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UNITED STATES GOVERNMENT

Memorandum

TO : USAID Agricultural Staffs

DATE: June 19, 1970

FROM : Office of Agriculture and Fisheries
Bureau for Technical Assistance - AID/W

SUBJECT: Progress Report on Regional Pulse Improvement Project PASA RA(AJ) -300

The attached report has particular signigicance, since it constitutes the last full year's results of the Regional Pulse Improvement Project (AID-PASA, USDA) that began in Iran in 1965 and in India in 1966. The Center at New Delhi will be closed out in June 1970, since the Indian Government has undertaken a pulse improvement project as an integral part of its agricultural research program. The program at Tehran will be continued in 1970 as an independent activity.

Significant progress has been made on improvement and culture of the food grain legumes in this regional project, particularly with chick-peas, lentils, pigeon peas, and mung beans. AID has been a pioneer in this type of research, in recognition of the major role that food grain legumes offer in meeting the world-wide deficiency in protein requirements for human nutrition. As noted by UNDP, FAO, and the US PSAC reports, the production of food grain legumes provides a practical and prompt method of substantially increasing protein supplies for the people on the land, as well as providing these staple foods for urban populations and for export.

This research project has made important contributions (1) in making world collections of the germ plasm for 8 major legumes species; (2) growing these collections in several ecological conditions to determine their adaptation and the plant and seed characteristics of each strain; (3) identifying major insect and disease pests, and collecting important information of their control; (4) evaluating cultural practices essential to higher grain yields - effective use of fertilizers, season of planting, plant populations, irrigation practices, etc.; (5) and initial multiplication of seed of more productive strains. Also seed samples have been provided to plant breeders in other countries. For example, an agressive breeding program on pigeon peas has now been launched at Makerere University, Uganda.

It is apparent that this project has had a stimulating effect on pulse improvement in Iran, India and in several other countries and regions. Continued AID leadership in this field, to stimulate and strengthen pulse improvement programs in many other LDC's appears to have considerable merit.

Attachment: a/s

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PROGRESS REPORT NUMBER 7

1969

REGIONAL PULSE IMPROVEMENT PROJECT

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U.S. Agency for International Development

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Iran

Plan Organization

Karaj Agricultural College

Ministry of Agriculture

Pahlavi University

Ghazvin Development Project

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SUMMARY

IRAN

The Government of Iran continued it's expanded support of the Project. An allotment of 12,500,000 Rials ($166,667) from the Plan Organization financed most of the costs for local personnel, equipment, and supplies. These funds were administrated by Karaj College, primarily through a committee representing the different subject matter disciplines. Under the Chairmanship of Dr. C. Amirshahi, this committee assumed more responsibility for planning and supervising the Project's program.

The Project continued without a resident American Plant Breeder. Dr. Kenneth H. Evans, RPIP/India, assisted in the Plant breeding work by means of correspondence and temporary duty assignments in Iran.

A three-day workshop was held at Karaj in January 1969. Twelve papers dealing with different phases of the program were presented. Research activities for 1969 were planned by committees representing the different disciplines. The proceedings of the workshop were published as a bound report.

Excessive rains delayed planting of lentils and chickpeas approximately one month, otherwise, conditions affecting the field trials were generally normal. Significant findings include:

(1) Several promising strains of various pulse crops were tested at multiple locations in Iran and seed increased for possible commercial use. Up to a ton of seed will be available for commercial use in 1970 of some varieties of cowpeas, beans, mungbeans, and chickpeas.

(2) No appreciable yield increase of cowpeas and dry beans were obtained by planting more than one row on 50-cm beds.

(3) Although maximum yields usually result from frequent irrigations, two varieties susceptable to root rot suffered yield depressions when irrigated at interval of seven days or less.

(4) Frequency of irrigation had a greater effect on crop yields than the amount of water applied at each irrigation.

(5) Identified three new and potentially important foliar diseases of chickpea.

(6) A black-seed chickpea selection from Israel was moderately to highly resistant to Ascochyta rabiei.

(7) A. rabiei survived in naturally-infected chickpea tissue for periods up to 10 months at temperatures of 10-35° C, relative humidities of 0-30%, and on the surface of soil. The fungus is also seed-borne.

(8) Several mungbean lines were highly resistant to mungbean mosaic virus.

(9) Several seed treatment fungicides effectively controlled a damping-off and root rot disease of peas caused by Pythium aphanidermatum.

(10) Pest control recommendations for pulses were updated and fumigation rates were established for storage pests of pulses.

(11) Seed of a lentil variety resistant to storage attack by cowpea weevil Callosobruchus maculatus was increased and will be available to plant breeders in 1970.

INDIA

In 1969 the program in India continued at about the same level as in the year before. The condition of staff and facilities under the All India Coordinated Pulse Project sponsored by the Indian Council of Agricultural Research, remained the same. The facilities at IARI, both in laboratory and field, stayed inadequate and none of the regional and substations still to be activated were sanctioned or staffed in 1969. At several of the Agricultural Universities, notably at Hissar, (Haryana), Ludhiana, (Punjab), Pantnagar, (U.P.) and Jabalpur (M.P.) work on pulses showed a considerable increase in 1969.

As a result of U.S. Government reductions in overseas activities and personnel the decision was made to phase out the RPIP activities in India by June 1970.

The third annual workshop conference on pulse crops was held in New Delhi, February 3-5, 1969 and a breeders' meeting, specifically to plan rabi crop trials, took place on September 13 and 14. The proceedings of the workshop, including all papers presented and recommendations made, were bound in a single volume and distributed.

A bibliography of pulse crops, including approximately 20,000 titles, 6000 of them abstracted and representing some 20 crops has been compiled and awaits publication.

Significant findings from the research program include:

(1) Several early maturing, short plant type, strains of pigeon pea were entered in the coordinated varietal trials. There is great interest in early maturing pulse crop varieties and success in increased acreage and production may well lay in fitting them into crop sequences between major cereal crops.

(2) Germplasm catalogs are in preparation, showing accession numbers, sources and origins of the two major pulse crops, chickpeas and pigeon peas.

(3) Three year's evaluation data on germplasm of chickpeas and pigeonpeas has been compiled and awaits final analysis and publication.

(4) A three year composite report on soil-water-fertility-plant relationship research on pulse crops in India is under preparation.

(5) Considerable yield increases could be obtained with present varieties if farmers would sow for higher plant populations and apply as little as 50 kg/hectare of NPK fertilizer.

(6) A new disease of pigeon pea (stem blight) was identified as caused by Phytophtora drechsleri. Five lines in inoculated germplasm showed good resistance. This disease may be a part of what has been generally called arhar wilt.

(7) After three years of screening of chickpea germplasm, ten (10) lines show consistent field tolerance to chickpea wilt. One fusarium isolate was found pathogenic; several other factors - salinity, soil moisture, nematodes - are likely involved in this disease complex.

(8) One line of mungbean was found free of three major diseases in Ludhiana.

(9) Chickpea strain 109-1 (accession No.12-069-06629) was found to have resistance to three species of bruchid insects (Callosobruchus maculatus, C. chinensis, C. analis) which are major pests in stored pulses.

(10) In 1890 lines of pigeon pea germplasm protein content was found to range from 16.1 to 32.0%. Two lines analysed over 30%, several over 25%.

INTRODUCTION

Pulses (grain legumes) are a major source of protein available for direct human consumption in many developing countries. They provide a high quality protein to large segments of populations which cannot afford animal proteins or do not use them because of religious beliefs. Unfortunately the levels of production are very low because of inherent characteristics of varieties grown, damage from diseases and pests, and poor cultural practices.

The problem cannot be solved by the simple transfer of U.S. varieties and cultural practices because the few available are seldom adapted. Many of the pulse crops of major importance in the developing world are of little economic importance in the U.S. or other developed countries. (e.g. chickpeas, pigeon peas, and mungbeans). For this same reason the amount of previous research done on pulses is limited, the information base is extremely low, and experienced and qualified research workers in these crops are few. This is in contrast to wheat on which world-wide research has been carried on for many years, germplasm banks have been available, and skilled research workers were in ample supply.

Research towards improvement of the pulse crops is essential because of the vital role these crops play in providing a reasonably balanced protein component in the diets of primarily cereal eating peoples. Pulses thus far have not shared in the agricultural advances of the "green revolution," in fact pulses acreages are decreasing in several countries due to the greater and more assured profits from the new cereal varieties.

The objectives of the Regional Pulse Improvement Project are to increase the economic yields and quality of pulses through
(1) breeding of varieties suitable for the environments of the regions,
(2) development of appropriate pest control measures, and
(3) improvement of cultural and management practice.

The research is done in Iran and India by teams of USDA scientists in collaboration with scientists of the host countries. Field research began in Iran in 1965 at the Karaj Agricultural College of Tehran University and in India in 1966 at the Indian Agricultural Research Institute.

After four to five years of operation the Project has not developed a "miracle" pulse variety, nor have the results of the research had a measurable impact on pulse crop production. In view of the weakness of the present scientific information base, the multiple crop species involved, and the modest scale on which the project was organized, a miracle pulse variety was not be expected. A base has however been formed on which further research leading to significant contributions and improvements can be built.

Germplasm collections of the major species have been assembled, totalling about 15000. These have been evaluated for adaptation, vigor, disease and insect resistance and other characteristics. Seed of these collections has been shared with breeders in some 20 countries, world-wide. In Iran, eight varieties (representing four pulse crops) have been named and seed is being multiplied by government agencies. In India an early maturing mungbean variety, suitable for multiple cropping patterns, has been named and released and early, semi-dwarf pigeon pea strains have been identified as a result of the screening of these germplasm collections. The major diseases and insects pests have been identified, and control measures and in several cases sources of genetic resistance for use in breeding programs have been found. Limitations to production due to cultural practices have been studied and at least preliminary information found on improved planting methods, irrigation and fertility has been developed.

A bibliography including about 20,000 titles, 6000 of them abstracted, of 31 pulse crops has been prepared. The final form of publication has not been decided. The material is available as a working bibliography.

Perhaps more significant than the specific research conducted has been the stimulation and motivation provided to the host countries. In Iran the government now includes pulses in its five-year Plan Production targets and has increased its financial support to the Project from $29,000 per year between 1964 and 1968 to $270,000 in 1968/69 and $160,000 per year during 1969-1972. Work on pulses is now being done at several places and institutions in Iran.

The project in India has stimulated country wide interest in pulses. The All India Coordinated Pulse Project was instituted by the Indian Council of Agricultural Research to provide counterpart facilities and staff to the U.S. project and to provide a coordinated approach to pulses improvement in the country. There are now many more people working specifically on pulses than ever before. A number of the Agricultural Universities and State Departments of Agriculture have appointed pulse specialists. Three annual pulse workers conferences have been held during which research reports are presented and discussed and plans made for the coming season.

The Project has not developed as strongly regionally as originally planned or anticipated. Limitations on U.S. funding, budget restrictions, personnel ceilings and travel limitations have been major factors in restricting regional work. The corresponding greater emphasis and dependence on host country contributions has led to greater concentration of effort within the host countries. A lack of specific results and information during these first years and the unavailability of U.S. contributions other than advice has made regional organization of specific research very difficult.

Regional activities have been carried on however through exchange of seed for breeding and trial purposes; third country nationals have participated in workshops and seminars; progress reports, workshop proceedings and other information have been distributed widely.

A review of the project organization and activities was held in Washington in June 1969. A proposal for a strengthened and world-wide pulses research program was formulated as a result of that review.

This report contains the details of the research program of the project's teams in Iran and India during 1969.

I R A N

VARIETAL IMPROVEMENT

Karaj (Karaj College)
Dr. M.C. Amirshahi

GOI/Plan Organization
M. Moadab
M. Khosrowshahin
J. Jafari
A. Ellini
M. Taghavi Bayat

Seed and Plant Improvement Institute
Ministry of Agriculture
P. Parvaneh

Shiraz (Pahlavi University)
M. Niknejad

Dez Pilot Project Kuzestan
M. Shishegan

Ghazvin Development Project
M. Chehrenegar

The varietal improvement section of the project has been carried on by the staff of the various cooperative institutions since the departure of the American plant breeder in May of 1968. The Ministry of Agriculture has increased the recommended strains in one hectare or larger plots at ten locations. The seed is available for distribution. Kamran cowpea has performed well at the Dez Pilot Project, Kuzestan. It is being increased and distributed in the area.

Germplasm

Seed requests from several countries were filled. A set of chickpea germplasm was sent to West Pakistan. Twenty-five chickpea strains were sent to Taipei China and three to Equador. Twelve strains of beans and five strains of chickpeas, mungbeans and cowpeas were sent to Afghanistan. Thirty-one fodder type cowpeas were sent to Lyallpur, Pakistan. The bean germplasm collection was sent to Cambridge, England.

Partial sets of germplasm was grown to increase seed stocks and renew the viability of the seed.

Yield Trials

Yield trials were continued at several locations. The tables for reporting locations are included. The Shiraz results will be reported in a separate publication by Phalvi University.

Lentils (*Lens esculenta*)

The lentil strains, included in the yield trials, were selected for good seed type and high yield. Some strains in the preliminary yield test table had medium large seed and produced high yields. The Isfahan types in the uniform advanced yield trial table also produced high yields, but have smaller seed.

Chickpeas (*Cicer arietinum*)

Strains with more desirable seed type and recent collections have been added to the yield trials. The limited international yield trial results indicate the varieties from other countries will not likely give a significant yield advance if used directly. I-13 can very likely be an exception to this in severe blight areas. I-13 can probably be used directly until its *Ascochyta* blight resistance is transferred to new varieties.

Beans (*Phaseolus vulgaris*)

Yield trials were grown at several locations, results are presented for the Karaj trials.

Cowpeas (*Vigna sinensis*)

Strains with large white seed were included in yield trials because of their market price advantage. The increased strains yielded about average in the Varamin and Karaj locations.

Mungbeans (*Phaseolus aureus*)

The preliminary yield trial contains material selected from some of the strains showing less virus symptoms. The uniform advanced yield trial contains several new strains selected from U.S. material by the Ministry of Agriculture.

Legend for Lentil Agronomic Data Tables 1-2

(1) Numbers assigned to collection maintained by the Regional Pulse Improvement Project.

(2) Source numbers refer to collection numbers assigned by the Iranian Ministry of Agriculture. Six digit numbers are PI numbers from Crops Research Division, ARS, U. S. Department of Agriculture, Beltsville, Maryland U.S.A.

(3) Source indicates area of origin or area in which the seed was collected.

(4) Plants per meter is an average number of plants per meter of row based on one meter sample per replication.

(5) Rated 1 to 9: 1 = Complete stand; 9 = poor stand.

(6) Rated 1 to 9: 1 = Vigorous plants;9 = weak plants.

(7) Days from planting to first opened flower.

(8) Indicates number of days after planting that the first pod in plot reached full maturity, ready for harvest.

(9) Indicates number of days after planting the whole plot was ready for harvest.

(10) Disease rated 1 to 9: 1 = Free from disease symptoms; 9 = Severe disease symptoms. For diseases present see pathology section.

(11) Seeds/10 pods indicates the average number of seeds in 10 pods.

(12) Average weight (grams) of 100 seeds.

(13) Yield in kilogram per hectare based on five or ten square meter plots.

Table 1. Agronomic Data - Lentils - Prel Yield Test - Planted April 26, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Plants /Meter	(5) Stand	(6) Vigor	(7) Pl. to 1st Fl.	(8) Pl. to 1st Mat.	(9) Pl. to Com.Mat.	(10) Disease Rating	(11) Seeds per 10 Pods	(12) 100 Seed Weight*	(13) Yield per Hectare
33-071-10946	212-77	Arasbaran, Iran	21	2	3	40	77	94	2	16	4	1418
33-071-10921	210-25	Jiroft, Iran	18	3	2	42	78	92	2	15	4	1390
33-071-10556	189-45	Isfahan, Iran	19	2	1	41	80	92	2	13	3	1348
33-071-10674	198-80	Azarbaijan, Iran	17	3	3	41	77	93	2	14	3	1335
33-071-10882	209-46	Isfahan, Iran	19	2	3	40	77	93	2	14	3	1316
33-071-10898	209-66	Isfahan, Iran	15	2	2	39	77	92	2	12	3	1290
33-071-10134	214	Torbat Heidarieh, Iran	21	2	2	39	76	93	2	13	3	1270
33-071-10910	210-55	Jiroft, Iran	22	2	3	39	77	92	2	13	3	1267
33-071-10901	209-63	Isfahan, Iran	22	2	2	40	77	93	2	13	4	1266
33-071-10496	44-188	Bandar, Fars, Iran	18	3	2	41	77	95	2	16	3	1263
33-071-10166		Gorgan, Iran	20	2	2	41	79	93	2	14	3	1248
33-071-10952	212-27	Arasbaran, Iran	21	2	2	39	77	93	2	14	4	1231
33-071-10892	209-82	Isfahan, Iran	21	2	2	39	76	92	2	15	4	1226
33-071-10864	209-79	Darregaz, Iran	22	2	2	40	83	91	2	12	3	1219
33-071-10879	209-45	Isfahan, Iran	20	3	3	41	77	92	2	14	3	1212
33-071-10504	188	Bandar, Fars, Iran	16	2	2	40	77	92	2	15	3	1207
33-071-10907	210-47	Jiroft, Iran	25	2	2	40	76	93	2	13	3	1208
33-071-10905	209-61	Isfahan, Iran	24	2	3	39	77	92	2	14	3	1206
33-071-10500	188-28	Bandar, Fars, Iran	20	2	3	40	76	93	2	15	3	1196
33-071-10483	187-89	Shostar, Iran	18	3	2	41	79	94	2	14	3	1178
33-071-10899	209-65	Isfahan, Iran	18	2	3	40	77	93	2	14	3	1168
33-071-10146	391	Khaledabad, Iran	16	2	2	41	77	92	2	13	3	1167
33-071-10944	212-87	Arasbaran, Iran	18	2	2	41	77	91	2	16	4	1148
33-071-10478	186-56	Shoshtar, Iran	18	2	2	40	78	94	2	14	2	1117
33-071-10906	210-50	Jiroft, Iran	17	2	3	39	77	93	2	11	2	1105
33-071-10894	209-80	Isfahan, Iran	17	3	3	39	76	93	2	15	3	1102
33-071-10791	296-71	Neyshabour, Iran	20	3	3	40	77	91	2	12	2	1101
33-071-10895	209-15	Isfahan, Iran	22	3	3	39	75	92	2	11	2	1094
33-071-10520	188-72	Bandar, Fars, Iran	20	3	3	40	76	94	3	13	3	1094
33-155-10564	109-45	Egypt	19	3	2	43	80	94	3	15	2	1088
33-071-10880	209-23	Isfahan, Iran	17	3	3	40	77	91	2	14	2	1077
33-071-10694	200-76	Ardebil, Iran	21	2	2	38	75	92	2	13	2	1071
33-071-10908	210-52	Jiroft, Iran	19	2	3	39	77	92	2	13	2	1050
33-071-10507	188-76	Bandar, Fars, Iran	19	3	2	41	78	94	2	14	2	1041
33-071-10925	210-64	Jiroft, Iran	19	2	3	38	77	92	3	15	3	1039
33-071-10512	188-9	Bandar, Fars, Iran	21	3	3	40	77	94	2	13	3	1035
33-022-10083	207-492	Afghanistan	19	3	2	40	80	93	2	15	2	1025
33-071-10502	188-26	Bandar, Fars, Iran	20	3	3	42	77	92	2	13	3	1019
33-071-10909	210-41	Jiroft, Iran	18	2	2	38	76	92	2	13	3	1018
33-071-10743	205-49	Neyshabour, Iran	20	2	2	42	82	94	2	14	2	1016
33-071-10900	209-64	Isfahan, Iran	21	2	2	40	76	92	2	14	3	1012
33-155-10567	190-37	Egypt	20	3	3	40	84	95	2	14	2	999
33-071-10521	188-81	Bandar, Fars, Iran	19	3	4	41	78	95	2	17	3	993
33-071-11012	2-42-4473	Fars, Iran	19	3	3	40	78	93	2	14	3	971
33-071-10499	188-29	Bandar, Fars, Iran	21	2	3	40	76	93	2	15	3	936
33-071-10951	212-80	Arasbaran, Iran	19	4	3	41	80	94	2	15	4	899
33-071-10710	201-19	Ghouchan, Iran	19	3	3	41	77	91	2	15	3	821
33-085-10076	181-771	Lebanon	17	2	4	40	75	93	2	14	3	682
33-071-10721	203-77	Kermanshah, Iran	19	2	2	42	81	93	2	13	3	616
CV % =												17
LSD..05 =												268

