purple spots and the second for brown seeds. Two linkage groups were established: Sbr, Lsta, and Llt; and Psta and Oyvsa. The other genes were independent.

DEOKAR, A.B., G.R. BHOLE, and R. D'CRUZ. 1971.
Genetic studies in pigeonpea. VII. Creeping 3-2-8 x Prostrate. Mahatma Phule Agric. Univ. Res. J. 2(1):26-37. 736

Three genes (Cgra, Cgrb1, and Cgrb2) controlling growth habit segregated 45 erect : 9 creeping : 10 prostrate. Two genes (Pvds1 and Pvds2) control vein color on the back of the standard petal and another two (Gpstpd and Gpshpd) control pod color, which segregated 9 purple : 3 green with purple streaks : 4 green with purple shades. Gpstpd controls green with purple streaks and Gpshpd is supplementary. One gene (Brsd) controls brown seeds. Cgra is linked with Pvds and Brsd is linked with Gpshpd.

DEOKAR, A.B., B.S. MANKE, and R. D'CRUZ. 1972.
Genetic studies in pigeonpea. VI. Leaflet shape, pod and seed coat colour. Indian Agric. 16:193-197. 737

The leaflet shape and seedcoat color characters were each governed by a single factor (3:1), while the unripe pod color was found to be caused by four factors (195:61). The genes let for leaflet shape and Rsd for seedcoat color were found to be linked with a crossover value of 21.42%. The four factors for pod color, Blp1, Blp2, 1-Blp, and A-1-Blp, were different from and independent of the factors for leaflet shape and seedcoat color.

DEOKAR, A.B., L.S. PACHPOL, and R. D'CRUZ. 1972.
Genetic studies in pigeonpea. X. N.P. 64 x N.P. 82. Botanique (Nagpur) 3:35-40. 738

The following segregation ratios were obtained from the cross: for habit, 9 spreading : 7 erect; for color of the ventral surface of the standard petal, 162 yellow : 94 lemon yellow; and for pod color, 117 purple with green streaks : 139 green with purple streaks. The results indicated that the genes controlling the three characters are independent.

DEOKAR, A.B., V.K. SHINDE, and R. D'CRUZ. 1971.
A case of linkage in pigeonpea. Mahatma Phule Agric. Univ. Res. J. 2(1): 92-93. 739

The F_1s from a cross between a white-grained parent with yellow flowers and self-colored veins on the back of the standard petal and a red-grained parent with yellow flowers and red veins segregated in the ratio of 3 red : 1 yellow for vein color and 9 red : 7 white for seed color. The genes for red veins and red testa were linked with a crossover value of 8 25%.

DESHMUKH, N.Y. 1959.
Sterile mutants in tur (*Cajanus cajan*). Nagpur Agric. Coll. Mag. 33:20-21. 740

Two sterile mutants are described. One, from strain 175, grew to a height of 9 ft (2.7 m) compared with the parents 5½ ft (1.67 m) and was unbranched. The other, from strain 148, possessed large simple leaves. The flower buds developed into bunches of thread-like green sepals.

DESHMUKH, N.Y., and T.S. PHIRKE. 1962.
Flattened pod - a point mutation in *Cajanus cajan* (L.) Millsp. Nagpur Agric. Coll. Mag. 36(2):46-47. 741

Treatment with chemical mutagens has produced plants with larger flowers and seeds and flattened pods. It was first thought that these plants were polyploids but investigation has shown that they are diploid (n = 11) and that the flattened-pod character is due to a point mutation, inherited as a dominant monogenic factor.

DESHMUKH, N.Y., and S.S. REKHI. 1960.
Inheritance of leaf in pigeonpea (*Cajanus cajan* (L.) Millsp.). Curr. Sci. 29: 237-239. 742

In crosses involving the mutants unifoliata (unifoliate pointed leaf) and oval-oblong trifoliata (trifoliate leaf with roundish apices) and two varieties bearing trifoliate leaves with pointed apices, the trifoliate condition is monogenic and dominant over the unifoliate, while the pointed apex is monogenic dominant over the round. The two gene pairs segregated independently.

DESHMUKH, N.Y., and S.S. REKHI. 1961.
Inheritance and linkage in *Cajanus cajan*. Indian J. Agric. Sci. 31(4): Suppl: 24-26. 743

Cotyledon shape, studied in the crosses described in an earlier report (abstract 742), was determined either by the pleiotropic action of a leaf-shape gene or by a gene closely linked to the latter, pointed leaf apex and lanceolate cotyledon being dominant over roundish leaf apex and ovate cotyledon.

DESHMUKH, N.Y., and S.S. REKHI. 1963.
Study of natural cross pollination in pigeonpea (*Cajanus cajan* (L.) Millsp.). Proc. Bihar Acad. Agric. Sci. 8-9: 135-139. 744

The strains Hyderabad and 56 were crossed with a unifoliate mutant and with a mutant which had rounded leaf apices. The F_1 showed heterosis. Trifoliate leaves and pointed apices were each controlled by a single dominant gene, the two genes being independent of each other. On an average 25.01% natural crossing was found.

DESHPANDE, R.B., and L.M. JESWANI. 1952.
A prostrate mutant in pigeonpea (*Cajanus cajan* (L.) Millsp.) - a possible soil conservation plant. Indian J. Genet. Pl. Breed. 12:50-51. 745

A prostrate mutant of the pigeonpea of possible value as a soil conservation plant was observed in 1950. The mutant breeds true to type.

DESHPANDE, R.B., and L.M. JESWANI. 1956.
A case of pleiotropy in pigeonpea. Curr. Sci. 25:201-202. 746

The obcordate leaflets with mucronate apices and the filiform keel of the flower, characterizing the variant designated *Cajanus obcordifolia* by Singh *et al.*, depend upon the pleiotropic duplicate factors L_1 and L_2. Since the variant resembles *C. cajan* in the inheritance of other characters, it should be assigned to this species.

DIVAKARAN, K., and G. RAMABHADRAN. 1958.
A marker gene for red gram (*Cajanus cajan* Millsp.). Curr. Sci. 27:100-101. 747

A variant with "oblong obovate" leaflets is described. This character appears to be associated with vigor and may prove useful as a marker for improved strains.

DORAIRAJ, M. STEPHEN, and V. VASANTHARAJ DAVID. 1963.
Bicarpellary syncarpous pistil in *Cajanus cajan* (Linn.) Millsp. Sci. Cult. 29(1):45. 748

The occurrence of an abnormal fruit developed from a bicarpellary syncarpous pistil in *Cajanus cajan* (Linn.) Millsp. (red gram) is recorded. The abnormal fruit was almost twice the size of a normal one and exhibited a four-sided appearance with two beaks at the apex. There was a single-celled ovary with four distinct sutures appearing even from the base of the fruit.

GANGULI, D.K., and D.P. SRIVASTAVA. 1967.
Inheritance studies in pigeonpea. Ranchi Univ. J. Agric. Res. 2:23-25. 749

The stem color pigmentation showed incomplete dominance of purplish pigmented stem over the green stem. Lateness in flowering was completely dominant over earliness in one cross, and incompletely dominant in the other cross. Purple standard was dominant over the yellow one, and orange wing over yellow. Purple-streaked pod was dominant over complete green pod. Purple-splashed seedcoat was incompletely dominant over chocolate seedcoat and light brown seedcoat.

GANGULI, D.K., and D.P. SRIVASTAVA. 1972.
Genotypic and phenotypic correlation studies in arhar (*Cajanus cajan* (L.) Millsp.). Indian Agric. 16(1): 109-111. 750

Average length of pods, average number of seeds per pod, and 100-seed weight, which were negatively correlated with seed yield, were positively correlated among themselves. The four characters, viz., total branches per plant, fruiting branches per plant, pods per plant, and leaves per plant - significantly correlated with yield and among themselves - might be used as selection criteria.

GOVINDA RAJU, D.R., and H.C. SHARAT CHANDRA. 1972.
Studies on variability in tur. Andhra Agric. J. 9(5-6):155-156. 751

Plant height, plant spread, number of branches per plant, weight of 100 grains, and yield of seed were studied in 36 varieties of *C. cajan* and values for heritability and genetic advance estimated for each character. All characters except plant height showed significant variability; 100-grain weight showed the highest heritability, followed by number of branches and plant spread.

GUNASEELAN, T., and H.K. HANUMANTHA RAO. 1976.
Discriminant function and study of the correlated effects on pigeonpea. Indian J. Agric. Sci. 46(4):175-177. 752

A trial of 94 lines derived from 26 varieties of *Cajanus cajan* was conducted. Discriminant function analysis of six yield components indicated that four lines from Shobha, two from T-2 and one each from S-5, AS-8, AS-37, AS-13, 4658, and Khargone-2 are promising for further hybridization. The most important yield components were plant height and number of pods.

GUPTA, L.N. 1968.
Correlation studies in Arhar. M.Sc. (1968) Thesis. Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur, India. 753

GUPTA, V.P., S.C. SETHI, and S. CHANDRA. 1975.
Variation, heritability and correlation among yield components in arhar (*Cajanus cajan* (L.) Millsp.). HAU J. Res. 5(2):110-115. 754

The highest phenotypic variability was observed for pod clusters per five branches, pod clusters per plant, pods per plant, and seed yield. High variability was also noticed for plant height, days to maturity, 100-seed weight, seeds per pod, and pod length in 65 cultivars. Estimates of heritability, genetic advance, and coefficients of variability and correlation suggested that selection for higher yields should be based on higher numbers of branches per plant, pod clusters per plant, and pods per plant.

HIREMATH, K.G., and S.N. TALWAR. 1971.
A study on genetic variability in pigeonpea (*Cajanus cajan* L. Millsp.). Andhra Agric. J. 18:144-148. 755

Seven quantitative characters were measured in 15 varieties. High heritability estimates and low estimates of genetic advance were found for number of primary branches, number of seeds per pod, pod length and 100-seed weight. High heritability and high estimates of genetic advance were obtained for plant height, number of pods per plant and yield per plant.

JAIN, S.K., and B.C. JOSHI. 1964.
Estimation of linkage and penetrance parameters in a study of petal color in the pigeonpea. Genetics 49:611-615. 756

The mode of inheritance of petal color and venation in the pigeonpea has been explained with a trigenic model: y, for basic color; u for absence of venation; and p, the locus that interacts with the y locus. Loci p and y were found to be linked with a recombination frequency of 29.7%.

JAMBHALE, NARAYAN DHONDI. 1974.
Genetic studies in pigeonpea (*Cajanus cajan* (L.) Millsp.). M.Sc. (1974) Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 757

JESWANI, L.M., and R.B. DESHPANDE. 1962.
Inheritance studies on some sterile mutants in pigeonpea. Indian J. Genet. Pl. Breed. 22:236-240. 758

In a sepaloid mutant, simple leaves replaced the normal trifoliate ones and were associated with a sepaloid condition of the flowers; a second mutant had simple leaves on the lower part of the plant and none on the upper part, rudimentary floral organs, dwarf habit, and thin, straggling branches; a cleistogamous mutant possessed thick, puckered trifoliate leaves. In all the mutants the abnormal condition was recessive to the normal.

JOGLEKAR, R.G., and N.Y. DESHMUKH. 1958.
Mutations in pigeonpea (*Cajanus cajan*). Nagpur Agric. Coll. Mag. 32:23-29. 759

A mutant with simple leaves and another with ovate-oblong trifoliate leaves, respectively designated var. *unifoliata* and var. *oval oblong trifoliata*, are described.

JOSHI, B.C., and S. RAMANUJAN. 1963.
Genetics of two mutants in pigeonpea. Indian J. Genet. Pl. Breed. 23: 64-66. 760

The nonflowering condition, found in a collection of CP-32 from Madhya Pradesh, is monogenically recessive to flowering and does not appear to be linked to the pleiotropic locus controlling trifoliate vs. simple leaf and normal vs. sepaloid flower. The multicarpellate condition of the pistil, isolated in an arhar culture from Uttar Pradesh, is monogenically recessive to the normal unicarpellate condition; this allele also controls the development of supernumerary petals, the development of stamens into petal- or carpel-like structures, and exposed ovules. The mutant plants are female sterile, although they have 80% stainable pollen.

JOSHI, S.N. 1973.
Variability and correlation studies in pigeonpea (*Cajanus cajan* L.). Madras Agric. J. 60(6):412-414. 761

A wide range of variation was noticed in seed yield per plant, number of seeds per pod, pod length, and plant height. The variation in plant height was largely due to environmental factors. Most of the characters indicated low heritability estimates. Seed yield was positively correlated with number of pods and number of branches. From the heritability estimates, expected genetic gain, and correlation coefficients, it was seen that the number of branches and pod number are the main yield components.

KAJJARI, N.B. 1956.
A new mutation in *Cajanus cajan* Millsp. Curr. Sci. 25:333. 762

A mutant with obcordate leaves, keel petals united at the top, and two or three apocarpous ovaries was found. It bred true in the 2 subsequent years. No cytological differences between this mutant and normal plants were found, the chromosome number for both being 2n = 22.

KAPUR, RAMAN. 1977.
Genetic analysis of some quantitative characters at different population levels in pigeonpea (*Cajanus cajan* (L.) Millsp.). M.Sc. (1977) Thesis. College of Agriculture, Punjab Agricultural University, Ludhiana, Punjab, India. 763

KOLHE, A.K., R.D. GHATGE, A.B. DEOKAR, and R. D'CRUZ. 1972.
Genetic studies in pigeonpea. XIV. Round leaf x *Obcordifolia* (N-Black). Mahatma Phule Agric. Univ. Res. J. 3(1): 21-26. 764

A single gene controls spreading branching habit (Sbr) which is dominant to erect; two genes (Bdlba and Llt) control presence of a petiole, which is dominant to absence; two genes (Bdlba and Bdlbb) control broad leaflet base, which is dominant to narrow; and one gene (Llt) controls notchless leaflet apex, dominant to notched; boat-shaped keel petals, dominant to filiform; united keel petals, dominant to free; and dense inflorescence, dominant to open. Red

veins on the dorsal surface of the standard petal are dominant to yellow and are controlled by two genes (Rdvdsa, and Rdvdsb). A single linkage group involves Sbr, Rdvdsa, Llt and Bdlbb.

KUMAR, A., and M.F. HAQUE. 1973.
Variability and correlation studies in F_2 population of pigeonpea (*Cajanus cajan* (L.) Millsp.). Mysore J. Agric. Sci. 7:174-183. 765

Ten characters were studied in BR-65 and BR-13 and in the F_1 and F_2 of BR-65 x BR-13. High heritability values in the broad sense and high estimates of genetic advance were obtained for the number of leaves and number of seeds per plant. Moderate estimates of genetic advance for the number of days to maturity were obtained. Moderate heritability and genetic advance were estimated for plant height, pod number, and yield per plant. Seed yield was significantly and positively correlated with the number of leaves, branches, pods, seeds per plant, and plant height. It was also significantly and negatively correlated with the number of days to first flowering and to maturity.

LAXMAN SINGH, and R.L. PANDEY. 1974.
Genetic analysis of some quantitative characters in pigeonpea (*Cajanus cajan* (L.) Millsp.). Himachal J. Agric. Res. 2(1):1-3. 766

Heritability estimates using six populations from a cross ranged from 54.9 for plant width to 96.6 for seed yield (broad sense) and from 28.7 for plant width to 95.2 for days to flowering (narrow sense). Additive genetic effects were significant for days to flowering and seed size, with partial dominance for smaller seed size. Magnitude of additive gene effects was relatively larger for plant height, plant width, and protein content as compared to nonadditive ones. Characters such as yield and plant width had a predominance of nonadditive gene effects.

MALHOTRA, R.S., and J.S. SODHI. 1977.
Genetic variability and discriminant function studies in pigeonpea (*Cajanus cajan* L.). Madras Agric. J. 64(10):677-678. 767

Forty varieties of pigeonpea when studied for six characters indicated that branch number, pod number, and cluster number form effective selection criteria for yield improvements in pigeonpea.

MENEZES, O.B. De. 1956.
Genetics and improvement of the pigeonpea (*C. indicus* Spreng.). Ceres Minas Gerais. 10(55):20-44. 768

Studies on the genetics of testa color, standard petal color, pod color, pod size, and habit are reported. Testa color depended on the interaction of two loci. White, pr; chocolate, pR; spotted, Pr; and black, PR. Pigmentation of standard petal was genetically controlled as follows: Yellow, Apcev or apcev; yellow streaked with red, Apcevs; uniform purple, APCEvs; yellow streaked with purple, ApCevs; purple streaked, APCEVs; and blood red, APCEVS. There are three types of pod pigmentation: green, ld; green with maroon markings, Ld; and maroon, LD. The mode of inheritance of pod size was uncertain. Plant height and angle of secondary branching were quantitatively inherited.

MOHAMED SHERIFF, N., W. MOHAMED ALI KHAN, and R. VEERASWAMY. 1975.
Studies on the inheritance of certain plant characters in red gram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 62(2): 64-65. 769

The inheritance of a few characters is reported, using induced mutants of red gram as one of the parents in the crosses.

MORBAD, I.R., and M.S. SOLANKI. 1957.
Study of heterosis in *Cajanus cajan*. Indian J. Genet. Pl. Breed. 17:90-95. 770

Hybrid vigor up to a maximum of 24.51% in grain yield was recorded. Best-yielding hybrid did not outyield the best-yielding parent but by exploiting more material of wider blood, more conspicuous vigor could perhaps be obtained, as has been noticed in some crosses involving perennial types of tur. Even if *Cajanus* proves a good crop for exploiting heterosis, the difficulty of hybrid seed production remains unsolved.

MUKEWAR, A.M., and D.P. MULEY. 1974.
Correlation studies of some yield components in tur (*Cajanus cajan* (L.) Millsp.). Nagpur Agric. Coll. Mag. 47:83-87. 771

Sixty varieties of tur were evaluated. The grain yield was positively and significantly correlated with bhusa (chaff) weight, weight of pods per plant, number of pods per plant, number of branches per plant, and length of pod. Grain yield was negatively correlated with plant height, 100-grain weight, days to maturity, days to flowering, and width of pod.

MUKHERJEE, D. 1956.
Genetic variability in *Cajanus cajan*. 160 pp. Thesis. Indian Agricultural Research Institute, New Delhi, India. 772

MUNOZ, A.M., and R. ABRAMS. 1971.
Inheritance of some quantitative characters in pigeonpeas (*Cajanus cajan* (L.) Millsp.). J. Agric. Univ. P. Rico 55(1):22-43. 773

Three varieties and a line derived by irradiation were used as parents in five crosses. There was greater variation in all crosses in seed weight, plant height, and flowering date than in number of seeds/pod. Seed yield was positively and highly correlated with number of pods/plant, but heritability of this latter character was low, 45.3 and 52.1% in the F_2 and F_3 respectively. Flowering date, plant height, and seed weight showed high heritability.

NARKHEDE, B.N. 1971.
Genetic studies in pigeonpea (*Cajanus cajan* (L.) Millsp.) and Wal (*Dolichos lablab* Roxb. and L.). 192 pp. M.Sc. (1971) Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 774

PANDYA, P.S., J.A. PATIL, and B.B. CHAUDHARY. 1954.
'Round and Tiny' leaf mutants in *Cajanus cajan* Millsp. Poona Agric. Coll. Mag. 45:18. 775

A mutant bearing obovate leaflets with rounded base and apex and a dwarf mutant bearing very small leaflets have been observed.

PANKAJA REDDY, R., and N.G.P. RAO. 1974.
Inheritance and relation with some yield components of plant and flowering habit in *Cajanus*. Indian J. Genet. Pl. Breed. 34(1):94-99. 776

The inheritance of indeterminate and determinate types in *Cajanus* revealed that the determinate type is recessive, with a single factor difference. Preliminary association analysis of plant type and yield indicated that the indeterminate types are favored over determinate forms. Further studies on the relationships between plant habit and yield are indicated.

PATHAK, D.K.V. 1952.
Correlation of characters (morphological and agronomical) in the different types of pigeonpea. Thesis. Indian Agricultural Research Institute, New Delhi, India. 777

PATHAK, G.N., and K.P. SINGH. 1964.
A new type of mutant in pigeonpea (*Cajanus cajan* (L.) Millsp.). Sci. Cult. 30: 397-398. 778

A spontaneous mutant plant was found in an early maturing line, No. 5, received from Malwa. The mutant was bushy and taller than the parental type. Four distinct types of branches were observed, three of which were sterile.

PATIL, J.A. 1959.
A mutation in *Cajanus cajan* (Linn) Millsp. Poona Agric. Coll. Mag. 49:264. 779

A dwarf mutant differing in leaf and floral morphology from either parent was obtained from *C. cajan* x *C. obcordifolia* at the College of Agriculture, Poona, and a genetic study of it was undertaken.

PATIL, J.A. 1970.
Extension of the linkage group I-Blpd-Llt in pigeonpea (*Cajanus cajan* Millsp.). Mahatma Phule Agric. Univ. Res. J. 1:37-45. 780

Genetic studies show that red vein on the dorsal surface of the standard petal is dominant to yellow and controlled by the genes Rdvdsa and Rdvdsb. Brown seedcoat is dominant to white and controlled by Brsb, an inhibitor BrsbI and an anti-inhibitor BrsdIA which are in the same linkage group as the genes for leaflet shape, L, and unripe pod color, Blpd.

PATIL, J.A., and R. D'CRUZ. 1962.
Inheritance of white flower colour in pigeonpea. Curr. Sci. 31:119-120. 781

White flower color in a mutant plant discovered at the Agricultural Research Station, Annigeri, resulted from the operation of two duplicate genes, W_1 and W_2, and the spontaneous mutation of the inhibitory gene I_y, which conditions yellow flowers.

PATIL, J.A., and R. D'CRUZ. 1965.
Linkage studies in pigeonpea. Indian J. Genet. Pl. Breed. 25:234-238. 782

The inheritance of growth habit, Sbr, leaflet shape (Llt) and color of the unripe pod (Blp) was studied in the F_2 of the cross between two *Cajanus cajan* mutants, one creeping, the other having obovate leaves. Recombination values of 40.83% between I (inhibitory gene of growth habit) and Llt, 35.75% between I and Blp, and 2.93% between Blp and Llt were determined.

PATIL, J.A., A.B. DEOKAR, and S.R. MASLEKAR. 1972.
Inheritance of leaflet number, flower and seed coat colour in redgram (*Cajanus cajan* Millsp.). Mahatma Phule Agric. Univ. Res. J. 3(1):6-11. 783

The investigation involved two mutants, one with creamy white flowers and the other with multifoliate leaves. Segregation in the progeny of the cross between them showed that trifoliate leaf is dominant to multifoliate and that four genes are involved: one hypostatic, one inhibitory, and two duplicate anti-inhibitory, designated Tf, ITf, A_1ITf, and A_2ITf, respectively.

PATIL, J.A., and N.V. SANDBHOR. 1958.
'Chimera' in tur (*Cajanus cajan* Millsp.). Curr. Sci. 27:358. 784

Chimeras have been observed in the progeny of a cross between two mutants, a creeping and a round-leaved type. It is thought that this is the first time the occurrence of chimeras has been reported for *C. cajan*.

PATIL, J.A., and Y.N. SHEIKH. 1957.
Short stigma, off type plant in pigeonpea (*Cajanus cajan* Millsp.). Curr. Sci. 26:253-254. 785

A plant of the strain N-282-7 was found to have a stigma which remained below the anthers instead of lying above them. No seed was obtained by either open- or self-pollination.

PATIL, R.B.
Genetic studies in tur (*Cajanus cajan* (L.) Millsp.). M.Sc. Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 786

POKLE, Y.S. 1976.
Pleiotropic mutant in redgram (*Cajanus cajan* Millsp.). Nagpur Agric. Coll. Mag. 48:42-44. 787

The mutant was characterized by its gigas leaf, with crinkled leaf surface, weak stem and branches, delayed flowering, and big flowers with free keel petals. Shedding of flowers was 99%; gigas leaf was recessive to normal leaf and governed by a single gene. All the characters that go with the gigas leaf indicate the pleiotropic action of this gene. The gene symbols proposed are Nh for normal and nh for mutant.

RAJAGOPALAN, C.K. 1970.
A case of chimera in pigeonpea *Cajanus cajan* (Linn.) Millsp. Sci. Cult. 36:475. 788

A plant with a few branches near the apex bearing chimerical leaves was observed. Some leaves were white, some normal green, and others green white.

RAJU, D.R.G., and H.C.S. CHANDRA. 1972.
Studies on variability in tur. Andhra Agric. J. 19(9-6):155-156. 789

Assesses heritable variability in plant characters in 36 varieties of tur (*Cajanus cajan* Millsp.) and concludes that improvement is needed for the characters plant spread, number of branches, and 100-grain weight.

RAM, R.A., I.B. SINGH, and P. SINGH. 1976.
Estimates of correlation, variability, heritability and genetic advance in redgram (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Res. 10(1):60-62. 790

An experiment with 18 genetically diverse strains of red gram was conducted in RBD with three replications. It was observed that the number of primary branches, clusters per plant, and harvest index are the major yield components. The value of the genotypic coefficient of variability ranged from 32.91 to 66.44%. It was highest for clusters per plant and lowest for pods per cluster. The grain yield and harvest index, in that order, were the other traits showing high genetic coefficient of variability. The estimates of heritability varied from 50.61 to 74.14%. Genetic advance ranged from 10.11 to 40.19%.

RAM, R.A., P. SINGH, I.B. SINGH, and P. SHARMA. 1976.
Path and discriminant techniques for the improvement of redgram (*Cajanus cajan* (L.) Millsp.). Indian J. Agric. Res. 10(2):101-104. 791

The primary branches, clusters per plant and pods per cluster contributed directly as well as indirectly to grain yield and are therefore considered major yield components. The harvest index, however, contributed indirectly to yield as its direct effect was negative. The function including four characters viz., primary branches, clusters per plant, pods per cluster and harvest index gave the highest relative efficiency of 125.29%.

RATHNASWAMY, R., R. VEERASWAMY, A. RAGHUPATHY, and G.A. PALANISWAMY. 1973.
Studies on genetic variability of certain quantitative characters in redgram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 60(3):204-206. 792

All the characters have wide phenotypic variation. Among the characters studied, plant height, branches per plant, clusters per plant, pods per plant, and days to flower have high heritability and similar genetic gain; as such, these characters may be considered as reliable for selection in red gram.

REDDY, B.V.S., L.J. REDDY, and A.N. MURTHI. 1977.
Reproductive variants in *Cajanus cajan* (L.) Millsp. Trop. Grain Legume Bull. 7:11. 793

A search for male sterility in the pigeonpea germplasm collection resulted in 75 plants, grouped into five types, which are briefly described.

REKHI, S.S. 1966.
Studies in the inheritance of intervarietal cross of tur (*Cajanus cajan* (L.) Millsp.). Nagpur Agric. Coll. Mag. (Spec. Res. No.): 100. 794

Erect branching habit was found to be dominant to spreading habit and monogenetically inherited. Pointed leaf apex was dominant to round apex and also monogenetically inherited. Brown seed color was partially or incompletely dominant over white seed color (Monogenic). Four-seeded pods were dominant to three-seeded pods; and the character is also monogenetically inherited.

RUBAIHAYO, P.R., and M.F. ONIM. 1975.
A study of some characters of pigeonpea. SABRAO J. 7(2):183-187. 795

The heritabilities and interrelationships of ten characters were studied. Heritability estimates were high for days to flowering, pod color, determinate habit, and height but low for grain yield. There was no significant correlation between incidence of *Mycovellosiella cajani* and grain yield.

SALUNKHE, A.R. 1971.
Inheritance of certain characters of tur (*Cajanus cajan* (L.) Millsp.). 331 pp. M.Sc. (1971) Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 796

SEN, S., S.C. SUR, and K. SEN GUPTA. 1966.
Inheritance of dwarfness in pigeonpea (*Cajanus cajan* (L.) Millsp.). Zuchter 36:379-380. 797

A dwarf bush pigeonpea was found in a plot of the cultivar Brazil P/2; it had brittle stalks, late maturity, and low yield. A single recessive gene designated as d, appears to be involved. Though no chromosome aberrations were detected, pollen fertility in the mutant was only 70%; female fertility was normal.

SHARMA, D., S.S. BHADOURIA, LAXMAN SINGH, and H.K. SHARMA. 1974.
Genetic analysis of protein content in pigeonpea. Indian J. Genet. Pl. Breed. 34(2):230-235. 798

Genetics of protein through diallel analysis of F_1 and F_2 generations revealed that both g.c.a. and s.c.a. variances for protein content were highly significant. The magnitude of additive and nonadditive components of variance further confirmed the importance of additive as well as nonadditive gene action. In F_1 the nonadditive component was predominant; in F_2 the additive and nonadditive components were of equal importance. Of the parents, Baigani showed the highest protein content (23.22 and 23.25%) in two seasons and had the highest g.c.a. effects.

SHARMA, D., LAXMAN SINGH, S.S. BAGHEL, and H.K. SHARMA. 1972.
Genetic analysis of seed size in pigeonpea *Cajanus cajan*. Can. J. Genet. Cytol. 14:545-548. 799

In a diallel analysis of ten varieties differing in maturity group and seed size, a predominance of additive gene effects was found, mainly involving partial dominance. Seed size had a high heritability value of 0.82.

SHARMA, H.K., LAXMAN SINGH, and D. SHARMA. 1973.
Genetic analysis of flower initiation in pigeonpea. Indian J. Genet. Pl. Breed. 33(3):393-397. 800

Component analysis of F_1 and F_2 indicated the predominance of additive genetic variance and degree of dominance was found to be in the partial dominance range. Dominant genes were associated with early maturity. The proportion of dominant and recessive genes in the parents was almost equal. Heritability in the narrow sense was high,

indicating that improvement can be made by simple selection procedures.

SHARMA, H.K., LAXMAN SINGH, and D. SHARMA. 1973.
Combining ability in diallel crosses of pigeonpea. Indian J. Agric. Sci. 43(1):25-29. 801

The general combining ability variances were higher than the specific combining ability variances, indicating the predominance of additive gene action for a number of characters. Ranking of parental lines on the basis of general combining ability estimates showed good agreement with ranking based on performance per se. Heterotic effects were highest for plant height and grain yield and this suggests that composite varieties could be developed.

SHAW, F.J.F. 1936.
Studies in Indian pulses: The inheritance of morphological characters and wilt resistance in Rahar (*Cajanus indicus* Spreng.). Indian J. Agric. Sci. 6:139-188. 802

In a cross between two varieties of *Cajanus indicus* (Pusa Types T-5 and T-80) inheritance of flower color followed a 9:3:3:1 ratio, the F_1 and the double recessive being new phenotypes unlike either parent. Erect habit was partially dominant over spreading; short stature was dominant to tall; crowded habit of inflorescence was dominant to the open; brown seed of T-80 was dominant to the silver white of T-5 each in a 3:1 ratio. F_2 and F_3 populations were grown in infected fields and the loss due to wilt in F_2 suggests that the inheritance of resistance may be found in a 9:7 or 27:37 ratio, resistance being dominant. Ratios of the various phenotypes were not disturbed by the incidence of the disease, showing that the inheritance of resistance was not linked with that of any of the morphological characters studied.