Table 2. Agronomic Data - Lentils - Advanced Yield Test - Planted April 26, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Plants /Meter	(5) Stand	(6) Vigor	(7) Pl. to 1st Fl.	(8) Pl. to 1st Mat.	(9) Pl. to Com.Mat.	(10) Disease Rating	(11) Seeds per 10 Pods	(12) 100 Seed Weight	(13) Yield per Hectare
33-071-11014	2-42-4467	Fars, Iran	23	2	4	41	76	92	2	13	3	821
33-071-10417		Ardebil, Iran	20	2	3	41	77	89	2	11	3	819
33-071-10406		Zanjan, Iran	20	2	4	41	76	92	2	13	4	661
33-071-10415		Ardebil, Iran	19	3	3	44	78	93	3	11	5	639
33-071-10425		Ahar, Iran	19	2	3	40	76	93	3	11	4	633
33-071-10588	192-67	Karaj, Iran	18	3	4	40	76	89	3	11	5	562
33-071-10582	192-48	Karaj, Iran	20	2	5	38	75	89	3	11	4	550
33-071-10430		Tabriz, Iran	18	3	4	41	79	92	3	13	4	548
33-071-10450	64-16(S)	Karaj, Iran	18	3	4	46	80	94	2	11	5	541
33-032-10254	299225	Chile	16	3	4	46	83	94	3	10	5	510
33-071-10420		Ardebil, Iran	19	2	4	42	76	94	3	12	4	509
33-153-10048	178-971	Turkey	22	3	3	41	75	90	2	13	4	507
33-071-10423		Moghan, Iran	19	2	4	45	76	90	3	12	4	485
33-071-10433		Ardebil, Iran	18	2	4	45	76	93	3	11	4	446
33-071-10427		Zanjan, Iran	15	2	4	42	75	92	3	12	5	442
33-071-10418		Ardebil, Iran	19	3	4	43	76	93	3	10	4	437
33-032-10253	299224	Chile	16	3	4	48	78	94	3	11		435
33-071-10416		Ardebil, Iran	16	3	4	46	77	93	3	11	3	426
33-032-10199	299160	Chile	21	3	5	47	78	94	3	10	4	401
33-157-10431		USA	19	3	4	47	78	95	3	11	4	356
33-032-10217	299182	Chile	16	2	4	47	78	92	4	11	4	351
33-032-10202	299164	Chile	15	3	5	48	78	93	3	12	5	322
33-032-10208	299171	Chile	17	3	4	46	81	92	3	11	4	304
33-032-10210	299174	Chile	14	3	5	49	83	94	3	11	5	255
33-032-10211	299175	Chile	18	3	5	46	78	92	4	10	4	200
CV % =												18
LSD .05 =												188

Table 2.A Agronomic Data - Lentils - Uniform Advanced Yield Test - Planted April 26, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Plants /Meter	(5) Stand	(6) Vigor	(7) Pl. to 1st Fl.	(8) Pl. to 1st Mat.	(9) Pl. to Com.Mat.	(10) Disease Rating	(11) Seeds per 10 Pods	(12) 100 Seed Weight	(13) Yield per Hectare
33-071-10903	209-48	Isfahan, Iran	19	2	3	38	75	88	2	14	3	1335
33-071-10445		Isfahan, Iran	19	3	4	41	76	90	2	14	3	1035
33-071-10408		Ahar, Iran	14	3	4	45	76	93	3	11	4	522
33-071-10428		Moghan, Iran	13	4	3	43	79	92	3	11	5	380
33-085-11147	127	Lebanon	12	3	5	39	76	91	3	11	4	355
33-071-11175	176	Arasbaran, Iran	12	3	4	41	75	91	3	11	4	310
33-071-10436		Ghazvin, Iran	11	3	5	44	77	93	3	10	5	292
33-071-10437		Ghazvin, Iran	10	3	5	43	76	92	3	10	5	266
33-071-10411		Moghan	10	3	4	46	80	92	3	10	5	257
33-039-11177	142	Cyprus	9	4	6	48	80	91	3	8	4	98
CV % =												45
LSD .05 =												335

Legend For Chickpea Agronomic Data Tables 3-19

(1) Numbers assigned to collection maintained by the Regional Pulse Improvement Project.

(2) Source numbers are numbers assigned to populations or collections by the Iranian Ministry of Agriculture; six digit numbers are PI numbers from Crops Research Division, ARS, U. S. Department of Agriculture, Beltsville, Maryland, U.S.A.

(3) Source indicates origin of seed either country or section of Iran.

(4) W = White; P = Purple; LP = Light Purple.

(5) Average plant height in centimeters.

(6) Average plant width in centimeters.

(7) Average number of plants per meter based on one meter of row per replication.

(8) Rated 1 to 9: 1 = poor stand; 9 = complete stand.

(9) Rated 1 to 9: 1 = weak plants; 9 = vigorous plants.

(10) Days from planting to first opened flower.

(11) Indicates number of days after planting the first pod in plot reached full maturity, ready for harvest.

(12) Indicates number of days after planting the whole plot was ready for harvest.

(13) Disease rated 1 to 9: 1 = severe disease symptoms including yellowing and wilting; 9 = free from disease symptoms.

(14) Average number of seeds per 10 pods.

(15) Br = Brown; W = White; B = Black; Cr = Cream; Y = Yellow; Gr = Green; L = Light; D = Dark.

(16) Average weight (in grams) of 100 seeds.

(17) Yield in kilograms per hectare based on 5 or 10 square meters per plot.

Table 3. Agronomic Data - Black Chickpeas - Preliminary Yield Test - Planted April 17, 1969 - RPIP-Varamin, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-10118	111	Varamin	LP	28	9	9	65	80	7	16	B	11	818
12-071-10108		Isfahan	LP	29	7	8	65	82	7	18	B	11	808
12-071-10121	153	Karaj	P	30	8	8	65	81	7	16	B	12	732
12-071-10120		Isfahan	LP	31	7	8	64	79	6	17	B	12	720
12-071-10107		Isfahan	LP	30	8	8	65	80	7	20	B	11	708
12-071-10127		Isfahan	LP	24	8	8	63	76	6	20	B	10	592
12-071-10126	206	Jiroft	LP	34	8	8	64	79	7	20	B	11	532
12-071-10113		Isfahan	LP	33	7	7	63	78	6	18	B	11	520
12-071-10124	194	Kermanshah	LP	34	8	8	63	76	7	17	B	10	512
12-071-10106	47	Karaj	LP	26	8	8	62	75	7	20	B	11	486
12-071-10130	153	Karaj	LP	31	7	7	63	77	7	19	B	11	474
12-071-10125	206	Jiroft	LP	31	7	8	67	79	6	14	LiBr	11	470
12-071-10119	194	Kermanshah	LP	32	8	7	65	76	7	15	B	9	458
12-071-10115	221	Isfahan	LP	27	7	7	63	79	6	17	B	10	448
12-071-10116		Moghan	P	33	7	7	63	80	7	16	B	9	448
12-071-10110	47	Karaj	LP	27	7	7	63	78	7	18	B	12	446
12-071-10112		Nishabour	LP	33	7	8	63	78	7	17	B	12	422
12-071-10123		Isfahan	LP	31	7	7	64	77	6	15	B	11	408
12-071-10114		Isfahan	LP	32	7	7	62	77	7	18	B	11	396
12-071-10109		Isfahan	LP	35	7	7	62	75	7	19	B	9	390
12-071-10111	153	Karaj	LP	32	7	8	65	80	7	18	B	11	352
12-071-10117	194	Kermanshah	LP	42	8	8	63	80	7	17	B	9	348
12-071-10122	194	Kermanshah	LP	33	8	8	64	79	7	17	B	9	306
12-071-10128		Ghazvin Local	P	29	8	8	61	79	7	16	B	10	306
12-071-10129		Nishabour	LP	24	8	7	63	81	6	19	LiBr	14	190
LSD 5%													104
CV %													43

Table 4. Agronomic Data - Black Chickpeas - Preliminary Yield Test - Planted May 2, 1969, RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-10106	47	Karaj	LP	29	55	22	8	9	40	75	103	9	20	B	11	1561
12-071-10107		Isfahan	LP	32	62	20	9	9	38	74	.96	8	20	B	11	1525
12-071-10108		Isfahan	LP	26	61	21	7	9	40	76	100	8	18	B	11	1505
12-071-10109		Isfahan	LP	30	55	22	9	9	39	75	100	8	19	B	9	1459
12-071-10110	47	Karaj	LP	29	60	18	8	9	39	71	100	8	18	B	12	1393
12-071-10111	153	Karaj	LP	31	61	23	8	9	41	75	100	8	18	B	11	1375
12-071-10112		Nishabour	LP	30	57	21	8	9	39	71	100	8	17	B	12	1354
12-071-10113		Isfahan	LP	31	63	24	8	9	40	75	99	9	18	B	11	1349
12-071-10114		Isfahan	LP	30	57	23	8	9	38	74	97	8	18	B	11	1339
12-071-10115	221	Isfahan	LP	30	65	22	8	9	40	72	98	8	17	B	10	1335
12-071-10116		Moghan	P	25	53	24	7	9	31	71	98	8	16	B	9	1329
12-071-10117	194	Kermanshah	LP	31	55	22	8	9	41	75	102	9	17	B	9	1300
12-071-10118	111	Varamin	LP	28	55	20	8	9	40	72	99	8	16	B	11	1279
12-071-10119	194	Kermanshah	LP	19	52	25	8	9	36	69	99	8	15	B	9	1267
12-071-10120		Isfahan	LP	28	59	21	7	9	38	72	100	8	17	B	12	1266
12-071-10121	153	Karaj	P	19	46	22	8	8	37	71	100	9	16	B	12	1266
12-071-10122	194	Kermanshah	LP	23	45	24	7	9	36	70	98	8	17	B	9	1227
12-071-10123		Isfahan	LP	28	54	18	7	9	38	72	97	8	15	B	11	1207
12-071-10124	194	Kermanshah	LP	28	51	24	8	9	40	75	97	9	17	B	10	1206
12-071-10125	206	Jiroft	LP	22	47	26	8	9	43	74	95	8	14	LiBr	11	1195
12-071-10126	206	Jiroft	LP	27	58	23	8	9	39	74	100	8	20	B	11	1187
12-071-10127		Isfahan	LP	28	60	23	7	9	37	71	101	9	20	B	10	1169
12-071-10128		Ghazvin Local	P	22	46	23	8	8	36	67	99	8	16	B	10	1150
12-071-10129		Nishabour	P	25	53	17	6	9	38	71	98	8	19	LiBr	14	1129
12-071-10130	153	Karaj	LP	28	53	22	7	7	38	73	.97	8	19	B	11	994
LSD 5%																348
CV %																23

Table 5. Agronomic Data - White Chickpeas - Preliminary Yield Test - Planted May 2, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pod	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-10057	162	Shahpour	W	40	74	23	9	9	41	82	111	9	10	W	28	4267
12-071-10058	168	Mamghan	W	37	60	23	8	8	40	81	109	8	11	W	26	4087
12-071-10059	169	Ardabil	W	34	60	22	8	9	41	78	110	8	11	W	29	3910
12-071-10060	111	Varamin	LP	36	64	27	9	9	40	78	108	8	10	LiCr	28	3895
12-071-10061	169	Ardabil	W	37	64	18	8	9	39	78	112	9	10	W	25	3841
12-071-10104		Selection Karaj Pop.	W	35	58	25	9	9	36	75	98	8	12	W	24	3836
12-071-10105		Unknown	W	36	62	21	7	9	40	78	110	9	11	W	29	3783
12-071-10062	162	Shahpour	W	36	71	20	9	9	41	83	108	9	11	W	26	3713
12-071-10063		Kurdestan	W	37	66	19	8	9	41	79	106	9	10	W	32	3630
12-071-10064		Rezaieh	W	38	66	21	9	9	42	84	109	9	10	W	27	3627
12-071-10065		Banab	W	39	63	22	9	9	37	79	106	8	10	W	31	3626
12-071-10066		Ahar Shahabad	W	37	69	20	8	9	40	79	107	9	11	W	30	3606
12-071-10067	217	Torbat Hasanabad	W	29	54	22	9	9	36	76	101	9	10	W	28	3606
12-071-10068	161	Moghan	LP	37	62	20	8	8	42	79	104	8	11	LiCr	25	3504
12-071-10069		Shahpour	W	57	65	22	8	9	40	82	108	9	11	W	30	3444
12-071-10070		Khoy	W	39	73	21	8	9	41	80	109	9	10	W	30	3363
12-071-10071		Isfahan	W	33	59	19	8	9	37	72	101	8	10	W	32	3292
12-071-10072	168	Mamghan	W	29	60	20	9	9	38	78	109	8	10	W	23	3198
12-071-10073	217	Torbat Hasanabad	W	29	49	23	9	9	38	76	100	8	18	W	28	3158
12-071-10074	217	Torbat Hasanabad	W	28	53	21	9	9	37	76	95	8	14	W	28	3129
12-071-10075	153	Karaj	W	44	61	23	8	9	40	72	101	8	11	W	32	3097
12-071-10076	217	Torbat Shadmehr	W	29	53	22	8	9	39	78	102	9	11	W	28	3045
12-071-10077		Djahrom	W	35	59	23	8	9	39	76	99	8	12	W	31	3044
12-071-10078	217	Torbat Heidarieh	W	31	54	20	8	9	40	76	94	8	12	W	34	3026
12-071-10079	168	Mamghan	W	39	71	22	9	9	40	79	108	9	12	W	31	3014
12-039-10080	139	Cyprus	W	31	50	22	8	9	36	68	92	8	11	W	32	3007
12-155-10081	NA11	Giza UAR	W	38	60	23	8	9	40	74	99	8	12	W	36	2998
12-071-10082	168	Mamghan	W	27	52	22	9	8	39	78	102	8	13	LiCr	27	2961
12-071-10083		Ghazvin local	W	39	55	19	8	8	37	72	103	8	12	W	25	2947
12-071-10084	162	Shahpour	W	32	61	23	8	9	41	76	106	8	10	W	30	2935
12-071-10085		Rezaieh	W	34	62	19	8	9	37	76	100	8	10	W	33	2929
12-071-10086	162	Shahpour	W	35	59	22	9	9	41	76	104	8	12	W	27	2928
12-071-10087	169	Ardabil	LP	36	63	18	7	9	41	77	100	7	10	DCr	30	2916
12-071-10088	232	Darehgaz	W	24	59	23	8	9	39	77	99	8	13	W	30	2913
12-071-10089	217	Torbat Shadmehr	W	29	50	24	8	8	43	78	97	8	12	W	33	2896
12-071-10090		Ghazvin Local	W	32	51	21	7	8	36	76	100	8	11	W	30	2879
12-071-10091		Ghazvin Local	W	31	49	24	9	9	36	75	102	8	11	W	27	2795
12-039-10092	139	Cyprus	W	31	51	25	9	9	38	76	100	8	10	W	26	2749
12-071-10093		FAO 13/680	W	37	63	19	8	9	39	74	101	8	11	W	35	2723
12-071-10094	217	Torbat Hasanabad	W	30	57	21	9	9	37	75	94	8	13	W	26	2722
12-071-10095		Progery Selection Karaj Pop.	W	34	60	17	7	8	37	72	102	8	10	W	40	2661
12-071-10096	168	Mamghan	W	35	59	23	9	9	37	73	94	8	12	W	27	2657
12-071-10097		Isfahan	W	34	56	20	8	9	36	70	101	8	11	W	34	2631
12-071-10098	217	Torbat Hasanabad	W	31	50	21	8	9	38	71	93	8	14	W	32	2459
12-071-10099	217	Torbat Hasanabad	W	27	47	22	9	8	38	74	97	7	13	W	29	2427
12-071-10100	169	Ardabil	W	41	64	17	7	9	47	79	107	8	10	W	45	2390
12-071-10101	217	Torbat Hasanabad	W	30	59	20	8	8	38	75	100	8	11	W	42	2388
12-071-10102	217	Torbat Hasanabad	W	27	52	17	8	8	38	69	89	8	10	W	32	2347
12-039-10103	139	Cyprus	W	31	50	22	8	9	36	68	92	8	11	W	32	1715
LSD 5%																480
CV %																22

Table 6. Agronomic Data - Black Chickpeas - First Year Advanced Yield Test - Planted April 17, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source No.	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-05132	174	Ahar	LP	48	64	20	9	9	41	74	98	7	19	B	11	1990
12-071-04287		Isfahan	LP	43	64	21	8	9	42	75	96	7	15	B	11	1860
12-071-04432	221	Isfahan	LP	49	62	20	8	9	41	73	100	7	71	B	12	1520
12-071-04282	129	Isfahan	LP	44	61	18	8	9	41	74	101	7	14	B	11	1520
12-071-04439	221	Isfahan	LP	47	60	20	8	8	41	72	96	7	17	B	11	1484
12-071-04466	221	Isfahan	LP	40	64	17	9	8	42	75	99	7	17	B	12	1440
12-071-04279	174	Ahar	LP	45	58	23	8	8	41	73	99	7	17	B	11	1320
12-071-05331	154	Gharyeh-gole	LP	44	56	20	9	9	41	72	97	7	18	B	10	1210
12-071-04509	193	Kermanshah	LP	40	62	20	8	8	41	73	96	7	16	B	10	1130
12-071-06465	175	Gharyeh-gole	LP	43	56	15	8	8	41	72	94	7	15	LiBr	12	900
LSD 5%																N.S.
CV %																55

Table 7. Agronomic Data Black Chickpeas - First Year Advanced Yield Test - Planted May 2, 1969, RPIP Karaj, Iran

(1) Accession Number	(2) Source No.	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-04439	221	Isfahan	LP	30	48	23	8	8	38	70	98	7	17	B	11	2042
12-071-04287		Isfahan	LP	33	49	24	8	8	41	72	101	8	15	B	11	1795
12-071-05132	174	Ahar	LP	33	45	21	7	9	38	70	99	7	19	B	11	1738
12-071-04432	221	Isfahan	LP	29	42	21	8	8	40	67	98	7	17	B	12	1635
12-071-04466	221	Isfahan	LP	27	46	24	8	8	38	69	97	7	17	B	12	1558
12-071-04279	174	Ahar	LP	28	38	22	8	8	38	68	93	8	17	B	11	1537
12-071-04282	129	Isfahan	LP	30	43	22	7	8	38	70	96	7	14	B	11	1492
12-071-05331	154	Gharyeh-gole	LP	30	37	22	8	9	37	69	93	7	18	B	10	1447
12-071-06465	175	Gharyeh-gole	P	26	40	20	7	8	38	69	96	8	15	LiBr	12	1425
12-071-04509	193	Kermanshah	LP	29	44	24	7	8	36	68	97	7	16	B	10	1352
LSD 5%																519
CV %																23

Table 8. Agronomic Data - White Chickpeas - First year Advanced Yield Test - Planted April 17, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source No.	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-02053	424	Karaj Selection	W	48	65	30	9	9	39	81	118	8	11	W	25	2949
12-071-03378	168	Moghan	W	44	67	25	9	9	41	75	109	7	13	W	25	2924
12-071-02345	241	Ghochan	W	44	68	31	9	9	40	71	107	7	14	W	20	2808
12-071-03260	111	Varamin	W	46	67	24	9	9	40	77	116	8	16	W	26	2788
12-071-02896	170	Ardabil	W	49	68	26	9	9	42	80	118	8	11	W	29	2778
12-071-03232	41	Varamin	W	51	62	25	9	9	43	78	111	8	12	W	29	2764
12-071-10055	207	Mazandaran	W	48	66	27	9	9	41	78	112	8	10	W	25	2632
12-071-01919	84	Karaj Selection	W	49	76	25	9	9	41	77	108	7	13	W	31	2614
12-071-02464	106	Fars	W	46	61	31	9	9	42	81	115	8	16	W	17	2613
12-071-01915	71	Karaj Selection	W	46	67	24	9	9	41	73	106	7	11	W	34	2514
12-071-02968	169	Ardabil	W	43	63	27	9	9	40	78	111	7	11	LiCr	23	2502
12-071-03355	168	Mamaghan	W	44	63	24	9	9	40	74	112	8	11	W	30	2459
12-071-01921	86	Karaj	W	46	69	26	9	9	40	76	108	7	15	W	28	2411
12-071-02185	241	Ghochan	W	45	64	30	9	9	39	58	113	7	12	W	20	2385
12-071-03251	111	Varamin	W	48	61	22	9	9	42	76	114	7	12	W	33	2384
12-071-03289	111	Varamin	W	47	63	24	9	9	43	71	112	7	11	W	34	2359
12-071-02290	220	Isfahan	W	58	66	26	9	9	43	87	118	7	15	W	22	2336
12-071-03005	169	Ardabil	W	45	61	23	9	9	40	73	113	7	11	W	25	2318
12-071-02516	232	Darehgaz	W	49	70	22	9	9	42	79	111	7	13	W	29	2280
12-071-02346	241	Ghochan	W	43	63	30	9	9	40	68	108	8	13	W	21	2100
12-071-02032	2	Torbat Haidarieh	W	49	65	23	9	9	42	72	111	7	13	W	33	2045
12-071-03220	194	Kermanshah	W	42	67	23	9	9	39	68	84	8	12	W	24	1865
12-071-01916		Karaj Selection	W	44	64	31	9	9	40	71	114	8	13	W	26	1792
12-071-10056	194	Kermanshah	W	46	65	30	9	9	42	79	115	7	10	W	32	1788
12-071-02188	241	Ghochan	W	57	65	30	9	9	43	88	118	8	12	W	21	1315
LSD 5%																1085
CV %																27

Table 9. Agronomic Data - White Chickpeas - First Year Advanced Yield Test - Planted May 2, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-02464	106	Fars	W	39	54	29	9	9	44	81	105	9	16	W	17	3921
12-071-02896	170	Ardabil	W	37	64	23	8	9	39	80	111	9	11	W	29	3777
12-071-02290	220	Isfahan	W	51	73	29	9	9	44	92	115	8	15	W	22	2649
12-071-10055	207	Mazandaran	W	35	60	25	8	9	38	77	102	8	10	W	25	2605
12-071-03005	169	Ardabil	W	32	53	24	8	9	37	74	103	8	11	W	25	3389
12-071-01919	84	Karaj Selection	W	30	51	22	8	8	38	76	98	9	13	W	31	3313
12-071-03289	111	Varamin	W	34	59	18	7	9	39	73	101	8	11	W	34	3288
12-071-02032	2	Torbat Heidarieh	W	32	57	24	8	9	37	68	96	8	13	W	33	3242
12-071-03232	41	Varamin	W	38	59	24	8	9	40	76	101	7	12	W	29	3183
12-071-01921	86	Karaj	W	34	57	17	9	9	38	74	101	8	15	W	28	3179
12-071-02185	241	Ghochan	W	27	56	31	8	9	35	70	100	8	12	W	20	3139
12-071-02968	169	Ardabil	W	29	53	23	8	9	37	74	103	8	11	LiCr	23	3094
12-071-02053	424	Karaj Selectior	W	29	52	28	8	9	36	69	108	8	11	W	25	3000
12-071-03260	111	Varamin	W	32	60	24	8	9	37	73	100	8	16	W	26	2999
12-071-03378	168	Moghan	W	28	52	28	8	9	38	73	101	8	13	W	25	2961
12-071-01916		Karaj Selection	W	30	56	25	9	9	36	69	91	8	13	W	26	2943
12-071-10056	194	Kermanshah	W	38	56	24	7	8	40	76	105	8	10	W	32	2939
12-071-03251	111	Varamin	W	32	55	20	7	9	39	74	100	8	12	W	33	2763
12-071-02188	241	Ghochan	W	56	72	28	8	9	43	93	116	9	12	W	21	2746
12-071-02346	241	Ghochan	W	28	61	26	8	9	35	68	91	9	13	W	21	2697
12-071-03355	168	Mamaghan	W	33	53	23	8	9	37	72	98	8	11	W	30	2591
12-071-02516	232	Darehgaz	W	32	61	18	7	9	34	73	102	8	13	W	29	2548
12-071-02345	241	Ghochan	W	28	54	28	8	8	38	66	100	8	14	W	21	2506
12-071-01915	71	Karaj Selection	W	33	51	22	7	9	38	71	93	8	11	W	34	2376
12-071-03220	194	Kermanshah	W	28	54	20	7	8	36	66	93	8	12	W	24	2052
LSD 5%																732
CV %																21

Table 10. Agronomic Data - Black Chickpeas - Uniform Advanced Yield Test - Planted April 17, 1969 - RPIP Ghazvin, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-05436	175	Gharyeh-gole	LP	23	7	7	27	60	81	7	16	LiBr	13	1853
12-071-05132	174	Ahar	LP	19	8	8	27	62	81	8	15	B	10	1767
12-071-05301	154	Gharyeh-gole	LP	19	8	8	29	61	81	8	17	B	12	1723
12-071-05432	154	Karaj	LP	21	8	8	26	60	82	7	16	B	11	1718
12-071-05451	174	Gharyeh-gole	P	24	7	7	26	61	82	8	13	LiBr	14	1685
12-071-05093	174	Ahar	LP	19	7	7	28	61	81	7	16	B	12	1615
12-071-04244		Ardabil	LP	20	7	7	29	60	82	8	18	B	12	1558
12-071-05442	251514	Iran	LP	19	7	7	27	63	81	7	19	B	11	1513
12-071-10054	171	Ardabil	LP	25	8	8	27	58	82	8	15	B	10	1481
12-071-10050	174	Ardabil	LP	17	8	8	26	62	82	8	20	B	11	1417
LSD 5%														331
CV %														14

Table 11. Agronomic Data - Black Chickpeas - Uniform Advanced Yield Test - Planted April 17, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source No.	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-05301	154	Gharyeh-gole	LP	47	65	19	9	9	41	75	103	7	17	B	12	2840
12-071-05093	174	Ahar	LP	46	70	17	9	9	41	75	105	7	16	B	12	2440
12-071-10050	174	Ardabil	LP	44	71	18	9	9	41	73	102	7	20	B	11	2160
12-071-06486	175	Gharyeh-gole	LP	41	68	18	9	9	41	76	102	7	13	LiBr	14	2120
12-071-04244		Ardabil	LP	48	61	16	9	9	41	75	104	8	18	B	12	2026
12-071-06485	154	Karaj	LP	41	65	19	9	9	40	74	104	7	16	B	11	1880
12-071-05132	174	Ahar	LP	47	64	24	9	9	41	71	102	7	15	B	10	1660
12-071-06465	175	Gharyeh-gole	LP	40	62	17	9	9	41	74	100	7	16	LiBr	13	1656
12-071-06476	251514	Iran	LP	43	62	21	9	9	41	74	102	7	19	B	11	1600
12-071-10054	171	Ardabil	LP	42	64	19	9	8	41	73	101	7	15	B	10	1530
LSD 5%																1023
CV %																37

Table 12. Agronomic Data - Black Chickpeas - Uniform Advanced Yield Test - Planted May 2, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source No.	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st Fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-05442	251514	Iran	LP	31	57	19	7	9	37	71	95	7	19	B	11	2057
12-071-05093	174	Ahar	LP	31	50	20	8	9	37	70	96	8	16	B	12	1988
12-071-05301	154	Gharyeh-gole	LP	31	52	23	8	7	38	70	95	8	17	B	12	1958
12-071-10050	174	Ardabil	LP	29	53	23	8	9	37	70	95	8	20	B	11	1920
12-071-04244		Ardabil	LP	32	50	22	7	9	37	69	96	8	18	B	12	1916
12-071-05132	174	Ahar	LP	31	49	22	7	9	38	71	99	8	15	B	10	1914
12-071-05436	175	Gharyeh-gole	LP	26	49	18	7	6	38	67	94	7	16	LiBr	13	1879
12-071-10054	171	Ardabil	LP	28	53	28	8	8	35	66	94	8	15	B	10	1860
12-071-05451	175	Gharyeh-gole	LP	24	45	22	7	8	38	70	93	7	13	LiBr	14	1684
12-071-05432	154	Karaj	LP	25	43	24	8	8	36	66	88	7	16	B	11	1475
LSD 5%																776
CV %																21

Table 13. Agronomic Data - White Chickpeas - Uniform Advanced Yield Test (No. 1) - Planted April 17, 1969 - RPIP Ghazvin, Iran

(1)	(2)	(3)	(4)	(7)	(8)	(9)	(10)	(11)	(13)	(14)	(15)	(16)	(17)
Accession Number	Source Number	SOURCE	Flower Color	Plant /Meter	Stand	Vigor	Fl. to 1st Fl.	Fl. to 1st Mt.	Disease Rating	Seeds per 10 Pods	Seed Color	100 Seed Weight	Yield per Hectare
12-071-05456	34	Karaj Selection	W	22	7	7	37	64	7	10	W	23	1402
12-071-10025	111	Isfahan	W	16	7	7	42	67	7	16	W	31	1184
12-071-05468	3	Karaj Selection	W	22	7	7	39	67	7	10	W	24	1164
12-071-10014	162	Shahpour	W	18	6	7	41	67	6	12	W	31	1098
12-071-05466	18	Karaj Selection	W	18	7	7	44	67	7	12	W	28	1092
12-071-10017	111	Isfahan	W	15	6	6	43	68	6	12	W	39	1019
12-071-05473	249982	Iran	W	14	7	7	42	67	7	12	W	32	939
12-071-10013	129	Moghan	W	15	6	7	41	68	6	11	W	31	914
12-071-10016	129	Moghan	W	17	6	6	39	67	6	10	W	31	910
12-071-10015	129	Moghan	W	15	6	7	41	67	6	10	W	31	858
LSD 5%													370
CV %													25

Table 14. Agronomic Data - White Chickpeas - Uniform Advanced Yield Test (No. 1) - Planted April 17, 1969 - RPIP Varamin, Iran

(1)	(2)	(3)	(4)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Accession Number	Source Number	SOURCE	Flower Color	Plants /Meter	Stand	Vigor	Fl. to 1st Fl.	Fl. to 1st Mat.	Fl. to Com.Mat.	Disease Rating	Seeds per 10 Pods	Seed Color	100 Seed Weight	Yield per Hectare
12-071-05456	34	Karaj Selection	W	25	9	9	35	81	119	7	10	W	23	3540
12-071-05473	249982	Iran	W	27	9	9	39	81	113	8	12	W	32	3460
12-071-05468	3	Karaj Selection	W	34	9	9	36	81	115	7	10	W	24	3330
12-071-10013	129	Moghan	W	24	9	9	37	81	116	7	11	W	31	3220
12-071-10014	162	Shahpour	W	29	9	9	39	82	114	7	12	W	31	2996
12-071-10025	111	Isfahan	W	28	9	9	39	82	114	7	16	W	31	2990
12-071-10015	129	Moghan	W	24	9	9	36	79	116	7	10	W	31	2570
12-071-05466	18	Karaj Selection	W	24	9	9	34	81	113	7	12	W	28	2500
12-071-10016	129	Moghan	W	24	8	9	37	80	116	7	10	W	31	2446
12-071-10017	111	Isfahan	W	20	9	9	41	81	116	7	12	W	39	2290
LSD 5%														1027
CV %														25

Table 15. Agronomic Data - White Chickpeas - Uniform Advanced Yield Test (No. 1) - Planted May 2, 1969 - RPIP Karaj, Iran

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Accession Number	Source No.	SOURCE	Flower Color	Plant Height	Plant Width	Plants /Meter	Stand	Vigor	Pl. to 1st Fl.	Pl. to 1st Mat.	Pl. to Com.Mat.	Disease Rating	Seeds per 10 Pods	Seed Color	100 Seed Weight	Yield per Hectare
12-071-05468	3	Karaj Selection	W	34	54	22	8	9	36	75	109	7	10	W	24	3394
12-071-05473	249982	Iran	W	31	48	23	7	9	38	75	99	8	12	W	32	3069
12-071-05456	34	Karaj Selection	W	31	55	19	8	9	36	74	105	8	10	W	23	3056
12-071-05466	18	Karaj Selection	W	31	48	18	7	8	37	75	107	8	12	W	28	3042
12-071-10014	162	Shahpour	W	34	52	20	7	8	38	77	105	7	12	W	31	3039
12-071-10025	111	Isfahan	W	34	47	26	8	9	39	72	100	7	16	W	31	2788
12-071-10016	129	Moghan	W	31	45	20	8	9	37	70	104	7	10	W	31	2754
12-071-10013	129	Moghan	W	30	46	21	8	8	36	71	106	7	11	W	31	2724
12-071-10017	111	Isfahan	W	37	52	17	7	8	38	72	100	6	12	W	39	2526
12-071-10015	129	Moghan	W	31	48	23	8	8	37	71	102	7	10	W	31	2388
LSD 5%																746
CV %																18

Table 16. Agronomic Data - White Chickpeas - Uniform Advanced Yield Test (No. 2) - Planted April 17, 1969, RPIP Varamin, Iran

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Accession Number	Source No.	SOURCE	Flower Color	Plant Height	Plant Width	Plants /Meter	Stand	Vigor	Pl. to 1st Fl.	Pl. to 1st Mat.	Pl. to Com.Mat.	Disease Rating	Seeds per 10 Pods	Seed Color	100 Seed Weight	Yield per Hectare
12-071-10031	169	Ardabil	W	60	63	25	9	9	38	82	118	8	11	W	31	3378
12-071-10032	152	Karaj	W	66	79	23	9	9	41	81	119	8	10	W	34	3010
12-071-10033	111	Isfahan	W	63	76	22	9	9	41	80	118	8	11	W	29	3002
12-071-02518	232	Darehgaz	W	63	72	20	9	9	43	81	116	7	12	W	27	2940
12-071-10039	152	Karaj	W	60	66	27	9	9	39	81	118	7	10	W	34	2920
12-071-10026	162	Shahpour	W	58	63	29	9	9	39	80	115	7	10	W	31	2752
12-071-10034	152	Karaj	W	57	67	19	9	9	41	80	116	7	13	W	29	2540
12-071-10025	111	Isfahan	W	54	63	20	9	9	41	80	116	8	16	W	26	2520
12-071-10020	169	Ardabil	W	64	77	24	9	9	40	79	118	8	11	W	37	2330
12-071-02089	254	Karaj Selection	W	58	78	22	9	8	39	81	116	8	10	W	27	2000
LSD 5%																1274
CV %																33

Table 17. Agronomic Data - White Chickpeas - Uniform Advanced Yield Test (No. 2) - Planted May 2, 1969 - RPIP Karaj, Iran

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Accession Number	Source No.	SOURCE	Flower Color	Plant Height	Plant Width	Plants /Meter	Stand	Vigor	Pl. to 1st Fl.	Pl. to 1st Mat.	Pl. to Com.Mat.	Disease Rating	Seeds per 10 Pods	Seed Color	100 Seed Weight	Yield per Hectare
12-071-10020	169	Ardabil	W	38	63	23	9	9	42	81	112	8	11	W	37	2832
12-071-10025	111	Isfahan	W	36	54	22	8	8	38	78	95	8	16	W	26	2753
12-071-02518	232	Darehgaz	W	32	60	22	8	9	41	77	98	7	12	W	27	2697
12-071-10034	152	Karaj	W	32	60	20	7	8	40	74	104	7	13	W	29	2531
12-071-10033	111	Isfahan	W	30	53	21	8	8	40	73	95	7	11	W	26	2461
12-071-10031	169	Ardabil	W	35	53	21	8	9	38	76	107	7	11	W	31	2358
12-071-10026	162	Shahpour	W	31	51	23	8	8	38	73	104	6	10	W	31	2308
12-071-10029	152	Karaj	W	34	58	17	6	8	38	73	103	7	10	W	34	2289
12-071-10032	152	Karaj	W	34	58	21	7	9	41	71	96	6	10	W	34	2212
12-071-02089	254	Karaj Selection	W	39	57	18	7	7	37	73	101	6	10	W	27	1942
LSD 5%																701
CV %																20

Table 18. Agronomic Data - Chickpeas - International Advanced Yield Test - Planted April 17, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(11) Pl. to 1st.Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 pods	(15) Seed Color	(17) Yield per Hectare
12-079-10004		Jordan	W	64	81	17	9	9	61	85	8	11	W	1635
12-074-10008	319	Israel	W	53	79	37	9	9	59	80	7	12	W	1602
12-071-65472	5006	Iran	LP	62	76	29	9	9	63	87	8	11	LiBr	1591
12-113-10006	C 727	Pakistan	LP	46	68	31	9	9	58	78	6	12	LiBr	1494
12-155-10002	Giza	UAR	W	59	69	21	9	9	59	80	7	13	W	1469
12-071-05475	5009	Iran	LP	62	73	34	9	9	64	88	8	10	LiCr	1379
12-074-10012	CP 43	Israel	W	68	82	20	9	9	68	87	8	10	W	1126
12-155-10003	F13	UAR	W	49	64	28	8	9	58	76	6	12	W	1114
12-074-10011	CP	Israel	W	70	86	20	9	9	67	88	8	10	W	1079
12-074-10009	CP 42	Israel	W	66	86	18	9	9	62	88	8	10	W	1062
12-071-05464	5015	Iran	LP	61	73	23	9	9	61	86	8	11	LiCr	1045
12-113-10007	C 612	Pakistan	LP	41	73	40	9	9	59	77	7	16	LiBr	996
12-113-10005	Punjab	Pakistan	W	52	63	23	8	8	57	75	6	13	W	948
12-074-10010	I 13	Israel	LP	63	75	32	9	9	62	86	7	13	B	860
12-155-10001	F1	UAR	W	45	51	51	8	8	56	74	6	11	W	739
LSD 5%														570
CV %														36

Table 19. Agronomic Data - Chickpeas - International Advanced Yield Test - Planted May 2, 1969 - RPIP, Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Height	(6) Plant Width	(7) Plants /Meter	(8) Stand	(9) Vigor	(10) Pl. to 1st fl.	(11) Pl. to 1st Mat.	(12) Pl. to Com.Mat.	(13) Disease Rating	(14) Seeds per 10 Pods	(15) Seed Color	(16) 100 Seed Weight	(17) Yield per Hectare
12-071-05475	5009	Iran	LP	48	55	27	9	9	42	82	102	9	10	LiCr	22	3923
12-071-05464	5015	Iran	LP	44	53	23	8	9	40	80	104	8	11	LiCr	23	3224
12-071-05472	5006	Iran	LP	46	52	25	8	9	41	77	91	8	11	LiBr	24	3054
12-074-10008	319	Israel	W	39	46	29	8	9	36	67	92	8	12	W	26	2563
12-074-10010	I 13	Israel	LP	50	56	22	8	9	49	83	97	9	13	B	27	2434
12-079-10004		Jordan	W	42	54	20	8	9	38	70	97	8	11	W	46	2187
12-074-10011	CP	Israel	W	51	63	19	7	9	42	78	111	8	10	W	42	2113
12-074-10012	CP 43	Israel	W	52	57	23	7	9	38	76	100	8	10	W	44	2080
12-074-10009	CP 42	Israel	W	50	55	21	8	9	39	76	104	8	10	W	48	2067
12-155-10002	Giza	UAR	W	40	44	26	8	9	36	66	91	8	13	W	32	2046
12-113-10005	Punjab	Pakistan	W	37	40	21	7	8	39	72	91	8	13	W	24	2010
12-113-10007	C 612	Pakistan	LP	29	36	32	8	9	39	68	87	8	16	LiBr	14	1907
12-113-10006	C 727	Pakistan	LP	35	37	38	8	9	42	75	90	8	12	LiBr	19	1806
12-155-10003	F13	UAR	W	37	46	23	8	8	37	64	89	8	12	W	23	1577
12-155-10001	F1	UAR	W	34	37	32	8	8	35	62	88	8	11	W	15	1133
LSD 5%																586
CV %																20

Legend for Beans Agronomic Data Tables 20-27

(1) Numbers assigned to collection maintained by the Regional Pulse Improvement Project.

(2) Indicates variety name or area of origin. Numbers are numbers assigned to populations or collection by the Iranian Ministry of Agriculture; six digit numbers are PI numbers from Crops Research Division, ARS, U. S. Department of Agriculture, Beltsville, Maryland, U.S.A.

(3) W = White; P = Purple; LP = Light Purple.

(4) V = Viney; B = Bushy.

(5) Average number of plants per meter based on one meter of row per replication.

(6) Rated 1 to 9: 1 = poor stand; 9 = complete stand.

(7) Rated 1 to 9: 1 = weak plants; 9 = vigorous plants.

(8) Days from planting to first opened flower.

(9) Indicates number of days after planting the first pod in plot reached full maturity, ready for harvest.

(10) Indicates number of days after planting the whole plot was ready for harvest.

(11) Disease rated 1 to 9: 1 = severe disease symptoms; 9 = free from disease.

(12) First column: C = Curved; S = Straight.
Second column: C = Cylindrical; F = Flat.

(13) S = Short; M = Medium; L = Long; VL = Very Long.

(14) Average of 10 pods per replication.

(15) W = White; Cr = Cream; R = Red; P = Purple; Br = Brown; Pi = Pink; Y = Yellow; Bl = Black; M = Mottled; S = Spotted; L = Light; D = Dark.

(16) C = Cylindrical; F = Flat; P = Plump.

(17) Average weight (grams) of 100 seeds.

(18) Yield in kilograms per hectare based on 5 or 10 square meter plots.