SHERIFF, N.M., W.M. ALIKHAN, and R. VEERASWAMY. 1975.
Studies on the inheritance of certain plant characters in redgram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 66(2): 64-65. 803

The inheritance of agronomical and other morphological characteristics was studied in Tamil Nadu, using induced mutants as one of the parents in crosses. The erect habit and tall plant habit were found to be dominant and controlled by a single pair of genes.

SHINDE, V.K., R. D'CRUZ, and A.B. DEOKAR. 1971.
Genetic studies in pigeonpea. XI. Creeping 3-2-8 x Red grained. Poona Agric. Coll. Mag. 61:53-55. 804

Three characters were studied: growth habit, color of dorsal surface of standard petal and pod color. Segregation data in F_2 showed 13 creeping : 3 erect, suggesting two factors, one of which has an inhibitory action. Data for petal color showed 3 yellow with [illegible] red veins : 1 yellow with red ve[illegible]; data for pod color showed 3 green with black diffused : 1 green with black streaks. These characters showed independent assortment.

SHRIVASTAVA, M.P., LAXMAN SINGH, and R.P. SINGH. 1976.
Heterosis in pigeonpea. Indian J. Genet. Pl. Breed. 36(2):197-200. 805

Mean heterosis of 67% was obtained for yield, 96% for secondary branches, and 80% for number of pods per plant. The latter two characters contributed maximum for the increase in yield; medium x medium, low x medium crosses generally resulted in high heterotic performance. Genetic diversity was the key to obtaining hybrid vigor.

SHRIVASTAVA, P.S., A.B.L. BEOHAR, and S.C. PANDYA. 1973.
Genetic variation for some nutrient element accumulation and their association with yield and maturity in arhar (*Cajanus cajan* (L.) Millsp.). JNKVV Res. J. 1:43-46. 806

The seed content of Zn, P, Cu, Fe, and Mn, differed significantly in the eight varieties studied, and heritability estimates in the broad sense were high, ranging from 0.69 for Mn to 0.91 for P. P content showed a negative correlation with number of days to maturity, in contrast to Mn content, which showed a positive correlation. A significant negative genotypic correlation between P and Mn contents was recorded.

SINGH, A.B., V.N. YADAV, D. SINGH, and S.P. SINGH. 1972.
Correlation and heritability studies in arhar (*Cajanus cajan* (L.) Millsp.). Indian Agric. 16(1):41-44. 807

Yield showed significant and positive phenotypic and genetic associations with plant height, secondary branches, and pod length. A high degree of association was also observed between primary branches and three characters, viz. days to flower,

secondary branches, and plant height. The association was negative between yield and days to flower. The estimate of heritability was maximum for pod length and minimum for plant height; genetic advance was maximum for yield.

SINGH, D.N., R.K. BANSAL, and S.P. MITAL. 1942.
Cajanus obcordifolia Singh. A new species of *Cajanus*. Indian J. Agric. Sci. 12:779-784. 808

A new species is described which has obcordate leaflets with retuse, mucronate apices as compared with the oblong-lanceolate leaflets with acute to slightly acuminate apices of the common pigeonpea (*Cajanus cajan*). There are differences in the floral characters also.

SINGH, K.B., and R.S. MALHOTRA. 1973.
Yield components in pigeonpea (*Cajanus cajan* L.). Madras Agric. J. 60(6): 364-366. 809

The study on 40 strains of pigeonpea showed significant and positive association of yield with clusters per plant, pods per plant, and secondary branches. Pods per plant also showed significant association with clusters per plant. Path coefficient and regression studies revealed that clusters per plant is the main yield component in pigeonpea.

SINGH, M.K. 1971.
Inheritance of seed coat colour in *Cajanus cajan* (L.) Millsp. (*C. indicus* Spreng). Proc. Indian Sci. Cong. Assoc. 58(3): 482-483. (Abstract). 810

The genetics of seedcoat color were studied in the F_1 and F_2 generations of two *Cajanus* varieties: B/3, with black seedcoat, and a commercial variety, with white and crimson seedcoat. In both the crosses monogenic ratios were obtained between black and white and crimson and black. On the basis of the breeding behavior it was assumed that crimson is the basic color controlled by gene R, because R is dominant over black and black is dominant over brown and white. Three genes, R, B, and P, may be responsible for seedcoat coloration. The parents with black seeds have the genotype rrBBpp; since RRBBpp will give a monogenic ratio between crimson and black, the crimson-seeded variety will have the genotype RRBBpp. The genetic mechanism and genotypes of the parents, based on their breeding behavior, have been explained and discussed.

SINHA, S.C., and RAM LAKHAN. 1976.
A new variant in pigeonpea. Indian J. Agric. Res. 10(2):141-142. 811

A completely branchless and extremely tall plant was observed in culture 6112. Its progeny gave a 15 normal : 1 variant ratio. The morphological characters of the plants, their comparative description, and usefulness in basket making are discussed.

SINHA, S.C., J.K. SAXENA, and RAM LAKHAN. 1976.
Note on the breeding behavior of a fasciated mutant in *Cajanus cajan*. Indian J. Agric. Res. 10(3):203-204. 812

Fasciation, a morphological abnormality that results in the coalescent development of branches which finally assume a deformed and flattened look, was found to be monogenic recessive.

SOLOMON, S., G.P. ARGIKAR, M.S. SALANKI, and I.R. MORBAD. 1957.
A study of heterosis in *Cajanus cajan* (L.) Millsp. Indian J. Genet. Pl. Breed. 17:90-95. 813

Data are given on a number of quantitative characters of ten F_1 hybrids of *Cajanus cajan* studied at Bijapur. Increases in grain yield up to 24.51% over that of the parents were obtained but the best yielding hybrid gave a lower yield than the best parental type.

SRINIVASAN, K. 1977.
Studies on induced mutagenesis in redgram (*Cajanus cajan* L.). M.Sc. (1977) Thesis. Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. 814

TEERANDAJ, G.H. 1973.
Inheritance studies in tur (*Cajanus cajan* (L.) Millsp.). 133 pp. M.Sc. (1973) Thesis. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India. 815

THORAT, T.Y. 1955.
Study of the genetic variability of pigeonpea (*Cajanus cajan* (L.) Millsp.). Thesis. Indian Agricultural Research Institute, New Delhi, India. 816

VEERASWAMY, R., P. RANGASAMY, A.K. FAZLULLAH KHAN, and N. MOHAMMED SHAREEF. 1973.
Heterosis in *Cajanus cajan* (L.) Millsp. Madras Agric. J. 69(9-12):1317-1319. 817

The intervarietal hybrids in red gram between Co-1 (a short-term, high-yielding strain) and 19 genetically diverse varieties expressed heterosis for plant height, plant spread, number of branches, number of clusters, number of pods, and days to 50% flowering. Five hybrids expressed maximum heterosis for the characters studied. The hybrid Co-1 x 80, which was outstandingly superior to the others, showed a mean percentage increase of 179.6 and 188.5 in two important economic attributes, number of clusters and number of pods, respectively, over the superior parent.

VEERASWAMY, R., R. RATHNASWAMY, and M. MURUGESAN. 1975.
Path analysis in red gram (*Cajanus cajan* (L.) Millsp.). Madras Agric. J. 62(3): 166-168. 818

It is shown from data on 21 diverse genotypes that (i) height had a low positive direct effect on yield but a high positive indirect effect through branch number, and a high negative indirect effect through days to first flowering; (ii) branch number had a high positive direct effect on yield; (iii) cluster number per plant and pod number had a positive indirect effect through branch number; and (iv) days to first flowering had a moderate negative direct effect and a high indirect effect through branch number. It is concluded that branch number had the greatest influence on yield.

VEERASWAMY, R., R. RATHNASWAMY, A. RAGHUPATHY, and G.A. PALANISWAMY. 1973.
Genotypic and phenotypic correlations in *Cajanus cajan* (L.) Millsp. Madras Agric. J. (9-12):1823-1825. 819

A close association was found to exist between number of clusters and number of pods per plant on phenotypic basis but this association was reduced on the genotypic level by environmental factors. These two characters were also found the most reliable index of selection for yield. The highest coheritability estimate (99.13) was for number of branches and pods per plant. However, plant height and number of days to flower are also useful as phenotypic indices for selection.

VENKATESWARLU, S., R.M. SINGH, and R.B. SINGH. 1976.
EMS-induced multicarpellate condition in *Cajanus cajan*. Curr. Sci. 45(2): 773-774. 820

All the three types of flowers (mono-, bi- and tri-carpellary) are found on the same plant with concomitant increase in the stamens and complete pollen and ovule sterility.

WAKANKAR, S.M., and L.N. YADAV. 1975.
Path analysis of yield components in arhar (*Cajanus cajan*). Indian J. Agric. Res. 9(4):182-186. 821

Correlations and path coefficients were estimated with regard to 14 characters in an F_2 population of a cross of var. Gwalior-3 x NP-69. Results showed that more pods, secondary branches per plant with high seed indices, and limited spreading are reliable selection criteria.

MICROBIOLOGY

ARORA, NIRMAL. 1956.
Morphological study of the root nodules on *Cajanus indicus*. Proc. Indian Sci. Cong. 43(3):244-245. (Abstract). 822

Large, more or less elongated nodules are sparsely distributed on the root system of *C. cajan*. Infection of the roots occurs through root hairs. A mature nodule shows a well marked bacteroid area, apical meristem, and vascular zone. Two vascular stands arising near the root protoxylem supply the nodule. The vascular bundles may be collateral, inversely collateral or bicollateral. In later stages they show the development of secondary elements. The rhizobia stimulate the cortical cells to divide. The nodule is exogenous in origin. The root nodules of *C. indicus* differ from the earlier described herbaceous nodules (Allen and Allen, 1954) in having a sclereid layer in the cortex, in a diffuse method of tissue degeneration, and in the fact that the orientation of xylem and phloem is not constant.

BHAGYARAJ, J., and G. RANGASWAMI. 1966.
On the variations in rhizosphere effects of some crop plants. Curr. Sci. 35(9): 238-239. 823

Amongst five crops grown in similar conditions, pigeonpea had the greatest rhizosphere effect on bacteria.

DART, P.J., RAFIQUL ISLAM, and A. EAGLESHAM. 1975.
The root nodule symbiosis of chickpea and pigeonpea. Proc. First International Workshop on Grain Legumes. 13-16 Jan 1975. ICRISAT. Hyderabad, India. 63-83. 824

Pigeonpea rhizobia are of the cowpea cross-inoculation group. Origin of the strains, performance of strains, and other observations on nodulation are discussed.

DIATLOFF, A. 1971.
Pelleting tropical legume seed. Qd. Agric. J. 97:363-366. 825

Seed inoculation with a suitable legume inoculant ensures that bacteria necessary for nodulation are introduced at the time of planting. Lime pelleting is common to improve nodulation. The following aspects are discussed: Seed pelleting and its benefits; pelleting material; stickers; inoculant; preparing the pellet; sowing pelleted seed. For *Cajanus cajan* inoculant requirement is cowpea type and pelleting material is rock phosphate.

EDWARD, J.C., and S.C. TRIPATHI. 1972.
Population densities of *Azotobacter* spp. within rhizosphere and non-rhizosphere soils of some crops during rabi. Allahabad Fmr 46(1):49-51. 826

The population densities of *Azotobacter* spp. associated with the rhizosphere and non-rhizosphere of wheat, hybrid napier-grass, *Cicer arietinum*, peas, and *Cajanus cajan* are described.

JADHAV, T.K., and L. MONIZ. 1972.
Cross inoculation studies with *Rhizobia* of cultivated and wild tur and Sannhemp. Mahatma Phule Agric. Univ. Res. J. 3(1-2):64-66. 827

Most effective strains, viz., CT-3, WT-4, CS-3, and WS-2, obtained from tur and wild tur (*Atylosia lineata* W. & A.) and Sannhemp strains were used. The strains from tur and wild tur gave positive results for nodulation with the host of cowpea and soybean cross-inoculation groups but failed to produce nodules on the hosts of other cross-inoculation groups. Strains CT-3 and WT-4, from tur and wild tur respectively, produced fairly good nodulation on six out of eight hosts of the cowpea group. The nodules were observed on the tap root.

LIM, G. 1977.
Nodulation of tropical legumes in Singapore. Trop. Agric. (Trinidad). 54(2):135-141. 828

A total of 68 species of legumes, comprising 27 members of Caesalpinioideae, 13 of Mimosoideae, 27 of Papilionoideae and one of Swartzioideae were examined for nodulation. Slightly more than half the species examined (37) did not have root nodules; most of the nonnodulating species belonged to Caesalpinioideae. The largest number of nodulating species (81.5 per cent) were found in Papilionoideae. Nodulation is reported for the first time for *Calliandra inaequilatera* (Mimosoideae). There was no correlation between nodulating ability of a plant and whether it is an indigenous or introduced species.

MANJUNATH, A. 1976.
Nodulation and nitrogen fixation in *Cajanus cajan* (L.) Millsp. Influence of dose and time of application of mineral nitrogen. M.Sc. Thesis. Thesis abstracts. 2(3):213. 829

NANDI, L.A., and V. BALASUBRAMANIAN. 1976.
Root nitrogen content and transformation in selected grain legumes. Trop. Agric. (Trinidad). 55(1):23-32. 830

The nitrogen content and the amount and rate of N mineralization of some tropical grain legume roots varied considerably not only among different species but also between cultivars of the same species (Cowpea). The chemical composition of the tropical grain legume roots including pigeonpea are given. These results suggest that the conflicting reports of the effects of grain legumes, especially cowpea, on soil N may be due in part to varietal difference.

NORRIS, D.O. 1959.
Legume bacteriology in the tropics. J. Aust. Inst. Agric. Sci. 25:202-207. 831

The scientific study of rhizobium, which was first isolated in 1888, started with Beijerinck. The following aspects of legume bacteriology in the tropics are discussed: Distribution of Leguminosae; the question of root hair infection; the form and appearance of bacteria in culture; claims that tropical legumes fail to nodulate; claims that tropical legumes fail to fix nitrogen; the practice of inoculation in tropical legumes; calcium nutrition of rhizobium and the necessity for lime in acid soils.

NORRIS, D.O. 1970.
The contribution of research in legume bacteriology to the development of Australian pastures. Proc. XI Internat. Grassland Cong. 13-23 April 1970. Queensland, Australia. 22-30. 832

Research in legume bacteriology has played a vital role in Australian pasture development, which is heavily dependent on introduced legume species, both temperate and tropical. Investigations of the symbiotic affinities of *Trifolium* and *Medicago* spp. and a variety of tropical legumes has led to the selection of highly effective *Rhizobium* strains for use as inoculants and serological techniques for studying their field performance have been developed and refined. The setting up of the cooperative organization U-DALS has resulted in high quality commercial inoculants. The development of seed pelleting procedures has greatly improved ease and efficiency of field establishment in many circumstances.

OKE, O.L. 1967.
Nitrogen fixing capacity of some Nigerian legumes. Expl Agric. 3(4):315-321. 833

The fixation of N in root nodules of *Cajanus cajan*, *Centrosema pubescens*, and *Stylosanthes gracilis* grown in pots in sand supplied with a N-free nutrient solution was studied in Nigeria. N-fixation in these legumes attained maxima of 14.5, 10.3, and 4.6 mg per day per plant, respectively. Some 90% or more of the N fixed was transferred from the nodules to the rest of the plant soon after fixation. Fixation per g of nodules was highest for *C. cajan* during the early development phase.

PALACIOS, G., and A. BARI. 1936.
A new microorganism associated with the nodule bacteria in *Cajanus indicus*. Proc. Indian Acad. Sci. (Sect. B) 3(4): 362-365. 834

A new organism (*Bacillus concomitans* nov. sp.) is described which is found frequently inside the nodules formed in *Cajanus indicus*. When isolated in pure culture it does not produce nodules. It gives a congo-red negative reaction and possesses many other characteristics which differentiate it from *Rhizobium radicicola* and *B. radiobacter*.

RAJU, M.S. 1939.
Studies on the bacterial-plant groups. VI. Variation in the effectiveness of different strains of nodule bacteria of cowpea groups (II. Influence of light on the effectiveness), *Cajanus cajan* and *Dolichos biflorus*. Zbl. Bakt. 11(99):449-460. 835

RAMASWAMY, P.P., and V.S. NAIR. 1965.
Symbiotic variation of Rhizobium from nodules of redgram (*Cajanus cajan*). Madras Agric. J. 52:239-240. 836

Among the *Rhizobium* isolated from the nodules of different hosts of the same species, there is wide variation in the capacity to fix atmospheric nitrogen in the host legume. The necessity for selecting suitable strains of *Rhizobium* to bring about maximum benefit to the legume crop is indicated.

SAXENA, M.C., K.V.B.R. TILAK, and D.S. YADAV. 1975.
Response of pigeonpea to inoculation and pelleting. Indian J. Agron. 20(4): 321-324. 837

Inoculation increased grain yield over that of non-inoculated control. During 1972, grain yield was maximum in case of seed pelleting with lime and inoculated with IARI culture. Various treatments did not differ significantly in grain yield during 1973. Maximum nodulation occurred during both the years in case of seed pelleted with lime and inoculated with Pantnagar culture. Maximum rhizobial number in rhizosphere was associated with lime-pelleted seeds.

SETHUNATHAN, N. 1970.
Foliar sprays of growth regulators and rhizosphere effect in *Cajanus cajan* Millsp. 1. Quantitative changes. Pl. Soil 33(1):62-70. 838

The response of rhizosphere microflora of pigeonpea to various growth regulators was studied. The number of fungi significantly increased in the rhizosphere of seedlings sprayed with 25 ppm naphthalene acetic acid. Significant increases in bacterial numbers occurred in the rhizosphere of plants treated with 2, 4-D (25 ppm). Gibberellin (100 ppm) or 0.2% maleic hydrazide generally depressed the accumulation of microorganisms. However, no additive ill effects occurred when they were applied in combination. The effects of indole acetic acid were inconsistent.

SHARMA, N.K., and C.L. SETHI. 1975.
Leghaemoglobin content of cowpea nodules as influenced by *Meloidogyne incognita* and *Heterodera cajani*. Indian J. Nematol. 45:113-114. 839

The data indicate that the nematodes interfered with the leghaemoglobin content of the cowpea root nodules, with *M. incognita* causing more reduction than *H. cajani*.

SHERIFF, N.M., R. RATHNASWAMY, G. SELVAKUMARI, A. RAGHUPATHY, and R.H. KRISHNAN. 1970.
Effect of bacterial inoculation for pulses cultivated in Tamil Nadu. Madras Agric. J. 57:181-184. 840

Experiments on effects of *Rhizobium* cultures on different pulses, did not indicate positive response in any of the pulses for increase in grain production. It may be due to a number of factors such as nonspecificity of the strains listed.

SIMHADRI, P., and K.V.B.R. TILAK. 1976.
Comparative performance of different strains of *Rhizobium* species on pigeonpea (*Cajanus cajan* (L.) Millsp.). Pantnagar J. Res. 1(1):26-29. 841

Inoculation of *C. cajan* seeds with *Rhizobium* strain A3 increased nodulation and leghaemoglobin synthesis and gave the highest seed yields (2.16 t/ha). Inoculation with *Rhizobium* strain PN gave the next highest yield, 1.71 t/ha, compared with 0.94 t/ha without inoculation.

SINGH, R., and T.P. MALL. 1974.
Studies on the nodulation and nitrogen fixation by infected leguminous plants. 1. Effect of arhar mosaic virus infection on nitrogen value, nodulation and nitrogen fixation by some pulse crops. Pl. Soil 41(2):279-286. 842

The arhar mosaic virus infection decreased the number, weight, and size of the nodule in cowpea and mung but increased the nodule number and fresh weight in urad plants. The arhar mosaic virus strains reduced the nitrogen fixation capacity of infected plants in comparison with their healthy counterparts.

SUBBA RAO, N.S. 1976.
Field response of legumes in India to inoculation and fertilizer applications/ *Rhizobium*. *Cicer arietinum*, *Cajanus cajan*. pp. 255-268. *In*: Nutman, P.S. (Ed.). International Biological Programme, No. 7. 843

PATHOLOGY

ADSUAR, J. 1964.
A mosaic disease of cowpea (*Vigna sinensis* savi) in Puerto Rico. J. Agric. Univ. P. Rico. 48(3):264. 844

A virus isolated from cowpea plants with mottled, misshapen, and dwarfed leaves was inactivated by dilution to 1:10,000, heating to 60°C for 10 min., or storage *in vitro* for 43 hr at 28 to 30°C. The virus was also transmitted to pigeonpea, *Canavalia ensiformis*, *Desmodium distortum*, and *D. gyroides*. The relationship of this virus to others infecting cowpea is being investigated.

AGNIHOTHRUDU, V. 1953.
Soil conditions and root diseases. B. Rhizosphere microflora of some of the important crop plants of South India. Proc. Indian Acad. Sci. (Sect. B). 37(1):1-13. 845

Various fungi isolated from Rhizosphere soil of pigeonpea, including *Fusarium* spp. are described.

AGNIHOTHRUDU, V. 1955.
Incidence of fungistic organism in the rhizosphere of pigeonpea (*Cajanus cajan*) in relation to the resistance and susceptibility to wilt caused by *Fusarium udum* Butl. Naturwissenschaften 42(2):1-2. 846

AGNIHOTHRUDU, V. 1957.
The density of the rhizosphere microflora of pigeonpea (*Cajanus cajan* (L.) Millsp.) in relation to the wilt caused by *Fusarium udum* (*F. merismoides*) Butler. Naturwissenschaften 44(18):497. 847

The rhizosphere population of pigeonpea increased in number in the presence of *F. merismoides*, the number of fungi decreasing but the number of bacteria increasing greatly. The rhizosphere of wilted and dying plants, however, contained a greater number of fungi than bacteria. The microfloral population in the rhizosphere of wilt-susceptible pigeonpea strains was larger than that of wilt-resistant plants; at higher levels of moisture there was no difference, which may be due to high moisture causing errors in soil sampling.

AGNIHOTHRUDU, V. 1958.
Fungi isolated from Rhizosphere. 4. J. Indian Bot. Soc. 37(3):422-431. 848

Sixteen ascomycetes were isolated from pigeonpea rhizosphere.

AGNIHOTHRUDU, V. 1959.
Fungi isolated from Rhizosphere. 5. J. Madras Univ. (Sec. B) 29(3):155-181. 49

Fifty deutermomycetes were isolated from pigeonpea rhizosphere.

AGNIHOTHRUDU, V., K. BHUVANESWARI, and S. SURYANARAYANAN. 1955.
Fungi isolated from rhizosphere. 1. Proc. Indian Acad. Sci. (Sect. B) 43: 98-104. 850

Some of the fungi frequently isolated from the rhizosphere of some crop plants, particularly pigeonpea (*Cajanus cajan*), are identified. Three of them are new records for the country, viz., *Melanospora brevirostrata* C. Moreau, *Aspergillus giganteus* Wehmer, and *Oedocephalum coprophilum* Kobayashi. The different characters of these species are given.

AHMED, T. 1974.
Rhizoctonia seedling blight of pigeonpea and its control. M.Sc. (1974) Thesis. Bidhan Chandra Krishi Viswa Vidyalaya, Kalyani, West Bengal, India. 851

ALAM, M. 1931.
Administration Report of the Botanical Section for the year ending 31st March 1931. Appendix 1(8): Rep. Dep. Agric. Bihar, Orissa, for the period from 1 Apr 1930 to 31 Mar 1931:42-65. 852

Sabour 2E 'Rahar' selection has given great satisfaction both generally and because of wilt and sterility resistance. Further information on varietal resistance is listed. The incidence and severity of sterility disease vary considerably from year to year and probably depend on external factors. A strain from Pusa, almost as prolific as the high-yielding Sabour 75 and Pusa P, proved wilt-resistant even on artificial inoculation.

ALAM, M. 1933.
Rahar sterility. Proc. 20th Ann. Meet. Ind. Sci. Cong. Poona: Sect. Agric. 43:15-16. 853

The type of sterility in question is characterized by (i) dwarfing of leaves, (ii) a bushy habit, and (iii) yellowish green instead of green leaves. The accompanying sterility due to the suppression of flowers and fruits may vary in degree in different types of *Cajanus indicus*. A negative correlation between the degree of sterility and yield was noted.

ALVAREZ, G.L.A. 1960.
Phoma canker of pigeonpeas in Puerto Rico. J. Agric. Univ. P. Rico 44(1):28-30. 854

An epidemic of phoma canker was observed in February 1954, causing considerable losses to the pigeonpea crop. This paper reports a study of the causal organism as a species of *Phoma* characterized by the formation of papillate pycnidia of variable size. The disease could be produced in healthy pigeonpea plants by inoculation or by spraying with a water suspension of conidia obtained from a pure culture. Further study is advisable.

AMIN, K.S., B. BALDEV, and F.J. WILLIAMS. 1976.
Differentiation of *Phytophthora* stem blight from *Fusarium* wilt of pigeonpea by field symptoms. FAO Pl. Prot. Bull. 24(4): 123-124. 855

Fusarium wilt, caused by *Fusarium udum* Butler, is a widespread and damaging disease of *Cajanus cajan* in India. *Phytophthora* stem blight of pigeonpea, caused by *Phytophthora cajani*, can easily be mistaken for *Fusarium* wilt, and this confusion may account for some of the alleged failure of wilt-resistant varieties. Leaves of plants affected by *Fusarium* wilt frequently turn yellow before drying, while leaves of plants affected by *Phytophthora* stem blight are initially light green with upward rolling and usually dry rapidly. Later, the two diseases cannot be distinguished by leaf symptoms, since the leaves become brown and dry in both cases. The stems of plants affected by these fungi are also described.

ANIL KUMAR, T.B., P.C. HIREMATH, and V.V. SULLADMATH. 1976.
Fungicidal control of foot-rot of pigeonpea. Curr. Res. 5(6):98-99. 856

Maximum protection was obtained using captan as soil drench. Thiram and Brassicol gave good control both as seed dresser and soil drench. Ceresan wet and captan were not effective as seed dressers. There was no complete control by any of the fungicides tested.

ANONYMOUS. 1931.
Review of agricultural operations in India, 1928-29. Imp. Coun. Agric. Res. Pusa 1931. 251 pp. 857

The isolation of productive wilt-resistant varieties of gram and pigeonpea (*Cajanus indicus*) and the discovery of certain types of pigeonpea resistant to an unknown sterility disease are described.

ANONYMOUS. 1938.
New plant diseases recorded in India. Intern. Bull. Plant Prot. Year XII: 122-123. 858

ANONYMOUS. 1940.
Pigeonpea. Indian Fmg 1:178. 859

The pigeonpea, usually called rahar or arhar (*C. cajan*), one of the most important food pulses of India, suffers severely from wilt or ukhra, the fungus disease caused by *F. vasinfectum*. Studies showed that varieties differ in their ability to withstand the attacks of the fungus, resistant varieties not being high-yielding and of good cooking quality. An attempt is being made to isolate a wilt-resistant strain from the variety Imperial Pusa 69 which, except for its susceptibility to wilt is ideal for eating and for other important qualities.

ANONYMOUS. 1941.
Agriculture and Animal Husbandry in India 1938-39. Imp. Coun. Agric. Res. Delhi 1941: 422 pp. 860

Pigeonpea (*Cajanus indicus*). A wilt-resistant strain was isolated at Pusa.

ANONYMOUS. 1950.
Annual Administration Report of the Department of Agriculture, Uttar Pradesh, for the year ending June 30, 1949. 125 pp. 861

Cajanus cajan: The wilt-resistant strain of arhar (*Cajanus cajan*). 17 W/2 was chosen for multiplication to replace the susceptible strain 66; selection of other resistant types continued.

ANONYMOUS. 1952.
List of intercepted plant pests, 1951. S.R.A., B.E.P.Q., U.S. Dept. Agric. 61. 862

Colletotrichum cajani intercepted on flight from Puerto Rico to USA. Believed to be new or not yet established.

ANONYMOUS. 1964.
Mycology and Plant Pathology Section. Agric. Res. 4(4):209-222. 863

Infection by sterility virus appeared to give some protection against *Fusarium udum* wilt. Sap from infected plants inhibited germination of *Fusarium* conidia.

ANONYMOUS. 1973.
Report of the Faculty of Agriculture, 1971-72. Univ. West Indies, St. Augustine, Trinidad and Tobago. 864

Cajanus: Three types of infection by *Puccinia* spp. were observed in F_2s of *C. cajan* crosses. One type, observed in two plants, gave indications of incipient resistance.

ANONYMOUS. 1976.
Testing of arhar (pigeonpea) strains against wilt diseases. Pesticides 10(2):17. 865

The entries identified as resistant to wilt are: 15-3-3, DT-236-6-3-102, (C.11 x N.252) (C.11 x N.252) 10, Vita-1, Osmanabad-1-5, Udgir-500. Fungicidal and biological control of wilt are also being studied.

ARCHIBALD, J.F. 1961.
Transmission of gall-disease of cacao, mango and pigeonpea. Nature 190:284. 866

Investigations showed that the "green-point" type of cacao cushion-gall could be transmitted by washings of galls and by extracts of macerated gall tissue, using the half-bean technique. Similar galls found on mango and pigeonpea could be transmitted in cacao; part of the galls produced on cacao by inoculation from pigeonpea galls were distinct from galls transmitted from cacao and mango. It is considered inadvisable to grow mango or pigeonpea in close proximity to cacao.

ARMSTRONG, G.M., and J.K. ARMSTRONG. 1960.
Biological races of *Fusarium* causing wilt of cowpea and soybeans. Phytopath. 40(2):181-193. 867

Inoculation gave slight infection of vascular tissue of pigeonpea.

ASHBY, S.F. 1927.
Macrophomina phaseoli (Mausl.) Comb. The pycnidial stage of *Rhizoctonia bataticola* (Taub) Butl. Trans. Br. Mycol. Soc. 12(2-3):141-147. 868

The type of *Macrophoma cajani* (Syd. and Butl.) on living stems of pigeonpea from Pusa included in synonymy of *M. phaseoli*. Range is said to be wide. From Formosa, Philippines, India, Ceylon, East Africa, Palestine, Egypt, W. Indies, Eastern United States, with a large range of economic hosts. Parasitism appears to be influenced by environmental and nutritional effect of hosts.

AYALA, A. 1962.
Parasitism of bacterial nodules by the reniform nematode. J. Agric. Univ. P. Rico 46(1):67-69. 869

In Puerto Rico the bacterial nodules of *Cajanus indicus* were observed to be attacked by the females of the nematode *Rotylenchulus reniformis*. Up to now this nematode was known to feed only on the roots of various plant species, including nine leguminous plants.