Table 20. Pinto Beans - Preliminary Yield Test - Planted May 19, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) SOURCE	(3) Flower Color	(4) Plant Type	(5) Plants /Meter	(6) Stand	(7) Vigor	(8) Pl. to 1st Fl.	(9) Pl. to 1st Mat.	(10) Pl. to Com.Mat.	(11) Disease Rating	(12) Pod Shape	(13) Pod Size	(14) Seeds per Pod	(15) Seed Color	(16) Seed Shape	(17) 100 Seed Weight	(18) Yield per Hectare
65-153-02141	Turkey	LP	V	18	8	9	39	94	105	9	CF	M	3	LPiM	C	45	1796
65-153-01297	Turkey	LP	V	20	8	9	47	94	108	5	CF	M	3	LPiM	C	36	1796
65-137-01650	Africa	LP	V	12	8	9	44	92	104	5	CF	M	4	LPiM	C	38	1390
65-032-00793	Chile	LP	V	13	7	8	39	89	101	8	SF	M	3	LPiM	C	45	1244
65-071-00416	Isfahan	LP	V	9	7	8	40	90	101	8	SF	M	3	LPiM	C	41	1230
65-153-02167	Turkey	LP	V	12	8	8	40	96	113	5	SF	M	5	LPiM	C	38	1212
65-153-01722	Eskeshir, Turkey	LP	V	13	8	9	39	92	108	6	SF	M	3	LPiM	C	44	1166
65-071-00396	Jiroft	LP	V	15	7	9	43	96	112	5	SF	M	4	LPiM	C	38	1162
65-153-01724	Ankara, Turkey	LP	V	11	7	8	39	91	103	8	CF	S	3	LPiM	C	38	1086
65-153-02261	Turkey	LP	V	18	7	9	41	93	108	6	CF	M	5	LPiM	C	38	594
LSD 5%																	282
CV %																	19%

Table 21. Red Beans - Preliminary Yield Test - Planted May 19, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) SOURCE	(3) Flower Color	(4) Plant Type	(5) Plants /Meter	(6) Stand	(7) Vigor	(8) Pl. to 1st Fl.	(9) Pl. to 1st Mat.	(10) Pl. to Com.Mat.	(11) Disease Rating	(12) Pod Shape	(13) Pod Size	(14) Seeds per Pod	(15) Seed Color	(16) Seed Shape	(17) 100 Seed Weight	(18) Yield per Hectare
65-071-00580	Darehgaz	W	V	16	8	9	43	85	100	5	CF	M	4	DR	F	25	2818
65-153-01282	Turkey Sel.	W	V	21	8	8	43	85	100	5	CF	M	3	DR	F	28	2400
65-035-00876	Congo	W	V	13	8	9	44	85	101	6	CF	M	6	DR	C	24	2200
65-153-01616	Turkey	W	V	16	8	8	45	85	100	5	CF	S	5	DR	C	23	1978
65-032-01627	Chile	W	V	17	8	8	45	87	104	5	CF	M	4	R	C	27	1814
65-071-00582	Isfahan	W	V	19	8	9	45	85	101	6	CF	M	4	DR	C	23	1762
65-069-01534	India	W	V	12	8	9	50	91	110	5	CF	M	5	R	F	28	1714
65-062-00832	Guatemala	LP	B	19	8	8	40	87	103	6	CF	M	3	R	P	38	1632
65-000-02615	Unknown	W	V	13	8	8	39	86	97	6	CF	M	5	R	C	25	1624
65-000-02612	Unknown	W	V	13	8	8	39	84	95	5	CF	M	5	R	C	28	1610
65-000-02602	Unknown	W	V	16	8	8	40	85	97	5	CF	M	4	R	C	25	1550
65-000-02605	Unknown	W	V	10	8	8	37	84	97	6	CF	M	5	R	C	26	1448
65-002-01034	Afghanistan	W	V	13	7	8	49	87	104	5	CF	M	5	R	F	26	1418
65-000-02613	Unknown	W	V	17	8	8	38	83	96	5	CF	M	5	R	F	25	1416
65-000-02604	Unknown	W	V	16	8	9	39	85	97	5	CF	M	4	R	F	28	1382
LSD 5%																	800
CV																	36%

Table 22. White Beans - Preliminary Yield Test - Planted May 19, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) SOURCE	(3) Flower Color	(4) Plant Type	(5) Plants /Meter	(6) Stand	(7) Vigor	(8) Pl. to 1st Fl.	(9) Pl. to 1st Mat.	(10) Pl. to Com.Mat.	(11) Disease Rating	(12) Pod Shape	(13) Pod Size	(14) Seeds per Pod	(15) Seed Color	(16) Seed Shape	(17) 100 Seed Weight	(18) Yield per Hectare
65-153-02252	Turkey	W	V	14	8	9	44	96	111	8	CF	M	4	W	C	23	2736
65-153-01735	Turkey	W	V	13	7	9	39	92	110	6	CF	M	2	W	F	54	1824
65-153-02066	Turkey	W	V	18	7	8	39	87	108	7	CF	M	4	W	F	30	1718
65-071-00353	Arak, Iran	W	V	21	8	9	42	93	96	6	CF	M	5	W	C	26	1692
65-000-02578	Unknown	W	V	16	7	8	44	84	98	7	CF	M	5	W	F	26	1644
65-153-01938	Bursa, Turkey	W	V	15	8	9	39	93	110	5	CF	M	4	W	F	50	1642
65-153-02274	Turkey	W	V	14	7	9	40	84	100	6	CF	M	4	W	F	26	1560
65-071-00042	Shiraz	W	V	11	8	9	42	84	97	7	CF	M	5	W	F	25	1524
65-153-01846	Fursa, Turkey	W	B	15	8	8	40	87	102	7	CF	M	4	W	P	40	1502
65-071-00772	Unknown	W	V	15	7	8	41	83	96	6	CF	M	4	W	C	24	1484
65-153-01801	Turkey	W	V	17	8	9	34	93	110	5	CF	M	3	W	F	49	1456
65-153-02551	Turkey	W	B	11	6	8	39	87	101	8	SC	M	4	W	P	46	1308
65-153-02503	Turkey	W	B	9	7	9	39	87	104	8	SF	M	5	W	P	48	1282
65-153-02470	Turkey	W	B	10	6	8	39	84	98	8	SF	M	4	W	P	43	1100
65-153-02552	Turkey	W	B	8	6	8	38	86	101	8	SC	M	5	W	P	43	1024
LSD 5%																	120
CV %																	26%

Table 23. Pinto Beans - Advanced Yield Test (No. 1) - Planted May 19, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) SOURCE	(3) Flower Color	(4) Plant Type	(5) Plants /Meter	(6) Stand	(7) Vigor	(8) Pl. to 1st Fl.	(9) Pl. to 1st Mat.	(10) Pl. to Com.Mat.	(11) Disease Rating	(12) Pod Shape	(13) Pod Size	(14) Seeds per Pod	(15) Seed Color	(16) Seed Shape	(17) 100 Seed Weight	(18) Yield per Hectare
65-157-00068	USA	W	V	19	8	8	31	81	98	4	CF	M	5	CrM	C	35	1681
65-153-00930	Turkey	LP	V	19	7	9	44	90	114	4	SF	M	4	PiM	C	44	1621
65-071-00446	Isfahan	W	V	19	8	8	42	87	102	5	CC	M	5	CrM	C	45	1315
65-071-00601	Isfahan	LP	V	19	8	9	40	88	107	6	CF	M	4	PiM	C	41	1221
65-071-00603	Isfahan	LP	V	15	8	7	40	86	112	5	CF	S	5	PiM	C	45	1161
65-071-00593	Isfahan	LP	V	17	7	8	40	87	107	5	SF	M	3	PiM	C	42	1156
65-071-00604	Isfahan	LP	V	17	8	9	40	88	105	5	SF	M	6	PiM	C	39	1148
65-071-00457	Isfahan	LP	V	15	7	9	43	94	113	6	SF	M	4	PiM	C	37	1138
65-071-00605	Isfahan	LP	V	13	7	8	40	86	113	5	CF	M	5	PiM	C	40	858
65-071-00594	Isfahan	LP	V	16	7	8	40	86	110	7	SF	S	3	PiM	C	41	684
LSD 5%																	370
CV																	25%

Table 24. Red Beans - Advanced Yield Test (No. 1) - Planted May 19, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) SOURCE	(3) Flower Color	(4) Plant Type	(5) Plants /Meter	(6) Stand	(7) Vigor	(8) Pl. to 1st Fl.	(9) Pl. to 1st Mat.	(10) Pl. to Com.Mat.	(11) Disease Rating	(12) Pod Shape	(13) Pod Size	(14) Seeds per Pod	(15) Seed Color	(16) Seed Shape	(17) 100 Seed Weight	(18) Yield per Hectare
65-071-00713	Darehgaz	W	V	14	8	9	59	98	118	6	CF	M	6	R	C	21	2970
65-071-00734	Nishabour	W	V	14	8	9	57	99	118	8	CF	M	5	R	C	23	2942
65-071-00537	Nishabour	W	V	13	8	9	61	99	118	6	CF	M	5	LR	C	25	2882
65-071-00536	Torbat Hedarieh	W	B	13	8	9	38	81	98	6	CF	M	5	Bl	C	24	2809
65-071-00721	Darehgaz	W	V	12	8	9	61	98	118	7	CF	M	5	R	C	23	2727
65-007-00292	Argentina	W	V	11	8	9	61	99	118	7	CF	M	4	LR	C	23	2709
65-071-01031	Iran	W	V	15	8	9	56	97	118	7	CF	M	6	R	F	22	2644
65-085-00100	Lebanon	W	V	12	8	9	39	82	98	6	CF	M	5	LR	C	29	2516
65-071-00582	Isfahan	W	V	14	7	9	47	83	99	6	CF	M	5	P	F	25	2439
65-071-00703	Unknown	W	V	15	8	9	47	88	103	7	CF	M	5	R	C	29	2378
65-071-00577	Ghouchan	W	V	13	8	9	60	100	118	8	CF	M	7	R	F	22	2340
65-071-00702	Torbat Hedarieh	W	V	10	7	9	45	86	99	6	CF	M	4	R	F	29	2322
65-071-00399	Fars	W	V	12	8	9	40	84	98	5	CF	M	5	LR	F	28	2321
65-071-00361	Rasht	W	V	15	8	9	47	86	101	6	CF	M	6	DR	F	26	2254
65-071-00560	Darehgaz	W	V	13	8	9	61	99	118	6	CF	M	5	R	C	22	2210
65-071-00534	Torbat Hedarieh	W	V	13	8	9	45	83	98	6	CF	M	5	R	F	29	2161
65-153-02122	Turkey	W	V	12	8	9	60	99	118	5	CF	M	6	R	F	24	2123
65-071-00732	Nishabour	W	V	12	7	9	44	83	98	7	CF	M	5	DR	F	24	1990
65-027-00071	Mexico	W	V	12	8	9	38	81	98	5	CF	M	5	R	F	29	1984
65-071-00709	Darehgaz	W	V	12	8	9	36	80	98	5	CF	M	6	LR	C	30	1971
65-071-00564	Kermanshah	W	V	11	7	9	39	81	98	5	CF	M	4	LR	F	32	1953
65-071-00710	Kermanshah	W	V	14	8	9	35	80	98	7	CF	M	6	LR	F	31	1939
65-071-00727	Unknown	W	V	13	8	8	38	80	101	5	CF	M	5	LR	C	30	1847
65-153-01390	Turkey	W	V	11	8	9	44	84	98	4	CF	M	5	R	F	29	1628
65-157-00589	USA (Red Kidney)	W	B	8	5	8	41	87	103	5	SF	M	6	R	F	34	896
LSD 5%																	470
CV %																	17

Table 25. White Beans - Advanced Yield Test Planted May 19, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) SOURCE	(3) Flower Color	(4) Plant Type	(5) Plants /Meter	(6) Stand	(7) Vigor	(8) Pl. to 1st Fl.	(9) Pl. to 1st Mat.	(10) Pl. to Com.Mat.	(11) Disease Rating	(12) Pod Shape	(13) Pod Size	(14) Seeds per Pod	(15) Seed Color	(16) Seed Shape	(17) 100 Seed Weight	(18) Yield per Hectare
65-071-00638	Shiraz	W	V	10	7	9	44	85	102	6	CF	M	5	W	F	22	2348
65-000-00512	Unknown	W	V	12	7	9	46	89	99	7	CF	M	3	W	C	26	2320
65-071-00640	Shiraz	W	V	16	8	9	41	83	100	5	CF	M	4	W	F	25	2288
65-071-00674	Karaj	W	V	14	8	9	41	82	97	7	CF	M	5	W	F	27	2266
65-071-00643	Shiraz	W	V	13	8	9	40	83	98	6	CF	M	4	W	C	26	2194
65-085-00690	Lebanon	W	V	12	8	9	41	82	97	7	CF	M	6	W	C	26	2115
65-071-00625	Karaj	W	V	14	8	9	45	85	98	6	CF	M	4	W	P	24	2111
65-071-00675	Karaj	W	V	9	7	8	45	85	99	5	CF	M	5	W	F	29	2097
65-071-00671	Karaj	W	V	12	7	9	47	86	99	6	CF	M	5	W	F	27	2091
65-071-00637	Shiraz	W	V	12	7	9	42	84	98	5	CF	M	3	W	C	26	2045
65-071-00650	Unknown	W	V	15	8	9	45	84	97	7	CF	M	4	W	C	26	2016
65-071-00212	Iran	W	V	12	8	9	35	93	112	7	CF	M	4	W	F	44	2014
65-071-00699	Unknown	W	V	11	8	9	44	82	97	7	CF	M	5	W	C	25	1981
65-071-00682	Shiraz	W	V	15	8	9	41	82	97	6	CF	M	4	W	C	28	1949
65-153-01286	Turkey	W	V	13	7	8	38	35	100	6	CF	M	4	W	F	36	1926
65-032-00814	Chile	W	V	10	7	8	43	91	104	7	CF	M	4	W	C	34	1879
65-071-00695	Isfahan	W	V	10	7	9	43	84	99	6	CF	M	4	W	F	25	1866
65-071-00042	Shiraz	W	V	11	7	9	40	83	96	7	CF	M	4	W	F	25	1805
65-071-00620	Karaj	W	V	10	7	8	42	82	98	6	CF	M	4	W	F	27	1780
65-071-00676	Karaj	W	V	11	7	8	42	82	98	7	CF	M		W		25	1765
65-157-00010	USA	W	V	13	7	9	44	84	98	7	CF	M	4	W	F	27	1761
65-071-00649	Unknown	W	V	13	8	9	45	87	98	6	CF	M	6	W	F	25	1760
65-071-00681	Shiraz	W	V	13	8	9	43	69	97	6	CF	M	4	W	F	26	1704
65-071-00654	Isfahan	W	V	10	7	9	42	82	99	5	CF	M	3	W	F	26	1692
65-153-02435	Turkey	W	B	9	6	8	44	90	102	7	CC	M	4	W	P	27	1375
LSD 5%																	387
CV																	17%

Table 26. Red Beans - Uniform Advanced Yield Test - Planted May 19, 1969 - RPIP Karaj, Iran

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Accession Number	SOURCE	Flower Color	Plant Type	Plants /Meter	Stand	Vigor	Pl. to 1st Fl.	Pl. to 1st Mat.	Pl. to Com.Mat.	Disease Rating	Pod Shape	Pod Size	Seeds per Pod	Seed Color	Seed Shape	100 Seed Weight	Yield per Hectare
65-071-00569	Nishabour	W	V	16	8	9	64	98	118	7	CF	M	5	R	F	26	2656
65-071-00538	Darehgaz	W	V	21	8	9	62	96	118	7	CF	M	6	R	C	25	2569
65-085-00440	Lebanon	W	V	20	7	8	50	89	100	6	CF	M	5	LR	F	26	2516
65-071-00707	Darehgaz	W	V	23	8	9	54	96	118	6	CF	M	4	R	F	24	2375
65-071-00582	Isfahan	W	V	17	8	9	44	84	97	7	CF	M	5	P	C	24	2311
65-071-00431	Unknown	W	V	16	7	9	44	83	98	8	CF	M	4	DPi	F	27	2172
65-071-00731	Nishabour	W	V	16	8	9	57	93	118	7	CF	M	5	R	F	25	2142
65-071-00744	Torbat Hedarieh	W	V	17	7	9	48	85	98	5	CF	M	6	PBr	F	28	1952
65-071-00566	Isfahan	W	V	10	6	9	46	85	97	5	CF	S	6	R	F	23	560
65-157-00589	USA Red Kidney	LP	B	16	7	7	40	85	99	5	SF	M	3	R	F	38	1272
LSD 5%																	516
CV %																	19%

Table 27. White Beans - Uniform Advanced Yield Test - Planted May 19, 1969 - RPIP Karaj, Iran

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Accession Number	SOURCE	Flower Color	Plant Type	Plants /Meter	Stand	Vigor	Pl. to 1st Fl.	Pl. to 1st Mat.	Pl. to Com.Mat.	Disease Rating	Pod Shape	Pod Size	Seeds per Pod	Seed Color	Seed Shape	100 Seed Weight	Yield per Hectare
65-071-00515	Ghouchan	W	V	19	8	9	46	87	100	6	CF	M	6	W	F	23	2680
65-071-00040	Kermanshah	W	V	14	7	9	41	81	99	7	CF	M	4	W	C	25	2630
65-071-00517	Ghouchan	W	V	21	8	9	44	81	99	8	CF	M	4	W	C	25	2586
65-071-00505	Shiraz	W	V	13	7	9	45	86	98	7	CF	M	4	W	C	29	2462
65-157-00014	USA	W	V	17	7	9	41	81	99	6	CF	M	6	W	C	23	2265
65-071-00680	Kermanshah	W	V	17	7	9	47	79	98	7	CF	M	4	W	C	27	2264
65-071-01948	Shiraz	W	V	19	8	9	39	80	98	7	CF	M	5	W	F	27	2249
65-071-00658	Dashtsar Amol	W	V	20	8	9	34	86	104	7	CF	M	3	W	F	43	2247
65-071-00042	Shiraz	W	V	17	7	9	41	79	98	8	CF	M	4	W	C	26	2244
65-153-00757	Otrak, Turkey	W	B	22	8	9	39	82	98	8	SF	M	4	W	P	40	2192
LSD 5%																	447
CV																	15%

Legend for Cowpea Agronomic Data Tables 28-33

(1) Numbers assigned to collection maintained by the Regional Pulse Improvement Project.

(2) Source numbers refer to PI numbers from New Crops Research Branch, Crops Research Division, ARS, U.S. Department of Agriculture, Beltsville, Maryland. "C" numbers are strains obtained from Oklahoma State University. Other three and four digit numbers are numbers assigned by the Iranian Ministry of Agriculture.

(3) Source indicates variety name or area of origin.

(4) Flower color: P = Purple; W = White; WP = mixed White and Purple flowers.

(5) Plant type: E = Erect; SE = Semi-erect; B = Bushy; P = Prostrate; BP = Bushy Prostrate.

(6) Plant height (in centimeters) at near full plant growth.

(7) Plant width (in centimeters) at near full plant growth.

(8) Plants per meter is an average number of plants per meter of row based on one meter sample per replication.

(9) Rated 1 to 9 : 1 = complete stand; 9 = poor stand.

(10) Rated 1 to 9 : 1 = vigorous plants;9 = weak plants.

(11) Days from planting to first opened flower.

(12) Days from planting to first mature pod ready for harvest.

(13) Rated 1 to 9 : 1 = free from disease symptoms; 9 = severe disease symptoms, major disease mosaic virus. See pathology section for diseases present.

(14) Pod shape: S = Straight; C = Curved; M = Mixture of Straight and Curved.

(15) Pod color: Br = Brown; Pu = Purple; P = Pink; Cr = Cream; W = White; Y = Yellow; G = Green; L = Light; D = Dark.

(16) Pod size: VL = Very Large; L = Large; M = Medium; S = Small.

(17) Seeds per pod is average based on five random pods per replication.

(18) Seed Color: Cr = Cream; P = Pink; M = Milky; Bk = Black; Br = Brown; G = Green; Bl = Blue; W = White; Y = Yellow; R = Red; Pu = Purple; Sp = Spotted; D = Dark; L = Light.

(19) Eye color: Cr = Cream; P = Pink; M = Milky; Bk = Black; Br = Brown; G = Green; Bl = Blue; W = White; Y = Yellow; R = Red; Pu = Purple; D = Dark; L = Light.

(20) Seed size: L = Large, approximately 24 grams per 100 seeds; M = Medium, approximately 15 grams per 100 seeds; S = Small, approximately 8 grams per 100 seeds.

(21) Shattering rated 1 to 9 : 1 = no loss of seed from shattering; 9 = considerable loss of seed from shattering.

(22) 100 seeds weight - average weight (in grams) of 100 seeds.

(23) Yield in kilogram per hectare based on 10 M^2 plots.

Table 28. Agronomic Data - Cowpea Preliminary Yield Test (No. 2) - Planted April 4, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Type	(6) Plant Height	(7) Plant Width	(8) Plants /Meter	(9) Stand	(10) Vigor	(11) Pl. to 1st Fl.	(12) Pl. to 1st Mat.	(13) Disease Rating	(14) Pod Shape	(15) Pod Color	(16) Pod Size	(17) Seeds per Pod	(18) Seed Color	(19) Eye Color	(20) Seed Size	(21) Shatter	(22) 100 Seed Weight	(23) Yield per Hectare
62-157-01431		USA (Mississippi Silver)	P	SE	43	62	8	2	5	48	76	5	C	LY	ML	15	YCr	LG	ML	3	20	1900
62-071-00197	293420	Iran	W	E	60	71	8	2	4	49	79	4	M	YW	ML	16	Cr	LG	ML	3	16	1680
62-157-00355	293516	USA (Hib-canel)	W	SE	45	64	8	2	4	51	84	4	M	LY	L	15	GCr	LG	L	3	14	1386
62-157-00383	293535	USA (Mississippi Crowder)	P	SE	42	66	8	3	4	55	85	5	C	LY	ML	12	YCr	GBr	S	4	18	1320
62-157-00468	C.261	USA (Climax)	W	E	55	62	9	2	3	53	85	4	M	LY	ML	12	MW	LG	ML	3	15	1280
62-157-00441	293574	USA (Texas Cream)	W	SE	46	53	8	4	6	47	83	5	C	YW	L	11	MW	LBr	ML	3	14	1210
62-157-00466	C.620	USA (Top Set)	W	SE	48	76	9	3	4	52	82	5	C	YBr	ML	12	LCr	GBr	S	4	14	1054
62-153-00057	179555	Turkey (Kamran)	W	B	38	40	6	4	6	51	38	5	M	LY	ML	10	W	Br	L	4	23	1054
62-157-00345	293503	USA (Early Black Eye)	W	SE	47	74	9	2	2	55	84	2	C	LY	ML	12	Cr	Bk	S	3	15	708
62-071-01444	177	Nishabour, Iran	W	SE	53	69	9	2	3	50	77	4	M	LY	ML	13	LCr	GBr	ML	4	13	702
CV % =																						34
LSD .05 =																						866

Table 29. Agronomic Data - Cowpea Preliminary Yield Test (No. 2) - Planted May 29, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Type	(6) Plant Height	(7) Plant Width	(8) Plants /Meter	(9) Stand	(10) Vigor	(11) Pl. to 1st Fl.	(12) Pl. to 1st Mat.	(13) Disease Rating	(14) Pod Shape	(15) Pod Color	(16) Pod Size	(17) Seeds per Pod	(18) Seed Color	(19) Eye Color	(20) Seed Size	(21) Shatter	(22) 100 Seed Weight	(23) Yield per Hectare
62-157-00345	293503	USA(Early Black Eye)	P	SE	46	47	20	4	4	57	77	3	M	LY	L	11	YCr	Bk	L	3	18	2247
62-071-01444	177	Nishabour, Iran	W	SE	53	60	23	3	4	59	81	3	M	LY	L	11	MW	GBr	L	3	12	2247
62-157-00441	293574	USA (Texas Cream)	P	SE	42	58	20	3	4	62	83	4	M	YW	L	12	MW	PuBr	L	4	23	2136
62-071-00197	293420	Iran	W	SE	52	59	24	3	5	62	83	3	M	YW	L	11	MW	LG	ML	2	14	2044
62-157-00355	293516	USA (Hib-canel)	W	SE	52	30	20	2	3	61	82	3	M	YW	ML	12	MW	LG	ML	4	14	1977
62-153-00057	179555	Turkey (Kamram)	W	SE	44	51	24	3	5	57	76	4	M	LY	ML	12	MW	LBr	ML	2	16	1909
62-157-00468	C.261	USA (Climax)	W	SE	42	49	20	3	5	57	75	4	M	YW	ML	11	MW	LG	ML	3	14	1879
62-157-00383	293535	USA (Mississippi Crowder)	P	B	49	46	27	3	4	61	76	4	M	LY	ML	12	YCr	G	L	3	20	1842
62-157-00466	C.620	USA (Top Set)	W	SE	50	45	18	4	5	56	80	4	M	YW	ML	10	Cr	LG	ML	2	15	1756
62-157-01431		USA (Mississippi Silver)	P	SE	50	52	23	3	3	64	82	3	M	LBr	L	11	Cr	LG	ML	3	13	1707
CV % =																						28
LSD .05=																						540

Table 30. Agronomic Data - Cowpea Preliminary Yield Test (No. 1) - Planted April 4, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Type	(6) Plant Height	(7) Plant Width	(8) Plants /Meter	(9) Stand	(10) Vigor	(11) Pl. to 1st Fl.	(12) Pl. to 1st Mat.	(13) Disease Rating	(14) Pod Shape	(15) Pod Color	(16) Pod Size	(17) Seeds per Pod	(18) Seed Color	(19) Eye Color	(20) Seed Size	(21) Shatter	(22) 100 Seed Weight	(23) Yield per Hectare
62-155-00223	250587	Egypt	W	E	58	71	7	2	4	48	76	5	C	LY	ML	12	W	Bk	L	3	30	2533
62-157-00295	293458	USA Calif. Black Eye No. 5	W	E	55	61	9	3	4	47	78	5	M	LY	L	11	W	Bk	ML	3	23	2372
62-157-00316	293477	USA California Black Eye	W	E	51	69	9	2	5	49	76	6	M	LY	ML	11	W	Bk	L	3	22	2068
62-155-00068	182350	Egypt	W	SE	40	60	7	3	5	51	80	5	M	LY	L	12	W	Bk	L	3	23	1948
62-157-00287	293449	USA (Bunch)	W	SE	46	66	9	2	5	51	78	5	S	PuY	L	12	MW	Bk	L	3	19	1926
62-069-00070	183363	India	W	SE	44	62	7	3	4	50	78	4	M	LY	ML	11	MW	Br	L	3	25	1756
62-153-00057	179555	Turkey (Kamran)	W	SE	50	67	7	3	5	49	78	5	M	CrW	L	12	CrW	Br	M	2	24	1724
62-071-01432	178	Isfahan, Iran	WP	E	63	74	8	2	3	49	78	3	M	YW	L	11	W	Bk	L	4	25	1659
62-071-01438	170	Shoushtar, Iran	W	SE	47	77	7	2	4	52	79	4	M	YW	ML	10	MW	Bk	ML	3	23	1958
62-071-01446	179	Isfahan, Iran	W	SE	59	66	7	2	3	51	80	4	M	LY	ML	10	MW	Bk	L	3	22	1244
CV % =																						28
LSD .05 =																						642

Table 31. Agronomic Data - Cowpea Preliminary Yield Test (No. 1) - Planted May 29, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Type	(6) Plant Height	(7) Plant Width	(8) Plants /Meter	(9) Stand	(10) Vigor	(11) Pl. to 1st Fl.	(12) Pl. to 1st Mat.	(13) Disease Rating	(14) Pod Shape	(15) Pod Color	(16) Pod Size	(17) Seeds per Pod	(18) Seed Color	(19) Eye Color	(20) Seed Size	(21) Shatter	(22) 100 Seed Weight	(23) Yield per Hectare
62-071-01432	178	Isfahan, Iran	W	SE	60	66	22	3	4	61	82	3	C	YW	ML	10	W	Bk	L	3	23	2312
62-069-00070	183363	India	W	SE	56	57	15	3	5	58	82	4	C	PuY	ML	10	W	Br	L	3	22	2239
62-155-00223	250587	Egypt	W	SE	56	51	26	2	4	60	81	3	S	PuY	ML	10	W	Bk	L	3	20	2201
62-157-00295	293458	Calif.Black Eye USA No.5	W	SE	61	61	19	3	4	61	78	3	S	LY	ML	10	W	Bk	L	2	26	2121
62-071-01446	179	Isfahan, Iran	W	SE	61	51	19	2	3	58	79	3	S	YW	ML	10	W	Bk	L	2	19	1975
62-157-00316	293477	Calif. Black Eye USA	W	P	58	51	17	3	5	64	76	3	C	PuY	ML	11	MW	Bk	ML	3	22	1845
62-157-00287	293449	USA (Bunch)	W	SE	53	52	20	3	4	58	78	3	C	PuY	ML	9	W	Bk	L	2	19	1777
62-153-00057	179555	Turkey (Kamran)	W	SE	47	48	17	4	4	55	78	3	C	YW	L	11	W	Br	L	2	21	1725
62-071-01438	170	Shoushtar, Iran	W	SE	47	55	20	4	5	56	77	3	S	YW	L	9	W	Bk	L	2	22	1716
62-155-00068	182350	Egypt	W	SE	55	51	18	4	5	59	75	4	C	LY	ML	10	W	Bk	L	2	22	1524
CV % =																						28
LSD .05 =																						559

Table 32. Agronomic Data - Cowpea Uniform Yield Test - Planted April 4, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Type	(6) Plant Height	(7) Plant Width	(8) Plants /Meter	(9) Stand	(10) Vigor	(11) Pl. to 1st Fl.	(12) Pl. to 1st Mat.	(13) Disease Rating	(14) Pod Shap	(15) Pod Colo	(16) Pod Size	(17) Seeds pe Pod	(18) Seed Col	(19) Eye Colo	(20) Seed Siz	(21) Shatter	(22) 100 Seed Weight	(23) Yield per Hectare
62-157-00347	293505	USA (Parastoo)	W	SE	54	50	9	2	4	44	75	4	M	YW	ML	10	W	Bk	L	3	22	2248
62-071-10003	238	Meshed, Iran	W	SE	50	51	8	3	4	45	69	3	C	YW	ML	11	W	Bk	L	3	21	2242
62-157-00353	293513	USA (Giant Ramshorn)	W	E	53	47	8	2	3	46	74	4	M	LY	L	11	W	Bk	L	3	23	2212
62-157-00296	293459	USA (Black Eye No. 7)	W	E	50	44	9	2	4	45	73	3	S	YW	L	12	W	Bk	L	3	24	2200
62-157-00470	C.642	USA (Princess Ann)	WP	E	51	58	8	2	3	46	76	3	M	LBr	L	13	W	Bk	ML	3	20	2034
62-071-00042	2-42-1375	Karaj, Iran 150	W	SE	40	54	7	2	4	46	76	4	M	LY	L	13	W	Bk	L	3	21	1958
62-153-00057	179555	Turkey (Kamram)	W	SE	39	52	7	3	4	44	73	4	M	YW	ML	12	Cr	Br	L	4	23	1822
62-157-00318	293480	USA (Calara)	WP	SE	36	52	8	3	4	46	75	3	M	YW	L	11	W	Bk	ML	3	15	1814
62-085-00065	181833	Lebanon	W	P	31	53	8	3	4	46	76	4	C	YW	L	13	LBr	Br	ML	3	14	1610
62-110-00234	255765	Nigeria	WP	SE	38	49	8	3	4	45	77	4	M	YW	ML	11	W	Bk	ML	3	18	1158

CV % = 45
LSD .05 = 693

Table 33. Agronomic Data - Cowpea Uniform Yield Test - Planted May 29, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Flower Color	(5) Plant Type	(6) Plant Height	(7) Plant Width	(8) Plants /Meter	(9) Stand	(10) Vigor	(11) Pl. to 1st Fl.	(12) Pl. to 1st Mat.	(13) Disease Rating	(14) Pod Shap	(15) Pod Color	(16) Pod Size	(17) Seeds per Pod	(18) Seed Color	(19) Eye Color	(20) Seed Size	(21) Shatter	(22) 100 Seed Weight	(23) Yield per Hectare
62-110-00234	255765	Nigeria	WP	SE	58	47	22	3	4	54	78	4	C	YW	ML	9	W	Bk	ML	2	17	2513
62-157-00296	293459	USA(Black Eye No.7)	W	SE	53	60	18	3	4	55	78	4	S	YW	L	10	W	Bk	ML	3	21	2054
62-157-00353	293513	USA (Giant Ramshorn)	W	SE	48	53	17	4	5	57	79	4	C	LY	ML	10	W	Bk	L	2	21	1982
62-071-10003	238	Meshed, Iran	W	SE	61	59	18	3	4	56	79	3	S	LY	ML	9	W	Bk	L	2	20	1982
62-085-00065	181833	Lebanon	W	SE	47	43	21	3	4	53	77	3	S	LY	ML	9	W	Br	ML	2	14	1922
62-153-00057	179555	Turkey (Kamran)	W	SE	49	51	20	2	4	55	79	4	S	LY	ML	9	W	Br	ML	2	21	1784
62-157-00318	293480	USA (Calara)	W	B	51	44	23	4	6	52	79	4	C	LY	ML	10	W	Bk	L	2	14	1515
62-157-00347	293505	USA (Parastoo)	W	SE	52	48	21	4	4	53	78	3	S	YW	ML	9	W	Bk	L	2	22	1510
62-157-00470	C.642	USA (Princess Ann)	WP	BP	44	54	18	5	4	53	77	4	S	LY	ML	10	MW	Bk	L	2	18	1474
62-071-00042	2-42-1375	Karaj, Iran 150	W	SE	57	50	31	4	5	55	78	4	S	LY	L	9	W	Bk	L	3	20	1399

CV % = 28
LSD .05 = 508

Legend for Mungbean Agronomic Data Tables 34-37

(1) Numbers assigned to collection maintained by the Regional Pulse Improvement Project.

(2) Three digit numbers are Iranian Ministry of Agriculture numbers, six digit numbers refer to PI numbers from New Crops Research Branch, CRD, ARS, U. S. Department of Agriculture, Beltsville, Maryland, USA.

(3) Indicates variety name or area of origin.

(4) E = Erect; B = Bushy; P = Prostrate; SP = Semi-prostrate.

(5) Plant height measured in centimeters at full plant growth.

(6) Number of plants per meter of row, based on one meter sample per replication.

(7) Rated 1 to 9: 1 = complete stand; 9 = poor stand.

(8) Rated 1 to 9: 1 = vigorous plants; 9 = weak plants.

(9) Days from planting to first open flower.

(10) Days from planting to first mature pod ready for harvest.

(11) Rated 1 to 9: 1 = free from disease symptoms; 9 = severe disease symptoms.

(12) L = Light; M = Medium; D = Dark.

(13) L = Light; M = Medium; D = Dark.

(14) S = Straight; M = Moderately curved; C = Curved

(15) Average number of seeds per pod based on ten pods/replication.

(16) Average weight (in grams) of 100 seeds.

(17) Yield in kilogram based on $4m^2$ plots in Karaj; Varamin $5m^2$ plots.

Table 34. Agronomic Data - Mungbeans - Preliminary Yield Test - Planted June 8, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Plant Type	(5) Plant Height	(6) Plants /Meter	(7) Stand	(8) Vigor	(9) Pl. to 1st Fl.	(10) Pl. to 1st Mat.	(11) Disease Rating	(12) Leaf Color	(13) Pod Color	(14) Pod Size	(15) Seeds per Pod	(16) 100 Seed Weight	(17) Yield per Hectare
48-071-10827	224	Daregaz, Iran	B	33	24	3	2	51	66	3	M	D	L	10	5	1172
48-071-10528	217	Kermanshah, Iran	SP	37	28	3	2	55	74	3	L	D	M	11	3	977
48-071-10539	217	Kermanshah, Iran	E	42	19	1	1	56	71	3	D	D	M	10	5	904
48-071-10961	210	Sari, Iran	B	30	23	1	2	52	70	3	M	D	L	10	5	851
48-071-10962	184	Shiraz, Iran	B	29	20	3	2	51	61	3	D	M	M	10	4	832
48-071-10414	216	Jiroft, Iran	P	40	23	3	2	55	77	2	D	M	L	10	5	823
48-071-10913	215	Karaj, Iran	E	43	20	3	2	55	73	2	D	D	L	10	4	819
48-071-10707	222	Sari, Iran	B	15	15	3	2	50	73	3	D	D	L	11	7	819
48-069-11007		Dezful (S), Iran	E	49	19	1	1	55	77	3	D	L	L	9	5	811
48-071-10808	224	Daregaz, Iran	E	41	21	3	1	52	72	3	D	D	M	10	5	811
48-071-10957	223	Isfahan, Iran	E	44	18	3	2	54	73	3	D	D	L	9	6	783
48-071-10681	223	Isfahan, Iran	E	41	22	4	1	53	71	3	D	D	L	11	4	774
48-071-10421	214	Isfahan, Iran	SP	36	30	3	2	56	73	3	L	M	S	10	3	748
48-071-10865	218	Zahedan, Iran	P	36	24	4	2	53	73	2	M	M	L	11	5	742
48-071-10829	224	Daregaz, Iran	SP	39	23	3	2	55	75	2	M	M	S	10	3	738
48-071-10862	218	Zahedan, Iran	E	37	20	3	2	55	72	2	D	D	L	10	4	729
48-157-11087		Berken (USA)	E	34	17	3	2	53	73	3	D	D	L	10	6	712
48-071-10960	211	Nosratabad, Iran	SP	39	22	4	3	56	71	3	M	D	M	10	4	712
48-071-10288	215	Karaj, Iran	P	38	18	5	2	56	75	2	L	M	L	9	5	699
48-157-11085	M-1	Kilgoa (USA)	B	30	24	3	2	53	67	2	D	D	L	10	5	663
48-071-11167		Unknown	E	36	19	3	2	52	71	2	L	D	M	11	3	654
48-071-10429	214	Isfahan, Iran	SP	35	26	3	2	54	73	3	D	M	M	8	3	633
48-069-10076	183337	India	SP	40	25	4	2	58	75	2	M	M	M	10	3	629
48-071-10677	223	Isfahan, Iran	B	36	19	4	2	52	70	3	M	D	L	11	5	624
48-071-10293	218	Zahedan, Iran	B	37	26	2	1	55	74	2	M	M	L	10	6	602
48-071-10354	216	Jiroft, Ira	SP	38	23	3	3	57	75	3	M	M	S	9	3	592
48-071-10887	215	Karaj, Iran	E	36	31	3	2	56	73	3	D	M	S	8	3	572
48-071-11168		Unknown	E	48	20	3	2	55	67	3	D	D	L	10	6	560
48-071-10289	215	Karaj, Iran	SP	40	19	4	2	56	71	2	D	D	M	11	4	555
48-071-10344	217	Nosratabad, Iran	SP	33	29	3	2	56	76	3	L	M	S	10	2	530
48-069-11019		Dezful (S), Iran	E	47	17	3	1	57	75	2	D	M	M	10	6	528
48-071-10867	218	Zahedan, Iran	SP	33	24	4	2	59	75	3	L	L	S	10	3	523
48-071-10981	15273	Isfahan, Iran	SP	41	26	3	2	57	75	3	L	M	M	9	3	513
48-069-11025		Dezful (S), Iran	E	47	19	4	2	54	73	2	D	L	L	11	6	502
48-078-11142		Japan	E	37	19	4	2	50	67	3	D	D	L	10	7	488
48-071-10385	216	Jiroft, Iran	SP	39	27	3	2	62	74	2	D	D	M	10	3	485
48-071-10682	223	Isfahan, Iran	SP	39	24	4	2	51	62	2	D	M	M	11	3	449
48-071-10424	214	Isfahan, Iran	E	40	23	3	2	57	75	3	D	M	S	10	3	433
48-071-10667	223	Isfahan, Iran	E	44	22	3	2	57	73	2	D	D	M	10	4	425
48-071-10353	216	Jiroft, Iran	SP	40	26	4	2	57	71	3	D	M	S	8	3	417
48-069-10986		Dezful (S), Iran	E	41	18	4	2	57	75	3	D	L	L	8	5	405
48-071-10410	216	Jiroft, Iran	E	41	26	3	1	57	73	2	M	M	M	9	4	359
48-071-10798	224	Dezful, Iran	E	36	27	3	3	59	76	3	D	M	S	9	3	351
48-071-10954	399	Dashtsar, Iran	E	48	22	2	2	56	72	2	D	D	L	11	3	336
48-071-10959	199	Helian, Iran	E	45	21	4	2	58	73	3	D	D	M	11	4	333
48-071-10422	214	Isfahan, Iran	E	42	24	3	2	60	74	2	D	M	L	10	3	300
48-071-10743	216	Karaj, Iran	E	42	28	3	1	59	77	2	D	M	S	8	3	292
48-071-10983	15270	Rasht, Iran	SP	35	26	3	2	59	75	3	D	D	S	10	3	265
48-071-10846	218	Zahedan, Iran	SP	36	27	2	2	55	76	3	D	M	S	9	3	238
LSD 5%																309
CV %																36

Table 35. Agronomic Data - Mungbeans - Advanced Yield Test - Planted June 8, 1969 - RPIP Karaj, Iran

(1) Accesion Number	(2) Source Number	(3) SOURCE	(4) Plant Type	(5) Plant Height	(6) Plants /Meter	(7) Stand	(8) Vigor	(9) Pl. to 1st Fl.	(10) Pl. to 1st Mat.	(11) Disease Rating	(12) Leaf Color	(13) Pod Color	(14) Pod Size	(15) Seeds per Pod	(16) 100 Seed Weight	(17) Yield per Hectare
48-071-10865	218	Zahidan, Iran	P	28	22	3	2	56	74	3	L	L	M	10	4	1210
48-071-10855	218	Zahidan, Iran	P	32	18	4	2	55	75	2	L	M	M	10	5	1121
48-157-11085	M-1	Kilgoa (USA)	B	28	20	3	2	53	65	3	D	M	S	10	4	1107
48-071-11089	15279	Kerman, Iran	E	41	18	3	2	58	74	3	M	D	S	11	5	1082
48-071-10283	215	Karaj, Iran	E	41	16	4	2	58	75	3	D	D	M	10	5	1080
48-071-10292	215	Karaj, Iran	E	38	16	3	2	56	73	2	D	D	M	11	6	1059
48-071-10810	224	Daregaz, Iran	P	30	21	4	2	55	74	3	L	M	L	10	5	1043
48-071-10757	226	Karaj, Iran	P	26	21	3	2	57	76	3	L	M	L	11	5	1036
48-157-11086	M-3	Oklahoma, USA	E	37	20	3	2	56	72	3	M	D	M	9	6	1030
48-071-10783	226	Karaj, Iran	P	31	18	4	3	56	73	3	L	M	L	10	5	999
48-071-10926	215	Karaj, Iran	B	34	18	4	2	55	73	3	M	D	L	9	6	998
48-071-10955	203	Jiroft, Iran	SP	36	21	3	2	56	74	3	D	D	S	10	4	995
48-071-10293	218	Zahidan, Iran	E	34	17	4	2	53	69	3	M	D	M	10	5	994
48-071-10289	215	Karaj, Iran	B	31	20	3	2	56	73	3	M	D	M	11	5	972
48-071-10678	223	Isfahan, Iran	E	35	17	3	2	53	70	3	D	M	M	10	4	962
48-071-10870	215	Karaj, Iran	B	36	22	3	2	58	76	3	D	D	S	9	4	858
48-157-11087		Berken (USA)	E	39	19	3	2	56	73	3	D	D	M	10	5	834
48-071-10962	184	Shiraz, Iran	B	26	20	4	3	54	71	3	D	D	M	9	4	796
48-071-10954	399	Dashtsar, Iran	E	38	18	4	2	57	75	3	M	D	M	11	5	789
48-071-10282	215	Karaj, Iran	SP	41	21	3	2	56	76	3	M	M	M	11	4	787
48-071-10923	215	Karaj, Iran	E	39	19	3	2	56	72	3	D	D	M	11	5	786
48-069-11020		Dezful(s)(65), Iran	SP	39	16	4	2	56	75	3	M	M	M	11	5	717
48-069-11035		Dezful(s)(65), Iran	E	40	17	3	2	59	77	3	D	L	M	9	5	365
48-069-10991		Dezful(s)(65), Iran	E	45	16	4	2	58	78	3	D	L	M	10	5	330
48-069-11019		Dezful(s)(65), Iran	E	50	17	3	2	57	78	3	L	L	S	8	6	320
LSD 5%																196
CV %																20