BALDEV, B., and K.S. AMIN. 1974.
Studies on the existence of races in *Fusarium udum* causing wilt of *Cajanus cajan*. SABRAO J. 6(2):201-205. 870

Of eight lines inoculated with ten isolates from various Indian states, C-11, NP(WR)-15, and S-103 were resistant. From the results of inoculation studies with 24 isolates, susceptible T-21 and resistant NP(WR)-15 and C-11, it is concluded that a number of pathogenic races of *F. udum* exist.

BARNES, R.F. 1973.
Bulletin No. 1, Department of Biological Sciences, University of the West Indies, St. Augustine, Trinidad. 871

A recent bibliography on diseases of pigeonpea indicates six fungus diseases and two virus diseases occur on pigeonpea in countries in the region--Puerto Rico, Bermuda, and Trinidad and Tobago. A survey of world literature indicated the total number of diseases reported to affect pigeonpea is: 20 of fungal origin, six of viral, two of bacterial, and two of unknown origin.

BATES, G.R. 1957.
Botany and Plant Pathology. Rep. Minist. Agric. Rhod. Nyasald. 1955-56:79-86. 872

New record of *Cercospora cajani* on pigeonpea.

BATISTA, A.C., and A.F. VITTAL. 1952.
Monografia Das especies De Phyllosticta em Pernambuco. Bol. Sec. Agric. Pernambuco. 19(1-2):1-80. 873

Phyllostieta cajani recorded in Brazil.

BHARGAVA, S.N. 1965.
Studies on the charcoal rot of potato. Phytopath. Z. 53(1):35-44. 874

Macrophomina phaseoli isolated from potato was successfully inoculated into wounded pigeonpea.

BHATNAGAR, P.S., L.C. GANGWAR, and V. KUMAR. 1966.
Phyllody in pigeonpea (*Cajanus cajan* (L.) Millsp.). Kanpur Agric. Coll. Mag. 26(1-2):51-52. 875

BIRD, J. 1962.
A white-fly transmitted mosaic of *Rhynchosia minima* and its relation to tobacco leaf curl and other virus diseases of plants in Puerto Rico. Phytopath. 52(3):286 (Abstract). 876

Pigeonpea was inoculated with the virus in the greenhouse and further observations were recorded.

BIRD, J., and K. MARAMOROSCH (EDITORS). 1975.
Tropical diseases of legumes. Agric. Exp. Stn Univ. Puerto Rico, Rio Piedras, PR. New York: Academic Press. 184 pp. 877

Papers presented at a workshop held in Puerto Rico, June 1974. It deals with rugaceous, mosaic, and bacterial diseases and with nematodes on common bean, cowpea, pigeonpea, soybean, lima bean, and other tropical legumes.

BISHT, N.S., and A.K. BANERJEE. 1965.
Occurrence of two new virus diseases in Uttar Pradesh (*Cajanus cajan*). Labdev J. Sci. Technol. 3(4):271-272. 878

A new mosaic disease of pigeonpea is reported, affecting 10% of the crop and causing loss of yield. Transmission to pigeonpea was by grafting.

BOSE, R.D. 1939.
The rotation of tobacco for the prevention of wilt disease of pigeonpea. Agriculture Live-Stk India 6:653-668. 879

The growth of *Fusarium vasinfectum* causing pigeonpea wilt is retarded by rotation with tobacco, thus enabling the pigeonpea to

escape infection to a considerable extent, particularly at an early age. Advocates the interposition of a tobacco crop every 3 or 4 years, especially in districts where the disease is severe.

BUTLER, E.J. 1906.
The wilt disease of pigeonpea and pepper Agriculture India 1:25-36. 880

The wilt disease of pigeonpea caused by *Fusarium udum* Butl. is responsible for 15 to 25% mortality of plants, and this may be more than 50% in epidemic years. The disease appears on young seedlings in August and highest mortality in mature plants is caused at flowering time in November and December. The disease progresses in patches; its symptoms are described.

BUTLER, E.J. 1908.
Selection of pigeonpea for wilt disease. Agriculture India 3:182-183. 881

The experiments were conducted to identify a strain of tur (*C. cajan*) resistant to wilt disease. A number of strains were collected and tested in a plot severely infected with fungus. A few of these collections showed promise and were found to be somewhat resistant.

BUTLER, E.J. 1910.
The wilt disease of pigeonpea and the parasitism of *Neocosmospora vasinfecta* Smith. Mem. Dep. Agric. India (Bot. Ser.) 2:1-62. 882

BUTLER, E.J. (EDITOR). 1918.
Fungi and disease in plants. Calcutta: Thacker, Spink pp. 244-251. 883

BUTLER, E.J. 1926.
The wilt diseases of cotton and sesamum in India. Agric. J. 21(4):268-273. 884

A detailed description is given of artificial inoculations of seedlings of both hosts with the organisms isolated from wilted plants, the results of which, together with the morphological and cultural features of the pathogen, suggest that the wilt-producing fungi attacking cotton, seasmum, and pigeonpea in India are specialized strains of *Fusarium vasinfectum*, the American cotton wilt organism.

CAPOOR, S.P. 1952.
Observations on the sterility disease of pigeonpea. Indian J. Agric. Sci. 22:271-274. 885

The symptom expression of the disease, its behavior under field conditions, as well as in the glasshouse, and experimental evidence are all characteristic of a virus disease. The disease is readily transmitted by graft inoculation, but only in a few cases by the inoculation of juice extracted from leaves of diseased plants. It is proposed that the causal virus of the sterility disease be called the 'pigeonpea sterility mosaic' virus.

CAVENESS, F.E. 1974.
Plants parasitic nematode population differences under no-tillage and tillage soil regimes in Western Nigeria. J. Nematol. 6(4):138 (Abstract). 886

Mixed populations of *Pratylenchus* spp. were 5:1 greater in soil and 4:1 greater in maize roots in plots grown to maize for seven consecutive cropping seasons (3.5 yr) under a soil management regime of tillage and nontillage respectively. *Meloidogyne incognita* was 3:1 greater in nontillage than tillage soils. Pigeonpea, soybean, and cowpea following six continuous crops of maize reduced the number of *Pratylenchus* spp. under both soil management regimes. Tillage soils had more than twice the number of *Pratylenchus* spp. than nontillage soil when grown to pigeonpea and soybean. D-D (1-2-dichloropropane and 1-3-dichloropropene) applied by hand-operated fumigun at the rate of 600 liters/ha controlled *Pratylenchus* spp. equally well in tillage and nontillage soils.

CHADHA, K.C., and S.P. RAYCHAUDHURY. 1966.
Interaction between sterility virus and *Fusarium udum* Butl. in pigeonpea. Indian J. Agric. Sci. 36:133-139. 887

Both diseases often occur simultaneously on the same plant. The interaction between a virus and a fungus in their common host has been reported in a number of cases and useful results have been obtained regarding the epidemiology of pathogens involved.

CHAKRABARTI, SIPRA, and P. NANDI. 1969.
Effect of griseofulvin on *Fusarium udum* Butler and its host pigeonpea (*Cajanus cajan* (L.) Millsp.). Proc. Indian Sci. Acad. 56(3):288 (Abstract). 888

Griseofulvin was found to be highly effective against *F. udum*. Growth of the fungus was inhibited by very low concentration of the antibiotic. Conidial germination was not hindered even by higher concentrations, but the germ tube was affected. Griseofulvin

did not retard growth of seedlings but lower concentrations (2.5 µg/ml to 0.1 µg/ml) stimulated growth. Shoot was noticeably affected above 10 µg/ml. There was rolling and mottling of the leaves at higher concentrations. In the presence of the antibiotic, roots became excessively branched, curled, and hairy; root stunting was observed from 5 µg/ml and above.

CHAKRAVARTHI, B.P. 1952.
Wilt of arhar (*Cajanus cajan*) in Bihar. Causal organism. *Fusarium udum* Butl. Bihar Agric. Coll. Mag. 3(1):9-10. 889

CHAUBE, H.S. 1968.
Combating diseases of arhar and gram. Indian Fmr Digest 1(7):26-27. 890

A number of pulse crops are grown in India. Most of the diseases attacking these crops can be effectively controlled by suitable protective measures at the right time. The pigeonpea diseases discussed are wilt and sterility mosaic. Wilt disease becomes apparent when the plants are 5 to 6 week old. Vascular tissues of the lower stem and roots are blackened in streaks or patches. This discoloration is clearly visible when the bark of the lower stem is peeled off. Losses from this disease can be minimized by growing wilt-resistant varieties such as NP(WR)-15, -16, and -42.

CHAUDHARY, S.K., and M. PRASAD. 1974.
Variations in sugar contents of healthy and *Fusarium oxysporum* f. *udum* infected plants of *Cajanus cajan*. Phytopath. Z. 80(4):303-305. 891

Glucose was present in healthy shoot and root extracts of all ten varieties analyzed. Sucrose was present in healthy shoots of six varieties and healthy roots of three varieties; fructose in healthy shoots of seven varieties and healthy roots of one variety. Raffinose and maltose were detected in the healthy roots and shoots of very few varieties. After infection by *F. oxysporum*, a rapid depletion of sugars was detected in all varieties. The most susceptible varieties, Early 269 and Early 348, showed the highest depletion.

CIFERRI, R., and FRAGOSO R. GONZALEZ. 1927.
Parasitic and saprophytic fungi of the Dominican Republic (10th series). Bot. R. Soc. Espinola Hist. Nat. 27:165-177. 892

Cercospora cajani was found on living leaves of *Cajanus indicus*.

COSTA, A.S., J. FRANCO DO AMARAL, A.P. VIEGAS, D.M. SILVA, C.G. TEIXEIRA, and E.D. PINHEIRO. 1957.
Bacterial halo blight of coffee in Brazil. Phytopath. Z. 28(4):427-444. 893

Pseudomonas spp., responsible for causing halo blight, also gave positive reaction when inoculated into pigeonpea.

DAKE, G.N. 1974.
Studies on *Fusarium oxysporum* f. *udum* (Butl.) Snyder and Hansen causing wilt of tur. *Cajanus* (L.) Millsp. M.Sc. (1974) Thesis. Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. 894

DALE, W.T. 1943.
Preliminary studies of the plant viruses of Trinidad. Trop. Agric. (Trinidad) 20(12):228-235. 895

Pigeonpea seedlings were infected with cowpea mosaic in greenhouse.

DALE, W.T. 1949.
Observations on a virus disease of cowpea in Trinidad. Ann. Appl. Biol. 36(3): 327-333. 896

Symptoms of cowpea mosaic on pigeonpea. *Ceratoma ruficornis* is an efficient vector.

DASTUR, J.F. 1946.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. New Delhi 1944-45: 66-72. 897

Of 28 pigeonpea varieties tested for their reactions to *F. udum*, IP-80 was immune, IP-41 and Hybrid-5 (D-419-2-4) showed up to 5% infection, and the rest were highly susceptible to wilt. In an infested field plot IP-80 developed 4% infection, C-15, A-126-4-1, and Thadgam 1-4-7 up to 7%, IP-41 12%, and three others were highly susceptible.

DEIGHTON, F.C. 1929.
Report of the mycological section. Ann. Rep. Lands and Forests Dep. Sierre Leone for the year 1928: 14-19. 898

A rust (*Uredo cajani*) was found to be common on the older leaves of pigeonpea.

DEIGHTON, F.C. 1932.
Mycological work. Ann. Rep. Agric. Dep. Sierre Leone for the year 1931:20-25. 899

Rhizoctonia with large sclerotia was found on maize and pigeonpea.

DEY, P.K. 1947.
Administration Report Agriculture Department, U.P. 1944-45:38-40 (Plant Pathology). 900

Incidence of pigeonpea wilt (*F. udum*) reduced from 66 to 38% in a susceptible variety when grown mixed with sorghum.

DEY, P.K. 1948.
Administration Report Agriculture Department, U.P. 1945-46:43-46 (Plant Pathology). 901

Breeding work and field trials for *Fusarium* wilt resistance are summarized.

DEY, P.K. 1948.
Administration Report Agriculture Department, U.P. 1946-47:39-42 (Plant Pathology). 902

By growing pigeonpeas with sorghum in artificially infected soils, incidence of *F. udum* wilt was reduced for second season. Variety NP-80 proved most resistant (only 2.3% infection) of all the varieties tested.

DOIDGE, E.M. 1941.
South African rust Fungi. 4. Bothalia 4(1):229-236. 903

Uromyces dolicholi recorded on pigeonpea leaves.

DWIVEDI, R.P., and H.K. SAKSENA. 1975.
Web blight disease of arhar (*Cajanus cajan* (L.) Millsp.) caused by *Thanatephorus cucumeris*. Indian J. Fm Sci. 3:113-114. 904

Disease surveys showed prevalence of this disease in several improved varieties such as Prabhat, T-21, and T-17. Repeated isolations from diseased leaf tissue yielded cultures of imperfect fungus *Rhizoctonia solani* Kuhn., The web blight disease of arhar has not been studied so far. Its symptoms are different from those of *R. solani* and *R. bataticola*.

DWIVEDI, R.S., and D.K. ARORA. 1975.
Fungal colonization of staled agar discs from rhizosphere soil inocula of pigeonpea. Proc. Indian Acad. Sci. (Sect. B) 41(6):571-575. 905

DWIVEDI, R.S., and R.N. TANDON. 1976.
Studies on some aspects of seed mycoflora of pigeonpea. Proc. Indian Sci. Cong. 63:63-64. 906

EDWARD, J.C. 1954.
Macrophomina and *Botryodyplodia*, two distinct genera of Sphaeropsidaceae. Allahabad Fmr 28(4):5. 907

Cultural and infection studies including *Macrophomina phaseoli* from pigeonpea are described.

EDWARD, J.C., and S.L. MISHRA. 1968.
Heterodera vigni n. sp. and second stage larvae of *Heterodera* spp. in Uttar Pradesh, India. Allahabad Fmr 43(3):155-159. 908

During routine examination of field soils and rhizospheres of crops, *Heterodera* spp. were found on roots of pigeonpea. The cysts were found to belong to a new species, named *H. vigni*; the morphology of its females, males, second-stage larvae, cysts, and eggs is described.

EDWARD, J.C., K.P. SINGH, S.C. TRIPATHI, M.L. SINHA, and K. RANADE. 1977.
Rhizosphere mycoflora and Nematodes Fauna of some field crops and vegetables in Allahabad, India. Allahabad Fmr 48(2): 131-151. 909

A higher number of fungi are found associated with legumes than with nonlegumes, irrespective of season. Although arhar (cv T-21) is a legume, it records a much lower number than other legumes, probably because it is raised under rainfed conditions. The observations show that the presence of moisture and adequate amounts of nutrients in the soil could influence favorably the multiplication of fungi. The population densities of rhizosphere fungi and nematodes in the roots and in the soils around arhar were 145,454 (1 gm dry soil) and 440 (100 ml soil).

FELIX, S., and L. ORIEUX. 1962.
Plant diseases and their control in Mauritius. Div. Pl. Path. Dep. Agric. Mauritius: Bull. 95. 910

Notes on the control of diseases of groundnut, maize, pigeonpea, potatoes, and sweet potatoes.

GADEWAR, A.V., and N.K. RAUT. 1976.
Translocation of Benlate in germinating seeds and seedlings of *Cajanus cajan*. Indian J. Mycol. Pl. Pathol. 6(1): 108-109. 911

Benlate was found translocable when applied as seed dresser. It was also absorbed by the roots and translocated into the leaves of 1-month old seedlings.

GHOSH, M.K. 1975.
Control of *Fusarium* wilt of pigeonpea by various treatments. M.Sc. (1975) Thesis. Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, India. 912

GHOSH, PRODYUT, and S. MUKHERJEE. 1969.
Preliminary note on the study of microflora from the rhizosphere of *Cajanus cajan* Millsp. Proc. Indian Sci. Cong. 56(3): 317-318 (Abstract). 913

Microflora, especially the fungus flora from the different leaves of the rhizosphere of *C. cajan* Millsp. were studied. The soil samples were collected every 5 cm along and around the length of the tap root of the host plant and designated as a, b, and c, from above downwards and a', a", b', b", c', c", along corresponding horizontal levels. The frequency of distribution of the growing colonies with 0.01 dilution was found to be 4 at c-level, 3 at c'-level and 2 at c"-level, indicating that fungus flora decreased away from the root region proper. The distribution of the colonies was, however, maximum at b-level of the soil. Many of the fungi recorded are also abundant in the phyllosphere, and are conspicuously saprophytic.

GODBOLE, G.M., G.N. DAKE, and C.D. MAYEE. 1967.
Quantitative estimation of pigeonpea stem canker intensity. Res. Bull. MAU 1(9):135-136. 914

A suitable technique for scoring infection grades is developed. Different infection grades formulated to record the diseases are given. Varieties such as BDN-1, BDN-2, and C-11 showed moderate reaction, while Prabhat and Kaki exhibited a high degree of susceptibility.

GONZAGA, E., and L. LORDELLO. 1960.
Interference of nematodes in agricultural practices. Rural Rev. Soc. Rural Bras. 40(473):12-13. 915

In Brazil in a rotation of rice and pigeonpea (*Cajanus cajan*), the pigeonpea crop showed an inferior stand in its consecutive second year while the plants in plots where rice and pigeonpea were sown alternately were healthy. This was due to a heavy infestation with two nematodes which proliferate when pigeonpea is cultivated and are thwarted in their development by rice.

GOVINDASWAMY, C.V. 1951.
Some studies on the effect of associated soil microflora on *Fusarium udum* Butl. the wilt organism of pigeonpea (*Cajanus cajan* (L.) Millsp.) with special reference to its pathogenicity. Thesis. Indian Agricultural Research Institute, New Delhi, India. 916

GUNASEKARAN, C.R., T.S. MUTHUKRISHNAN, and G. RAJENDRAN. 1976.
Evaluation of chemicals for controlling pigeonpea cyst nematode *Heterodera cajani* in red gram. Madras Agric. J. 63(5-7): 382-383. 917

The total absence of cyst formation of *H. cajani* on the roots of the treated plants indicate the possible control of the nematode with the two chemicals, fensulfothion and carbofuran.

GUPTA, S.C., and S. SINHA. 1951.
Further additions to *Synchytria* of India. Indian Phytopath. 4(1):7-10. 918

Description of *Synchytrium phaseoli-radiata*, a new sp. on pigeonpea is given.

GUPTA, S.L. 1961.
The effect of mixed cropping of arhar (*Cajanus indicus* Spreng.) with jowar (*Sorghum vulgare* Pers.) on incidence of arhar wilt. Agric. Anim. Husb. U.P. 3(10-12):31-35. 919

HABISH, H.A. 1972.
Aflatoxin in haricot bean and other pulses. Expl Agric. 8(2):135-137. 920

Fifty samples of ten pulses were collected from Khartoum and the northern province of Sudan. Moisture content of the pulses was determined by oven-drying and aflatoxins were determined by TLC. Fungi were determined in 50 seeds of each sample by incubating batches of five seeds in a petri dish lined with moist filter paper. Tables of results are given.

HANSFORD, C.G. 1938.
Annual Report of the Plant Pathologist 1936. Rep. Dep. Agric. Uganda, 1936-37 (Part 2):43-49. 921

Various *Fusarium* spp. including forms belonging to *Hypomyces impomoea, lisia,* and *gibberella* were isolated from pigeonpea plants that had died from the top downwards. The *Gibberella* spp. appeared to be the primary parasites. A different disease from wilt in India is caused by *F. vasinfectum.*

HANSFORD, C.G. 1943.
Contributions towards the fungus flora of Uganda 5. Fungi imperfecti. Proc. Linn. Soc. Lond. 43(1):34-67. 922

Dendrochium gigasporum isolated from dying pigeonpea stems.

HASAN, ABUL, M. WAJID KHAN, A. RASHID, and M.K. ABRAR. 1975.
Relative efficiency of certain fungicides against *Colletotrichum* spp. Indian J. Mycol. Pl. Pathol. 5(1):41. 923

All the fungicides, viz., Brassicol, thiram, coprantol, Dithane Z-78, Dithane M-45, Agrosan G.N.; captan and DDT successfully inhibited the growth and sporulation of *C. truncatum* (pigeonpea isolate). The best performance was exhibited by coprantol where pathogen failed to grow at any of the concentrations tried. It was followed by Brassicol. Captan and Agrosan G.N. were effective at higher concentrations (0.3%).

HIREMATH, R.V., R.H. BALASUBRAMANYAN, and S.B. PURANIK. 1973.
Effect of culture filtrate of *Fusarium udum* Butler on the rhizosphere microflora of *Cajanus cajan* (L.) Millsp. Indian J. Microb. 12(4):229-230. 924

F. udum has been shown to produce three enzymes viz., pectin methyl esterase, polygalacturonase, and cellulose *in vivo* and *in vitro*. The culture filtrate was added to the base of 25-day old pigeonpea seedlings grown in pots. Fungal, actinomycete, and bacterial population of rhizosphere soil were significantly higher than nonrhizosphere soil. The plants treated with culture filtrate did not show any variation in the fungal population. These was significant increase in the bacterial population in the rhizosphere of treated plants within 24 hours after treatment.

HUTTON, D.G., and J.L. HAMMERTON. 1975.
Investigation on the role of *Rotylenchulus reniformis* in a decline of pigeonpea. Nematropica 5(2):24. 925

No relationship was found between numbers of *Rotylenchulus reniformis* in the soil around plants of three pigeonpea varieties and the number of these plants showing a decline. This decline starts with yellowing of new leaves after the first bearing, progressive dieback of twigs and main stem and premature death of many plants. However, where nematode populations were suppressed, plants grew faster and flowered earlier than where populations were high, and plants of one variety produced significantly greater yields of green pods.

HUTTON, F.M., and N.E. GRYLLS. 1956.
Legume 'little leaf', a virus disease of subtropical pasture species. Aust. J. Agric. Res. 7:95-97. 926

The symptoms of little leaf are similar to those caused by the "big-bud-witches broom" complex of viruses. Its vector is the leaf hopper, *Orosius argentatus* (Evans), which also transmits other viruses. Most of the species and strains considered to be promising pasture legumes, including *Cajanus cajan*, possess field resistance to little leaf.

IHFIS, T., R.H. FREVRE, and H.C. KENNARD. 1937.
Pellicularia filamentosa on Tephrosa and *Cajanus indicus* in Puerto Rico. FAO Pl. Prot. Bull. 5(10):159-160. 927

The disease can be controlled by using Bordeaux mixture and Zineb.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1950.
Scientific report of the Indian Agricultural Research Institute, New Delhi for the year 1947-48. 182 pp. 928

Summary of work on *Fusarium udum* wilt is given.

INDIAN AGRICULTURAL RESEARCH INSTITUTE. 1953.
Scientific reports of the Indian Agricultural Research Institute for the year ended 30th June 1951. 120 pp. 929

Cajanus cajan: Out of eight wilt-resistant varieties and five hybrid derivatives, D-16-17-2 gave the highest yield. The varieties NP-41, C-38-1-2, and D-419-2-4 were highly resistant to *Fusarium udum*.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH. 1950.
In: ICAR Annual Report for 1948-49 Delhi. pp. 177-190. 930

Varietal tests for wilt resistance and experiments with *Bacillus subtilis* as inhibitor of *Fusarium udum* are summarized.

INGHAM, J.L. 1976.
Induced isoflavonoids from fungus-infected stems of pigeonpea (*Cajanus cajan*). Z. Natur. 39(9-10):504-508. 931

From stems inoculated with *Helminthosporium* (*Cochliobolus*) *carbonum*, four antifungal isoflavones (7-hydroxy-4-methoxy-, 5, 7, 4'-trihydroxy-; 5,7,2',4'-tetrahydroxy; 5,2',4',-trihydroxy-7-methoxy) and one isoflavonone (5, 2'-dihydroxy-7, 4'-dimethoxy-) were isolated. The structure of the last (cajanol) was confirmed by synthesis from ferreirin. A sixth compound was provisionally identified as 5,2'-didydroxy-7, 4'-dimethoxyisoflavone.

ISLAM, N. 1970.
Effects of various carbon and nitrogen sources on growth and sporulation of *F. udum*. 39 pp. M.Sc. (1970) Thesis. Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, India. 932

JAIN, A.C. 1949.
Effect of certain micro-organisms on the activity of *Fusarium udum* Butler, the causal agent of pigeonpea (*Cajanus cajan* (Linn.) Millsp.) wilt. 50 pp. Thesis. Indian Agricultural Research Institute, New Delhi, India. 933

JANARTHANAN, R. 1972.
Occurrence of the pigeonpea cyst nematode in Tamil Nadu. Indian J. Nematol. 2:215. 934

The pigeonpea cyst nematode was found present in Tamil Nadu and infested cowpeas, which may also pose a serious problem to the cultivation of pulses.

JANARTHANAN, R., G. SATHIABALAN SAMUEL, K.S. SUBRAMANIAN, G. NAVANEETHAN, and T.K. KANDASWAMY. 1973.
A report on the survey of sterility mosaic disease incidence on red gram in Tamil Nadu. Madras Agric. J. 60(1):41-44. 935

From a survey made over 9,142 hectares in different parts of Tamil Nadu, it was observed that the red gram sterility mosaic was prevalent in almost all parts of the state. The percentage incidence of the disease suggests heavy crop losses of red gram in Tamil Nadu.

JAYARAJ, S., and A.R. SESHADRI. 1967.
Preference of the leaf *Empoasca kerri* Pruthi (Homoptera: Jassidae) for pigeonpea (*Cajanus cajan* (L.) Millsp.) plants infected with sterility mosaic virus. Curr. Sci. 36(13):353-355. 936

The higher content of carbohydrate in the healthy pigeonpea plants over diseased ones in leaves of medium maturity is probably not attractive to *E. kerri*. The leaf hopper prefers the reduced C/N ratio found in diseased leaves. Detailed studies on the nutrition physiology of the leaf hopper, including enzymatic studies, are required for understanding of the problem.

JEHLE, R.A., and J.I. WOOD. 1926.
Diseases of field and vegetable crops in the United States in 1925. Pl. Dis. Reptr (Supp.) 45:152. 937

Diseases reported from Puerto Rico on pigeonpea were leaf spots *Cercospora instabilis*, *Phyllosticta* spp., *Vellosiella cajani*, *Rhizoctonia ferruginea*, damping-off.

JESWANI, M.D., N. PRASAD, and P.D. GEMAWAT. 1977.
Morphological variability in *Fusarium lateritium* f. *cajani*. Indian J. Mycol. Pl. Path. 5(1):4. 938

The pathogen is highly variable in cultural characters. Single-spore isolates from single strains have also been observed to vary among themselves with regard to growth pattern, segmentation, substrate reaction, and pigmentation. Different isolates have the capacity of secreting differing quantities of metabolic products.

JOFFE, A.Z. 1974.
A modern system of *Fusarium* taxonomy. Mycopath. 53(1-4):201-228. 939

A modern system comprising 13 sections, 33 species and 14 varieties is proposed, based on the study over 30 years, of the morphology and growth characteristics of *Fusarium* spp. and their variability under a wide range of conditions.

JOHNSON, J. 1939.
Studies on the nature of brown root rot of tobacco and other plants. J. Agric. Res. 58(11):843-863. 940

Symptoms of affected host and characteristics of unknown causal agent of brown root rot disease are given. Pigeonpeas were also found to be susceptible.

KAISER, S.A.K., and P.K.S. GUPTA. 1960.
Cross protection against wilt disease caused by *Fusarium oxysporum* sp. *udum* in pigeonpea. Indian J. Mycol. Res. 7:38-39. 941

77.50 to 81.25% control of pigeonpea wilt due to *F. oxysporum* f. sp. *udum* can be achieved by prior inoculation of the host

with the nonpathogenic *F. oxysporum* f. sp. *ciceri* and *F. oxysporum* f. sp. *vasinfectum*.

KAISER, S.A.K., and P.K.S. GUPTA. 1975.
Infection and pathological histology of pigeonpea (*Cajanus cajan* (L.) Millsp.) inoculated with pathogenic and non-pathogenic formae speciales of *Fusarium oxysporum*. Z. pflanzk. pflanzs. 82(8-9): 485-492. 942

Inoculation studies using the susceptible variety EB-3 and the formae speciales *udum*, *vasinfectum* and *ciceri* showed *F. oxysporum* f. sp. *udum* to be host specific. The other formae speciales produced initial wilt symptoms but the seedlings then recovered and developed new leaves. Hyphae of all three formae speciales invaded the seedlings, distribution being similar, but the extent of invasion being much greater in pathogenic formae speciales. Vascular tissues were partially affected.

KALYANASUNDARAM, R. 1952.
Ascorbic acid and *Fusarium* wilted plants. Proc. Indian Acad. Sci. (Sect. B) 36(3):102-104. 943

Studies in Madras on *Fusarium vasinfectum* on cotton and *F. udum* on red gram (*C. cajan*) showed reduction in ascorbic acid content of host leaves and increase in reducing sugars. Conclusion is that reduction in chlorophyll and retardation of growth preceding wilting causes decrease in ascorbic acid content.

KAMAL, T.P. MALL, and R.P. SRIVASTAVA. 1975.
Rhizosphere mycofloras of some virus infected cultivars of arhar (*Cajanus cajan* (L.) Millsp.). Technology 11(2-3):234-238. 944

The rhizosphere mycopopulation of different arhar cultivars differed considerably. There were myco-organic makeup differences in the roots of healthy and diseased plants. The rhizosphere effect was always greater in the healthy plants than in their diseased counterparts. The minimum rhizosphere effect was manifested by cultivar Prabhat infected with the severe strain of the virus. The results readily fit in with the physiological derangements of the plants. The degree of quantitative reduction in the rhizosphere mycoflora of diseased plants appeared to be directly correlated with the degree of the severity of infection in cultivar T-17.

KAMAL, T.P. MALL, and R.P. SRIVASTAVA. 1975.
Microfungi at the root-soil interface of arhar (*Cajanus cajan* (L.) Millsp.) infected by pigeonpea sterility mosaic virus. Technology 11(4):434-436. 945

There was no difference in the total number of species associated with healthy and diseased rhizosphere. Certain fungi were confined to the rhizosphere either of the healthy or the diseased plants. Colony counts/g of dry soil were more in the healthy plants than in the diseased ones. Several *Penicillia* and *Aspergilli*, particularly the members of *Aspergillus ustus* group, were characteristic of the rhizosphere under both diseased and healthy conditions. The rhizosphere effect was more prominent in the case of healthy plants.

KAMAL and AJAY KUMAR VERMA. 1976.
Microfungal flora in the root region of arhar (*Cajanus cajan* (L.) Millsp.). Fertil. Technol. 13(2-3):155-157. 946

Fungal population in rhizosphere-free soil, rhizosphere soil and rhizoplane of arhar have been studied.