Table 36 Agronomic Data - Mungbeans - Uniform Advanced Yield Test - Planted June 15, 1969 - RPIP Varamin, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(5) Plant Height	(7) Stand	(8) Vigor	(9) Pl. to 1st Fl.	(11) Disease Rating	(15) Seeds per pods	(16) 100 Seed Weight	(17) Yield per Hectare
48-157-11156	921 V	USA	108	2	2	45	3	11	7	2103
48-157-10023	31728	Beltsville	113	2	2	47	3	10	5	1918
48-157-11155	906 V	USA	107	2	2	49	3	12	6	1558
48-071-10293	218	Zahidan, Iran	106	2	3	46	4	11	5	1470
48-069-10104	212908	India	112	2	3	46	3	11	5	1430
48-157-11152	901 V	USA	100	2	4	46	4	10	5	1420
48-033-10045	171435	China	106	3	3	46	4	11	4	1274
48-157-11153	903 V	USA	104	3	3	45	3	11	5	1260
48-071-10283	215	Karaj, Iran	104	3	3	45	3	11	6	1176
48-069-10075	183136	India	106	3	3	46	4	10	4	1164
LSD 5%										575
CV %										28

Table 37 Agronomic Data - Mungbeans - Uniform Advanced Yield Test - Planted June 8, 1969 - RPIP Karaj, Iran

(1) Accession Number	(2) Source Number	(3) SOURCE	(4) Plant Type	(5) Plant Height	(6) Plants /Meter	(7) Stand	(8) Vigor	(9) Pl. to 1st Fl.	(10) Pl. to 1st Mat.	(11) Disease Rating	(12) Leaf Color	(13) Pod Color	(15) Seeds per Pod	(16) 100 Seed Weight	(17) Yield per Hectare
48-157-11156	921 V	USA	B	19	15	3	1	50	63	4	D	L	11	6	1409
48-033-10045	171435	China	SP	34	18	3	2	51	67	4	D	M	10	4	1120
48-157-11155	906 V	USA	SP	27	20	4	2	54	77	3	M	L	10	4	1019
48-157-11153	903 V	USA	B	28	20	3	2	50	69	3	D	L	11	4	1104
48-071-10293	218	Zahidan, Iran	SP	34	20	2	1	51	74	4	D	D	10	4	936
48-157-10023	31728	Beltsville	SP	28	18	3	2	53	75	3	M	L	11	5	926
48-071-10282	215	Karaj, Iran	SP	29	16	4	2	53	73	3	D	L	10	4	902
48-069-10075	183136	India	SP	30	19	4	2	51	74	3	D	D	12	5	881
48-069-10104	212908	India	SP	31	19	3	2	51	70	3	D	M	10	3	871
48-157-11152	901 V	USA	SP	27	18	3	2	51	69	5	D	M	9	4	671
LSD 5%															248
CV %															20

SOIL AND CROP MANAGEMENT

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SUMMARY

Plant Population Density - Grain yields of cowpeas were not increased by planting two rows per 50-cm bed when plant spacing within the row provided at least 10 plants per meter. The higher plant population densities resulting from closer row spacing decreased the number of pods per plant and tended to increase the straw-grain ratio. Similarly for dry beans, there was no advantage of planting more than one row on a 50-cm bed.

Fertilization - Nitrogen and phosphorus fertilization, applied by broadcasting and mixing in the surface layer of soil or by banding near the seed, had no significant effect on the yield of chickpeas, cowpeas, or dry beans.

Irrigation - Irrigating at intervals of seven days resulted in a yield depression of a red-seeded variety of dry beans, because of root rot. This effect did not occur with a white-seeded variety, suggesting a differential in varietal resistance to root rot. Yields of lentils were also reduced by disease when irrigated every 4 days as compared with 7 or 10 days.

Dry beans yielded more grain when irrigated at 6-day intervals than at 10-day intervals. This differential held for levels of water application of 40, 32, and 24 cm over a 60-day period. For the 6-day frequency, the 40-cm level resulted in the highest yield. The level of water application had no effect on yield at the 10-day frequency.

Plant Population Density

Cowpeas and dry beans were planted or 50-cm beds with one row and two rows per bed. Plants were spaced in the row so as to result in 10, 15, and 20 plants per meter of row. For two rows per bed, the rows were approximately 20 cm. apart. The same within-the-row spacing applied to both the single and the double rows. Thus, population densities ranged from 200,000 to 400,000 plants per hectare for a single row per bed and from 400,000 to 800,000 for the double row beds. A split-plot design in four replications was used, with rows per bed as the main plots and spacing within the row as sub-plots.

The effect of plant population density on the growth of cowpeas is given in Table 38. Although the effect was not significant at the 5% level, cowpeas yielded slightly more grain when planted as single row beds than as double row beds. This row effect occurred for all three within row spacings. Plant spacing within the row, over the range of 10 to 20 plants per meter, did not effect grain yield. Results from previous years showed,however, that a marked reduction in grain yield occurred when density was decreased to five plants per meter. The straw-grain ratio and straw yield were significantly lower at 10 plants per meter than at 15 or 20. The effect of the number of rows per bed on the straw-grain ratio was not significant at the 5% level, although two rows per bed tended to increase the value. Close spacing of plants markedly reduced the number of pods per plant. For 10 plants per meter andsingle row beds, each plant averaged 8.7 pods compared with 2.0 pods per plant for the density of 20 plants per meter and double row beds. This effect accounts for the failure to obtain higher grain yields of cowpeas with population densities greater than approximately 200,000 plants per hectare. There was a trend toward smaller seed with high population density.

For dry beans (Table 39), grain yields tended to increase with closer plant spacing, although differences in the means were not significant at the 5% level.

From 1969 data, there appears to be no advantage from the grain yield standpoint of having more than one row on a 50-cm bed for cowpeas and dry beans.

Table 38. Influence of row and plant spacing on growth of cowpeas, Karaj, 1969.

Plants per meter of row	Rows per 50-cm. bed		
	1	2	Mean
	Grain yield, tons/ha		
10	1.38	1.25	1.31 a 1/
15	1.31	1.21	1.26 a
20	1.41	1.19	1.30 a
Mean	1.37 a	1.22 a	
	100 Seeds Weight, gm.		
10	22.1	21.1	21.6 a
15	21.1	21.3	21.2 a
20	21.8	20.8	21.3 a
Mean	21.7 a	21.1 a	
	Pods per plant		
10	8.7	4.1	6.4 a
15	4.7	2.8	3.8 b
20	3.4	2.0	2.7 c
Mean	5.6 a	3.0 b	
	Straw-grain ratio		
10	2.12	2.13	2.13 b
15	2.47	2.93	2.70 a
20	2.67	2.76	2.72 a
Mean	2.42 a	2.61 a	

1/ Figures within a column or line followed by the same letter are not significantly different at the 5% level.

Table 39. Influence of row and plant spacing on growth of dry beans, Karaj, 1969.

Plants per meter of row	Rows per 50-cm. bed		
	1	2	Mean
Grain yield, tons/ha.			
10	1.05	1.32	1.18 a 1/
15	1.15	1.28	1.21 a
20	1.27	1.51	1.39 a
Mean	1.16 a	1.37 a	
100 Seeds weight, gm.			
10	22.8	22.1	22.4 a
15	22.2	22.4	22.3 a
20	22.5	22.1	22.3 a
Mean	22.5 a	22.2 a	

1/ Figures within a column or line followed by the same letter are not significantly different at the 5% level.

Irrigation - Fertilization

Irrigation treatments, consisting of irrigating at 7 and 12-day intervals, were applied as main plots. Fertilization treatments, consisting of combinations of three nitrogen (ammonium nitrate) and four phosphorus (superphosphate) rates, were applied as sub-plots. Four replications were used. Two groups of field plots were established. Group I plots were planted May 3 to chickpeas, cowpeas, and dry beans. The fertilizer was broadcast and mixed into the surface layer of soil. Group II plots were planted June 5 to cowpeas and dry beans. The fertilizer was banded near the seed. The two groups of plots were located in adjacent fields having apparently similar soil conditions. A white-seeded variety of dry beans was used in the group I plots and a red-seeded variety in group II.

Results from the group I plots showed that irrigating at 12-day intervals caused a substantial yield reduction of chickpeas and dry beans and a moderate yield reduction of cowpeas (Table 40, 41 and 42). For the group II plots (Tables 43 and 44), however, no reduction in yield resulted from irrigating at 12-day as compared with 7-day intervals. In fact there was a trend toward higher yields with the drier irrigation treatment. The reason for these contrasting results may be associated with the differences cited above in the procedure for the two groups of plots. One factor, the varietal difference for dry beans, probably had an effect. The variety used for the group II plots was damaged by root rot during the later part of the blooming period when irrigated at 7-day intervals. This disease caused the plants to stop blooming. Such a condition was not observed for the 12-day irrigations. This suggests a differential between the two varieties of dry beans in their resistance to root rot.

Nitrogen and phosphorus fertilization had no significant effect on grain yield of the three crops under the two methods of application. The plants were well nodulated, which at least partly accounts for the lack of response to nitrogen fertilization. However, soil test values indicated a low to medium level of available phosphorus and a probable response to fertilization.

Irrigation - Plant Population Density

Frequency and level of irrigation and plant population density treatments were applied in a split-plot design with three replications. Main plots were irrigated at 6-day and 10-day intervals. Three levels of water, 40, 32, and 24 cm., were applied to the sub-plots in the course of a 60-day period beginning at the start of bloom. Thus, the 6-day frequency plots were irrigated 10 times and the 10-day plots 6 times. The quantity of water applied at each irrigation was equal to the season total divided by the number of irrigations. Population

Table 40. Influence of irrigation frequency and fertilization on grain yield of chickpeas, tons/ha Karaj, 1969.

Fertilizer applied, kg/ha.					
Nitrogen (N)	Phosphorus (P)				Mean
	0	30	60	90	
Irrigated at 7-day intervals					
0	2.22	2.71	2.53	2.05	2.38 a 1/
50	2.42	2.46	1.95	2.34	2.29 a
100	2.24	2.54	1.87	2.57	2.31 a
Mean	2.29 a	2.57 a	2.12 a	2.32 a	2.33
Irrigated at 12-day intervals					
0	1.72	1.46	1.78	1.89	1.72b
50	1.62	1.37	1.34	1.47	1.45 b
100	1.51	1.61	1.81	1.37	1.57 b
Mean	1.62 a	1.58 a	1.64 a	1.58a	1.58
Phosphorus Mean	1.95 a	2.03 a	1.88 a	1.95 a	

1/ Figures within a column followed by the same letter are not significantly different at the 5% level.

Table 41. Influence of irrigation frequency and fertilization (mixed) on grain yield of dry beans, tons/ha, Karaj, 1969.

Nitrogen (N)	Fertilizer applied, kg/ha. Phosphorus (P) 0	30	60	90	Mean
	Irrigated at 7-day intervals				
0	1.63	1.82	1.48	1.61	1.63 a 1/
50	1.56	1.66	1.54	1.69	1.61 a
100	1.54	1.47	1.45	1.52	1.50 a
Mean	1.58 a	1.65 a	1.49 a	1.61 a	1.58
	Irrigated at 12-day intervals				
0	0.70	0.79	0.95	0.92	0.84 b
50	0.77	0.87	0.85	0.77	0.81 b
100	0.82	0.84	0.84	0.90	0.85 b
Mean	0.76 a	0.83 a	0.88 a	0.86 a	0.83
Phosphorus Mean	1.17 a	1.24 a	1.19 a	1.23 a	

1/ Figures within a row or column followed by the same letter are not significantly different at the 5% level.

Table 42. Influence of irrigation frequency and fertilization (mixed) on grain yield of cowpeas, tons/ha, Karaj, 1969.

Nitrogen (N)	Fertilizer applied, kg/ha. Phosphorus (P) 0	30	60	90	Mean
Irrigated at 7-day intervals					
0	1.41	1.73	1.60	1.72	1.61 a 1/
50	1.58	1.46	1.46	1.40	1.48 a
100	1.60	1.67	1.40	1.58	1.56 a
Mean	1.53 a	1.62 a	1.49 a	1.56 a	1.55
Irrigated at 12-day intervals					
0	1.26	1.36	1.40	1.30	1.33 b
50	1.24	1.32	1.47	1.34	1.34 b
100	1.29	1.14	1.15	1.40	1.24 b
Mean	1.26 a	1.27 a	1.34 a	1.35 a	1.30
Phosphorus Mean	1.40 a	1.44 a	1.41 a	1.45 a	

1/ Figures within a row or column followed by the same letter are not significantly different at the 5% level.

Table 43. Influence of irrigation frequency and fertilization (banded) on grain yield of cowpeas, tons/ha, Karaj, 1969.

Nitrogen (N)	Fertilizer applied, kg/ha. Phosphorus (P_2O_5) 0	30	60	90	Mean
Irrigated at 7-day intervals					
0	1.58	1.31	1.26	1.31	1.36 a 1/
50	1.45	1.39	1.57	1.34	1.43 a
100	1.41	1.68	1.26	1.36	1.42 a
Mean	1.48 a	1.46 a	1.36 a	1.33 a	1.41
Irrigated at 12-day intervals					
0	1.47	1.44	1.52	1.43	1.46 a
50	1.62	1.39	1.57	1.76	1.58 a
100	1.43	1.73	1.57	1.43	1.54 a
Mean	1.51 a	1.52 a	1.56 a	1.54 a	1.53
Phosphorus Mean	1.49 a	1.49 a	1.46 a	1.43 a	

1/ Figures within a row or column followed by the same letter are not significantly different at the 5% level.

Table 44. Influence of irrigation frequency and fertilization (banded) on grain yield of dry beans, tons/ha, Karaj, 1969.

Nitrogen (N)	Fertilizer applied, kg/ha. Phosphorus (P_2O_5) 0	30	60	90	Mean
Irrigated at 7-day intervals					
0	1.57	1.47	1.80	1.24	1.52 a 1/
50	1.43	1.68	1.97	1.79	1.72 a
100	1.74	1.37	1.67	1.64	1.60 a
Mean	1.58 a	1.51 a	1.81 a	1.55 a	1.61
Irrigated at 12-day intervals					
0	1.63	1.61	1.97	1.65	1.71 a
50	1.30	2.15	1.67	1.75	1.72 a
100	1.78	1.67	1.75	1.73	1.73 a
Mean	1.57 a	1.81 a	1.79 a	1.71 a	1.72
Phosphorus Mean	1.58 a	1.66 a	1.80 a	1.63 a	

1/ Figures within a row or column followed by the same letter are not significantly different at the 5% level.

densities of 200,000, 300,000, and 400,000 plants per hectare were applied to the sub-sub-plots, which were four rows (two meters) by four meters long. The furrows were established with a zero grade and closed ends. Thus, water was impounded on each sub-sub-plot until absorbed. Irrigation water was applied thru siphons for the required length of time. A white variety of dry beans was planted as the test crop.

Data showing the effect of these treatments on grain yields and seed size are given in Table 45. Irrigating at 10-day intervals resulted in lower grain yields than at 6-day intervals. This differential held for all three levels of water applied. Within the 10-day treatments, the different levels of application did not effect the grain yield. Within the 6-day treatments, however, the application of 4.0 cm of water at each irrigation resulted in the highest yield. Seed size increased with an increase in the level of water applied. Frequency of irrigation had little effect on seed size, except irrigating every 6 days resulted in larger seed at the 40-cm level. Plant population density, at the range tested, had no significant effect on grain yield or seed size.

Irrigation (Pahlavi University, Shiraz)

Chickpeas and lentils were irrigated at intervals of 4, 7, 10, 14, and 17 days. Each irrigation frequency was divided into two levels of application. One series of plots received approximately 6 cm of water at each irrigation. The other series received amounts based on evaporation losses between irrigations. These quantities ranged from 3 to 13 cm per irrigation. The plots (7 x 8 meters) were leveled to a flat surface and provided with an embankment for impounding water. Parshall flumes were used to measure the prescribed amount of water onto each plot. The crops were planted in rows spaced 50 cm apart, chickpeas on March 31 and lentils on April 18, 1969. All plots were uniformly irrigated four times from planting to beginning of bloom, when the treatments were started. Treatment irrigations were continued until the maturity stage for each treatment was reached.

Grain and straw yields and seed size data are given in Table 46. The frequency of irrigation significantly effected crop growth, but the level of application of water at each irrigation did not. Therefore, data are given only as means for each irrigation frequency. For chickpeas, grain and straw yields decreased with an increase in the length of time between irrigations. The yield depression was particularly severe with irrigation intervals of 14 or 17 days. Straw production was favored by irrigating every four days.

Maturity of chickpeas occurred approximately 20 days earlier when irrigated every 17 days as compared with every 4 or 7 days. Lentils followed the same general pattern, except for the adverse effect from irrigating every four days. At this frequency of irrigation, pale color of the lentil plants indicated the presence of root rot.

The 4-day irrigation interval resulted in smaller seed. Maximum seed size was obtained with the 14-day treatment.

Table 45. Influence of plant population density, irrigation frequency, and amount of water applied on growth of dry beans, Karaj, 1969.

Water applied, cm		Plants per hectare			
Each irrigation	Season	200,000	300,000	400,000	Mean
Grain yield, tons/ha:					
	Irrigated at 6-day intervals (10 irrigations)				
4.0	40	1.44	1.35	1.32	1.37 a 1/
3.2	32	1.20	0.95	1.12	1.09 b
2.4	24	1.20	1.06	0.96	1.07 b
Mean		1.28 a	1.12 a	1.13 a	1.18
	Irrigated at 10-day intervals (6 irrigations)				
6.7	40	0.82	0.91	1.06	0.93 c
5.3	32	0.75	1.02	0.92	0.90 c
4.0	24	0.98	1.00	0.84	0.94 c
Mean		0.85 a	0.98 a	0.94 a	0.92
Population Mean		1.06 a	1.05 a	1.04 a	-
Weight of 100 seeds, gm:					
	Irrigated at 6-day intervals (10 irrigations)				
4.0	40	24.4	23.8	22.1	23.4 a
3.2	32	22.1	21.5	21.9	21.8 b
2.4	24	21.0	19.9	20.4	20.4 c
Mean		22.5 a	21.7 a	21.5 a	21.9
	Irrigated at 10-day intervals (6 irrigations)				
6.7	40	21.0	21.8	22.5	21.8 b
5.3	32	22.6	21.9	21.3	21.9 b
4.0	24	21.3	20.2	21.0	20.8 c
Mean		21.6 a	21.3 a	21.6 a	21.5
Population Mean		22.1 a	21.5 a	21.5 a	

1/ Figures within a column or line followed by the same letter are not significantly different at the 5% level.

Table 46. Influence of irrigation frequency on growth of chickpeas and lentils, Pahlavi University, Shiraz, 1969.

Irrigations		Yield, kg/ha		Weight of 100 seeds, gm
Frequency (days)	Number per season	Grain	Straw	
Chickpeas:				
4	15	2198 a[1/]	3530 a	20.2 c
7	8	2152 a	2743 b	24.8 b
10	5	1892 a	2218 b	26.6 ab
14	3	1134 b	1328 c	28.1 a
17	2	788 b	1113 c	26.0 ab
Lentils:				
4	12	501 b	2088 b	4.6 c
7	7	1136 a	2730 a	5.1 b
10	5	1146 a	2303 ab	5.4 ab
14	3	659 b	1618 c	5.5 a
17	3	384 b	1548 c	5.1 ab

Figures within a column followed by the same letter are not significantly different at the 5% level.