KAMAT, M.N., and M.K. PATEL. 1948.
Some new hosts of *Oidiopsis taurica* (Lev.) Salmon in Bombay. Indian Phytopath. 1(2):153-158. 947

This fungus was collected from pigeonpea and other hosts. Each collection was found to reinfect its own host only, showing that the fungus was highly specialized.

KANDASWAMY, T.K., and K. RAMAKRISHNAN. 1960.
An epiphytotic of pigeonpea sterility mosaic at Coimbatore. Madras Agric. J. 47:440-441. 948

No signs of tolerance or resistance to sterility mosaic virus were noted in a group of over 100 varieties of *Cajanus cajan*, grown at the Millet Breeding Station, Coimbatore, India.

KERNKAMP, M.F., and G.A. HEMERIK. 1953.
The relation of *Ascochyta imperfecta* to alfalfa seed production in Minnesota. Phytopath. 43(7):378-383. 949

Pigeonpea reacted positively to inoculation with *Ascochyta imperfecta*.

KHAN, W.M.A., and R.K. SINGH. 1974.
Anthracnose of arhar incited by *Colletotrichum truncatum*. Indian Phytopath. 27:622-624. 950

Stem anthracnose of pigeonpea (*Cajanus cajan* (L.) Millsp.) caused by *Colletotrichum truncatum* (Sch.) Andrush and Moore, was observed in the last week of September 1972. Survey of varieties indicated that only some of the early maturing varieties were free from the disease during this period. Infection was confined to main axis and lateral branches. Defoliation and drying-up of the complete plant were the ultimate signs of the infection.

KHANNA, R.N., and R.S. SINGH. 1975.
Microbial populations of pigeonpea rhizosphere in amended soils. Indian J. Mycol. Pl. Pathol. 5(2):131-138. 951

Count of fungi and actinomycetes had inverse relationship with plant age in nonamended soil, while optimum bacterial activity occurred at maximum vegetative growth of plant. Oil cake was stimulatory to microflora and sawdust was inhibitory. The inhibitory effect was overcome by supplemental nitrogen. Rhizosphere of pigeonpea significantly changed the effect of amendments on microflora. It reduced stimulatory effects of amendments on bacteria and actinomycetes but accentuated inhibitory effect of sawdust on these groups.

KOSHY, P.K. 1968.
Studies on the cyst-forming nematode of pigeonpea. Ph.D. (1968) Thesis. Indian Agricultural Research Institute, New Delhi, India. 952

KOSHY, P.K., and GOPAL SWARUP. 1967.
Factors affecting emergence of larvae from cyst of *Heterodera cajani* Koshy. Indian J. Nematol. 1:209-219. 953

Emergence took place between 15 and 37°C, with 29°C optimum. More emergence was obtained from cysts conditioned to 40°C than those at 12°C. Aeration did not affect emergence of larvae. But constant exposure to light gave a significantly higher hatch than subjecting to total darkness. Optimum pH was 10.5. Root leachates from *Cajanus cajan* stimulated emergence of larvae from cysts. The cysts stored in air-dried soil under laboratory conditions remained viable for at least 2 years.

KOSHY, P.K., and GOPAL SWARUP. 1971.
Investigations on the life history of the pigeonpea cyst nematode *Heterodera cajani*. Indian J. Nematol. 1:44-51. 954

Temperature was an important factor governing the time required to complete the life cycle. At a soil temperature of 84°F the nematode completed one generation in 16 days, whereas under cool conditions (10-25°C/50-75°F) the time required was 45 to 80 days. The nematode was able to reproduce parthenogenetically, though it is a bisexual species. For rapid multiplication, however males were considered necessary.

KOSHY, P.K., and GOPAL SWARUP. 1971.
On the number of generations of *Heterodera cajani*, the pigeonpea cyst nematode, in a year. Indian J. Nematol. 1:88-90. 955

H. cajani could complete nine generations in a year under laboratory conditions. Duration of life cycle was prolonged during winter months. The favorable multiplication of the nematode was from June to September and April to June.

KOSHY, P.K., and GOPAL SWARUP. 1972.
Susceptibility of plants to pigeonpea cyst nematode, *Heterodera cajani*. Indian J. Nematol. 2:1-6. 956

One hundred and five plant species, representing 58 genera in 21 families, were tested for their suitability as hosts of *Heterodera cajani*; 19 of them (family: Leguminosae) were recorded as hosts.

KULDIP SINGH, B.S. DAHIYA, and J.S. CHOHAN. 1975.
Evaluation of arhar (*Cajanus cajan*) germplasm lines against the sterility disease in the Punjab. PAU Res. J. 12(3): 327-328. 957

Two hundred and thirty-four lines were screened for reaction to the sterility virus in 1973 and 1974. L-3 and P-4785 were resistant and 16 others were tolerant.

KULKARNI, Y.S., M.K. PATEL, and S.G. ABHYANKAR. 1953.
A new bacterial leaf spot and stem canker of pigeonpea. Indian Phytopath. 5(1): 21-22. 958

Gives an extended account of the disease and its causal agent and lists factors conducive to disease development. Since the pathogen infects pigeonpea alone, showing host range specificity, it is proposed as a new species to be called *Xanthomonas cajani*.

KULKARNI, Y.S., M.K. PATEL, and S.G. ABHYANKAR. 1960.
A new bacterial leaf spot and stem canker of pigeonpea. Curr. Sci. 19(2):384. 959

A new bacterial leaf spot was first noticed on the lower leaves of pigeonpea (*Cajanus cajan* Millsp.) at Jalgaon and Anand in September 1949. The disease symptom and its attack on the plant are described.

LEACH, R., 1934.
Report of the Mycologist for 1933. A. Rep. Dep. Agric. Nyasaland. 1933:54-55. 960

Armillaria mellea killed pigeonpeas in infested tea plantation.

LEACH, R., and J. WRIGHT. 1930.
Collar and stem canker of (*Cajanus cajan*) pigeonpea caused by a species of *Physalospora*. Mem. Imp. Coll. Trop. Agric. Trinidad (Mycol. Ser.) 1:12 pp. 961

The primary symptoms are the formation of grey, scutiform, dark-edged lesions averaging 5 cm long on the stem and branches. The lesions turn dark brown at the collar region and usually canker girdles the collar and kills the plant. Description of *Phoma* and *Macrophoma* are given. Cultural studies are briefly described.

LOPEZ ROSA, J.M. 1969.
Phoma sp. The causal agent of pigeonpea canker (Abstract). Phytopath. 59(10):1348. 962

Isolation, varietal reactions, growth in culture, and inoculation of a *Phoma* sp. causing canker in pigeonpea in Puerto Rico are described.

McDONALD, J., 1924.
Annual report of the Mycologist for the year 1923. A. Rep. Dep. Agric. Kenya for the year ended 31st December 1923:81-85. 963

Disease similar to that of Madagascar butter beans caused by a fungus similar to *Vermicularia capsici* observed on pigeonpea, controlled on beans by Bordeaux mixture.

McRAE, W. 1923.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. Pusa 1922-23: 53-60. 964

Fusarium wilt of pigeonpea was very severe in the season. Manurial experiments showed that superphosphate increased disease incidence and green manure decreased it. Superphosphate after green manure reduced it.

McRAE, W. 1924.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. Pusa, 1923-24: 41-51. 965

Seed-borne spores of *Fusarium udum* caused little wilt of Rahar (Pigeonpea). Seed disinfection trial on 1-acre (0.4 ha) plots gave 0.04 and 1.4% wilt on treated and untreated plots. Disease found to spread up to 9 ft (2.74 m) through soil in one season, apparently along roots. Thus previous work on soil treatment rendered useless. Green manure plus superphosphate reduced wilt incidence by 25%.

McRAE, W. 1926.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. Pusa, 1925-26: 54-69. 966

Further details of field trials with green manure and superphosphate are given.

McRAE, W. 1928.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. Pusa, 1927-28: 56-70. 967

Further report of green manure and superphosphate treatments in study of *Fusarium* wilt. Suggestion of some other factor as dominant.

McRAE, W. 1930.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. Pusa, 1928-29: 51-66. 968

Incidence of pigeonpea wilt (*Fusarium vasinfectum*) was favored by superphosphate but checked by green manure. Applying both gave intermediate results. Top 3 ft (92 cm) of soil was dug out and treated with superphosphate (0.002% soluble P_2O_5) and moisture content raised to local optimum before sowing in September after the rains. No further watering was done for 5 months. Larger roots and branching rootlets were more numerous in treated top 2 ft (60 cm) but there was no marked difference in the third ft.

McRAE, W. 1931.
Note on 'wilt' in Rahar in permanent plots at Pusa. Proc. Bd Agric. India, 1929. Appendix 3:236-241. 969

Details of first 20 years trials of fertilizers on *Fusarium* wilt are discussed.

McRAE, W. 1932.
Report of the Imperial Mycologist. Scient. Rep. Imp. Inst. Agric. Res. Pusa, 1930-31: 73-86. 970

Discussed varietal trials for wilt disease

on rotation length and partial sterility. Description of *Colletotrichum cajani* and a *Cercospora* sp. is also given.

McRAE, W., and F.J.F. SHAW. 1926.
Report on experiments with *Cajanus indicus* (Rahar) for resistance to *Fusarium vasinfectum* (wilt disease). Scient. Rep. Agric. Res. Inst. Pusa, 1925-26:208-212. 971

Progress in selection for resistance to wilt is described.

McRAE, W., and F.J.F. SHAW. 1933.
Influence of manures on the wilt disease of *Cajanus indicus* Spreng. and isolation of types resistant to the disease. Part II. The isolation of resistant types. Scient. Monogr. Coun. Agric. Res. Pusa. 7:37-68. 972

Particulars of selection in progress since 1923 for resistance of *Cajanus indicus* Spreng. to *Fusarium* wilt. A form designated Type 80 proved highly resistant and Types 16, 41, 50, 51, and 82 were also resistant. No correlation was found between morphological characters and resistance. A loss of resistance noted in a resistant type grown in a field that had been under the crop for several years was not transmitted to the next generation.

MAHENDRA PAL, and J.S. GREWAL. 1975.
Physiological studies on *Phytophthora drechsleri* var. *cajani*. Indian Phytopath. 28(4):479-482. 973

Three weeks' incubation period and Mehrotra's medium were found to be optimum for the growth of the fungus. Maximum growth of the fungus was recorded at pH 6.5 and optimum temperature for the growth of the fungus was 30°C. Growth was also good on hexoses (D-glucose, D-fructose, D-mannose, and D-galactose). The growth was negligible on arabinose and in the absence of carbon.

MAHENDRA PAL, and J.S. GREWAL. 1975.
Utilization of different source of *Phytophthora drechsleri* var. *cajani*. Indian Phytopath. 28(4):499-501. 974

Ammonium salts in general supported good growth of *Phytophthora drechsleri* var. *cajani*, indicating better utilization of ammoniacal nitrogen. Maximum growth was on ammonium nitrate. Growth was poor on calcium nitrate and sodium nitrate was not utilized at all. Moderate to good growth of the fungus was recorded on monoamino dicarboxylic amino acids and amides i.e. L-aspartic acid, L-glutamic acid, L-asparagine, and glutamine.

MAHENDRA PAL, and J.S. GREWAL. 1975.
Resistance of pigeonpea to *Phytophthora* blight. 1. Total phenolic content. Indian Phytopath. 28(4):559-560. 975

The total phenolic content in leaves of the resistant variety AS-3, measured 4 to 6 days after inoculation with *P. drechsleri* var. *cajani* was greater in inoculated than in uninoculated plants, while in the susceptible T-21 it was greater in the leaves of uninoculated plants.

MAHENDRA PAL, and J.S. GREWAL. 1976.
Effect of NPK fertilizers on the *Phytophthora* blight of pigeonpea. Indian J. Agric. Sci. 46(1):32-35. 976

In the absence of K, high doses of N increased the incidence of *Phytophthora* blight of pigeonpea (*Cajanus cajan* (L.) Millsp.). Addition of K decreased the incidence, regardless of the presence or absence of N or P in the soil. P did not have much effect on disease development.

MAHENDRA PAL, J.S. GREWAL, and A.R. SARBHOY. 1970.
A new stem rot of arhar caused by *Phytophthora*. Indian Phytopath. 23(5):83-87. 977

A new disease caused by *Phytophthora drechsleri* Tucker var. *cajani* was observed in severe form on arhar var. T-21 at Delhi and Kanpur during 1968-1969. Affected plants dry up rapidly, causing total loss to the crop. Brown to dark brown lesions, distinctly marked from dark green healthy portions on the stem, appear at ground level or a few inches higher. High humidity coupled with the disease may cause rapid development of stem rot.

MAHMOOD, M. 1962.
Factors governing the production of antibiotic bulbiformin and its use in the control of pigeonpea wilt. 101 pp. Ph.D. (1962) Thesis. Indian Agricultural Research Institute, New Delhi, India. 978

MAHMOOD, M. 1964.
Factors governing the production of antibiotic bulbiformin and its use in the control of pigeonpea wilt. Sci. Cult. 30(7): 352. 979

The incidence of pigeonpea wilt was markedly reduced in soil supplemented with groundnut cake, molasses, and sweet clover root materials on inoculation with *B. subtilis*.

MAITRA, A. 1972.
Studies on some aspects of *Fusarium* wilt of pigeonpea. 53 pp. M.Sc. (1972) Thesis. University of Kalyani, West Bengal, India. 980

MAITRA, A., and A.K. SINHA. 1973.
Partial inhibition of *Fusarium* wilt symptoms in pigeonpea by non-pathogenic formae of *Fusarium oxysporum*. Curr. Sci. 42(18):654-656. 981

Plants were inoculated with the nonpathogen when 2 weeks old and with the pathogen a week later. An earlier inoculation with *F. oxysporum* f. sp. *ciceri* or *F. oxysporum* f. sp. *vasinfectum* delayed the onset of wilt symptoms, the inhibitory effect being slightly more pronounced with the former. Histological studies indicated that inoculation with *F. oxysporum* f. sp. *ciceri* led to deposition of gum in the vessels, which never showed any hyphae. The inoculation with nonpathogens delayed the onset of wilt symptoms.

MALI, V.R., A.M. SHIRSAT, and G.M. GODBOLE. 1977.
Occurrence of pigeonpea sterility mosaic in Marathwada. Res. Bull. MAU. 1(10:143-149. 982

Recorded for the first time in Marathwada. Transmission was possible by bud-grafting, also transmitted by mite. The disease was not found to be transmissible by sap.

MALIK, R.P. 1945.
Collar rot of pigeonpea caused by *Pythium aphanidermatum* (Edson) Fitz. Indian J. Agric. Sci. 15:92-93. 983

Isolations made from wilted pigeonpea plants of UP-132 variety yielded a species of *Pythium*, *Macrophomina phaseoli*, a *Fusarium* distinct from *F. udum*, and *Corticium rolfsii*. The author's isolate is accordingly referred to *P. aphanidermatum*. Inoculation with the fungus on pigeonpea stems just above soil level a few days after showing caused desiccation of the foliage and young shoots, and in some plants of the collar region also.

MALL, T.P. 1975.
Studies on some virus diseases of pigeonpea, *Cajanus cajan* (L.) Millsp. Ph.D. (1975) Thesis. University of Gorakhpur, Gorakhpur, Uttar Pradesh, India. 984

MARAMOROSCH, K., and E. HICHEZ. 1973.
Rhabdovirus and mycoplasma-like organism: Natural dual infection of *Cajanus cajan*. Phytopath. 63:202 (Abstract). 985

C. cajan plants with a proliferation disease were observed growing wild on the north shore of Hispanola island in the Dominican Republic near the border of Haiti. Plants were pale green and showed symptoms of witches' broom. Electron micrographs revealed the presence of mycoplasma-like organisms (MLO) as well as bullet-shaped (Rhabdo) virus particles in the phloem. The rhabdovirus particles were 45 to 55 mm in diameter and 240 to 260 mm in length. This is believed to be the first report of a natural dual infection of a plant by a rhabdovirus and MLO.

MARAMOROSCH, K., H. HIRUMI, M. KIMURA, J. BIRD, and N.G. VAKILI. 1974.
Pigeonpeas witches'broom disease. Phytopath. 64:582-583. 986

Pigeonpea plants with a witches' broom disease of unknown etiology were collected at Rio Piedras and Mayaguez, Puerto Rico. In the sieve tube elements there were large accumulations of mycoplasma-like organisms (MLO) in the diseased plants. Rhabdovirus particles were also detected in the Mayaguez material. Witches' broom disease at Mayaguez might be the result of the combined action of *Empoasca* toxin, MLO, and virus. The MLO-associated pigeonpea disease of Puerto Rico resembles the MLO - and rhabdovirus-associated pigeonpea disease from the Dominican Republic.

MARAMOROSCH, K., M. KIMURA, and Y.L. NENE. 1976.
Mycoplasma-like organisms associated with pigeonpea rosette disease in India. FAO Pl. Prot. Bull. 24(2):33-35. 987

Pleiomorphic, mycoplasma-like organisms (MLO) were found in sieve elements of pigeonpea (*Cajanus cajan*) plants with rosette disease. MLO were confined to phloem and to phloem parenchyma cells. Healthy control plants were free of MLO. Virus or virus-like particles were not detected in these sections.

MARAMOROSCH, K., M. KIMURA, H. HIRUMI, J. BIRD, and N.G. VAKILI. 1974.
Diseases of pigeonpea in the Caribbean area: an electron microscopy study. FAO Pl. Prot. Bull. 22(2):32-36. 988

At least four different diseases of uncertain etiology affect pigeonpea, *Cajanus cajan*, plants in the Caribbean islands. The white-fly-borne agent of the yellow mosaic disease has not been visualized by electron microscopy and may be a viroid, rather than a virus. The proliferation, or witches' broom, disease observed in the Dominican Republic and the more severe form occurring in Puerto Rico, have been found associated with mycoplasma-like microorganisms, as well as a rhabdotype virus.

MATHUR, R.S. 1954.
Diseases of pulse crops in U.P. Agric. Anim. Husb. U.P. 5(1):24-28. 989

Brief notes are given on the economic importance, symptoms, and control of the most important diseases of pulses in Uttar Pradesh, India.

MISHRA, D.P., and R.C.S. MEHRA. 1969.
Choanephora cucurbitarum on *Cajanus cajan* in India. Indian Phytopath. 22: 515-517. 990

C. cucurbitarum is pathogenic on arhar and several genetic stocks of economic value are susceptible to it. This disease appears to have particular importance in relation to early maturing varieties of arhar.

MISHRA, R.R., and K.K. PANDEY. 1975.
Studies on soil fungistasis. Part VII. Studies on colonization of fungi on roots of *Cajanus cajan* in relation to soil fungistasis. Fertil. Technol. 12(4): 328-330. 991

The fungistasis of the soil samples collected from different depths and close vicinity of root surface and the rhizosphere micropopulation was determined. There was a close correlation between the soil fungistasis and the soil micropopulation.

MITRA, M. 1925.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. Pusa, 1924-25: 45-57. 992

Study of soil and fertilizer on wilt incidence continued. *F. udum* wilt was not associated with waterlogging. Average number of wilted plants in plots with superphosphate 5 x. With green manure only 1/10. With both treatments numbers 1.7 x. Also demonstrated bulk of infection in soil, little on seed.

MITRA, M. 1931.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. Pusa, 1929-30: 58-71. 993

Survey of pigeonpea fields around Pusa showed 15% infection by *Fusarium* wilt. Some wilt is also caused by *Rhozoctonia solani*, inoculation with which gave about 80% positive results.

MITRA, M. 1934.
Wilt disease of *Crotalaria juncea* Linn (Sunn-hemp). Indian J. Agric. Sci. 4(4):701-704. 994

Cross-inoculation experiments showed that the strains of *Fusarium vasinfectum* causing wilts of sunnhemp and pigeonpea were similar, since cross-infection could be caused. The cotton strain will not infect these crops, nor will their strains infect cotton. Fungus often carried on seed. Minor wilting fungi are *Rhizoctonia solani* and *Neocosmospora vasinfecta*.

MOHAMED SHERIFF, N., W. MOHAMMED ALI KHAN, and S. IYEMPERUMAL. 1977.
A note on the study of redgram mutants for resistance to root-rot disease under field conditions. Madras Agric. J. 64(10): 691. 995

Of seven red gram mutants with desirable characters and four currently grown varieties studied for resistance to root-rot disease for three seasons, mutant S-18 showed the lowest incidence throughout; mean root-rot incidence was only 3.9% in S-18, as against 68.1% in Prabhat and 32.3% in parental stock, Co-1.

MOHANTY, U.N. 1942.
Pt. 1. Study of some Indian Aspergilli.
Pt. 2. The wilt disease of pigeonpea (*Cajanus cajan* (L.) Millsp.) with special reference to some methods of dissemination. 69 pp. Thesis. Indian Agricultural Research Institute, New Delhi, India. 996

MOHANTY, U.N. 1946.
The wilt disease of pigeonpea (*Cajanus cajan* (L.) Millsp.) with special reference to the distribution of the causal organism in the host tissue. Indian J. Agric. Sci. 16:379-390. 997

Fusarium udum Butler, which causes wilt of pigeonpea, forms abundant spore masses on the surface of infected plants. It was found that the spore masses occur only on branches of infected plants at a point considerably below that which the fungus has reached in the tissue, and it is concluded that the spore masses do not form as a result of primary infection in the aerial parts, but arise as a result of the outward spread of the fungus from internally infected branches. The fungus was never found to be carried within the seeds.

MUKHERJEE, D., T.K. DE, and N.R. PARUI. 1971.
A note on screening of arhar against wilt disease. Indian Phytopath. 24:598-601. 998

Of 54 varieties of *Cajanus cajan* screened for resistance to *Fusarium udum* by a technique which is described, none was resistant but nine were moderately resistant. Evidence was found for the existence of pathogen races. The rechnique allows for the identification of races on the basis of reaction to a set of differential varieties.

MULK, M.M., and M.S. JAIRAJ PURI. 1975.
Nematodes of leguminous crops in India. IV. Two new species of *Rotylenchulus filipjev.* 1936. (Hoplolaimidae). Indian J. Nematol. 5:9-14. 999

Observations were made in measurements of the specimens. *R. siddiqui* sp. n., 0.61-0.78 mm long; lip region with indistinct annulations; spear 22-24μ long; spear knobs rounded, foil hemispherical and phasmids 10-13 strial anterior to anus. *R. secondus* sp. n. 0.63-0.77 mm long; lip region faintly striated; spear 24-25μ; spear knobs anteriorly pointed; tail cylindroid and phasmids at anal level.

MULLER, A.S. 1953.
A foliar disease of legumes in Central America. FAO Pl. Prot. Bull. 1(6): 83-84. 1000

Chaetoseptoria wellmanii was collected in Guatemala on leaves of pigeonpea. The disease was also found to be spreading on various legumes.

MULLER, A.S., and C. CHUPP. 1942.
Las *Cercospora* de Venezuela. Bot. Soc. Venez. Cien. Nat. 8(52):35-39. 1001

Cercospora cajani has been recognized in Venezuela as a potent disease of pigeonpea. Its symptoms are described.

MUNDKUR, B.B. 1935.
Influence of temperature and maturity on the incidence of sunn-hemp and pigeonpea wilt at Pusa. Indian J. Agric. Sci. 5:609-619. 1002

Records made weekly of the deaths of pigeonpea (*Cajanus cajan*) plants from *Fusarium vasinfectum*. Low soil temperature between 17° and 29° favored the disease. The influence of soil temperature and maturity on the incidence of wilt is not due to either of these acting independently but is the combined influence of both.

MUNDKUR, B.B. 1938.
Phytopathology - mycology: Pigeonpeas: A. Rev. Biochem. Appl. Res. India. 9:112. 1003

A survey of relevant literature about study of cultural characteristics of fungi in pigeonpea is given. Wollenweber reports that pigeonpea that had wilted in a characteristic manner in the fields at Pusa yielded the cultures of *Fusarium lateritium* var. *uncinatum*. In infective experiments conducted at Berlin Dahlem, the fungus caused a severe foot rot of the crop. This experiment indicates that at least tur spp. *F. vasinfectum* and *F. lateritium* var. *uncinatum*, case diseases of pigeonpea in India. Bose finds that a pigeonpea-tobacco rotation can considerably reduce the disease in wilt-sick fields.

MUNDKUR, B.B. 1946.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst., New Delhi, for the Triennium ended 30th June, 1944: 57-63. 1004

Of 20 pigeonpea varieties tested in pots against wilt (*F. udum*) in 1942-43, A-126-4-1 was unaffected. In 1943-44, IP-80, IP-41, C-38, C-15, A-126-4-1, D-16-12-2, PT-12, and D-33-4-22 were resistant. Bulsar white, reputedly resistant, was severely infected. In field plots inoculated with cultures of fungus and infected debris, D-16-17-2, PT-12, and D-33-4-22 lost resistance.

NAMBIAR, K.K.N. 1967.
Studies on pigeonpea sterility mosaic disease. Ph.D. (1967) Thesis. University of Madras, Madras, Tamil Nadu, India. 1005

NAMBIAR, K.K.N., and K. RAMAKRISHNAN. 1968.
Studies on pigeonpea sterility mosaic disease. VI. Effect of disease on carbohydrates. Proc. Indian Acad. Sci. (Sect. B) 68:295-300. 1006

Total carbohydrates were significantly less in virus-diseased pigeonpea leaves than in comparable healthy leaves at all ages below the second leaf. While the total carbohydrate content increased with age in healthy plants, no such regular pattern was discernible in diseased leaves. Starch and resin were significantly lower in diseased leaves than in healthy leaves but

sucrose levels were not significantly different. Increased levels of reducing sugars and nonfermentable reducing substances were observed in diseased leaves over healthy leaves.

NAMBIAR, K.K.N., and K. RAMAKRISHNAN. 1969.
Studies on pigeonpea sterility mosaic disease. VII. Effect on mineral metabolism. Proc. Indian Acad. Sci. (Sect. B) 70: 37-41. 1007

Ca, K, Na, and Mn contents were lower in diseased than in healthy plants, Ca decreasing with the age of the leaves.

NAMBIAR, K.K.N., and K. RAMAKRISHNAN. 1969.
Studies on pigeonpea sterility mosaic virus. VIII. Effect on photosynthesis and nucleic acids of pigeonpea leaves. Phytopath. 66:91-94. 1008

A significant reduction in photosynthesis and rate of Hill reaction was recorded in diseased leaves, photosynthesis being least in the yellow patches. RNA and DNA levels were higher in diseased leaves of all ages. RNA fractions presumably contained viral as well as plant RNA.

NAMBIAR, K.K.N., and K. RAMAKRISHNAN. 1969.
Studies on pigeonpea sterility mosaic. IX. Effect on nitrogen metabolism. Proc. Indian Acad. Sci. (Sect. B) 70: 200-207. 1009

Total N was higher in diseased than in healthy leaves at all ages. All forms of N, except ammoniacal and nonprotein, were increased. Free amino acids, viz., valine, leucine, and arginine were at higher concentrations in younger than in older diseased leaves. The high concentrations of amino acids in the bound form in diseased leaves suggests their probable incorporation into the virus protein.

NARAYANASWAMY, P. 1964.
Studies on the sterility mosaic disease of red gram. Ph.D. (1964) Thesis. University of Madras, Madras, Tamil Nadu, India. 1010

NARAYANASWAMY, P., and T. JAGANATHAN. 1975.
A note on powdery mildew disease of pigeonpea (*Cajanus cajan* (L.) Millsp.). Sci. Cult. 41(3):133-134. 1011

The disease was generally seen on young leaves. Stems and petioles also showed symptoms. In severe cases, the affected leaves turned yellow, exhibiting crinkling. This species, *Oidiopsis taurica*, did not produce the perfect stage. Pigeonpea was reported as a new host for this fungus.

NARAYANASWAMY, P., and K. RAMAKRISHNAN. 1965.
Studies on the sterility mosaic disease of pigeonpea. I. Transmission of the disease. Proc. Indian Acad. Sci. (Sect. B) 62: 73-86. 1012

The pigeonpea sterility mosaic was not transmitted by sap or insects. There were indications to show that the disease was probably soil-borne. Decrease in nematode population reduced disease incidence, the reduction being greater in DD-treated plots than in Nemagon-treated plots. It is surmised that the disease is probably transmitted by *Rotylenchulus reniformis* and/or *Tylenchorhynchus* spp. A negative correlation was obtained between the population of plants and percentages of infection.

NARAYANASWAMY, P., and K. RAMAKRISHNAN. 1965.
Studies on sterility mosaic disease of pigeonpea. II. Carbohydrate metabolism of infected plants. Proc. Indian Acad. Sci. (Sect. B) 62:130-139. 1013

The reduction in the chlorophyll content virus-diseased pigeonpea leaves was as high as 60.9%. Carotene and xanthophyll contents of diseased leaves also showed a decrease as did the total carbohydrate content. The activity of chlorophyllase was increased due to virus infection. The synthesis of sucrose in diseased leaves was at a lower rate than in healthy ones and resulted in derangement of photosynthetic activity in diseased plants. The translocation of sugars was reduced and the nature of sugars translocated was altered in the diseased plants.

NARAYANASWAMY, P., and K. RAMAKRISHNAN. 1966.
Studies on the sterility mosaic disease of pigeonpea. III. Nitrogen metabolism of infected plants. Proc. Indian Acad. Sci. (Sect. B) 63:288-296. 1014

A decrease in the chloroplastic protein and a slight increase in the cytoplasmic protein was seen in the diseased leaves. There was no appreciable quantitative difference

in the aminoacid content of proteins of healthy and diseased plants. The total nitrogen content of the diseased leaves showed a progressive increase over healthy during the day, from morning till evening. The free aminoacids of diseased leaves showed variations both in quality and quantity. The presence of two unidentified aminoacids was detected only in diseased leaves. The aminoacids alanine, asparagine, aspartic acid, and arginine, which were in very high concentrations in diseased leaves at 6 a.m., were either completely absent or present only in very small amounts at 6 p.m. A decrease in the C/N ratio resulted due to virus infection.

NARAYANASWAMY, P., and K. RAMAKRISHNAN. 1966.
Studies on sterility mosaic disease of pigeonpea. IV. Changes in activity of enzymes in diseased plants. Proc. Indian Acad. Sci. (Sect. B) 64(2):78-82. 1015

The diastatic activity in pigeonpea leaves infected by PSMV was more than in the healthy leaves. Very low peroxidase activity was noticed in diseased leaves. The catalase activity in infected leaves was increased slightly. The activities of nitrate reductase and proteolytic enzymes in the diseased leaves showed an increase over the healthy leaves. The significance of these changes is discussed.