PLANT PATHOLOGY

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Summary

Studies of the biology and epidemiology of two important virus diseases of broadbean (Vicia faba) caused by bean yellow mosaic (BYMV) and pea leaf roll (PLRV) viruses were continued. The stage of plant development at the time of infection greatly influenced subsequent plant growth and seed yields. Largest yield reductions occurred in broadbeans inoculated with each virus singly or in combination prior to and during flowering. BYMV was found to be seed-borne in broadbean with highest transmission (1%) occurring in plants inoculated at full bloom. However, PLRV does not appear to be seed-borne in this host.

Three foliar diseases caused by fungi and favored by high moisture were observed for the first time in chickpea (Cicer arietinum) trials in Southwestern Iran (Khuzestan Province). These diseases were: Ascochyta blight (A. rabiei), Stemphyllium leaf spot (S. sarciniforme) and Sclerotinia crown blight (S. sclerotiorum). Foliar diseases caused by Ascochyta and Stemphyllium occurred in epidemic proportions and drastically reduced yields of most chickpea lines (especially white-seeded types) being tested. Both fungi were seed-borne in chickpea. A few black-seeded types, particularly one accession from Israel, showed moderate to high resistance to Ascochyta blight in these trials. The effects of various nutritional and environmental factors on growth, sporulation and survival of A. rabiei have been studied.

Four viruses have been isolated from lentils (Lens esculenta) grown in various regions of Iran. Growth and yields of lentils were adversely affected when plants at various stages of plant development were infected by alfalfa mosaic, bean yellow mosaic, cucumber mosaic or pea leaf roll viruses. Preliminary results indicate that these viruses are not seed-borne in this host.

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Field trials were established at Karaj to study the effect of various seed treatment fungicides in controlling a damping-off and stem canker disease of mungbean (Phaseolus aureus) caused by Rhizoctonia solani. Disease control was highest in treatments utilizing Terraclor or Dexon-Terraclor. Two new diseases of mungbean caused by alfalfa mosaic and cucumber mosaic viruses were identified. Several mungbean lines included in yield trials at Karaj were highly resistant to mungbean mosaic virus, an important and widely distributed seed-borne virus disease of mungbean.

A damping-off and root rot disease of green peas (Pisum sativum) caused widespread damage to pea plantings in Khuzestan Province. The pathogen was identified as Pythium aphanidermatum. Isolates of this fungus from various pulse crops were highly pathogenic to peas in greenhouse inoculation studies. Treatment of pea seed with various fungicides, especially Captan and Arasan, effectively controlled the disease under field conditions in soil with a high inoculum potential of the pathogen.

Pea leaf roll virus infects several pulse crops grown in most regions of Iran. Beans, broadbeans, chickpeas, cowpeas, lentils, and peas are pulses affected in nature. The virus is not juice transmissible, but is transmitted by several aphid species in a circulative (persistent) manner. The biology and vector-virus relationships of the virus have been investigated.

Details

Broadbeans (Vicia faba)

At Karaj we have continued our studies on the biology of two important virus diseases of broadbeans, bean yellow mosaic (BYMV) and pea leaf roll (PLRV). In field experiments at Karaj Algerian broadbean plants were inoculated at three stages of plant growth -- pre-bloom, full bloom and post bloom (pod set), with both viruses, singly and in combination. At maturity plots were harvested and the effect of virus infection on yields (Fig.1) and seed transmission (Table47, Fig. 2) was determined.

Virus infection at all stages of plant growth reduced seed yields. However, greatest yield reductions of 99-100% occurred with pre-bloom inoculation with PLRV and BYMV + PLRV. Inoculation with BYMV at pre-bloom and full bloom reduced yields by 42 and 44%, respectively (Fig.1).

Seed transmission of BYMV occurred at all inoculation dates (Table47). Highest seed transmission of BYMV (1.00%) occurred in plants inoculated at full bloom (Table47). Seed transmission in plants inoculated at pre-bloom and post bloom was 0.25 and 0.19%, respectively. PLRV was not seed-borne in these experiments. However, BYMV was seed-borne (0.23%) in plants inoculated at full bloom with BYMV + PLRV.

We have conducted surveys in farmer's broadbean fields in Khuzestan for the past three years on seed transmission and subsequent spread of BYMV, and have found that BYMV is generally seed-borne in less than 1% of the broadbean seeds. However, aphids pick up and spread the virus from these few virus-infected seedlings to other plants in the same or adjacent plantings, and by harvest time over 95% of the plants in most broadbean plantings are infected with BYMV, in addition to other aphid transmitted viruses, like PLRV.

Table 47. - Virus transmission in seed harvested from broadbean (Algerian) plants inoculated in the field at three stages of growth with bean yellow mosaic virus (BYMV) and/or pea leaf roll virus (PLRV).

Virus	Stage of Plant Growth When Inoculated	No. Seeds Harvested	No. Seedlings Emerged	No. Virus Infected Seedlings	% Seed Transmission
Check (Not inoculated)	---	1220	1178	0	0
BYMV	Pre-bloom	874	794	2	0.25
BYMV	Full bloom	1210	1160	11	0.95
BYMV	Post bloom	1090	1065	2	0.19
PLRV	Pre-bloom	0 a/	0	0	0
PLRV	Full bloom	570	395	0	0
PLRV	Post bloom	740	673	0	0
BYMV + PLRV	Pre-bloom	40	34	0	0
BYMV + PLRV	Full bloom	579	437	1 b/	0.23
BYMV + PLRV	Post bloom	540	481	0	0

a/ No seed was harvested from virus-infected plants

b/ BYMV

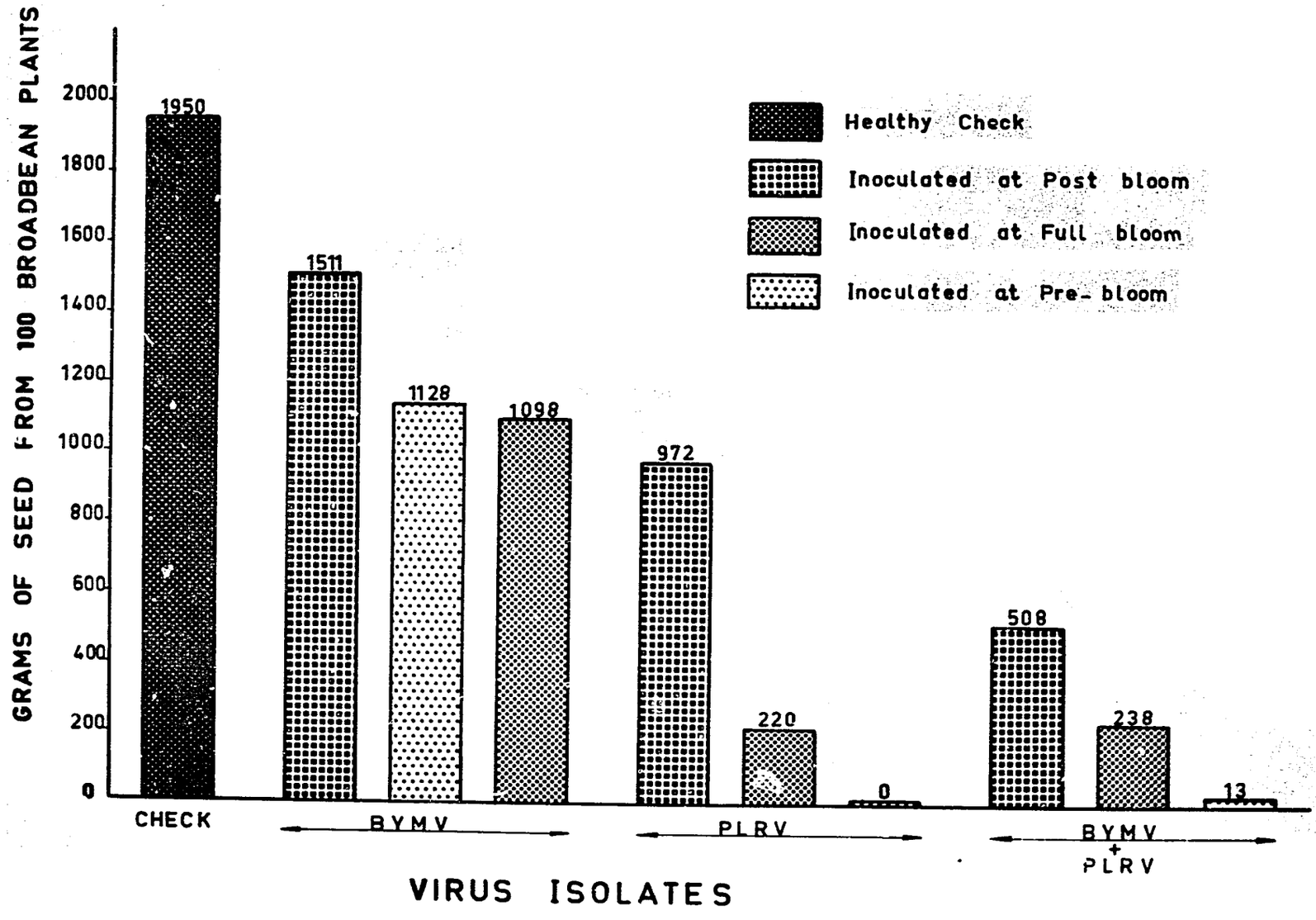

Figure 1 Effect of infection by bean yellow mosaic virus (BYMV) and pea leaf roll virus (PLRV), singly and in combination, on yields of Algerian broadbean inoculated at three stages of plant growth in field studies at Karaj.

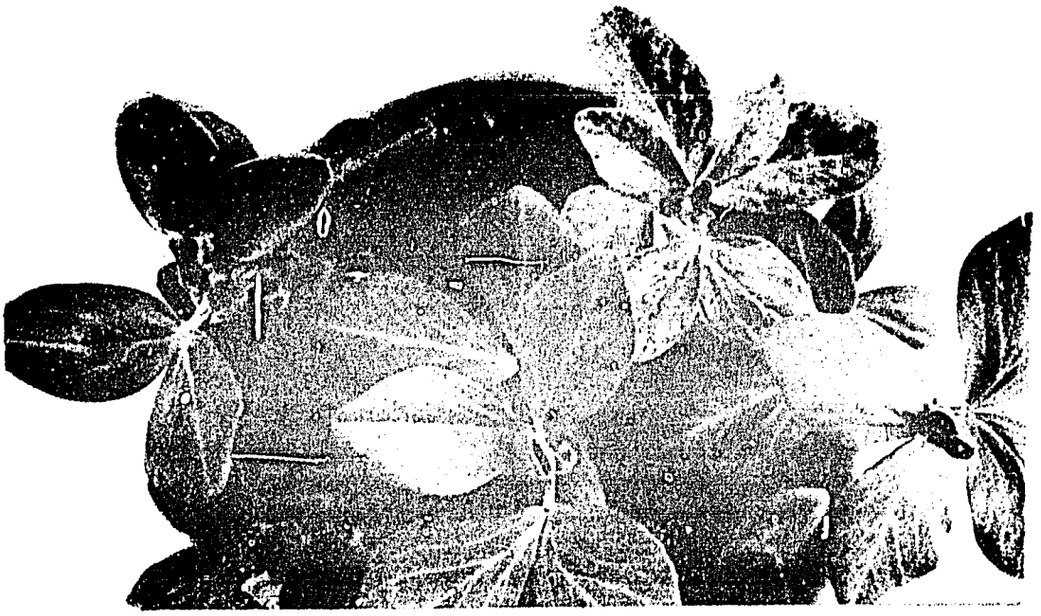

Figure.2 . -- Mosaic symptoms in an Algerian broadbean seedling (upper right) infected from seed with bean yellow mosaic virus.

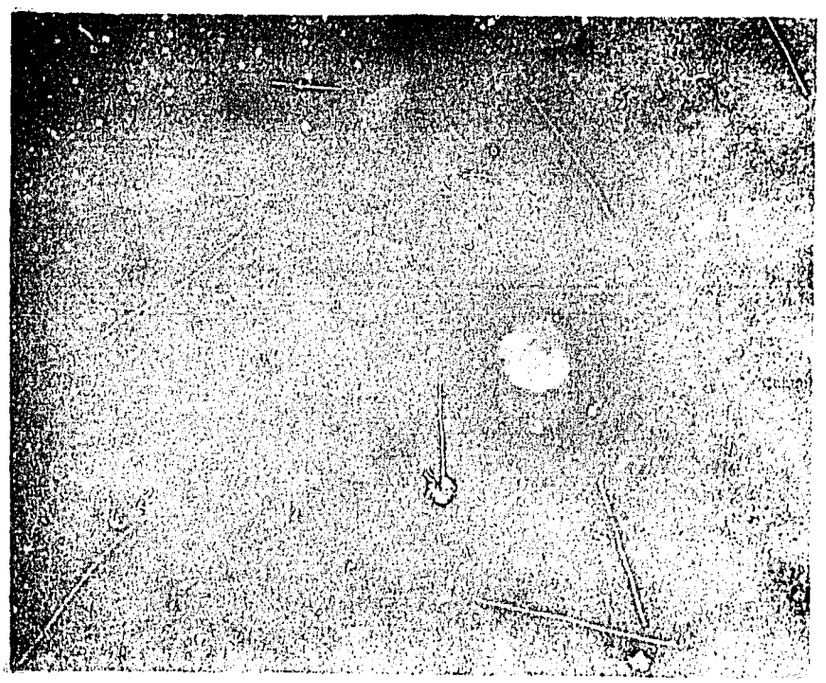

Figure 3 . An electron micrograph of rod-shaped virus particles, approximately 750 mu in length (magnified 40,000 times), of bean yellow mosaic virus from broadbean. The preparation was made by using a leaf dip technique and negatively staining with phosphotungstic acid.

Chickpea (Cicer arietinum)

Since 1967 chickpea yield trial studies have been conducted at the Research Experiment Station, Khuzestan Water and Power Authority, Safiabad. From January to April, 1969 Khuzestan Province, including Safiabad, experienced exceptionally heavy and prolonged rainfall. Several chickpea diseases favored by high rainfall and humidity were observed for the first time in the chickpea plantings at Safiabad. In March, 1969 we conducted a disease survey through the chickpea trials and found that many lines were infected with one or more of the following fungal diseases: Ascochyta blight (A. rabiei) (Fig. 4), Stemphyllium leaf spot (S. sarciniforme) (Fig. 5), and Sclerotinia crown blight (S. sclerotiorum) (Fig. 6).

The foliar diseases caused by Ascochyta and Stemphyllium increased and spread in epidemic proportions throughout the plantings between March and May, 1969. Due to the generally favorable weather and growing conditions in Khuzestan, chickpeas make abundant foliar growth and often attain heights of 75 cm to 1 meter. With the excessive moisture and high humidity in the lower canopy of chickpea plants between March and May disease development was extensive and rapid resulting in excessive die-back of the foliage which appeared to contribute greatly to the premature death of diseased plants, especially the white-seeded lines (Fig. 7). Yields were greatly reduced in all white-seeded chickpea lines because of sparse pod formation. Most pods that formed were infected with one or both foliar fungi (Fig. 8), and seeds which developed were usually shrivelled, discolored, and deformed (Fig. 9). Both these fungi are seed-borne in chickpea (Fig. 10).

The black-seeded chickpea types in the Safiabad trials showed varying degrees of resistance to Ascochyta blight, but were generally more resistant to Ascochyta than the white-seeded lines. One black-seeded type (No. 15), in particular, stood out as being moderately to highly resistant to A. rabiei in the Safiabad field trials. Line 15 (Accession No. 12-074-10010 from Israel) had previously shown high resistance to various isolates of Ascochyta in greenhouse inoculation studies at Karaj.

When environmental conditions are favorable for infection (high rainfall and humidity), A. rabiei is a serious pathogen and destructive disease of chickpeas in India, Iran, and West Pakistan. Chickpea line No. 15 should provide plant breeders in these countries with a source of resistance to A. rabiei which hopefully can be transferred to Ascochyta susceptible, but agronomically desirable chickpea varieties.

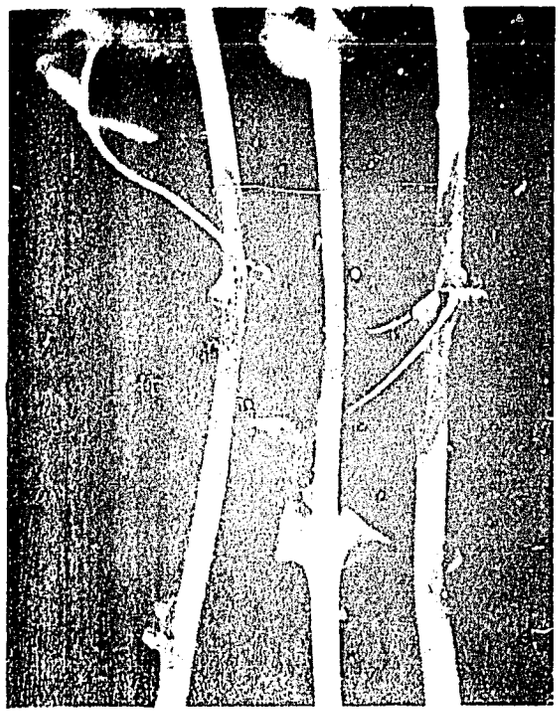

Fig. 4 Lesions on chickpea stems caused by Ascochyta rabiei. The small black spots within the lesion are pycnidia.

Fig. 5
Chickpea leaves after inoculation with spores of Stemphylium sarciniforme.

Fig. 6.
Whitish mycelium in the crown of chickpeas infected with Sclerotinia sclerotiorum. Affected plants wilt and die after the stem is girdled by the fungus. Large black sclerotia often form in the crown and are useful in identification of this pathogen.

Figure 7 . -- A plot of white-seeded chickpeas in the field trials at Safiabad, Khuzestan Province which was severely damaged by Ascochyta rabiei and Stemphyllium sarciniforme. Disease development and spread of these fungi which attack the leaves, stems, and pods of chickpea are favored by a moist, humid environment.

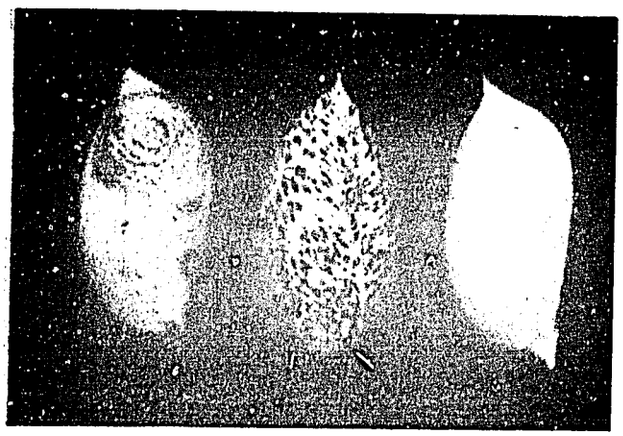

Figure 8 . -- Chickpea pods from diseased plants in the Safiabad field trials, Khuzestan Province infected with Ascochyta rabiei (left) and Stemphyllium sarciniforma (middle). Healthy pod, on right.

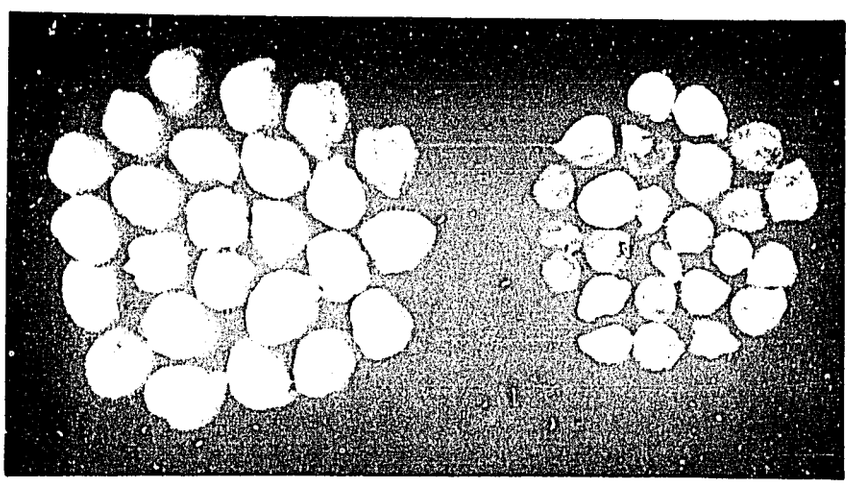

Figure 9 .-- Seeds from chickpea plants infected with Ascochyta rabiei and Stemphyllium sarciniforme were often discolored, deformed, and shrivelled (right), in comparison to seeds from healthy plants (left).

Figure 10. -- Chickpea seeds from diseased plants in the Safiabad field trials, Khuzestan Province infected with Ascochyta rabiei (a) and Stemphyllium sarciniforme (s). Seeds were removed from pods, surface sterilized in 0.5% sodium hypochlorite for 5 min. and placed on potato dextrose agar.

Isolates of A. rabiei are being collected from diseased chickpeas in different regions of Iran to determine whether races of the pathogen occur in the country. To date isolates of A. rabiei have been collected from Dezful (Khuzestan), Ghazvin (Tehran), Gorgan (Mazandaran), and Saquez (Kurdestan).