NARAYANASWAMY, P., and K. RAMAKRISHNAN. 1966.
Studies on the sterility mosaic disease of pigeonpea. V. Organic acid metabolism and respiration of infected plants. Proc. Indian Acad. Sci. (Sect. B) 64: 135-142. 1016

A general reduction in the organic acid contents of leaf, petiole, stem, and buds of diseased plants was observed. Ascorbic acid contents of different tissues exhibited a reduction. Maleic acid and citric acid were absent in diseased leaves and petioles respectively; citric acid and succinic acids accumulated in stem and root, respectively, of the diseased plants. The rate of respiration was increased in diseased plants throughout the day.

NARAYANASWAMY, P., A.R. SESHADRI, and K. RAMAKRISHNAN. 1963.
Preliminary note on suspected nematode transmission of redgram sterility mosaic virus. Madras Agric. J. 50(2): 109-110. 1017

There was disease in the field where the crop was sown for the first time, but it occurred in high percentage in the fields where grown successively. The virus is probably transmitted by one or more of the soil nematode species listed in the text.

NATTRASS, R.M. 1958.
Report of the Senior Plant Pathologist. A. Rep. Dep. Agric. Kenya, 1965. 2:9-14. 1018

Note on a bark disease of pigeonpea showing short longitudinal splits and stem-pitting leading to Die-back and collapse. *Cercospora cajani* and *Uromyces dolicholi* were found as new records.

NEMA, KRISHNA GOPAL. 1950.
Inhibitory effect of certain soil microorganisms on *Fusarium udum* Butler, the pigeonpea (*Cajanus cajan* (L.) Millsp.) wilt organism. 54 pp. Thesis. Indian Agricultural Research Institute, New Delhi, India. 1019

NENE, Y.L. 1973.
Viral diseases of some warm weather pulse crops in India. Pl. Dis. Reptr 57(5): 463-467. 1020

Four viral diseases attacking a large number of pulse crops were investigated. Mung bean yellow mosaic virus, transmitted by the white fly, *Bemisia tabaci*, is the most widespread and causes serious losses. It affects several pulse crops, including pigeonpea.

NENE, Y.L. 1977.
Survey of pigeonpea diseases with special reference to wilt and sterility diseases. The All-India Workshop on Assessment of Crop Losses due to Pests and Diseases. 12 Sep 1977. University of Agricultural Sciences, Bangalore, India. 1021

During roving surveys it was found that two diseases, wilt (*Fusarium udum*) and sterility mosaic (Virus?), were more serious than others such as leaf spots and powdery mildew. The average wilt incidence varied from 1.12 to 22.61%. The average sterility mosaic incidence was 1.09 to 12.84%. In some of the farmers' fields the incidence of wilt varied from 0 to 93% and sterility mosaic from 0 to 95%.

NENE, Y.L., and M.V. REDDY. 1976.
A new technique to screen pigeonpea for resistance to sterility mosaic. Trop. Grain Legume Bull. 5:23. 1022

Brief notes are given on the leaf-stapling technique in which leaflets from diseased plants infested with mites (*Aceria cajani*) are stapled to the primary leaves of test seedlings. The superiority of this technique over the twig tying technique is indicated.

NENE, Y.L., and M.V. REDDY. 1976.
Screening for resistance to sterility mosaic of pigeonpea. Pl. Dis. Reptr 60(2):1034-1036. 1023

The sterility mosaic (SM) is widely prevalent in the Indian subcontinent, producing complete or partial sterility in affected plants. In some fields 100% incidence was observed. Transmission of the causal agent is through the *eriophyid* mite, *Aceria cajani*. Two thousand eight hundred and four accessions, including pigeonpea (*Cajanus cajan*) germplasm/cultivars, *Atylosia* spp., and *Cajanus* x *Atylosia* crosses were screened for resistance to SM, by utilizing a leaf-stapling inoculation technique. Four pigeonpea lines ICRISAT-3783, -6986, -6997, -7035, and one cultivar (ICRISAT-7179 or HY-3C) were identified as immune. Lines showing other desirable characters including longer incubation period, less disease incidence, mild symptoms, and flowering in spite of infection were also identified.

NEWTON, W., and J.W.L. PEIRIS. 1953.
Virus diseases of plants in Ceylon. FAO Pl. Prot. Bull. 2(2):17-21. 1024

Pigeonpea in Ceylon (Sri Lanka) is affected by yellow mosaic and pale mosaic; symptoms of both virus infections are given.

ONIM, J.F.M., and P.R. RUBAIHAYO. 1976.
Screening pigeonpea for resistance to *Mycovellosiella cajani*. SABRAO J. 8(2):121-125. 1025

Of 15,000 plants comprising 2,107 varieties, 314 plants were selected for resistance to *M. (Cercospora) cajani*. When progeny lines from 11 of these selections were grown at five sites in Uganda and Kenya, lines UC-796/1, UC-2515/2, UC-2113/1, and UC-2568/1 were both resistant and high-yielding. Disease incidence was significantly and negatively correlated with grain yield.

ORILLO, F.I., and R.B. VALDEZ. 1958.
Four diseases of coffee hitherto undescribed in the Philippines. Philipp. Agric. 42(7):292-302. 1026

Rhizoctonia blight was seen on pigeonpeas used as temporary shade for coffee transplants. It killed all infected plants and produced many large light brown sclerotia on leaves. Disease also caused defoliation of coffee but no sclerotia formed. Symptoms and culture are described.

OVERMAN, A.J. 1974.
The influence of certain nematicides on weed population in sandy soils. Proc. Soil Crop Sci. Soc. Fla. 33:72-74. 1027

Prior to seeding pigeonpeas (*Cajanus cajan* Millsp.) as a summer crop in May, the plots were broadcast-treated with carbofuran (11.2 kg/ha), sodium azide (26.9 kg/ha), and a combination of the two. The carbofuran increased the number of crabgrass and nutsedge plants in the second cover crop test. Sodium azide was not effective when used alone or in combination with carbofuran. Residual effects were also realized.

PADWICK, G.W. 1939.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. New Delhi, 1938-39: 105-112. 1028

Isolated from wilted pigeonpeas were several distinct species of *Fusarium*, one of which appeared to differ from *F. udum* and to produce severe wilting, but no foot-rot. Identity being established.

PADWICK, G.W. 1940.
Report of the Imperial Mycologist. Scient. Rep. Agric. Res. Inst. New Delhi, 1939-40: 103-115. 1029

Experiments with cross-inoculation tests with *Fusarium* wilt fungi are described.

PADWICK, G.W. 1940.
Genus *Fusarium* 5: *Fusarium udum* Butler. *F. vasinfectum* Atk. and *F. lateritum* var. *uncinatum* W.R. Indian J. Agric. Sci. 10(6):863-878. 1030

Full descriptions of cultural characters of various isolates of *Fusarium* causing wilt in cotton, pigeonpea, and sunn-hemp. Suggests *F. udum* Butl. var. *cajani* for pigeonpea wilt, organism being morphologically and culturally identical with, but pathogenetically different from, that causing sunn-hemp wilt.

PADWICK, G.W., M. MITRA, and P.R. MEHTA. 1940.
The genus *Fusarium* IV infection and cross-infection tests with isolates from cotton (*Gossypium* sp.) pigeonpea (*Cajanus cajan*) and sunn-hemp (*Crotalaria juncea*). Indian J. Agric. Sci. 10:697-706. 1031

Fifty-one isolates of *Fusarium* from cotton, pigeonpea, and sunn-hemp were tested for cross-inoculation. Only one of the 16 cotton isolates caused wilting, but a number of them prevented normal germination of one or more of the three hosts. The results showed that most of the wilt-producing strains are almost if not entirely restricted to the original hosts.

PANDEY, K.K., G.S. MISHRA, and S.K. GROVER. 1976.
Some studies on chemosterilants. 1. Thiourea as fungus growth inhibitor. Sci. Cult. 42(9):476-477. 1032

Increasing concentrations of thiourea caused a gradual decrease in the mycelial dry weight and sugar content of *Helminthosporium sativum* (*Cochliobolus sativus*) and *Fusarium oxysporum* f. sp. *udum* (*F. udum*).

PARK, M. 1929.
Report of the mycological division. Dep. Agric. Tech. Rep. Ceylon. Year 1928: 1-6. 1033

New record of *Oidiopsis* sp. causing powdery mildew of pigeonpea leaves has been reported.

PARK, M. 1935.
Report of the work of the mycological division. Adm. Rep. Dir. Agric. Ceylon. 1934:D124-D131. 1034

Rust recorded on pigeonpeas as *Woroninella umbilicata* has been described with its symptoms on the host and time of spread.

PATEL, M.K., and Y.S. KULKARNI. 1949.
Nitrogen utilization by *Xanthomonas malvacearum* (SM) Dowson. Indian Phytopath. 2(1):62-64. 1035

Nitrogen requirements of *Fusarium udum* were investigated together with those of other fungi and bacteria. The source of nitrogen is not the only factor; the source of carbon is also very important for the growth of microorganisms.

PATHAK, P.D., and D.K. MAHESHWARI. 1973.
Deterioration of seeds of *Cajanus cajan* Linn.by *Aspergilli* in storage. B.V.J. Agric. Sci. Res. 15(1-2):97-100. 1036

In a sample drawn from storage, about 60% of the seeds were found distorted and apparently in a state of decay. No work has been done so far in India on storage of *Cajanus cajan* seeds. In the present study mycoflora was isolated and the effect of fungi on storage was investigated for 180 days. The survival of mycoflora on seeds in storage was also recorded.

PATIL, B.G., and J.E. SABLE. 1973.
A note on the screening of tur against wilt disease. PKV Res. J. 2(1): 73-76. 1037

Some promising *C. cajan* selections from a screening program against *Fusarium oxysporum* f. sp. *udum* are tested.

PAVGI, M.S., and R.A. SINGH. 1965.
Some parasitic fungi on pigeonpea from India. Mycopath. Mycol. Appl. 27(1-2): 97-106. 1038

List of eight species includes as new *Cercoseptoria cajanicola*, *Macrophoma cajanicola*, and *Pyrenochaeta cajani*.

PAVGI, M.S., and U.P. SINGH. 1964.
Parasitic fungi from Northern India. 3. Mycopath Mycol. Appl. 24(4): 355-361. 1039

Among a number of parasitic fungi on different crops, *Colletotrichum cajani* is listed on pigeonpea.

PEARL, R.T. 1923.
Report of the Mycologist to the Government of the Central Provinces and Berar. Rep. Dep. Agric. Cent. Prov. Berar, for the year ending 30th June, 1922:19-20. 1040

The wilt caused by *Fusarium udum* was found to be quite severe in parts of Berar.

PRASAD, M., and S.K. CHAUDHARY. 1966.
Studies on the effect of different phosphorus concentrations on the production of chlamydospores, microconidia and macroconidia in the culture of *Fusarium udum* Butler. Proc. Nat. Acad. Sci. (Sect. B) 36(1):43-48. 1041

A concentration of 0.064% P in liquid medium was optimum for mycelial growth and conidial formation of *F. udum* from pigeonpea while chlamydospores were formed in

abundance at only the lowest levels (0.002 - 0.004%).

PRASAD, M., and S.K. CHAUDHARY. 1967. Effect of sulfur on sporulation of *Fusarium udum* Butl. J. Indian Bot. Soc. 46(1): 45-51. 1042

The sulfur nutrition of *Fusarium udum* Butler was studied. Ten concentrations of sulfur, supplied as $MgSO_4$ $7H_2O$ were tried for their effects on mycelial growth, conidial production, and chlamydospore formation. While 0.32% of S was optimum for growth and conidial production, chlamydospore formation was best at 0.008% and 0.016%. Beyond the optimum, growth as well as sporulation declined sharply.

PRASAD, M., and S.K. CHAUDHARY. 1977. Relation of pH levels and varied nutrient media to growth and sporulation of *Fusarium oxysporum* f. *udum* (Butler) Sn. et H. Res. J. Ranchi Univ. 13:214-222. 1043

In *Fusarium oxysporum* f. *udum* best mycelial growth and sporulation of macroconidia and microconidia were recorded at pH level of 6.0; chlamydospores, however, sporulated best at pH 3.5 and least at pH 6.0. For macroconidial and microconidial sporulation as well as for mycelial accumulation, the pH level of 6.5 had a positive adverse effect. With the age of culture, the comparative performance of the different media varied. The best growth was in Rawlin's and Richard's media, the sporulation of macro and microconidia were best in potato-dextrose and Cpapeck's media respectively.

PRASAD, S.N. 1965. Studies on sterility disease of 'rahar' (*Cajanus cajan*). Allahabad Fmr 39(6): 235-237. 1044

Symptoms of the mosaic virus disease on small and chlorotic leaves and suppression of flowering are listed. First symptoms in late varieties appeared 10th day after the date of first flowering. All varieties were more or less susceptible to the disease. At harvesting time the infected plants were 10 to 35% and 100% in semi-late varieties. Severely diseased branches did not form flower buds.

PRESTON, N.W. 1977. *Cajanone*: an antifungal isoflavanone from *Cajanus cajan*. Phytochem. 16(1): 143-144. 1045

Description of molecular structure of *Cajanone* is given. *Cajanone*, isolated by TLC from a methanolic extract of direct, milled pigeonpea roots, totally inhibited germ tube growth of *Fusarium oxysporum* f. sp. *udum*, the pigeonpea wilt pathogen, at 50 ppm *in vitro*.

PURKAYASTHA, R.P., and ARATI DAS. 1973. Amino acids associated with pathogenicity of UV-induced mutants of *Fusarium udum*. inciting wilt of pigeonpea. Proc. Indian Sci. Cong. Assoc. 60(3):357. (Abstract). 1046

A virulent strain (FU 13) of *F. udum* was subjected to UV-radiation. The 0.01% survival was most useful in producing the highest rate of mutation. Of the 400 surviving colonies studied, 8 stable amino acid-deficient mutants were isolated and characterized. Four of these mutants required methionine either singly or alternatively while one mutant ($M60_2$) had three alternate deficiencies as methionine/cysteine/cistine. Growth responses of $M60_2$ and a methionine-requiring mutant ($M60_7$) were studied *in vitro*. The pathogenicities of $M60_2$ and $M60_7$ were tested on a susceptible variety of *Cajanus cajan*. It was observed that inocula, supplemented with optimal concentrations of the required amino acids partially restored the pathogenicity of the test mutants which were otherwise nonpathogenic. Methionine, however, appeared to have an important role in pathogenesis.

PURKAYASTHA, R.P., and M. CHATTOPADHYAY. 1975. Antibiotic sensitivity of normal and amino acid-deficient mutants of *Fusarium udum* in relation to control of wilt disease of *Cajanus cajan* (L.) Millsp. Indian J. Expl Biol. 13(1):58-60. 1047

Sensitivity of three UV-induced amino acid-deficient mutants in *F. udum* and their parent strain (FU 13) to four antibiotics was tested *in vitro*. Aureofungin (100 µg/ml) most effectively inhibited spore germination, germ tube, and mycelial growth of the test strains. Pathogenicity tests on *C. cajan* revealed that FU-13 and M-802 were virulent and avirulent respectively, while M-602 and M-607 were nonpathogenic. Selective toxicity of antibiotics to test strains was discussed in relation to the control of wilt disease of *C. cajan*.

RAGHAVAN, D. 1962 (EDITOR).
Crop disease calendar. New Delhi: Indian Council of Agricultural Research. 115 pp. 1048

Symptoms and control measures for important diseases of 41 crops are described and illustrated and the month in which they occur in the northern plains, the hills, and the peninsular region of India is given.

RAMAKRISHNAN, K., and T.K. KANDASWAMY. 1972.
Final technical report, investigation on virus diseases of pulse crops in Tamil Nadu. Coimbatore: Tamil Nadu Agricultural University. 1049

RAMAKRISHNAN, T.S., and N.V. SUNDARAM. 1955.
Notes on some fungi from South India. 4. Indian Phytopath. 7(2):140-151. 1050

Woroninella umbilicata (B and Br) Petch. (*Synchytrium umbilicatum*), which has bright orange sporangia, recorded on pigeonpea.

RANGEL, E. 1915.
Fungus parasites of the pigeonpea. Boln. Agric., São Paulo. Ser. 16(2): 145-146. 1051

RAO, V.G. 1964.
The genus *Phyllosticta* in Bombay - Maharashtra. 4. Mycopath. 22(2-3): 157-166. 1052

Phyllosticta cajani given as new record on pigeonpea for the state. Its symptoms and other characteristics are described.

RATHI, Y.P.S., and Y.L. NENE. 1976.
Influence of different host combinations on virus-vector relation of mung bean yellow mosaic virus. Pantnagar J. Res. 1(2):107-111. 1053

Influence of different source-test combinations in virus-vector relation of mung bean yellow mosaic virus (MYMV) was studied. The minimum acquisition and inoculation periods required for white fly adults (*Bemisia tabaci* Genn.) to become ineffective varied from 15 to 760 min. and 10 min. to 760 min., respectively. The adults require longer acquisition and inoculation periods to infest Bragg soybean and T-21 pigeonpea than to infect black gram and mung bean.

RAVISHANKER. 1936.
Isolation of wilt-resistant tur. Nagpur Agric. Coll. Mag. 10(4):162-167. 1054

RAYCHAUDHURY, S.P. 1941.
Pt. 1. Studies on the canker disease of pigeonpea (*Cajanus cajan* (L.) Millsp.) caused by *Diplodia cajani* Nov. Spec. Pt. 2. Studies on *Erysiphe cichoracearum* D.C. and *Erysiphe polygone* De. Thesis. Indian Agricultural Research Institute, New Delhi, India. 1055

RAYCHAUDHURY, S.P. 1942.
A disease of pigeonpea (*Cajanus cajan* (L.) Millsp.) caused by *Diplodia cajani* sp. No. 1. Indian J. Agric. Sci. 12: 837-847. 1056

The diseased pigeonpea plants were examined and the collar region were found to be cankered. The disease appeared to be different from those so far described on this crop from India. It was found that the attack of the pathogen was very virulent when the collar regions were wounded before the inoculation; hence it appears that damage due to the disease can be minimized to a great extent if injuries at the collar regions are avoided.

RAYCHAUDHURY, S.P. 1947.
Further studies on *Diplodia cajani* Raychaudhury. J. Indian Bot. Soc. 26: 221-225. 1057

Growth and culture of several strains of *Diplodia cajani* from cankered pigeonpeas is described.

RAYCHAUDHURY, S.P. 1950.
Studies on canker disease of pigeonpea. II. Studies on rice. III. Virus disease of plants. D. Phil. Thesis. Calcutta University, India. 1058

RAYCHAUDHURY, S.P. 1968.
Diseases of pulses. Indian Fmg 17(11): 39-43. 1059

Wilt disease of pigeonpea causes serious damage to the crop. The disease is incited by *F. udum*. Other diseases of pulse crops are also discussed.

ROY, T.C. 1949.
I. Studies on the soil microorganisms with special reference to their antibiotic effect on *Fusarium udum* Butler, the wilt organism of arhar (*Cajanus cajan* (Linn.) Millsp.). II. Some aspects of cultural

variation and taxonomic considerations of *F. udum* Butl. the causal organism of wilt of pigeonpea. 62 pp. Thesis. Indian Agricultural Research Institute, New Delhi, India. 1060

SABET, K.A. 1959.
Studies on the bacterial diseases of Sudan crops. 3. On the occurrence, host range and taxonomy of the bacteria causing leaf blight diseases of certain leguminous plants. Ann. Appl. Biol. 47:318-331. 1061

The concept of *Xanthomonas phaseoli* is broadened to include several bacteria causing leaf blights of legumes, including the new combination *X. phaseoli* f. sp. *cajani* which, unlike most of the other special types, infects only on its original host i.e. *Cajanus cajan* (L.) Millsp.

SABET, K.A., F. ISHAQ, and O. KHALIL. 1969.
Studies on the bacterial diseases of Sudan crops. 7. New Records. Ann. Appl. Biol. 63(3):357-369. 1062

Xanthomonas phaseoli f. sp. *cajani* was a new record for Sudan on pigeonpea. The nomenclature of *Xanthomonas* is discussed. The strains on weeds can also infect cultivated crops.

SAKSENA, H.K., and K. KUMAR. 1971.
Some aspects of epidemiology and control of *Phyllosticta* leaf spot of arhar (*Cajanus cajan* (L.) Millsp.). Proc. Nat. Acad. Sci. India. (Sect. B) 37(6):399-406. 1063

Leaf spot of *Cajanus cajan* (L.) Millsp. caused by *Phyllosticta cajani* Sydow has been found to occur in increasing proportions throughout U.P. in recent years. The disease appears in July and persists throughout the crop season. Two years' data on disease incidence in fields have shown that percentage of disease intensity varies from 4.3 to 31.8. The disease intensity was high (21.2 to 31.8%) from July to October, at mean temperature range of 20 to 30°C and mean humidity range of 73 to 89%. The maximum disease intensity was observed in August, after which it gradually declined, touching its lowest during the cool months of December and January. The pathogen survived in infective stage for more than 15 months in diseased plant refuse in soil, which serves as a primary source of inoculum. Spores germinated in 6 to 8 hours and penetration of leaf occurred through stomata and intact surface by means of an infection peg produced from appressorium. Out of 139 arhar varieties screened, 3/23-36/1 alone was found resistant. Bisdithane was effective to some extent in checking the secondary spread of the disease.

SAKSENA, H.K., and R.R. UDIT NARAIN SINGH. 1976.
Mycosphaerella from a leaf spot of arhar (*Cajanus cajan* (L.) Millsp.). Indian J. Fm Sci. 4:124-125. 1064

On the basis of the morphological characters, the fungus is identified as a species of *Mycosphaerella*. This appears to be the first record of *Mycosphaerella* on arhar from any part of the world. This species has been reported as the perfect state of species of imperfect genera such as *Phyllosticta* and *Cercospora*.

SAMAJPATI, N. 1973.
Interaction of near-ultraviolet radiation and hydrogen-ion concentration on growth and sporulation of *Fusarium udum* Butl. Sci. Cult. 39(3):127-129. 1065

At proper pH 5.0, NUV irradiation can effectively induce either vegetative growth or sporulation. At pH 3.5 to 4.5, and 8.0 there is no sporulation either under dark or NUV but at 4.5 and 7.5 there is a sporulation under NUV. A treatment of NUV irradiation and pH or the interaction of both on growth and sporulation of the test-fungus are studied.

SAROJINI, T.S. 1946.
Soil conditions and root diseases with special reference to *Fusarium udum* on red gram. Ph.D. (1946) Thesis. University of Madras, Madras, Tamil Nadu, India. 1066

SAROJINI, T.S. 1950.
Soil conditions and root diseases micronutrient elements and disease; development of *Fusarium udum* on red gram (*Cajanus indicus* Linn.). J. Madras Univ. (Sect. B) 19:1-32. 1067

SAROJINI, T.S. 1951.
Soil conditions and root diseases. Part II. *Fusarium* disease on red gram (*Cajanus indicus*). Proc. Indian Acad. Sci. (Sect.B) 33(2):49-68. 1068

A number of distinctly varying strains were isolated. Pathogenicity tests with *F. udum* and isolates indicated that strain I and strains II and III were more virulent than the other strains. Preemergence wilt was mainly caused by strains V and VI. Micro-

nutrient solution (boron, manganese, and zinc) provided seedling protection in wilt-infested soils. Presoaking of seeds in various concentrations of microelements also induced early germination and better seedling vigor, zinc being responsible for the most rapid disappearance of the fungus.

SAROJINI, T.S. 1954.
Soil conditions and root diseases. II. *Neocosmospora vasinfecta* Smith. Disease of *Cajanus cajan*. J. Madras Univ. (Sect. B) 24(1):137-142. 1069

Symptoms and distribution of this fungus are given.

SAROJINI, T.S., and L. YOGESWARI. 1947.
Aeration affecting growth and sporulation of some *Fusaria* in liquid cultures. Proc. Indian Acad. Sci. (Sect. B) 26(2): 69-76. 1070

Effect of aseptic aeration on growth and sporulation of the three soil fungi, viz., *F. vasinfectum*, *F. moniliforme*, and *F. udum* was studied in detail. Sporulation of all the three was optimum at 0.2% nitrate nitrogen in standard Horne and Mitters' liquid medium. Aeration stimulated mycelial growth (on both dry and ash weight basis) but inhibited sporulation (quantitatively determined). Aeration had no direct effect on the pH of the culture medium. Sporulation decreased with increasing hours of aeration.

SATHYANARAYANA, G., and R. KALYANASUNDARAM. 1952.
Soil conditions and root diseases. V. Symptomology of wilted cotton and red gram. Proc. Indian Acad. Sci. (Sect. B) 36:54-58. 1071

Symptoms of the wilt (*F. udum*) are recorded. Wilt symptoms in red gram by do not culminate in vein clearing as in cotton, although there is a general and well-marked dechlorophyllation presenting almost a toxemic condition. This is first seen on the 18th day after germination. The possibility of these vascular wilts interfering with the normal uptake of some of the essential chlorophyll-forming heavy metals is discussed.

SENGUPTA, P.K. 1974.
Diseases of major pulse crops in India. PANS 20(4):409-415. 1072

Lists of varieties of *Cicer arietinum* resistant to *F. oxysporum* f. sp. *ciceri* and *Mycosphaerella pinoides*, and of *Cajanus cajan* resistant to *F. oxysporum* f. sp. *udum*. Similarly resistant varieties of peas and black gram are also given.

SETH, M.L. 1965.
Further observations and studies on pigeonpea sterility. Indian Phytopath. 18: 317-319. 1073

In tests on the reaction of eighteen *Cajanus cajan* varieties to the virus causing sterility, all were found to be susceptible.

SHARIFF, M.H. 1973.
Studies on the mycoflora associated with the seed of wheat, paddy, pigeonpea and Bengal gram from three different storage conditions. M.Sc. (1973) Thesis. University of Allahabad, Allahabad, Uttar Pradesh, India. 1074

SHARMA, M.C. 1964-65.
Soil micro-fungi in relation to certain edaphic factors and arhar and cowpea crops. Proc. Indian Sci. Cong. 51 & 52: 323 (Abstract). 1075

Soil conditions of a particular crop and its microflora have been shown to be influenced by surface vegetation. This study compares the influence of arhar (*C. cajan*) and cowpea (*V. sinensis*) on the microfungi and conditions of the soils on which they are grown. Soil samples from 0 to 3", 3 to 6", and 6 to 9" (0 to 7.5 cm, 7.5 to 15 cm, and 15 to 21.5 cm) horizons were analyzed. It was found that the fungal population in soils under arhar crops is higher than in those under cowpea. Also, more species of fungi are found in soils under arhar (53) than under cowpea, the *moniliales* and *phycomycetes* being the most prevalent. In all, 58 fungi were isolated, out of which 27 were common to both areas, 26 restricted to arhar soils, and 5 confined to cowpea soils. It was presumed that the soil microflora in this case are more influenced by the surface cover than by the edaphic factors. The differences may also be due to the nature of their root exudates and hence the rhizosphere effect.

SHIT, S.K. 1976.
Studies on variability in *Fusarium oxysporum* f. sp. *udum* the incitant of wilt of pigeonpea. 57 pp. M.Sc. (1976) Thesis. Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, India. 1076

SHUKLA, D.S. 1975.
Incidence of *Fusarium* wilt of pigeonpea in relation to soil composition. Indian Phytopath. 28(3):395-396. 1077

Fusarium udum causing wilt of pigeonpea plants in India is influenced by soil composition: the higher the proportion of sand in the soil, the more the percentage of wilt.

SIDERIS, C.P. 1929.
Pythiaceous root parasites of various agricultural plants. Phytopath. 19(12): 1140 (Abstract). 1078

Pigeonpea was found susceptible to most of *Pythium* spp. isolated from various crops.

SIDERIS, C.P. 1932.
Taxonomic studies in the family *Pythiaceae*. 2. *Pythium*. Mycologia 24(1):14-61. 1079

Pythium splendens var. *hawaiianum* n. var., a very aggressive parasite of pineapple roots, is moderately parasitic on those of the pigeonpea and several other plant species in Hawaii.

SINGH, D.V., and A.N. MISHRA. 1976.
Search for wilt-resistant varieties of red gram in Uttar Pradesh. Indian J. Mycol. Pl. Pathol. 6(1):89. 1080

Some of the varieties of red gram, viz., C-11, C-28, C-36, F-18, NP(WR)-15, NP-41, and T-17 which were earlier reported to be resistant or tolerant to wilt have proved susceptible. Some lines, Bori 192-12-5-1-2 and Bori 192-15-2-2-11-42 were moderately resistant.

SINGH, G.P. 1965.
Studies on wilt of arhar. Ph.D. (1965) Thesis. Agra University, Agra, Uttar Pradesh, India. 1081

SINGH, G.P., and A. HUSAIN. 1962.
Production of pectic and cellulolytic enzymes by arhar wilt fungus. Curr. Sci. 31:110-112. 1082

Studies on the role of enzymes in the pathogenesis of *Fusarium lateritium* f. sp. *cajani*, the agent of pea wilt, revealed that the fungus produces cellulose as well as polygalacturonase in culture, and these may play a role in the disease syndrome.

SINGH, G.P., and A. HUSAIN. 1964.
Presence of fusaric acid in wilt-affected pigeonpea plants. Curr.Sci.33(9):287. 1083

Chromatographic demonstration showed the presence of fusaric acid in all affected parts (roots, stem, and leaf) after inoculation of susceptible variety T-105 with mycelium and spores of virulent isolates of *Fusarium lateritium* f. sp. *cajani*.

SINGH, G.P., and A. HUSAIN. 1968.
Role of enzymes in pathogenesis by *Fusarium lateritium* f. *cajani*. Indian Phytopath. 21(4):361-373. 1084

Degradation of cellwalls and disorganization of vessels were evident in sections of roots and stems of infested arhar present in these sections. The main function of these enzymes in pathogenesis by *F. lateritium* f. *cajani* is to cause the breakdown of the host tissue.

SINGH, G.P., and A. HUSAIN. 1970.
Role of toxic metabolites of *Fusarium lateritium* f. *cajani* (Padw.) Gord. in the development of pigeonpea wilt. Proc. Nat. Acad. Sci. India. (Sect. B) 40:9-15. 1085

SINGH, N.D. 1975.
Effect of oxamyl applications on eelworm penetration into roots of tomato, lettuce and pigeonpea. Trop. Agric. (Trinidad) 52:369-373. 1086

In glasshouse tests a single foliar application of oxamyl of 2,500 ppm inhibited significantly the penetration of pigeonpea seedlings by *Rotylenchulus reniformis*.

SINGH, N.D. 1975.
Studies on the selected hosts of *Rotylenchulus reniformis* and its pathogenicity to soybean (*Glycine max*). Nematropica 5(2):46-51. 1087

Six plant species were tested for host suitability to *R. reniformis*. Tomato, pigeonpea, and watergrass supported large population increases but the nematode population declined under Bermudagrass (*Cyanodon dactylon*) after 10 weeks. Significant reductions occurred in dry weights of tops and roots and linear growth of infected soybean plants 8 weeks after transplanting into naturally infested soil. Initial larvae populations of 500 and 1,000 *R. reniformis* reduced the mean weights of roots by 14.7 and 53.7%, the tops by 37.0 and 54.7%, and linear top growth of soybean by 23.1 and 27.5% respectively, when compared with noninoculated controls.

SINGH, R., and T.P. MALL. 1974.
Effect of arhar mosaic virus on yield and chemical constitution of seeds of some legumes. Labdev. J. Sci. Technol. 12(4):145-149. 1088

Field infection of legumes such as lentils with arhar (pigeonpea) mosaic virus strains AMM or ASM reduced the number, size, and weight of pods and seeds; decreased reproductive capacity and seed germination; and decreased the N and P compounds and carbohydrates in the seed. Decreases were greater with strain ASM than with AMM.

SINGH, R., and T.P. MALL. 1976.
A new virus disease of arhar (*Cajanus cajan* (L.) Millsp.). Curr. Sci. 45(17): 635-636. 1089

Pigeonpea (*Cajanus cajan*) in India was recently found to be infected by a new virus disease. The symptoms and tests conducted are briefly described.

SINGH, SHIV BAHADUR.
Studies on leaf spot disease of arhar (*Cajanus cajan* (L.) Millsp.). Ph.D. Thesis. Kanpur University, Kanpur, Uttar Pradesh, India. 1090

SINGH, T.C.N. 1935.
Sterility of crop plants and a study of their root system. Curr. Sci. 4:30-32. 1091

A preliminary note on an experiment to elucidate the possible physiological basis of sterility in *Cajanus indicus* Spreng. Irrigation of groups of sterile plants with solutions of various salts of potassium or sodium and irrigation of the strong laterial roots of a further group with well water was followed after a couple of weeks by flowering. The control groups showed no flowers. Other crop plants are to be similarly tested.

SINGH, U.B. 1934.
Studies on *Cercospora indica*, new species parasitic on *Cajanus indicus* Spreng. Indian J. Agric. Sci. 4:343-360. 1092

The leaf-spot disease of *Cajanus indicus* caused by two strains of *Cercospora* occurs commonly. The symptoms of the disease and the morphology are described. Between 20°C and 25°C infection occurs readily. Best growth of the strains takes place at 100% humidity. Both the strains have been found to belong to one species, which has hitherto not been described and is named *Cercospora indica*, the diagnosis of which is given.

SINHA, A.K. 1975.
Control of *Fusarium* wilt of pigeonpea with Bavistin, a systemic fungicide. Curr. Sci. 44(19):700-701. 1093

Pot tests in India revealed that carbendazim applied as a soil drench at 2000 ppm 10 days before inoculation of pigeonpea plants with *Fusarium* wilt controlled the disease.

SMALL, W. 1922.
On the occurrence of a species of *Fusarium* in Uganda. Kew Bull Miscellaneous Inform. 9:269-291. 1094

A full description is given of cultural characters of the fungus on different media as well as of a large series of cross-inoculations on different hosts, including pigeonpea, believed to be the same as *Fusarium udum* Butl. from India.

SNYDER, W.C., and H.N. HANSEN. 1940.
The species concept in *Fusarium*. Am. J. Bot. 27:64-67. 1095

A species concept in *Fusarium* is presented which takes full cognizance of the variation displayed by members of this genus. In employing this concept in the taxonomy of *Fusaria* section of *elegans* in particular, it has seemed necessary to revise the system of classification heretofore in use. The necessity of this revision is demonstrated by the analyses of many former "species" by means of large numbers of single-spore cultures. These analyses have shown that the progeny of a single-spore culture may fall into more than one species or subsection of the genus as formerly constituted.

SOMANI, R.B., P.D. WANGIKAR, and V.N. SHUKLA. 1975.
A new stem canker and die-back disease of pigeonpea. Indian Phytopath. 28(3): 436-437. 1096

The new varieties PL-8796 and Kaki are reported to be susceptible to this disease which is caused by a species of *Colletotrichum* not conforming to the *Colletotrichum cajani* state of *Glomerella cingulata*.

SPENCE, J.A. 1975.
The importance of diseases in relation to the grain legume research program in the Eastern Caribbean. *In*: Tropical Diseases

of Legumes. Eds. J. Bird and K. Maramorosch. New York: Academic Press. 151-155. 1097

The grain legumes program in the Eastern Caribbean focusses on pigeonpea breeding and selection, physiology, biochemistry, microbiology, crop protection, agronomy and mechanization, food-technology, economics and diseases. The chapter on pigeonpea points out the need for a survey of pigeonpea diseases and for assessment of potential danger from diseases currently of minor importance and more intensive study of diseases that have already been shown to be of importance.

SREENIVASAYA, M. 1932.
Present position of the problem of spike disease. *Cajanus indicus*. Curr. Sci. 1(5):126. 1098

The simplest and the readiest way of diagnosing spike is through the external symptoms. Communicability of the symptom from one plant to another is the criterion on which infectious nature of spike disease has been firmly established. In the regeneration plots, the sandal plants associated with leguminous hosts (*Cajanus indicus*), which favor a rapid growth of the parasite, have succumbed to the disease.

SRIKANTHA MURTHY, G. 1975.
Studies on the nature of persistence in *Cajanus cajan* (L.) Millsp. against wilt caused by *Fusarium udum* Butl. Mysore J. Agric. Sci. 9(4):716-717. 1099

Analysis of two varieties indicates that resistance was associated with a higher content of total sugar, reducing sugars, amino nitrogen, amino acids, phenols, flavanols, and alkaloids. The resistant variety also contained higher amounts of xylose, cysteine, and tryptophan, and lower amounts of phenylalanine. Bioassay revealed that caffeic and chlorogenic acids and an unidentified phenolic compound, which were present in the resistant variety, inhibited spore germination. It is considered that cysteine counteracts fungal infection by chelating ferric ions which activate the *Fusarium* toxin.

SU, U THET. 1931.
Plant diseases in Burma. Intern. Bull. Plant Prot. Year V: 141-142. 1100

SUBRAMANIAN, C.V. 1955.
Studies on South Indian Fusaria. The 'Wild type' in *Fusarium udum* Butl. J. Indian Bot. Soc. 34(1):29-56. 1101

Morphological characters of conidia useful in diagnosis have been given in detail. Also with reference to *F. udum* Butl., which causes wilt disease of pigeonpea.

SUBRAMANIAN, K.S., G. SATHIABALAN SAMUEL, R. JANARTHANAN, and T.K. KANDASWAMY. 1973.
Studies of the varietal resistance of pigeonpea (*Cajanus cajan* L.) to sterility mosaic disease. Madras Agric. J. 60(1):38-40. 1102

All 549 varieties studied were susceptible but are classified in three categories depending on the severity of virus infection observed.

SUBRAMANIAN, S. 1961.
Studies on the wilt of pigeonpea. Ph.D. (1961) Thesis. University of Madras, Madras, Tamil Nadu, India. 1103

SUBRAMANIAN, S. 1963.
Fusarium wilt of pigeonpea. I. Symptomology and infection studies. Proc. Indian Acad. Sci. (Sect. B) 57:134-138. 1104

The pathogenicity of four isolates of *F. udum* was tested on six varieties of *Cajanus cajan* NP-15 proved to be the least susceptible and it is suggested that no spores are produced in that variety as a result of the lack of proper substrate in the root system or the action of some inhibitory substance in the xylem.

SUBRAMANIAN, S. 1963.
Fusarium wilt of pigeonpea. II. Changes in the host metabolism. Proc. Indian Acad. Sci. (Sect. B) 57:178-194. 1105

In healthy plants of the three varieties studied, content of chlorophyll, ascorbic acid, free reducing sugars, and total Mn were highest in the least susceptible variety, NP-15, and lowest in the most susceptible, NP-24. In NP-24, the roots contained more total carbohydrates than the shoots, whereas in NP-15 the reverse was true. The Fe/Mn ratio increased with increasing susceptibility. In inoculated plants, lower susceptibility was associated with a smaller reduction in contents of chlorophyll, ascorbic acid, and total carbohydrates.

SUBRAMANIAN, S. 1963.
Fusarium wilt of pigeonpea. III. Manganese nutrition and disease resistance. Proc. Indian Acad. Sci. 57(4):259-274. 1106

Manganese amendment to the soil was found to reduce pigeonpea wilt to a considerable extent. In plants grown in inoculated soil with 80 ppm Mn, the pathogen colonized only in the roots. At 100 and 200 ppm there was complete exclusion of the fungus. Foliar sprays and pre-soaking of seeds gave even more encouraging results. The role of Mn in the mechanism of disease resistance is discussed.

TATHODE, M.N. 1975.
Further studies on *Fusarium oxysporum* f. *udum* Butl. Snyder and Husain, causing wilt of pigeonpea (*Cajanus cajan* (L.) Millsp.). M.Sc. (1975) Thesis. Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. 1107

THIRUMALACHAR, M.J., M.K. PATEL, N.B. KULKARNI, and G.W. DHANDE. 1956.
Effects *in vitro* of some antibiotics on thirty-two *Xanthomonas* species occurring in India. Phytopath. 46(9):486-488. 1108

The antibiotics used showed varying degrees of inhibition of growth against all the *Xanthomonas* species tested. *Xanthomonas cajani* is included in the 32 species.

TUCKER, C.M. 1927.
Pigeonpea anthracnose. J. Agric. Res. 34(6):589-596. 1109

Described symptoms of *Colletotrichum cajani*, common in Puerto Rico. Loss in yield is mainly due to pod drop and seed decay. Moisture is important for its spread. The description of conidia and their culture is also given. No infection of *Phaseolus vulgaris* was observed.

TUCKER, C.M. 1927.
Report of the Plant Pathologist. Rep. P. Rico Univ. Agric. Exp. Stn 1923: 24-40. 1110

Rhizoctonia ferruginea from sugarcane caused severe damping-off in pigeonpea seedlings. Other hosts were also inoculated, more damage was observed in dry soils. Pigeonpeas are damaged each year by stem canker associated with *Botryosphaeria xanthocephala*, reported as a saprophyte in India.

UPPAL, B.N. 1937.
Appendix, X. Summary of work done under the Plant Pathologist to Govt. Bombay Presidency, Poona, for the year 1935-36. Rep. Dep. Agric. Bombay 1935-36:203-207. 1111

Oidiopsis taurica was found on *Cajanus indicus* (*C. cajan*), apparently for the first time in India, other aspects are also discussed regarding the pathogen.

VAHEEDUDDIN, S. 1956.
Selection of tur (*Cajanus cajan* L.) resistant varieties against wilt (*Fusarium udum* Butler). Agri. Coll. J. Osmania Univ. 3:12-13. 1112

Selection at Sangareddy, Hyderabad State, has resulted in the varieties ST-1, ST-2, and ST-3, which yielded two to two and a half times more than the local type and exhibited a high degree of resistance to *F. udum*.

VAHEEDUDDIN, S., and S.N. NANJUNDIAH. 1956.
Evolving wilt-resistant strains in tur (*Cajanus cajan* L.). Proc. Indian Sci. Cong. Assoc. 43(4):20 (Abstract). 1113

A wilt-sick field was created by spreading compost made of wilted plants. Tur was grown in this field and a systematic selection of plants was made year after year. Later, the work was continued only to the selected plants and their progeny found resistant. By 1949, three lines showing resistance to the extent of 80 to 90% were isolated. In each year care was taken to see that the plot was thoroughly infested with wilt *Fusarium udum* and material to be tried was flanked by susceptible local to serve as control. Three strains, ST-1, ST-2, and ST-3, were isolated, showing a range of resistance of 30 to 90%.

VAKILI, N.G., and K. MARAMOROSCH. 1974.
"Witches-broom" disease caused by mycoplasma-like organisms on pigeonpeas (*Cajanus cajan*) in Puerto Rico. Pl. Dis. Reptr 58:96. 1114

The mycoplasma-like organism associated with the disease was positively identified and later observed under the electron microscope. Intensive efforts should be made to find local sources of resistance and develop resistant cultivars. Leaf hoppers (*Empoasca* spp.) most probably are the insect vectors, transmitting the disease from plant to plant. A possible method to reduce the cost of insecticide

applications, as well as to ensure a disease-free crop, is to develop varieties that combine resistance to witches-broom with resistance to leaf hoppers.

VAN VELSON, R.J. 1961.
Witches broom on pigeonpea induced by mealy bug (*Planococcus*) i.e. *Pseudococcus citri* infestation. J. Papua N. Guinea Agric. 14(2-3):129. 1115

VASUDEVA, R.S. 1949.
Soil-borne plant diseases and their control. Curr. Sci. 18(4):114-115. 1116

The spread and control of *Fusarium udum* and *Bacillus subtilis* are discussed.

VASUDEVA, R.S. 1955.
The effect of associated soil microflora of *Fusarium udum* Butl. on the causing of wilt of pigeonpea (*Cajanus indicus*). Proc. Sixth Intern. Cong. Microbio. 5: 239-242. 1117

VASUDEVA, R.S. 1958.
Report of the Division of Mycology and Plant Pathology. Rep. Agric. Res. Inst. New Delhi, 1955-56:85-104. 1118

A brief report of varietal resistance to *Fusarium udum* wilt and field trials with *Bacillus subtilis* antibiotic is given.

VASUDEVA, R.S. 1958.
Report of the Division of Mycology and Plant Pathology. Rep. Agric. Res. Inst. New Delhi, 1956-57:86-100. 1119

The cultivar S-55 developed 3.3% infection with *Fusarium udum* wilt in plot but remained wilt-free in the field.

VASUDEVA, R.S., and C.V. GOVINDASWAMY. 1953.
Studies on the effect of associated soil microflora on *Fusarium udum* Butl. The fungus causing the wilt of pigeonpea (*Cajanus cajan* (L.) Millsp.) with special reference to its pathogenicity. Ann. Appl. Biol. 40(3):573-583. 1120

The filtrates of *Aspergillus niger* and mixed filtrates of all the saprophytes inhibited the growth of *F. udum* on solid medium. The culture filtrates after passage through soil beds failed to affect adversely the growth of *F. udum* because of change in pH. *Aspergillus terreus* appears to enhance the virulence of *F. udum*.

VASUDEVA, R.S., A.C. JAIN, and K.G. NEMA. 1952.
Investigation of the inhibitory action of *Bacillus subtilis* on *Fusarium udum* Butl. the fungus causing wilt of pigeonpea (*Cajanus cajan* (L.) Millsp.). Ann. Appl. Biol. 39:229-238. 1121

Effects of temperature, period of incubation, aeration, etc., on the production of the inhibitory substance are described. The active principle is absorbed by soil and to a lesser degree by kaolin. A suitable basic medium for the growth of *Bacillus subtilis*, particularly in relation to the production of an antibiotic inhibitory to *Fusarium udum*, is described.

VASUDEVA, R.S., and T.G. ROY. 1950.
The effect of associated soil microflora on *Fusarium udum* Butl. the fungus causing wilt of pigeonpea (*Cajanus cajan* (L.) Millsp.). Ann. Appl. Biol. 38(2):169-178. 1122

Inoculation with *Fusarium udum* Butl. produced more wilt of pigeonpea in sterilized than in unsterilized soil at the same pH. From unsterilized soils with low disease incidence, nine fungi, *Bacillus subtilis* and an *Actinomyces* were isolated. The number of isolations of a particular organism varied from month to month during cropping season of pigeonpea at Delhi. Interaction of *Fusarium udum* and other organisms isolated was studied. *Aspergillus niger* and *A. terreus* secreted inhibitory substances in potato dextrose broth. The nature of medium employed and period of growth were important factors in the production of the inhibitory principle, which is thermostable. The low incidence of pigeonpea wilt in unsterilized soil may result from the inhibitory activity of the associated microflora in the soil.

VASUDEVA, R.S., G.P. SINGH, and M.R.S. IYENGAR. 1962.
Biological activity of bulbiformin in soil. Ann. Appl. Biol. 50(1):113-117. 1123

Bacillus subtilis is capable of producing the antibiotic bulbiformin in soil. Under unfavorable conditions for antibiotic production, such as the presence of root residues, inoculation of *B. subtilis* into soil results in a marked lowering of the incidence of pigeonpea wilt due to *F. udum*.

VASUDEVA, R.S., P. SINGH, P.K. SEN GUPTA, and M. MAHMOOD. 1963.
Further studies on the biological activity of bulbiformin. Ann. Appl. Biol. 51(3):415-423. 1124

Amendment of soil with roots of certain leguminous crops, molasses, and oil cake markedly increased the antibiotic production by *Bacillus subtilis*. A soil amendment consisting of a combination of groundnut cake and molasses was about five times more effective than a dextrose amendment in increasing the production of bulbiformin and also favored its persistence in the soil. The antibiotic was found to act systemically and to be nonphytotoxic when taken up by the roots of pigeonpea (*Cajanus cajan*) in pot experiment. Inoculation of *B. subtilis* into autoclaved soil amended with molasses, sweet clover roots, and groundnut cake reduced by 88% the incidence of pigeonpea wilt caused by *Fusarium udum*.

VASUDEVA, R.S., T.V. SUBBAIAH, M.L.N. SASTRY, G. RANGASWAMY, and R.S. IYENGAR. 1958.
'Bulbiformin', an antibiotic produced by *Bacillus subtilis*. Ann. Appl. Biol. 46(3):336-345. 1125

Antibiotic is chiefly antifungal. Its presence leads to formation of characteristic bulbs in the spores and hyphae of the test fungi. Active principle is thermolabile. It is suggested that the antibiotic under consideration is different from those of *B. subtilis* previously described, therefore the name proposed for this antibiotic is bulbiformin. Effective against *F. udum*.

VENKATA RAM, C.S. 1955.
Soil fusaria and their pathogenicity. Proc. Indian Acad. Sci. (Sect. B) 42(4):124-144. 1126

A number of transitional forms were observed between the virulent and avirulent isolates pathogenic on cotton and pigeonpea, indicating that *Fusaria* occur in soils in a multiplicity of pathogenic forms. In certain strains of highly specialized wilt *Fusaria*, *F. udum* and *F. vasinfectum* host selectivity was observed and many others were nonspecific to the host. The significance of these results in the taxonomy of *Fusaria* is discussed. Mixing two isolates resulted either in synergism and augmentation in pathogenicity or in antagonism and decrease in infection.

WALLACE, G.B. 1932.
Report of the Mycologist. A. Rep. Dep. Agric. Tanganyika Territory, 1930: 53-55. 1127

Nematospora coryli found in the seeds of pigeonpea.

WALLACE, G.B. 1932.
Tanganyika territory fungus list. Recent Records. 10. Mycol. Circ. Dep. Agric. Tanganyike, 23:1-5 (Mimeograph). 1128

Fusarium lateritium var. *uncinatum* was isolated from roots, collar and stems of pigeonpea. Reinoculation caused death of two seedlings.

WATERSTON, J.M. 1944.
Plant Pathology. Rep. Dep. Agric. Bermuda, 1943:7-8. 1129

Uromyces dolicholi new record and *Sclerotinia sclerotiorum* found for the first time on pigeonpea pods.

WEISS, F. 1945.
Viruses described primarily on leguminous vegetable and forage crops. Pl. Dis. Reptr (Suppl.) 154:32-80 (Mimeograph). 1130

A summary of available literature is presented and descriptions given of typical viruses occurring in the leguminosae. Notes on other viruses and similar diseases reported on the leguminous crops.

WIEHE, P.O. 1939.
Division of Plant Pathology. Rep. Dep. Agric. Mauritius. 1938:34-39. 1131

Pigeonpea wilt outbreak found due to *Gibberella fujikuroi* var. *subglutinans*.

WILLIAMS, F.J., K.S. AMIN, and B. BALDEV. 1975.
Phytophthora stem blight of *Cajanus cajan*. Phytopath. 65(9):1029-1030. 1132

A new stem blight disease of *Cajanus cajan* was first observed in experimental plots in India in 1966, and was epiphytotic at New Delhi in 1969. It is capable of causing widespread damage. Symptoms are dark brown to black lesions which partially or entirely encircle the stem at the base or on branches up to a meter above soil level. Rapid wilting of foliage occurs above the lesion. The pathogen appears to be a new species of *Phytophthora*.

WILLIAMS, F.J., J.S. GREWAL, and K.S. AMIN. 1968.
Serious and new diseases of pulse crops in India in 1966. Pl. Dis. Reptr 52: 300-304. 1133

Several diseases caused considerable reduction in yield of pulse crops in India during the 1966 season. Sterility mosaic of *Cajanus cajan* was prevalent in eastern

Uttar Pradesh. A new yellow symptom (probably of virus origin), and a new wilt (caused by a fungus), were seen on *Cajanus cajan* at New Delhi.

WILLIAMS, R.J., and D.J. ALLEN. 1976. Pigeonpea diseases. Grain legume training course. Pathology. 16 August to 26 November, 1976. IITA, Ibadan, Nigeria. 58 pp. 1134

Pigeonpea appears to be relatively disease-free in Africa. In Nigeria, the only disease of consequence is leaf rust, caused by *Uredo cajani* Syd. *Cercospora* leaf spot (*Cercospora cajani* Henn.) occurs at IITA. Virus-like symptoms are rare. In East Africa, *Fusarium* wilt, powdery mildew (*Leveillula taurica*) (Lev., Arn.) and a leafspot (*Mycovellosiella cajani* P. Henn. Rangel ex. Trotter) may occasionally assume economic importance.

WOLLENWEBBER, H.W. 1933 *Fusarium*-produced diseases of pigeonpea (*Cajanus cajan*). Arb. Biol. Anst. Reichsanst. Berl. 22:339-347. 1135

Expanded Latin diagnosis given of *Fusarium lateritium* Nees var. *uncinatum* WR. 1930 held in pure culture since its isolation from pigeonpea in 1905 by Butler, still pathogenic, giving a brown basal rot. This fungus only attacks pigeonpea and appears less serious than wilt caused by *F. udum*.

YOGESWARI, L. 1948. The element nutrition of fungi. I. The effect of boron, zinc, and manganese on *Fusarium* species. Proc. Indian Acad. Sci. (Sect. B) 28:177-201. 1136

Nutritional physiology of *F. udum* and other species was studied. Media with high C.N ratio were favored by the fungus. Optimum pH for growth was 5.0. Responded well to various concentrations of boron, zinc, and manganese. *F. udum* 0.5 ppm of B, Zn, and Mn was optimum. Higher concentrations were toxic. Combination of elements was better than individual elements alone.

PHYSIOLOGY

ABRAMS, R. 1960. Effect of gibberellic acid on dormant seed and subsequent crops of pigeonpea (*Cajanus cajan*). J. Agric. Univ. P. Rico 44(1): 21-27. 1137

Seed of commercial pigeonpea varieties (Kaki, Saragateado, and Florido) were soaked overnight in gibberellic-acid solutions, (0, 20, 30, 40, and 50 ppm) in order to determine the effect of the acid on plant height, flowering period, and yield. There were no significant differences in plant height between the three varieties that could be attributed to the gibberellic-acid treatments. Differences in flowering periods could not be attributed to the gibberellic-acid treatments, as such differences are of genetic origin. Gibberellic acid had no effect on yield of the green peas.

ADSULE, R.N., and G.K. BARAT. 1977. Occurrence of oxylyl-CoA synthetase in Indian pulses. Experientia 33(4): 416-417. 1138

The presence of oxalyl-CoA synthetase was observed in common edible pulses. Excepting in chickpea, the changes in oxalyl-CoA synthetase activity of winter pulses proceeded in stages. The enzyme remained more active in late strains than in early strains of winter pulses. The enzyme in summer pulses behaved differently from that in winter pulses. On the basis of activity of oxalyl-CoA synthetase, it is surmised that pea, chickpea, and lentil may be placed in one group, summer pulses (pigeonpea, soybean, green gram and cowpea) in a second group, and chickpea only in a third group.

AGARWAL, P.K., and J.L. KARIHALOO. 1975. Standardization of germination method for pigeonpeas (*Cajanus cajan*) seed. Seed Res. 3(1):21-25. 1139

Using seeds from only one region in India, it was found that a good method to effectuate germination is between blotting paper layers or in sand at 30°C. Seven abnormalities are described.

ANONYMOUS. 1951.
The root system of plants. Agronomico Campinas 3(3):1-3. 1140

Cajanus cajan: The maximum rooting depth observed was 2.95 m but 91% of the total root weight was found in the first 30 cm. Two-year-old plants growing 50 cm apart furnished the soil with a root weight of 14,968 kg per alqueire (6,160 kg/ha), of which 13,571 kg were found in the first 30 cm layer.

ANONYMOUS. 1970.
Report of the faculty of agriculture, University of the West Indies, 1967-68. Peroxidase activity in leaves of *Cajanus cajan*. 269 pp. 1141

Pigeonpea: Preliminary tests on mature leaves of *Cajanus cajan* indicate that dwarf cultivars show more peroxidase activity than tall cultivars.

ASANA, R.D., and M.N. SARIN. 1968.
Crop Physiology in India. Tech. Bull. 16 Indian Coun. Agric. Res. (Agric. Ser.). 1968. 98 pp. 1142

This review deals with a number of crops, cereals, and legumes including pigeonpea. Aspects considered include seed germination, dormancy, growth and development, mineral nutrition and uptake (N, P, K, micronutrients) growth regulators, salt tolerance, water relations (water requirement, drought resistance), vernalization and photoperiodism.

BALDEV, B., and S.K. SINGH. 1974.
Effect of TIBA on yield and photosynthetic enzyme in red gram. Curr. Sci. 41(4): 94-95. 1143

Seed yield was enhanced by TIBA application in Cv. BS1. The conc. 100 µg/ml gave the maximum yield increase of 21% over control. Also there was a gradual decrease in the activity of RUDP carboxylase enzyme with the increase of TIBA concentration. It is suggested that the action of TIBA needs further investigation.

BASU, R.N., T.K. BOSE, K. CHATTOPADHYAY, M.D. GUPTA, N. DHAR, C. KUNDU, R. MITRA, P. PAL, and G. PATHAK. 1975.
Seed treatment for the maintenance of vigour and viability. Indian Agric. 19(1):91-96. 1144

Soaking seeds of different crops (including pigeonpea) in water for 2 to 6 hours, followed by drying, significantly increased subsequent storage life under certain temperature and humidity conditions. A range of chemicals -- including salts such as NaCl, phenols, vitamins, and antipathogenic compounds -- added to the water in low concentrations (10^{-5} to 10^{-3}) gave further improvement in germinability.

CHEEMA, K.S. 1976.
Transport, distribution and utilization of 14_C photosynthate in arhar (*Cajanus cajan* L.). M.Sc. (1976) Thesis. G.B. Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh, India. 1145

DEKA, P.C., A.K. MEHRA, N.N. PATHAK, and S.K. SEN. 1978.
Isolation and fusion studies on protoplasts from pollen tetrads. Experientia 33(2):182-184. 1146

Pollen tetrads and pollen grains of *Cajanus cajan*, *Zea mays*, *L. cylindrica* and *L. esculentum* were treated with several different enzymes. After 4 h of treatment with 5% cellulose, about 80% protoplast isolation was obtained from pollen tetrads of *C. cajan* and *Z. mays* and about 60% from *L. cylindrica* and *L. esculentum*. When these mononucleate protoplasts were incubated in the presence of 0.05 M $CaCl_2$ in 0.3 M glucose at pH 10.5, 70 to 80% fusion was achieved.

DERIEUX, M. 1969.
Study about the formation and the evolution of the seeds of pigeonpea (*Cajanus cajan*). Proc. Caribb. Fd Crops Soc. 7:204-207. 1147

In the conditions of wet Guadeloupe, when blooming flowers were marked every day, a low rate of pod setting (10 to 12%) was noticed. The maximum weight of fresh pea is reached 27 days after flowering for the variety GI-54/3 of Trinidad and 29 days after flowering for the variety 249623 from India. At this stage the quality of the pea is quite good (29% dry matter for GI-54/3). The dry weight of pea reaches the maximum 38 days after flowering.

DERIEUX, M. 1970.
Research on seed setting and seed development in the pigeonpea. Proc. 7th Ann. Meet. C.F.C.S. Martinique - Guadeloupe 1969:204-211. 1148

About 10% of the flowers produced pods, pod length increased until the 11th day. The maximum size and maximum fresh weight

of the seeds were attained after about 28 days; the dry-matter percentage was then 29 and 37 respectively. A rapid decline in fresh weigh was seen after the 28th day. Dry-matter weight of the seeds continued to increase until the 38th day; a slight decline occurred in the next few days until full maturity.

DEY, P.M. 1973.
B.L. Arabinosid from *Cajanus cajan*. A new enzyme. Biochim. Biophys. Acta. 302(2):393-396. 1149

A new enzyme, B.L. Arabinosidase, has been detected in the dormant seeds of *Cajanus indicus*. This enzyme is different from α-galactosidase and does not hydrolyze an α-β-galactoside or an α-β-fucoside.

DEY, P.M., and M. DIXON. 1974.
Separation and properties of α-galactosidase and β-galactosidase from *Cajanus indicus*. Biochim. Biophys. Acta. 370:269-275. 1150

In *Cajanus indicus* α and β-galactosidase, which are inseparable by Sephadex gelchromatography, have now been separated by C.M. Cellulose chromatography. α-Galactosidase (EC 3, 2.1.22) has been resolved into isoenzymes and β-galactosidase (EC 3, 2.1.23) into three. Various properties of enzymes have been studied, each with its own characteristic features.

DUTT, B.K., and A.G. THAKURTA. 1937.
Investigations on the 'after ripening' of the seed (*Cajanus cajan*). Trans. Bose Res. Inst. 10(1934-35):73-91. 1151

DUTT, B.K., and A.G. THAKURTA. 1939.
Catalase activity of *Cajanus* seed at different stages: pre-resting, resting and post-resting. Trans. Bose Res. Inst. B: 93-103. 1152

Preresting seeds (i) were fresh before being dried, resting (ii), those that had been dried to less than 12% moisture; postresting (iii), those that had been steeped in water to various degrees. In (i), both catalase activity and respiration (O_2 absorption) dropped rapidly with decreasing moisture, although the two curves were not parallel. In (ii), there was some catalase activity but practically no respiration. In (iii), catalase increased regularly with increasing moisture above 10%, while respiration did not start to increase until moisture was 30%.

EZEDIMA, F.O.C. 1965.
Some factors influencing the production of grain legumes in Southern Nigeria. Proc. Agric. Soc. Nigeria. 4:48-50. 1153

Pigeonpea is intermediate in its nutritional requirements. Low yields are because of diurnal variations in temperature, heavy overcast, and high humidity during growing season or from daylength sensitivity. Local strains are preferred to higher yielding introduced varieties. Interplanting may affect yield and hamper effective control of pests. Pest control increases yields.

GHODKI, J.P., and P.V. SANE. 1974.
Study of photosynthetic and metabolic role of different nonleaf green tissues of plants. Proc. Symp. G.B. Pant Univ. Agri. Tech. Pantnagar, April 12-14: 764-774. 1154

The rates of fixation and distribution of CO_2 by fruits of red kidney bean (*Ph. vulgaris*), arhar (*C. cajan*), cotton, and peas are described.

GURURAJA RAO, G., and G. RAJESWARA RAO. 1978.
Salinity induced changes in keto acids in the leaves of pigeonpea. Indian J. Expl Biol. 16:270. 1155

Accumulation of phosphenol pyruvate and oxaloacetate was found in salinized plants, while pyruvate, glucozylic acid, and ketoglutarate accumulated in control plants in the first trifoliate leaves at five stages of development.

HAMMERTON, J.L. 1975.
Effects of defoliation on pigeonpeas (*Cajanus cajan*). Expl Agric. 11(3): 177-182. 1156

Mild manual defoliation of pigeonpea plants had little effect on pod number, pod weight, or number of seeds per pod in two experiments. The effects of severe defoliation depended on timing and differed between pigeonpea cultivars. Late severe defoliation reduced pod numbers in both experiments, but early and intermediate severe defoliation differed in their effects. Some physiological implications of these results are discussed.

HAMMERTON, J.L. 1975.
Effects of growth regulators on pigeonpea (*Cajanus cajan*). Expl Agric. 11(4): 241-245. 1157

The pod set of pigeonpea varieties widely grown in Jamaica may be as low as 2 to 4%. Treatment with ethephon (500 ppm) substantially increased pod numbers of a rust-susceptible cultivar by inducing leaf fall and a second flowering. The treatment reduced seed number per pod in both cultivars. Bg (2,300 ppm) increased pod number in the rust-resistant cultivar but reduced mean pod weight and seed number per pod.

HAMMERTON, J.L. 1977.
Predicting dry weights of pigeonpea plants from non-destructive measurements. J. Agric. Sci. Camb. 88(2):449-454. 1158

In experiments with six *Cajanus cajan* varieties grown in the field at one site, height and stem diameter was the most reliable character for predicting total dry weight.

HUXLEY, P.A., and R.J. SUMMERFIELD. 1976.
Photomorphogenetic effects of lamp type on growth of some species of tropical grain legumes in controlled environment growth cabinets. Pl. Sci. Letters 6(1): 25-33. 1159

Three cultivars of *Ph. lunatus*, two of pigeonpea, one of cowpea, and one of soybean were grown in growth cabinets with illumination from various types of lamps. Different responses to illumination were found both between species and between cultivars. Measurements of leaf area, number of main stem nodes and internode length were measured within 2 days of the beginning of flowering and the morphogenetic effects of the various types of lamp compared and the most suitable regime for individual cultivars determined.

INDRA RANI. 1966.
Studies on urease of *Cajanus indicus* and urease inhibitor of melon seeds. Ph.D. (1966) Thesis. Banaras Hindu University, Varanasi, Uttar Pradesh, India. 1160

ISTVAN, P., E. PENA GARCIA, and A. LEVIA SANCHEZ. 1975.
A study of growth and absorption of macronutrients in the first stages of development of pigeonpea (*Cajanus cajan*). Ciencias: Serie 10 Botanica 1:16. 1161

Pigeonpea seedlings were grown in solution culture under controlled conditions (25 ± 2°C, and 12-hr daylength), and data collected on the increase in length of stem and root and in leaf area, and on the uptake of water and K, Ca, Mg, N, and P, up to the age of 73 days.

ISWARAN, V. 1976.
Photoperiodic study on pigeonpea (*Cajanus cajan*). Fd Fmg Agric. 7(11):13. 1162

This study showed that pigeonpea (*Cajanus cajan*) also responded to the effect of daylength. Pigeonpea plants grown under long-day conditions produce more flowers and taller plants, compared with short-day treatments, and the yields are also higher. The outcome of the study shows that photoperiod and other factors also influence the flowering and fruiting in pigeonpea.

IYENGAR, A.K., and P.R. KULKARNI. 1975.
Modified method for isolation of verbascose from *Cajanus cajan* (red gram). Indian J. Expl. Biol. 13(3):307-308. 1163

A modified method has been developed to isolate verbascose from legumes. The production has been confirmed on the basis of its hydrolysis products, chromatographic characteristics and melting point.

JERMYN, M.A. 1975.
Precipitation reactions between components of plant tissue extracts. Aust. J. Pl. Physiol. 2:533-542. 1164

For the leguminous seeds, including *Cajanus cajan*, precipitation reactions occur between extracts of cotyledons and extracts of tissues of the parent plants, even of the tests of the seeds. The nature of these reactions appears to be the same as those of the inter-species ones. Both types of reaction may be examples of ways in which plant cells recognize self from nonself.

JERMYN, M.A., and Y.M. YEOW. 1975.
A class of lectins present in the tissues of seed plants. Aust. J. Pl. Physiol. 2:501-531. 1165

In legume seeds the major part of the specific glycoprotein lectin is concentrated in the intercellular spaces as distinct globular bodies. The purification and analysis of the glycoprotein from a selection of species is described. Hydroxyproline and glucosamine are present and the major sugars are galactose and arabinose. Neither the function of lectin nor the reasons for its extraordinary evolutionary stability is known. Lectins from *C. cajan* have been studied in more detail by physiochemical techniques.

KABI, J., and UMA DEVI. 1975.
Interaction of coumarin and light on the germination of the seeds of *Cajanus cajan*. Proc. Indian Sci. Cong. 62(3):92-93 (Abstract). 1166

Coumarin (1.0×10^{2}m) inhib ed germination of *Cajanus cajan* seeds and light had no reverse action on the inhibitory effects of coumarin. Amino acids increased in the axis of the control up to 72 and in the cotyledons up to 48 hours after soaking, whereas in the cou-treated, slight increase was found after 24 hours, followed by decrease. Sugars increased in the axis after 48 hours in the control and decreased gradually in the treated. The respiration rate was greatly enhanced after 48 hours in the control axis, whereas in the cou-treated ones the rate was slightly enhanced up to 24 hours followed by a decline. Coumarin showed similar inhibiting effects both in light and dark.

KANTA KUSUM, and D. PADMANABHAN. 1964.
In vitro culture of embryo segments of *Cajanus cajan* (L.) Millsp. Curr. Sci. 33(23):704-706. 1167

The responses of the radicle, the plumule, and the cotyledonary node are not identical. The phenomenon of apical dominance prevails even in the embryonal stages. The differentiation of primary xylem takes place independently in the plumule (endarch), the cotyledonary node (transition), and the radicle (exarch). The destiny of the organs has already been determined.

KATHJU, S., and M.N. TIWARI. 1968.
Nuclear distribution of acid phosphatase in *Cajanus indicus* Spreng. Curr. Sci. 37(3):83-84. 1168

The autonomous cytoplasmic inclusions, namely lysosymes and mitochondria, which were supposed to be the only centers of the enzyme activity did not indicate any activity. The reports about the distribution in nucleus and nucleoli appear to be more convincing for the cells of the radicle of the seedlings of *Cajanus indicus*.

KAUL, C.L., and S.P. SINGH. 1967.
Effects of some growth regulators with gametocidal properties on *Cajanus cajan* (L.) Millsp. Indian J. Agric. Sci. 37:69-76. 1169

Maleic hydrazide, FW-450, and coumarin, each applied as foliar sprays of 0.5%, 1%, and 1.5% concentrations, induce male sterility but reduce the yield. The 1% solution of FW-450 applied before floral-bud initiation induces 100% pollen sterility with minimum reduction in yield.

KHAN, M.A., R.P. CHANDOLA, and P.C. TYAGI. 1973.
Laboratory germination tests on arhar (*Cajanus cajan* (L.) Millsp.). Raj. J. Agric. Sci. 4(1):25-27. (From Indian Science Abstracts 12,965). 1170

The temperature in the germinating chambers was alternated 8 hours 20°C and 16 hours 30°C. Dehradun paper and roll paper towel gave equal results, slightly higher than in sand. Seeds were counted after 6 days and final count was after 13 days. The germination was constant at 25°C and 30°C. 35°C temperature gave slightly higher germination.

MADHAVA RAO, K.V. 1970.
Some aspects of protein and nucleic acid changes during seed development and germination of pigeonpea (*Cajanus indicus* Spreng). Ph.D. (1970) Thesis. Sri Venkateswara University, Tirupati, Andhra Pradesh, India. 1171

MADHAVA RAO, K.V., and G. RAJESWAR RAO. 1974.
Gibberellin-like substances in developing and germinating seeds of pigeonpea (*Cajanus indicus* Spreng). Indian J. Pl. Physiol. 17(1-2):65-72. 1172

The developing and germinating seeds of *C. indicus* (*Cajanus cajan*) contained one neutral and one acidic fraction of gibberellin-like substances. The low activity of these substances in developing seeds at 10 days after anthesis increased up to 30 days after anthesis and decreased thereafter except for the neutral ethyl acetate fraction (NEAF). Their high activity at the 4th day of germination decreased up to the 10th day after germination and increased in roots and seedlings with age; the acidic ethyl acetate and acidic chloroform fractions showed a higher gibberellin-like activity than NEAF and acid butanol fractions at all stages of germination.

MADHAVA RAO, K.V., and G. RAJESWAR RAO. 1974.
Protein and nucleic acid metabolism of developing and germinating seeds of pigeonpea (*Cajanus indicus* Spreng). J. Indian Bot. Soc. 53(3-4):249-260. 1173

Protein and nucleic acid metabolism of the developing and germinating seeds of *Cajanus indicus* Spreng were studied. Proteinase and rNase activities in developing and germinating seeds were also analyzed for total protein and RNA contents. The rate of protein synthesis associated with different organs were also studied using 14C-L-leucine. The results are discussed in relation to the physiological function of each organ.

MADHAVA RAO, K.V., and G. RAJESWAR RAO. 1975.
Growth, respiration and endogenous auxins of developing and germinating seeds of pigeonpea (*Cajanus indicus* Spreng). Seed Res. 3(1):1-10. 1174

It was observed that the maximum dry weight of the seed preceded the maximum amounts of respiration and endogenous auxins, indicating their involvement and utilization during synthesis and accumulation of reserve substances in the embryo. A close correlation between the rate of respiration and endogenous auxins was also observed in the germinating seed. Throughout, the RF regions corresponding to IAA and IAN synchronized with the stages of growth and development, indicating their close association with these processes.

MALHOTRA, O.P., and INDRA RANI. 1969.
Purification and properties of urease of *Cajanus indicus*. Indian J. Biochem. 7(1):15-20. 1175

Urease from *C. indicus*, its ultraviolet absorption spectrum, and thermal denaturation are described. Urease is inhibited at high substrate concentrations in Tris-acetic acid buffers. Alkali metal and nitrate ions also inhibit the enzyme. It has been concluded that the substrate (Urea) binds to the enzyme through hydrogen bonding, which involves urea protons.

MALHOTRA, O.P., and INDRA RANI. 1970.
Kinetic behavior of urease of *Cajanus indicus*. Indian J. Biochem. 7(3): 162-166. 1176

Cajanus urease is inhibited by Hg^{2+}, pcMB, cu^{2+}, N-ethylmaleimide and iodoacetamide. This inhibition is noncompetitive (k^{i} for Hg^{2+} = 1.6 x 10^{-8}M). The SH content of *Cajanus* urease has been estimated by amperometric titration with Ag^{+} ions at room temperature in the native and denatured states. On the basis of the SH content, the minimal molecular weight of enzyme is found to be 450,000 with 3 readily accessible and 11 masked SH groups. The latter react after denaturation only.

MEHTA, B.V., and P.D. KHATRI. 1962.
Accumulation and movement of minerals in pigeonpea (*Cajanus cajan* Millsp.) plant. J. Maharaja Sayajirao Univ. Baroda. II:109-122. 1177

At all stages of growth, calcium and magnesium are greater in the leaves than other organs, and seeds are richer in nitrogen, phosphorus, and potassium than other tissues. The nutrients exported in a crop producing 1630 lb/ac (1825 kg/ha) of dry matter were N = 29 lb (13.15 kg); P = 9 lb (4.08 kg); K = 10 lb (4.5 kg); Ca = 12 lb (5.4 kg); and Mg = 5 lb (2.2 kg).

MISHRA, D., and S.K. MOHANTY. 1966.
The effect of B-Nine (N-dimethyl amino succinamic acid) on the shoot growth of *Cajanus cajan*. Curr. Sci. 35:340-341. 1178

B-9 at the highest concentration (0.50%) is definitely inhibitory to the shoot growth of arhar. The cause of shoot retardation in the treated plants may be either an inhibition of cell division or a reduction in the number of cells.

MISHRA, D., and S.K. MOHANTY. 1966.
A note on the response of crop seeds to pre-sowing treatment with B-Nine. Trop. Agric. (Trinidad) 43:347-349. 1179

Seeds of a number of crops including pigeonpea were soaked for 24 hr in 0.125, 0.25, and 0.5% solution of B-9 (N-dimethyl-amino succinamic acid) and then germinated. The inhibitive effect of B-9 was evident in all plants under trial: 0.5% solution reduced the length of seedlings by 25% to 50%, depending on species and cultivar. Rice and finger-millet were affected less than other crops.

MITRA, P., and S. BANERJEE. 1958.
Studies on the effect of germination on strepogenin contents of pulses. Indian J. Med. Res. 46:492-495. 1180

Strepogenin was estimated in six pulses and in casein with *Lactobacillus casei* as test organism. *Phaseolus radiatus*, *Ph.mungo*, and *Pisum sativum* contained more strepogenin and *Cajanus indicus*, *Lens esculenta*, and *Cicer arietinum* less strepogenin than casein; for 48 hours after germination, values for the pulses were all less than for casein.

MUKHERJEE, D. 1974.
Keto-acids and amino acids changes in leaves, flowers and fruits of *Cajanus cajan*. J. Indian Bot. Soc. 53(1-2): 115-118. 1181

Correlative studies on changes in keto acids and free amino acids and amide have been made in leaves, flowers, and fruits of *Cajanus cajan*. The concentration of keto acids has been found to be much higher than the quality of amino acids in these parts. These metabolites, especially keto acids, are readily used up during the transformation of vegetative into reproductive phase and other active growth periods of the plant.

MULIMANI, V.H., and MADAIAH. 1974.
Studies in urease EC-3.5-1.5, distribution of Urease in plant, seeds/*Cajanus indicus*, *Cucumis sativus* dry imbibed seeds synthesis. J. Karnataka Univ. 19:176-183. 1182

NATH, R.L. 1960.
Action of urease from *Cajanus indicus* on blood urea *in vivo*. J. Proc. Inst. Chem. 32(4):165-167. 1183

A highly soluble preparation was made of urease from *C. indicus*. This preparation when injected intravenously into dogs showed that the average lowering of blood urea was about 28% in 45 minutes.

NATH, R.L., and T.K. PRADHAN. 1960.
Note on the study of Urease from *Cajanus indicus* (Arhar). Bull. Calcutta Sch. Trop. Med. 8(2):59-60. 1184

Urease was prepared from dehusked seeds by various methods. The activity at 37°C, determined by the method of Nath and Ullah, was almost 1.6 times higher than that at 30°C. The highest activity was obtained when extraction was carried out with 40% ethanol. Products from acetone preparations were more soluble in water than those from ethanol preparations. At lower concentrations there was deviation from the first order law, which could be explained by inhibition by NH_4+ from $(NH_4)_2\ CO_3$ formed by the hydrolysis of urea.

NATH, R.L., and T.K. PRADHAN. 1960.
A study on urease from *Cajanus cajan* Linn. Millsp. Part III. Crystallization. Ann. Biochem. Exp Med. 20(5):127-130. 1185

Extraction of the crude powder with water, acetone, or ethanol followed by precipitation with various concentrations of ethanol or acetone were tried. Best crystallization was achieved, but in poor yield, by extraction with 40% ethanol and precipitation with an equal amount of absolute ethanol. The enzyme appears to be completely specific for urea.

NATH, R.L., and T.K. PRADHAN. 1960.
A study on urease from *Cajanus cajan*. IV. Kinetic study with crystalline urease. Ann. Biochem. Expl Med. 20:157-164. 1186

The optimum pH was found to be 7.2 to 7.5 at substrate concentrations of 0.01 to 0.05 M and 7.4 to 7.6 at 0.5 M. A pH higher than optimum favors enzyme-substrate complex formation while lower pH favors decomposition of the products.

NATH, R.L., and T.K. PRADHAN. 1964.
Effect of versene on the activity of urease from red gram. *Cajanus cajan*. J. Proc. Inst. Chem. 36(3):188-191. 1187

PALIWAL, K.V., and G.L. MALIWAL. 1973.
Salt tolerance of some arhar (*Cajanus indicus*) and cowpea (*V. sinensis*) varieties at germination and seedling stages. Ann. Arid Zone 12(3-4):135-144. 1188

The effects of different salinity levels at various concentrations of NaCl + $CaCl_2$ on 23 *C. indicus* varieties, and 13 varieties of *V. sinensis*. Increased salinity reduced germination percentage and seedling height in all varieties but significant varietal differences in salt tolerance were noted.

PANDEY, R.K., and M.C. SAXENA. 1974.
Morphological considerations in the development of efficient plant types of arhar and gram. Proc. 2nd General Cong. SABRAO, New Delhi, India. 1012-1015. 1189

The vegetative and reproductive phases in ideal types of *Cajanus cajan* and *Cicer arietinum* are considered in relation to photosynthesis and respiration. *C. arietinum* is also considered in relation to frost and salinity resistance.

PANDEY, R.K., M.C. SAXENA, M.H. KALUBARME, V.B. SINGH, and V.V.S.S. PRASAD. 1976.
Genotypic variations in photosynthetic rate and respiratory losses in some grain legumes. Pl. Biochem. J. 3(1):72-80. 1190

The relative rate of photosynthesis (RRP) in *Cajanus cajan* cultivars, as measured by 14 CO_2 fixation ranged from 100% in cv. Pant A-3 to 126% in cv. UPAS-120. $^{14}CO_2$

fixation was not related to specific leaf weight. Respiratory losses during 20 days after exposure were 63% in seedlings of UPAS-120 and 51% in Prabhat. The RRP in 13 *Vigna aureus* cultivars ranged from 100% in LM-646 to 196% in LM-205. The translocation of 14_C from leaves, stems, and petioles to reproductive organs and seeds increased with age. The RRP in 20 *Cicer arietinum* cultivars ranged from 100% in S-330-1 to 224% in L-550. Pods and stem made a considerable contribution to photosynthesis.

PANDEY, S.N. 1975.
Effect of planofix (α-NAA) on flower abscission and productivity of arhar (*Cajanus cajan*) and soybean (*Glycine max* (L.) Merrill). Pesticides 9(9):42-44. 1191

This experiment showed clearly that crops differ in specific requirements of hormones for minimizing abscission, and for maximum production of biomass and grain yield. Low concentrations (10 to 30 ppm) were found effective in at least two phases of growth in both the legumes tried. On the other hand, high concentrations (40 to 80 ppm) were effective at the first phase of growth.

POKLE, Y.S. 1974.
Foliar abnormality in first foliage pairs of *Vigna catjang* and *Cajanus cajan*. Nagpur Agric. Coll. Mag. 47:88-90. 1192

A plant with three first foliage leaves was found in *Cajanus cajan*. The progeny raised from the selfed seeds of these plants was found to possess normal first foliage leaves, indicating that the plant was not a mutant. A temporary reversion of a gene or polygene block governing the leaf character may have promoted development of extra foliage.

PRADHAN, T.K. 1963.
1. Studies on urease from *Cajanus indicus*, arhar, and 2. studies on phosphate from *Phaseolus vulgaris*, French bean. Ph.D. (1963) Thesis. University of Calcutta, West Bengal, India. 1193

PRESTON, N.W. 1977.
Cajanone: an antifungal isoflavanone from *Cajanus cajan*. Phytochem. 16(1): 143-144. 1194

Description of molecular structure of *cajanone* is given. *Cajanone*, isolated by TLC from a methanolic extract of direct, milled pigeonpea roots, totally inhibited germ tube growth of *Fusarium oxysporum* f. sp. *udum*. The pigeonpea wilt pathogen, at 50 ppm *in vitro*.

RACHIE, K.O., and T.N. KHAN. 1972.
Effect of various drying and freezing treatments on the viability of some grain legume seeds. SABRAO Newsletter 4(2): 79-84. 1195

The viability of seed following storage at subzero temperatures appeared to depend on the moisture content of seed. It was shown that legume seeds need not have greater moisture content than cereal seeds to withstand storage at subzero temperatures, a factor important to the long-term storage of grain legume seeds.

REDDY, P.R., L.V. SUBBA RAO, and MADHUSUDHAN RAO. 1978.
Nutritional disorders in pigeonpea (*Cajanus cajan* (L.) Millsp.) cv. HY-3C and remedial measures. Sci. Cult. 44(1):36-37. 1196

Among these mineral deficiencies, Zn deficiency was found to be predominant over calcium and boron. A combined nutritional spray of zinc sulfate, calcium nitrate, and boraz at 0.2% concentration each at weekly intervals for two times is recommended to overcome these deficiencies.

RIOLLANO, A. 1964.
Effects of photoperiodism and other factors on the improvement of pigeonpea varieties. J. Agric. Univ. P. Rico 48:232-235. 1197

In Puerto Rico, where the annual daylength variation is no more than 2 hours, the early, highest yielding varieties of *Cajanus cajan* flower and produce most heavily under the shorter day conditions, but only one generation can be produced in a year. Under controlled 8-hr photoperiods, it has been found that two generations can be produced each year and it has been suggested that this technique could be used to accelerate breeding.

SEN GUPTA, J.C. 1955.
The physiology of growth and development of some crop plants. Bull. Bot. Soc. Bengal. 9:62-80. 1198

SETHUNATHAN, N. 1970.
Foliar sprays of growth regulators and Rhizosphere effect in *Cajanus cajan* Millsp. 2. Qualitative changes in the rhizosphere and certain metabolic changes in the plant. Pl. Soil 33(1):71-80. 1199

Sprays affected the percent distribution of individual species in the rhizosphere of *C. cajan*. Sprays of 2-4-D, NAA, and IAA-promoted starch hydrolyzing group, sprays of MH and gibberellin reduced their incidence. Suggested that transport and accumulation of carbohydrates in the roots might limit the incidence of this group of bacteria in MH-and gibberellin-treated plants. The results are discussed with reference to metabolic changes in the plant.

SHAMA RAO, H.K., and S. NARAYANASWAMY. 1975.
Effect of gamma irradiation on cell proliferation and regeneration in explanted tissues of pigeonpea (*Cajanus cajan* (L.) Millsp.). Radiat. Bot. 15(3):301-305. 1200

Seeds exposed to 5 Krad produced a cluster of adventitious roots on a callusing medium, while hypocotyl explants of germinated seedlings from similar seeds produced abundant calluses, which on a differentiating medium, regenerated shoot buds and plantlets. Only calluses derived from seeds exposed to 5 Krad differentiated plantlets. However, callus tissues derived from the 5-Krad treatments were friable and released protoplasts readily and in large numbers on enzymatic digestion of the cell walls of cells grown as suspensions. Mesophyll cell protoplasts obtained from the tissue-culture-induced plant showed spontaneous adhesion and fusion.

SHARMA, D.P., and M. STREIL. 1977.
Phytosterols, triferpincid and other lipidic constituents from *Cajanus cajan* (L.) Millsp. leaves. Czechoslavak chemical communications 42:2448-2451. 1201

SINGH, A., and A. PAL. 1963.
Role of manganese in the growth of root and shoot of *Cajanus cajan*. Proc. Nat. Acad. Sci. India (Sect. B) 33(4):571-582. 1202

Morphogenetic effects of increasing dosage of manganese on the light-avoiding and light-loving parts of *Cajanus cajan* (Type 1) plants under constant supply of iron at 0.07 ppm in each case have been recorded. Manganese deficiency series has also been included. Increased supply of manganese stimulated ramification of roots. In linear growth, manganese supply of 2.5 ppm (Mn. Fe. 32:1) proved deleterious for shoot as well as root; the normal supply (0.01 ppm, Mn. Fe. 1:7) proved optimum. Dry matter production of both shoots and roots increased with increase in Mn. supply. Widest Mn/Fe ratio of 32:1 proved optimum for the reducing and nonreducing sugars of the shoots, and only nonreducing sugar of the root; for reducing sugar content of the root, the ratio 1:7 proved optimum. The accumulation of larger number of amino acids in the shoot of the manganese-deficient plants was evidenced.

SINGH, A., and A. PAL. 1964.
The influence of molybdenum on the growth of root and shoot of *Cajanus cajan*. Proc. Nat. Acad. Sci. India (Sect. B) 34: 142-152. 1203

The differential response of molybdenum on the light-loving and light-avoiding parts of *Cajanus cajan* was investigated under controlled pot-culture conditions in diffused daylight. Branching of shoots remained unchanged under the various molybdenum levels, though the roots behaved differently with the dose of supply. While Moa treatment proved optimum for the rate of elongation of both the shoot and the root, the Mo was least conducive. Dry matter accumulation of shoots remained stationary under the Mob level of supply. For reducing sugars of both shoots and roots, Mob treatment proved optimum. Mo deficiency resulted in decrease of free amino acids in shoot. With age, glutamic acid content was depressed, irrespective of the level of Mo supply. Maximum level of molybdenum helped in the maximum accumulation of histidine and lysine at 41 days. A large number of unidentified amino acids also developed in the Mob treatment.

SONAVNE, K.M. 1928.
Longevity of crop seeds. Part I. Agric. J. India 23(4):271-276. 1204

Sixteen farm-grown crops were examined to ascertain longevity of crop seeds in storage. Seeds were stored in sealed glass bottles with a naphthalene ball in each. Germination tests were carried out indoors in the laboratory by simple methods. The studies showed that with the exception of groundnut, and to a lesser extent, bajra (germination percentages 23.8 and 61.2 respectively in the fifth year), the crop seeds tested lost little viability over 5 years. Tur (*C. cajan*) showed 87.1% germination. The "hard seed" of pulses (seeds that fail to germinate immediately after the sowing to freshly harvested seed) tested lost this hardness within a year of harvesting and storage.

SONAVNE, K.M. 1934.
Longevity of crop seeds. Part II. Agric. Live-Stk. India 4(3):287-292. 1205

Studies showed that legume seeds stored in sealed glass bottles, with a naphthalene ball in each, remained viable even after 12 years of storage in some cases. After 7 years' storage, the germination percentage for pulses (except Kabuli gram, which gave only 42% germination), ranged from 55 to 99 (61% for *C. cajan*).

SOOTHA, G.D., and S.K. GUPTA. 1976.
Electron spin resonance study of manganese (ii) and free radical in pulses. Indian J. Biochem. Biophys. 13(3):304-305. 1206

In electron spin resonance (ESR) spectra of ground and unground samples of pigeonpea and other pulses, six resolved hyperfine components of different line widths due to Mn^{2+} ions and one narrow line due to a free radical (not identified) were observed. Mn^{2+} ions were found only in the inner seed tissues, but the free radical occurred only in the outer coat and was thought to play a role in seed dormancy and storage stability.

SPENCE, J.A., and S.J.A. WILLIAMS. 1972.
Use of photoperiod response to change plant design. Crop Sci. 12(1):121-122. 1207

In Trinidad, pigeonpeas are usually sown with relatively wide spacing in May-June when tall indeterminate cv. grow to 2.5 m and dwarf determinate cv. to 1.5 m, necessitating hand harvesting because of their height and woody stems. By planting dwarf determinate cv. in December, so that the plants were immediately subjected to flower, inducing short days, small plants about 1 m tall were produced, which could be harvested mechanically. With a population of 165,000 such plants/ha a seed yield of 2.5 t/ha was obtained, which compares favorably with the commercial yields of tall cv. grown at about 6,600 plants/ha.

SUBRAMANIAN, V., A. MANICKAM, and G. PADMANABHAN. 1976.
Biochemical changes during early germination of red gram, *Cajanus cajan* (L.) seeds. Indian J. Expl Biol. 14(6): 736-737. 1208

Carbohydrate content of cotyledons decreased initially followed by further rise, while in embryonic axes, the quantity increased initially followed by a reduction and further increase. The sugars content of embryos increased up to 3 days, while in cotyledons the increase was up to 2 days only. The protein content of cotyledon decreased and the amino acids increased for 3 days followed by a decrease. The amino acids decrease. The amino acids decreased in embryonic axes; while the protein increased initially followed by a decrease thereafter.

SUMATHI, S., and T.N. PATTABHIRAMAN. 1976.
Natural plant enzyme inhibitors. 2. Protease inhibitors of seeds. Indian J. Biochem. Biophys. 13(1):52-56. 1209

Seeds of nine legumes, including red gram, were screened for inhibitory activities. Inhibitory activity against trypsin was stronger than activity against chymotrypsin, and sword bean showed comparable activity against all three proteases. The inhibitory activities were generally more thermolabile under acidic conditions.

SUMMERFIELD, R.J., P.A. HUXLEY, and F.R. MINCHIN. 1977.
Plant husbandry and management techniques for growing grain legumes under simulated tropical conditions in controlled environments. Expl Agric. 13(1):81-92. 1210

Offers practical solutions to problems incurred in growing cultivars of cowpea, soybean, lima bean, and pigeonpea under simulated tropical conditions in controlled environments namely (i) 'Saxcil' growth cabinets in which daylength, day and night temperatures, light intensity and quality, Rh and CO_2 concentrations were precisely controlled and could be varied over time; (ii) compartmentalized glasshouses and adjoining dark compartments where daylength and day and night temperatures were automatically controlled and night-break illumination could be provided, and (iii) heated plastic-film houses simulated the environment of wet tropics in all respects except daylength, for growing daylength-insensitive tropical legumes to maturity during the UK summer months.

TAITT, E.G., and J.A. SPENCE. 1976.
The micro meteorology of a pigeonpea stand. Agric. Meteor. 17(3):205-210. 1211

Data are presented on the microclimate above the crop canopy of a large stand of pigeonpea (*Cajanus cajan*) growing at the field station of the University of the West Indies, Trinidad. There are also additional data on certain physiological parameters -- stomatal resistance and leaf water potential -- and complementary data

from potted plants whose soil moisture was controlled.

THAKURTA, A.G., and B.K. DUTT. 1938.
Investigation on the oxygen consumption of the seed of *Cajanus*. Trans. Bose. Res. Inst. 11(1935-36):39-53. 1212

VAMADEVAN, V.K., S. NAYAK, C. SREEDHARAN, and B.K. MANDAL. 1973.
Studies on sunlight illumination profile in different crops. Annual report, CRRI, Cuttack. 1973. 1213

Data on sunlight illumination profiles measured at the flowering stages in maize, red gram, wheat, kenaf, mustard, rice bean, sweet potato, sunnhemp, French bean, and peas are given. Rice bean (*V. umbellata*) was the most efficient utilizer of solar energy.

VARADARAJAN, T., and J. SAKHARAM RAO. 1973.
Effect of temperature pre-treatment on the ascorbic acid content in germinating *Cajanus cajan* (L.) red gram. Madras Agric. J. 60(5):339. 1214

The ascorbic acid content of red gram was found to be accelerated at lower temperatures round about 30 to 40°C.

VEERASWAMY, R. 1959.
Fasciation of shoots in redgram (*Cajanus cajan* Mill.). Madras Agric. J. 46(7): 276-277. 1215

First record of fasciation in pigeonpea type Anand-4B. The characteristics of the fasciated shoot are described. It is suggested that fasciation is a physiological phenomenon.

VENKATARAMAN, K., and K. MEENAKSHI. 1962.
Activation of dormant meristems in the cotyledonary axils of *Cajanus cajan* Linn. Millsp. Madras Agric. J. 49(1):32. 1216

The germination of the seed in *C. cajan* (Linn) Millsp. is hypogeal. There were meristematic tissues in the axils of the cotyledons, remaining latent under the suppressive influence of the primary shoot. Apical dominance has been reported.

VENKATASUBBAN, A., R. KARNAD, and N.N. DASTUR. 1936.
Urease activity of germinating seeds. Proc. Indian Acad. Sci. (Sect. B) 4:370-375. 1217

The urease activity of extracts of germinated seeds of *Glycine hispida, Dolichos biflorus, Canavalia,* and *Cajanus indicus* were higher than those of ungerminated seeds. The activities of the powdered germinated seeds were somewhat lower than those of the ungerminated seeds. This difference between extracts and powders indicates that germination merely increases the solubility of the urease.

VISWANATH, B. 1917.
Some enzymes of germinating red gram (*Cajanus indicus*). Agric. J. (Special Indian Sci. Cong. No.) 12:109-116. 1218

An aqueous extract of the germinated dhal possesses the properties of an ereptase, amylase, cytase, maltase, sucrase, oxidase, lipase, and urease. No peptase is present in the normal seed. Hydrolysis of the reserve protein takes place at a much later stage in germination, whether this hydrolysis is due to protoplasmic activity or to the secretion of a separate enzyme in the course of germination is still doubtful.

UTILIZATION

ABBAS, M. 1934.
The preparation of Thiruppathur Dhall (from *Cajanus cajan*). Madras Agric. J. 22(7):245-248. 1219

Two methods--commercial and ordinary-- of dhal preparation are discussed. In the commercial method, a surplus of water soaks into the gram, making it bulge; when dried, the gram shrinks, becomes light, and assumes a boat shape with a depression in the middle. In the ordinary method, only the required quantity of water is used and the dhal does not shrink but weights more. This dhal is known as Getti parupu, while the commercially prepared dhal is known as Thatti parupu. Variations in soil conditions also affect the quality of dhal.

AGUIRRE, E.F., and M.A. VALDIVIA. 1941.
Cajanus indicus as a forage plant. Agricultura Mod. Habana 2(1):148-150. 1220

ANANDASWAMY, B., P. GOPINATH, S. KUPPUSWAMY, and N.Y.R. IYENGAR. 1970.
Package and storage studies on precooked and dehydrated rice and tur dhal (*Cajanus cajan*) is consumer package. J. Fd Sci. Technol. 7:43-45. 1221

Results of a study on packaging and storage of precooked and dehydrated rice and tur dhal (*Cajanus cajan*). Using a consumer package consisting of a double pouch--an inner pouch of regenerated cellulose film (300 MST) and an outer pouch of polycell--gave the precooked and dehydrated rice and tur dhal a shelf life of 80 days under accelerated conditions of storage at 37°C and 90% RH.

ANONYMOUS. 1947.
Report of the University of Hawaii Agricultural Experiment Station for the biennium ending June 30, 1946. 157 pp. 1222

Investigations showed that *C. cajan* is a good feed stuff for a range of domestic animals and it has been found useful in swine production and for dairy cattle.

ANONYMOUS. 1948.
Report of the University of Hawaii Agricultural Experiment Station for the biennium ending June 30, 1948. 171 pp. 1223

C. cajan as a grazing crop has the disadvantage of poor survival. Grazing swine entirely uprooted the stands. Even with more lenient grazing by cattle, severe breakage often necessitated stand renewal after every 3 to 5 years. The effective overall grazing duration suggested is 3 years.

ARAULLO, E.V. 1974.
Processing and utilization of cowpea, chickpea, pigeonpea and mungbean. Interaction of agriculture with food science. Proc. interdisciplinary symposium, 1974. 131-142. 1224

AYKROYD, W.R., and J. DOUGHTY (EDITORS). 1964.
Legumes in human nutrition. FAO Nutritional Studies No. 19. Rome; FAO. 138 pp. 1225

The monograph gives an account of the grain legumes and their contribution to human diets and nutrition, based on the available technical literature. It also deals with measures to increase production and consumption of this group of foods. This is intended for agronomists, doctors, nutritionists, dietitians, community development workers, school teachers, and popularizers. The information will also be of value in developing programs to influence the dietary habits of people and to increase the production and consumption of grain legumes, which offer, in many countries, the most feasible means of attacking protein malnutrition.

BARLOW, J.W. 1971.
Color stabilization of peas. United States Patent 3583, 873. 1226

The natural green color of pigeonpeas is stabilized by treatment in the presence of water with compounds capable of yielding SO_2 at pH of 6.0.

BELOSLUDCEVA, N.G. 1962.
Pigeonpea - a new plant material for obtaining native shellac. Tr. Prikl. Bot. Genet. Selek. (USSR) 34(1):197-203. 1227

Describes 24 cultivars of *Cajanus indicus* obtained from India and elsewhere. Some of the early maturing forms would, it is thought, be suitable for cultivation in the Soviet Union.

BENEZRA, M.V., and M.A. BARROETA. 1953.
A preliminary investigation of Quinchoncho (*Cajanus indicus*). Revta Fac. Agric. Univ. Cent. Venez. 1(2):211-215. 1228

The protein content of the meal from *Cajanus indicus* cut after 60 days was higher, and the crude fiber content lower than that of good alfalfa leaf meal. Protein increased and in crude fiber, ash, fat, and Ca decreased with the density of cultivation. The meal from flowering plants (120 days old) was inferior to that from plants 60 days old.

BODDY, M. 1971.
Who needs poetry when you have got some pigeonpeas? The Sunday Australian. 19 Sep. 1971. 1229

An Australian columnist recollects that *C. cajan* pea dishes have long been familiar in the European diet, particularly in the north of England.

CARMEN MURO, J. 1956.
Ramie as a protein forage. Bol. Trim. Exp. Agropec. 5(2):20-24. 1230

The protein content of ramie (*Bochmeria nivea*) is less than that of alfalfa (*Medicago* spp.) but higher than that of

soys (*Glycine soja*), pigeonpea (*Cajanus indicus*), and guineagrass.

CHAUDHARI, R.M. 1936.
A note on the preparation of dhal (Pulse) from tur (*Cajanus cajan*) grain. Poona Agric. Coll. Mag. 28(1):30-32. 1231

DATE, W.B. 1955.
Antioxidant property of some legume flours. Sci. Cult. 21:106. 1232

Comparative contributions of antioxidant by different legume flours in a sweet product were studied. None of the samples developed any rancidity at the end of 2 months. Only the Bengal gram flour sample developed some rancidity after 4 months. Bengal gram has the least keeping quality, a fact supported by the phospholipid content figures of these flours.

DHILLON, R.S., A. SINGH, and A.S. PARMAR. 1970.
Studies on the establishment of young mango grafts with various green shelters. Pb Hort. J. 10(3-4):213-221. 1233

The field establishment of young mango grafts in the marginal climatic conditions of the central Punjab was considerably helped by planting banana suckers to provide shelters. Almost 90% of the plants survived, compared with 62% under *Sesbania aegyptiaca* and 54% under *Cajanus indicus*.

DRAPER, C.I. 1944.
Algaroba beans, pigeonpeas, and processed garbage in the laying mash. Hawaii Agric. Exp. Stn Prog. Rep. 44. 1234

The seed of *C. cajan* is not commonly used in feeding young chickens, incorporating it into the rations of pullets was found beneficial as it was not toxic to the poultry.

ELLIOT, W. 1862.
On the farinaceous grain and the various kinds of pulses used in Southern India. Trans. Proc. Bot. Soc. Edinb. 7:276-300. 1235

The pigeonpea plant is known by many names. In India *Cajanus indicus* flavus is termed (according to Elliot) adhaki, tuvarai, kandu. The pulse when split is in great and general esteem, and forms the most generally used article of diet among all classes.

GAYWALA, P.M. 1938.
The cultivation of *Cajanus cajan* and the methods of preparing marketable Dhal. Trop. Agric. Ceylon 60(1-6):212-221. 1236

A close observation and study of the conditions under which *Cajanus cajan* is cultivated in India indicates that some varieties are capable of successful cultivation for seed production in the dry parts of Ceylon. The small-scale processes of dhal-making described here are fairly simple and do not require expensive outfits. The requisite number of dry sunny days are available in the dry zones for the preparation of dhal. The local consumption of dhal in Ceylon is considerable. Under the circumstances it is quite possible with some effort and attention to produce good quality dhal for local consumption. The crop itself is likely to prove an important rotational crop or an appropriate mixed crop in the village agriculture of this country, while the preparation of dhal offers an opportunity of being taken up as a new and profitable cottage industry in the dry zone.

GRUBBEN, G.J.H. 1970.
Observations on living supports, hedges and climbing plants in domestic enclosures in South Dahomey. Commun. Found. NEDERF. Amsterdam. 17 pp. 1237

Family kitchen gardens in Dahomey are often surrounded by palisades made from palm leaves supported by living plants. Eight such plants are here described and illustrated. *Cajanus cajan* is among the commonest hedging plants listed here. The illustrated descriptions of these plants include information on planting, and their value for shade, food, or medicinal purposes.

HENKE, L.A. 1943.
Roughages for dairy cattle in Hawaii. Hawaii Agric. Exp. Stn Bull. 92. 1238

The utility of *C. cajan* as a forage for dairy cattle in Hawaii was demonstrated when podded green tops fed to cattle gave higher milk production than alfalfa gave.

HENKE, L.A., S.H. WORK, and A.W. BURT. 1940.
Beef cattle feeding trials in Hawaii. Hawaii Agric. Exp. Stn Bull. 85. 1239

Studies on the suitability of *C. cajan* as a feedstuff for beef cattle in Hawaii showed that the forage was valuable for beef

grazing and fattening and also for swine production.

HERRERA, P.G., and L.V. CROWDER. 1963.
Influence of cutting, on the herbage yield of pigeonpeas (*Cajanus cajan*). Agricultura Trop. 19:521-531. 1240

Crude protein yields from defoliated stands totaled 4,850 kg/ha over a 3-year period. By deferring defoliation until the reproductive stage, a higher total crude protein yield was realized. Regrowth did not occur when the crop was cut at ground level, compared with cutting at heights of 1.50 to 0.15 or 0.30 m, or of 1.00 to 0.30 m.

HEYNES, K. 1919.
Food and fodder plants (Redgram). Kew Bull. 15. 1241

Cajanus indicus Spreng.: Pigeonpea, Congopea, Angolapea, Dhal, or Dal (India), Bombay Tare. Perennial, usually grown as an annual, 8 to 9 ft. The principal source of supply to the U.K. is British India, also cultivated in Tropical Africa, Venezuela, Madagascar, Philippines, Mauritius, West Indies, Guiana, Australia, and other hot countries. Used as food - the tender green pods, the young green peas, and the ripe ones whole, split, or ground into meal. The young shoots and leaves, stripped off at time the peas are harvested, make good fodder for cattle. The plant is specially grown in Bengal and Assam for feeding the lac insect and in Madagascar and Antilles for feeding silkworms.

INDIAN STANDARDS INSTITUTION. 1965.
ISI specification for "tur" Chuni. ISI: 3160-1965: pp. 8. 1242

Prescribes the requirements and the methods of test for tur or arhar (*Cajanus cajan*) chuni for use as livestock feed.

JAYAL, M.M., P.S. GUPTA, and V. MAHADEVAN. 1970.
Nutritive value of arhar (*Cajanus indicus*) bhoosa for feeding cattle. Indian Vet. J. 47(3):253-260. 1243

Fed as sole feed, arhar bhoosa (chaff) could meet only a part of the dry matter, digestible crude protein, and total digestible nutrient requirements of growing calves but in combination with a cereal roughage and an oil cake, it formed a satisfactory ration and fulfilled nutrient requirements.

KHARE, R.N., K. KRISHNAMURTHY, and S.V. PINGALE. 1966.
Milling losses of food grains. Part I. Studies on losses of red gram (*Cajanus cajan*) during milling. Bull. Grain Technol. 4(3):125-132. 1244

The processing of pigeonpea grain in a mill is outlined. The nature of various products and byproducts and their proportions are shown. While theoretical output of split kernels (dhal) was 84.7%, only 76.1% was recovered in the test run and 10% was unfit for human consumption. Losses are ascribed to faulty rollers and shellers, rats, birds, and storage insects. Methods to avoid losses are recommended.

KRISHNAMURTHY, K., G.K. GIRISH, T. RAMASIVAN, S.K. BOSE, K. SINGH, and R.P.S. TOMER. 1972.
A new process for the removal of husk of red gram using 'Sirka'. Bull. Grain Technol. 10(3):18. 1245

In laboratory trials, heating the pulse at 60°C for 30 minutes facilitated easy removal of husk in rollers. In a large dhal mill, however, treatment with sirka (fermented sugarcane molasses) gave better quality of dhal at less cost than treatment with mustard oil.

KRISHNASWAMI, S., and D.R. SAIKIA. 1959.
Lac cultivation in Assam with notes on use of Arhar, *Cajanus cajan*, and other species as lac hosts. Indian Lac Res. Inst. Bull. Ranchi. 97:7. 1246

KURIEN, P.P., and H.A.B. PARPIA. 1968.
Pulse milling in India. I: Processing and milling of Tur arhar (*Cajanus cajan* Linn.). J. Fd Sci. Technol. 5(4):203-207. 1247

Dhal milling is a vital industry, for more than three-fourths of the total pulses produced in the country are processed into dhal. However, methods and machinery currently in use are laborious and wasteful. Improved processing technique and machinery are required. Problems of dust prevention, infestation control, effective quality control, and development and production of improved varieties of pulses with better milling quality and yield are needed on a countrywide basis.

LIORENS, A.A., A. JOSE OLIVIERI, and J.M. RIOS. 1956.
Production and marketing of pigeonpeas in Puerto Rico. (E and R.S.) 32. Agri. Exp. Stn Univ. P. Rico. 1248

Production, canning, and marketing of pigeonpea, a major crop in Puerto Rico, are described. It was estimated that 25% of the green pea produced in Puerto Rico was locally consumed and during the 1953-54 season, 66% of the 250,000 cases of seed canned was shipped to New York for consumption by immigrant Puerto Ricans.

MAHER, C. 1949.
Economic and social studies in their relation to soil conservation. Bull. Agric. Congo Belge 40:2439-2445. 1249

The uses of *Cajanus cajan*, a deep-rooted protective and restorative crop, in conserving soil are discussed.

MANKAD, B.N., and R.C. THACKER. 1958.
Saccharification of agricultural wastes. 1. Hydrolysis of sticks of Bhinu, Vijay cotton and Tur under different concentrations of acid and different pressures. J. Indian Appl. Chem. 21(1):25-30. 1250

An increase of acid increases the percent yield of reducing sugars. The optimum treatment time is 1 hr. and the optimum pressure 40-60 lb/sq. in.

MATHUR, V.K., B. PRABHAKARA BHATT, B. BHAGIRATHI, B.S. BHATTI, and H. NATH. 1974.
Development of quick-cooking dehydrated curried spinach-dehusked red-gram. J. Fd Sci. Technol. 11(2):57-59. 1251

Spinach was dehydrated without impairing its green color, and the deep-fat fried spinach curried along with precooked, dehydrated red gram. The curried product is found to be stable up to 1 year both at ambient temperature (24-30°C) and at 37°C.

NATH, R.L. 1959.
Preparation of protein-rich biscuits with protein hydrolysates of pulses. Bull. Calcutta Sch. Trop. Med. 7:100-101. 1252

A paste from *Carica papaya* was mixed with pastes made from the pulses, including *Cajanus indicus*, and kept for 24 hours at 37°C. After boiling and straining, the residue was concentrated and mixed with flour, fat, and sugar to make palatable biscuits that could be stored for 2 to 3 weeks. Protein content ranged from 11.3 to 15.5% and free amino acid N from 123 to 240 mg per 100 g.

NATH, R.L., S.K. JAIN, and R. DUTT. 1960.
On the preparation of protein-rich biscuit from protein hydrolysates. Bull. Calcutta Sch. Trop. Med. 8(5):161-162. 1253

The biscuits were prepared with or without hydrolysate of *Cajanus indicus*, arhar, which raised the protein content from 9.5 to 13%. The pulse-free biscuits had no measurable free amino acids and only 0.15% SH groups measured as cysteine. A papain hydrolysate of small prawns was not suitable because its objectionable smell could not be removed, but a hydrolysate made with 6 N HCl gave more promise.

OAKES, A.J. 1970.
Legumes in the U.S. Virgin Islands. Turrialba 2-(2):151-165. 1254

Legumes as green manure crops are recommended to provide ground cover and improve fertility, tilth, and water-holding capacity of the soils. Several legumes have been evaluated as green manure crops in the Virgin Islands, species particularly adapted locally include (*Dolichos lablab* L., *Canavalia ensiformis*, *Crotalaria juncea* L., *Cajanus cajan* (L.) Millsp., cowpea, and velvetbean. Pigeonpea thrives in the Virgin Islands, where it is often grown as an annual. It also serves as windbreak prior to being turned under for green manure. The maximum green matter is produced by sowing the crop broadcast at the rate of 15 to 30 lb/ac (11.7 to 33.0 kg/ha) at the onset of the fall wet season. Yields of 7 to 8 tons/ac (16 to 18 mt/ha) green matter are produced within 5 to 6 months. The most serious insect damage observed on pigeonpea is that caused by pod and stem borers.

PANIKKAR, M.R. 1950.
Alternate fuel - Arhar stalk. Indian Fmg 11:496. 1255

In Bombay arhar stalk is profusely used as fuel by cultivators. Data have been collected from different states regarding the yield of dry stalks, which ranges from 8 maunds (650 lbs) to 60 maunds. The heating value of arhar stem was about half to that of an equal weight of good quality coal. Its use as a fuel is suggested to avoid wasteful burning cattle manure.

PATEL, B.M., and P.C. SHUKLA. 1973.
Effect of feeding clusterbean fodder and pigeonpea fodder on body weights and milk yield of Kankrej cons. Indian Vet. J. 50(11):1126-1132. 1256

The tur gotar treatments resulted in loss in bodyweight of cows, reduced dry matter intake, somewhat poor utilization of dietary nutrients, and depressed production of milk of low nutritional quality. It is possible that there may be some toxic principle and/or specific substances in tur gotar which is responsible for these adverse effects. On the other hand guar gotar appeared to be a good quality feed and can sustain about 5 kg of milk per day.

PATEL, B.M., M.S. NAPHADE, and L.D. KAMDEV. 1972.
Microbial population of strained rumen liquor of lactating cows fed with clusterbean and pigeonpea fodder. Indian J. Microb. 12(1):55-57. 1257

The observations on differential count of protozoa in clusterbean fodder indicate that all the genera except holotrichs, increased in population due to supplementation of tapioca and molasses. In the pigeonpea fodder experiment Entodinium increased, while Epidithium and Opyryoscolex decreased. Entodinium was predominant in CBF experiments. The lower protozoa population in PPF may be due to lower availability of carbohydrates.

PULLE, M.W. 1974-75.
Utilization of vegetable proteins in cheese manufacture. J. Nat. Agric. Soc. Ceylon 11/12:45-52. 1258

The preparation of a "cheese" from plant proteins was investigated. Protein extracts were obtained from soybeans, green gram, and tur dhal; filtered to remove insoluble sediments; and processed with addition of 0.4% $CaSO_4$, 1.5% citric acid, 0.5% rennet extract, 2% lactic acid, and 5% culture (curd or Yoghurt). Beany flavor was eliminated by heating to 100°F (38°C) over 30 min. After 2 to 4 weeks ripening at 60 to 70% RH in a refrigerator, the soft cheese prepared could be used as a spread. To produce cheddar-type hard cheese, enrichment with 100% milk solids provided the desirable attributes. Tabulated values for the approximate percent composition and taste panel scores showed that soybean cheese was superior to the other two in protein and fat contents.

RAHMAN, A.R. 1961.
The effect of chemical pretreatment on the quality of dehydrated pigeonpeas. J. Agric. Univ. P. Rico 45(3):172-191. 1259

Pigeonpeas soaked in a 0.2% sodium hydroxide solution for 4 hours were slightly easier to dehydrate than untreated ones; after dehydration they were able to absorb more water. The treated pigeonpeas had a higher starch content and a lower sugar content than the untreated ones; the protein content of the treated and untreated samples was the same.

RAHMAN, A.R. 1964.
Effect of storage and packing on the quality of dehydrated and dehydrofrozen pigeonpeas. J. Agric. Univ. P. Rico 48(4): 318-326. 1260

Storage in polythene bags at room temperature and at 37°C resulted in a reduction of the total sugar content; storage in bags as well as at the higher temperature reduced the reconstitution percentage. The overall quality, determined in organoleptic tests, was highest in the frozen product and lowest in the peas stored in polythene bags. However, since all samples were well accepted, storage of dehydrated pigeonpeas in polythene bags may be the most profitable method.

RAJAGOPALAN, C.K. 1973.
Red gram dhal: Fm Factory 7(8):25. 1261

RIVAS, N., and E. GOMEZ RIVAS. 1975.
Study of the canning quality of the pigeonpeas (*Cajanus cajan*) var. Panameno. Revta de la Facultad de Agronomica 8(3): 77-81. 1262

Experimental work conducted in Venezuela suggests that the Panameno variety, when tested for flavor, color, aroma, and texture is suitable for canning.

RODRIGUES PEIXOTO, A. 1960.
Guandu (*Cajanus indicus*) and its uses. Rural Rev. Soc. Rural Bras. 40:79. 1263

Cajanus indicus was introduced into Brazil in the days of the slave-trade. It has various uses, for example, as human food, as a fodder, as a green manure, as a shade plant for young coffee trees, and as fuel. A wider use of *Cajanus indicus* by humans would contribute to improving the protein supply of the Brazilian population, as the dry seeds contain about 18% of proteins.

SAMMY, G.M. 1971.
Canning potential of the pigeonpea cultivar Gl 26/2. Fd Technol. Ser. Fac. Engg Univ. W. Indies 4:4. 1264

Cultivar Gl 26/2 pigeonpeas were compared with a canning factory supply of freshly shelled pigeonpea of mixed varieties processed and analysed in identical fashion. The best retorting time was found to be 25 min, which for Gl 26/2 resulted in 20% splits, good texture, and 29.4% light transmittance for a 1:5 dilution. For the mixed varieties, the splits were 55%, texture was good, and light transmittance was 24.0% for a 1:20 dilution. Gl 26/2 had good canning characteristics and gave a higher quality product than did the mixed varieties.

SÁNCHEZ-NIEVA, F. 1961.
The influence of degree of maturity on the quality of canned pigeonpeas. J. Agric. Univ. P. Rico. 45(4):217-251. 1265

Investigations on the tinning of pigeonpeas (*Cajanus cajan*) in brine showed that a satisfactory product can only be obtained from fully mature, but still green, peas. Overripe yellow peas are more starchy than green ones, and consequently, absorb more water. The presence of an appreciable percentage of yellow peas causes a proportionate increase in the percentage of broken skins and split peas, and the brine becomes dark and turbid.

SÁNCHEZ-NIEVA, F. 1962.
Processing characteristics of pigeonpeas of the Kaki and Saragateado selections. J. Agric. Univ. P. Rico 46(1):23-33. 1266

A study to determine the effect of selection characteristics on the product quality of pigeonpeas (*Cajanus cajan*). The selections generally grown in Puerto Rico for canning purposes were compared. No marked differences between the two varieties were observed, but for the color of the brine, which was less turbid and lighter for the Saragateado selection. The results of the shelling operations and a number of desirable characteristics of pigeonpeas for processing are discussed.

SÁNCHEZ-NIEVA, F. 1964.
The influence of the degree of maturity during the harvesting period on the quality of canned pigeonpeas. Bull. Estac. Exp. Agric. Univ. P.R. 117:1-16. 1267

Pigeonpeas of the varieties Saragateado and Kaki, grown in Puerto Rico, were harvested (i) according to the commercial method (selective picking of ripening pods); (ii) by removal of all the pods, including the dry ones, (iii) as in (ii) but excluding the dry pods. The harvested seeds were canned and the product judged according to the color and turbidity of the liquor and the color of the peas. The quality of the product obtained with harvesting method (iii) equalled that of (i) with the extra advantage of easier harvesting operations.

SÁNCHEZ-NIEVA, F. 1964.
Application of the shear press to determine the degree of maturity of pigeonpeas. J. Agric. Univ. P. Rico 47(3):212-216. 1268

Trials demonstrated that the Lee-Kramer shear press affords a rapid and sufficiently accurate means of assessing the degree of maturity of pigeonpeas for canning purposes. The maximum pressure readings obtained when pigeonpeas of the Kaki variety, harvested at different stages of ripeness from very tender green to overripe yellow. Maturity criteria used were: alcohol-insoluble solids content, starch content, total solids content and percentage of yellow peas.

SANCHEZ-NIEVA, F., M.A. GONZALEZ, and J.R. BENERO. 1961.
The freezing of pigeonpeas for market. J. Agric. Univ. P. Rico 45(4):205-206. 1269

Experiments conducted in Puerto Rico showed that frozen pigeonpeas (*Cajanus cajan*) can be kept for at least 2 years without any appreciable deterioration in quality, provided the enzyme system is completely inactivated by proper blanching. The best results were obtained with fully mature green peas blanched in water at a temperature of 90.5°C for 5 minutes. A marketing test demonstrated that the product was well received by consumers.

SÁNCHEZ-NIEVA, F., M.A. GONZALEZ, and J.R. BENERO. 1961.
The effect of some processing variables on the quality of canned pigeonpeas. J. Agric. Univ. P. Rico 45(4):232-258. 1270

Storage of unshelled peas at 45°F for 9 days had no appreciable effect on the quality of canned product. The length of the blanching period was found to determine to a certain degree the color and turbidity of the brine; the longer the blanching period, the clearer and less turbid the brine. Holding time before retorting and length of cooling time had no effect

on the quality of the canned product. Contact of pigeonpeas with iron, brass, or copper surface was found to result in brine discoloration. The addition of 2% sugar to the brine was found to have no effect on the flavor or the overall quality of canned peas. Recommendations are made for the best process to use in canning high-quality pigeonpeas.

SÁNCHEZ-NIEVA, F., M.A. GONZALEZ, J.R. BENERO, and I. HERNANDEZ. 1963.
The brine-grading of pigeonpeas. J. Agric. Univ. P. Rico 47(1):14-23. 1271

Investigations on the grading of pigeonpeas, either before or after blanching, in brines of specific gravities ranging from 1.09 to 1.14 were conducted in Puerto Rico. In every case a clear separation was obtained, all the floaters being young, tender peas of superior canning quality. The sinkers, however, consisted of a mixture of green and yellow (overripe) peas which could not be separated. Brine-grading of pigeonpeas is not economical.

SÁNCHEZ-NIEVA, F., A.J. RODRIGUES, and J.R. BENERO. 1961.
Improved methods of canning pigeonpeas. Bull. Agric. Exp. Stn Univ. P.R. 157:1-26. 1272

When pigeonpeas (*Cajanus cajan*) are canned by a process similar to that used commercially for canning peas (*Pisum sativum*) the brine darkens and develops a high turbidity which adversely affects their quality. But an almost colorless brine of low turbidity can be obtained if the enzyme is inactivated before shelling by steaming the pods at atmospheric pressure. Shell-life studies showed that pigeonpeas canned by the preheating methods keep for at least a year without any change in flavor or undesirable changes in the color and turbidity of the brine. Equipment requirements for a commercial processing line are given.

SCHAFFHAUSEN, R.V. 1965.
Weight increase of Zebu Cattle grazing on legumes. *Dolichos lablab* and *Cajanus indicus*. Proc. 9th Int. Grassld Congr. Sao Paulo 2:965-968. 1273

The potential of pigeonpea as a tropical dry-season protein supplement for increased beef production was indicated in Brazil, when *C. cajan* was sown in contour furrows in a pangola grass (*Digitaria decumbens*) pasture, Zebu bulls gained an average of 35 kg in 93 days during severe drought.

SINGH, JAGDAYAL. 1965.
Arhar (*Cajanus cajan*) as green shelter for young mango trees. Pb Hort. J. 5(1): 9-11. 1274

A novel method of planting each mango graft within perennial green shelters of arhar (*Cajanus indicus*) was evaluated and found to be ideal in preventing sunburn, frost, and cold injury, at the same time was capable of inducing vigorous shoot elongation growth. The organic content of 'basin soil' incidentally increased from arhar leaf shed, and prunings left also acted as an effective mulch.

SQUIBB, R.L., A. FALLA, J.A. FUENTES, and H.T. LOVE. 1950.
Value of *Desmodium*, pigeonpea fodder, Guatemalan and United States alfalfa meals in rations for baby chicks. Poultry Sci. 29:482-485. 1275

Desmodium meal and to a lesser extent, pigeonpea fodder meal, may replace alfalfa meal as a source of carotene and other essential nutrients in baby chick rations. This is of importance for Latin American tropical regions as alfalfa grows only in limited areas, whereas numerous species of the genus *Desmodium* grow abundantly throughout the tropics. Pigeonpeas yield good fodder crops in certain areas and may be used to supplement the production of *Desmodium* meals.

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APPENDIX

PIGEONPEA SYNONYMY

Language	Name(s)
English	Alberga, Angolapea, Congopea, Gungo, Gungopea, No-eye-pea, Pigeonpea, Porto Rican pea, Red gram, Yellow-dhal
French	Ambre'vade, Pois d'Angole, Poispigeon
Spanish	Guandu, Gandul, Quinchonchos
Indian languages	
Bengali	Tur, Rahar, Orhor
Gujarati	Tuver
Hindi	Arhar
Kannada	Togari
Malayalam	Thuvaram
Marathi	Tuver
Sanskrit	Adhaki, Tuvari, Tuvarika
Tamil	Thuvarai
Telugu	Kandulu
Local names	
Armenia	Yewof-aten
Congo	Ohota-farengota
Philippines	Kadyos
Somali	Salbono-ghed
Venezuela	Quinchonchos

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