Studies have been initiated on the effect of different environmental factors on growth, sporulation, and survival of the pathogen. Temperature greatly affected growth and sporulation of Ascochyta. Maximum mycelial growth and sporulation on different culture media occurred at 20° C (Fig. 11). The fungus did not grow at 35° C.

Ascochyta rabiei survived over one year in naturally-infected and artifically inoculated chickpea tissue at temperatures of 10 to 35° C and at ambient temperatures in a weather station shelter located at Karaj. The relative humidity under the conditions of these experiments was usually less than 40%. The viability of the pathogen in chickpea tissue at room temperature (22-25° C) decreased rapidly at high relative humidities (85-100%) and died out after 2-3 months. However, at lower relative humidities (0-30%) the fungus was still viable after 10 months.

The effect of soil on survival of A. rabiei was also studied under field conditions. Naturally-infected chickpea pods collected on May 16, 1969 in Khuzestan Province were placed between pieces of nylon screen (5-6 spaces per cm) and buried at depths of 0-40 cm in a clay loam soil at Karaj, Iran on May 29, 1969. The plots were exposed to direct sunlight for the first month, but were later partially shaded by foliage of plants growing nearby. Plots were irrigated every 10-14 days from June to September, 1969. Pod tissue from different depths was collected at periodic intervals and observed for survival of the pathogen. The fungus was no longer considered viable when spores from crushed pycnidia failed to germinate on agar media. Ascochyta survived less than 3 months when buried at soil depths of 10 to 40 cm, but was still viable on the soil surface after 10 months.

These experiments on survival of the pathogen, especially in soil, illustrate an important principle which may be highly effective in controlling the pathogen after harvest in Ascochyta-infected plantings. Incorporation of Ascochyta-infected chickpea debris in soil by plowing will result in rapid inactivation of the pathogen and will greatly reduce the likelihood of reinfection of subsequent chickpea plantings. However, great care must be taken not to introduce A. rabiei into healthy chickpea plantings on infected seed. Seed transmission appears to be a very important factor in spread and survival of the fungus. We have isolated the pathogen from chickpea seed stored in the laboratory at room temperatures after 18 months, and after 10 months in seed maintained in a weather station shelter in Khuzestan Province where summer temperatures exceed 50° C.

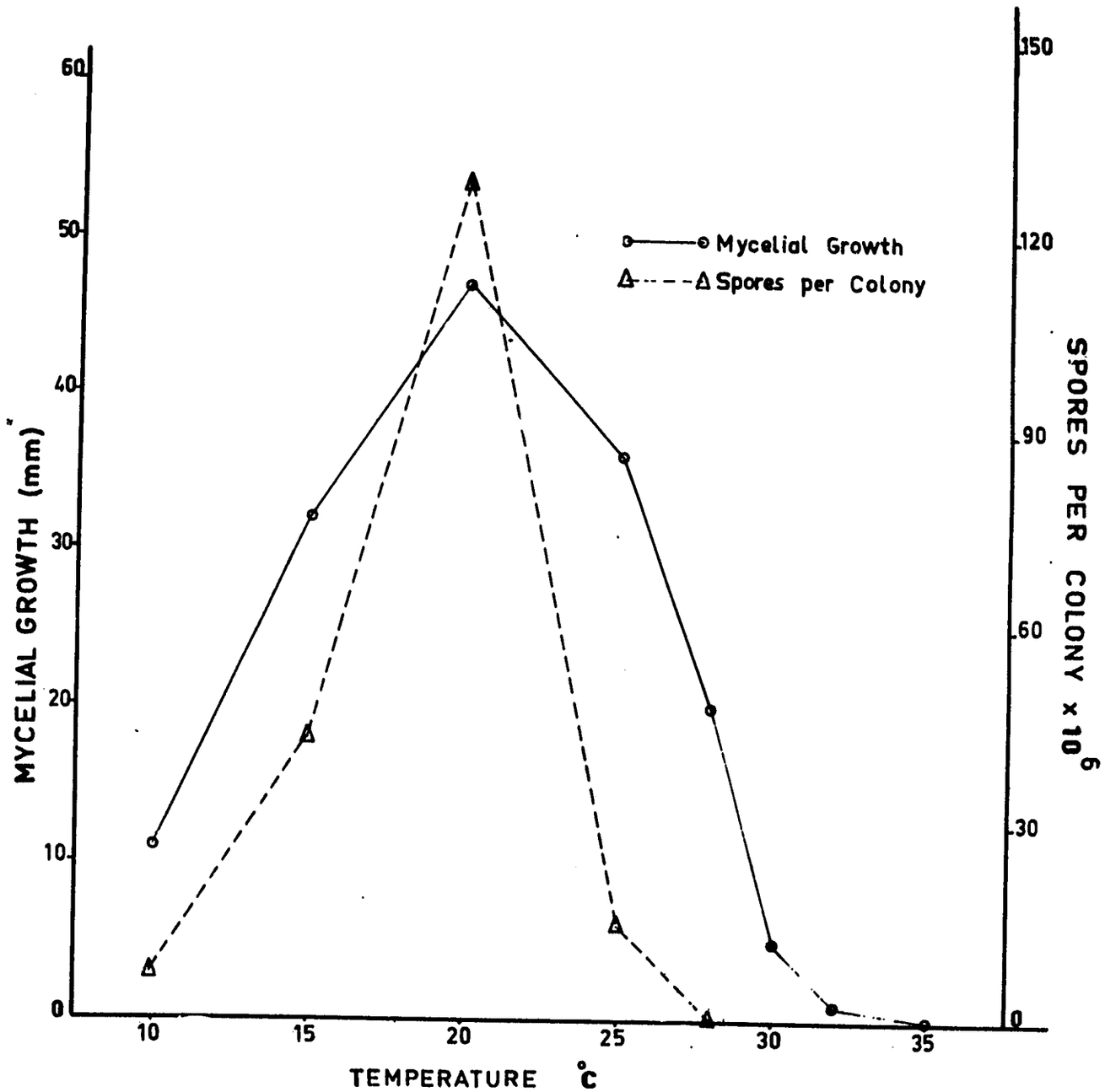

Figure 11. -- The effect of temperature on mycelial growth and sporulation of an isolate of Ascochyta rabiei from Ghazvin on chickpea seed meal agar after 13 days.

Lentils (Lens esculenta)

In nature lentils are infected by at least four viruses in different parts of Iran. In 1968, most lines in lentil yield trials at Varamin were heavily infected by two viruses (bean yellow mosaic (BYMV) and cucumber mosaic (CMV)). However, some of the small-seeded lentil lines from the Isfahan area showed varying degrees of resistance to these viruses.

A virus inoculation trial was conducted at Karaj with four viruses and a virus-susceptible, large-seeded lentil line from Ghazvin. The viruses included in this field study were alfalfa mosaic (AMV), bean yellow mosaic, cucumber mosaic, and pea leaf roll (PLRV), all of which have been isolated from lentils naturally infected in the field. Plants were inoculated at the pre-bloom and full bloom stages of growth with each virus separately, and simultaneously by BYMV and CMV since individual lentil plants in nature were commonly found to be infected with both viruses.

Yields were reduced by all viruses at both inoculation dates. However, greatest yield reductions, ranging from 73-94%, occurred when plants were infected at pre-bloom (Fig. 12). Preliminary results indicate that these viruses are seldom, if ever, seed-borne in lentils.

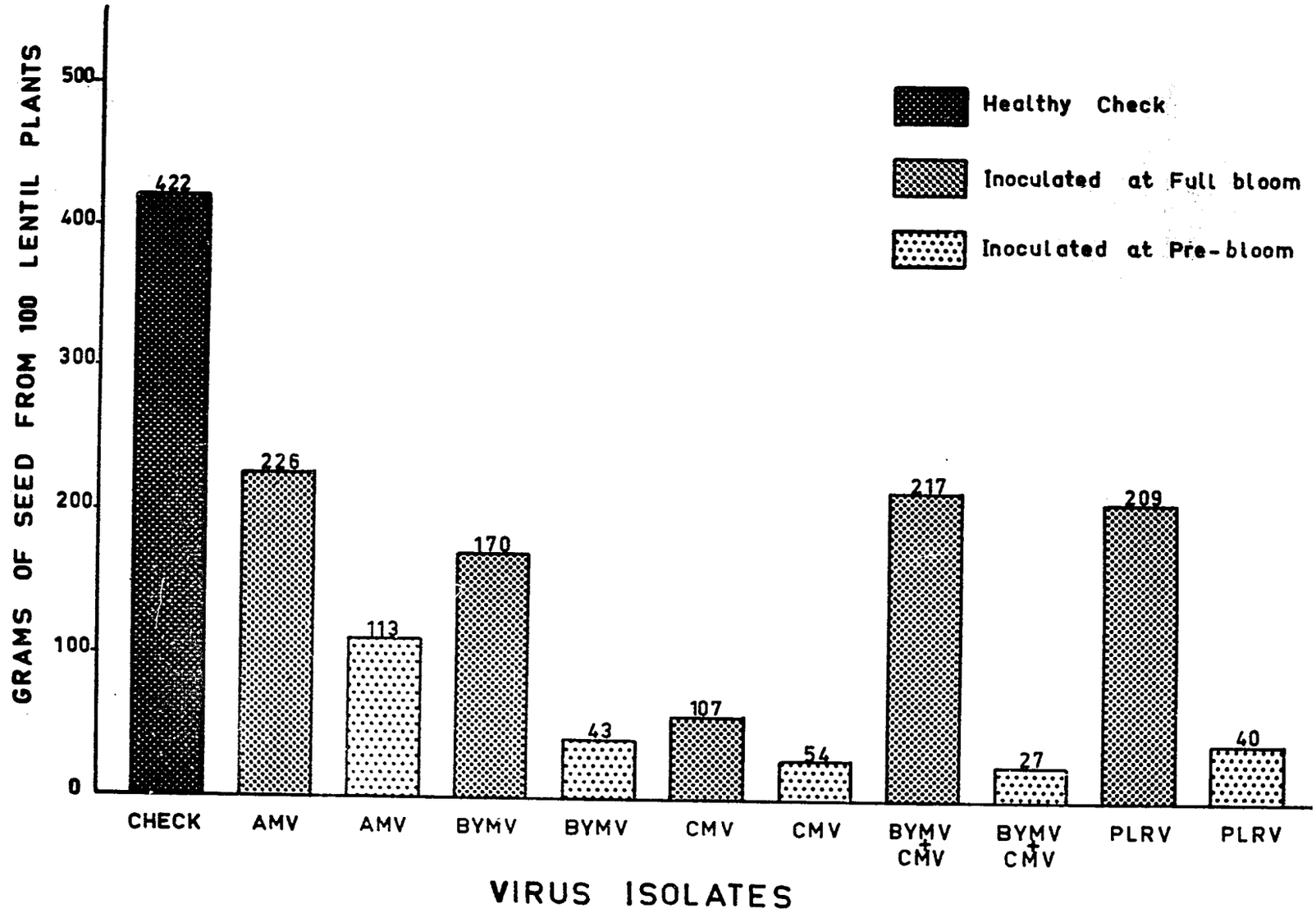

Figure 12. Effect of infection by alfalfa mosaic (AMV), bean yellow mosaic (BYMV), cucumber mosaic (CMV), and pea leaf roll (PLRV) viruses at two stages of plant growth on yields of lentil (variety: Ghazvin) in field inoculation trials at Karaj, Iran.

Mungbean (Phaseolus aureus)

A damping-off and stem canker disease of mungbean incited by Rhizoctonia solani has caused serious damage to mungbean plantings in the Karaj area. Experiments were conducted in the field at Karaj to determine the effects of different fungicides applied as seed treatments in controlling this disease. To insure a high, uniform incidence of disease, soil in the center 15 cm of each bed down to a depth of 12 cm was infested with a cornmeal-sand (5% - 95% v/v) inoculum of three mungbean isolates of R. solani.

One hundred mungbean seeds (variety: Berken) were planted in the center of the treated area of each plot and treatments were replicated four times. Each plot was a 1.5 m row, with rows 50 cm apart. Stand counts were taken at three intervals and plots were harvested at the end of the test.

Rhizoctonia was recovered consistently from rotted seeds or from wilted and dying seedlings in different treated and non-treated plots which had collapsed due to girdling of the stem at ground level.

After nine weeks, Rhizoctonia reduced stand counts in the infested control (no seed treatment) to 14% (Table48, Fig.13). However, seeds treated with Dexon-Terraclor or Terraclor resulted in the highest stand counts of 82 and 79% in the seed treatment series, respectively. Rhizoctol combi caused a burning of the mungbean foliage, and this phytotoxicity may have contributed to the high mortality which occurred in this treatment series.

Virus diseases of mungbean are widely distributed in Iran and are at times an important factor contributing to the low and erratic yields produced by this crop. Two new virus diseases of mungbean were identified in 1969 -- alfalfa mosaic (AMV) and cucumber mosaic (CMV). Plants infected with AMV were scattered through the Pulse Project's yield and observation trials at Karaj. A yellow mosaic of the foliage was the predominant symptom of AMV observed (Fig.14). In the Khorramabad area, stunted mungbean plants with mosaic, deformation and curling symptoms of the foliage were found to be infected with CMV. In mungbean, CMV produced symptoms similar to those caused by mungbean mosaic virus (MMV) which is a strain of bean common mosaic virus.

Surveys were taken through the yield and observation trials at Karaj for disease incidence. Several mungbean lines in these tests showed high resistance to MMV which is the most important virus disease of mungbean in the Karaj area (Table49).

The mungbean germplasm was evaluated during the pod set stage for resistance to mungbean mosaic virus (a strain of Bean common mosaic virus) at Karaj. The results are in Table 50.

Table 48. -- Effect of seed treatment fungicides on emergence and yield of mungbean, var. "Berken" in field trials at Karaj, Iran a/

Seed Treatment	b/ Dosage	Percent Stand Days After Planting			Yield d/
		9	25	68 c/	
No treatment (Natural field soil without *Rhizoctonia* inoculum)	-	97	98	98 a	195
No Treatment (Natural field soil and sterile cornmeal-sand)	-	97	97	95 ab	187
Dexon-Terraclor 35-35 WP	2.5	93	85	82 abc	196
Terraclor 75 WP	1.9	95	87	79 abcd	209
Demosan 65 WP	3.7	95	80	74 bcde	231
Thiabendazole (TBZ) 60 WP	3.7	91	81	72 cde	199
Vitavax 75 WP	3.7	92	67	58 def	176
Arasan 75 WP	1.9	64	55	53 efg	135
Captan 75 WP	2.5	62	48	45 fgh	168
Difolatan 75 WP	2.5	59	45	44 fgh	162
Dexon 70 WP	1.2	55	44	44 fgh	165
Ceresan M 7.7 WP	1.2	59	43	43 fgh	182
Dithane M-45 80 WP	3.1	55	36	35 ghi	148
Daconil 2787 75 WP	3.7	45	29	27 hij	153
Plantvax 75 WP	3.7	54	21	18 ij	124
Lindane 25 WP	1.9	32	18	17 ij	112
Captan - PCNB 10-10 WP	6.2	61	18	16 ij	137
No Treatment (Soil infested with *Rhizoctonia* inoculum)	-	29	14	14 ij	122
Dyrene 50 WP	3.7	54	14	14 ij	123
Rhizoctol Combi	3.7	60	20	5 j	53

a/ Field soil infested with a cornmeal-sand inoculum of *Rhizoctonia solani* and mungbean seeds planted (100/plot) on June 28, 1969; stand counts were taken at three intervals and are the average of 4 replications.

b/ Grams fungicide/kg seed.

c/ Within each column, all figures not followed by the same alphabetical letter are significantly different at the 5% level.

d/ Average yield of seeds (grams) from four single row plots, 1.5 m long.

Table 49. -- Mungbean lines in the 1969 Karaj Yield Trials which showed a high resistance to infection by Mungbean Mosaic Virus. a/

Preliminary Yield Test		Advanced Yield Test		Uniform Advanced Yield Test	
Accession No.	Source	Accession No.	Source	Accession No.	Source
48-071-11167	Unknown	48-071-10757	Karaj, Iran	48-033-10045	China
48-071-10808	Dare Gaz, Iran	48-071-10783	Karaj, Iran	48-069-10104	India
48-071-10539	Kermanshah, Iran	48-071-10810	Dare Gaz, Iran	48-071-10282	Karaj, Iran
48-071-10707	Sari, Iran	48-071-10855	Zahedan, Iran	48-157-10023	USA
48-071-10293	Zahedan, Iran	48-071-10865	Zahedan, Iran	48-157-11155	USA
48-071-10865	Zahedan, Iran	48-071-10926	Karaj, Iran	48-157-11156	USA
48-071-10677	Isfahan, Iran	48-071-11089	Kerman, Iran		
48-071-10288	Karaj, Iran	48-071-10292	Karaj, Iran		
48-071-10414	Jiroft, Iran	48-157-11086	USA		
48-071-10827	Dare Gaz, Iran				
48-071-10962	Shiraz, Iran				
48-157-11087	USA				

a/ Mungbean mosaic virus (MMV) is a strain of bean common virus; virus infection by MMV in highly resistant lines was less than 10%.

Table 50. Incidence of Mungbean Mosaic Virus* in germplasm at Karaj, Iran, 1969.

Accession No.	Virus rating**	Accession No.	Virus rating	Accession No.	Virus rating
48-157-10005	10	48-069-10058	6	48-069-10133	8
10007	9	10059	9	10134	8
10008	10	10060	7	10135	7
10010	7	10061	4	10137	8
10012	10	10062	6	48-11[illegible]-10139	9
10013	10	10065	8	10140	8
10014	10	10068	8	10141	8
10015	9	10069	8	10143	8
10016	10	10070	9	10144	8
10017	9	10071	9	10145	9
10018	7	10072	7	48-002-10146	10
10020	9	10077	8	10147	9
10022	8	10079	5	10149	10
10023	8	10080	6	10151	9
48-069-10025	9	10082	6	10152	9
10026	8	48-023-10317	8	10322	8
10027	7	48-071-10085	8	10154	8
10030	5	10086	8	48-071-10155	9
10031	7	10087	8	10157	9
10032	6	10088	7	48-002-10158	8
10034	8	10089	7	10159	9
10035	7	10091	8	10160	8
48-069-10308	9	10092	8	10161	8
10037	10	10093	10	10162	8
10038	9	10094	9	48-069-10163	8
10039	7	48-002-10095	8	48-002-10165	9
10040	7	48-002-10316	7	48-157-10168	9
10041	9	10100	7	48-062-10296	6
10042	10	10101	9	48-157-10171	9
48-153-10043	10	10122	9	10172	7
10044	9	10123	8	10173	8
48-069-10049	3	10124	7	48-069-10175	10
48-153-10052	5	10125	9	48-090-10176	9
10053	8	10127	8	48-071-10177	8
10054	9	10128	7	10178	8
48-069-10056	9	48-069-10131	8	10179	7
10057	5	10132	8	10180	6

* Mungbean mosaic virus is a strain of Bean Common Mosaic Virus.

** Rated on 1-10 scale, 1=no disease, 10=all plants seriously affected.

Accession No.	Virus rating	Accession No.	Virus rating	Accession No.	Virus rating
48-072-10181	8	48-071-10331	8	48-071-10388	5
48-002-10182	9	10332	6	10389	6
10183	10	10334	9	10390	7
10184	8	10335	4	10391	7
10185	6	10336	7	10393	7
10186	8	10337	5	10394	7
10187	7	10338	7	10396	3
10188	8	10339	8	10397	8
48-119-10189	8	10340	9	10398	6
48-002-10190	6	10341	9	10399	6
10191	5	10342	9	10400	5
48-113-10192	6	10343	8	10401	7
10193	7	10346	5	10402	5
10194	8	10347	4	10403	8
48-069-10195	8	10349	6	10404	6
10196	8	10313	9	10406	8
10197	7	10351	7	10407	6
10198	9	10355	5	10408	7
10199	8	10356	4	10409	7
10200	6	10357	4	10411	8
10201	8	10359	5	10412	8
10202	8	10360	7	10413	8
10323	8	10362	7	10415	8
10206	7	10363	5	10416	8
10207	8	10364	6	10418	7
10312	7	10365	5	10419	8
48-113-10209	8	10367	5	10420	8
48-069-10211	8	10368	8	10425	7
10212	7	10370	8	10302	9
10213	9	10372	7	10427	7
10214	9	10373	4	10428	8
10215	8	10374	7	10430	7
48-076-10216	8	10375	3	10431	6
48-071-10219	7	10376	5	10432	6
10220	8	10377	6	10433	7
10221	9	10379	6	10434	6
10222	9	10380	6	10435	6
10223	8	10381	7	10436	8
10224	8	10382	5	10437	7
48-113-10225	10	10383	3	10438	6
10226	9	10386	5	10439	6
48-071-10309	9	10387	8	10440	7

Accession No.	Virus rating	Accession No.	Virus rating	Accession No.	Virus rating
48-071-10442	6	48-071-10490	8	48-071-10536	7
10443	7	10314	7	10537	7
10444	7	10492	7	10544	8
10318	7	10493	8	10545	8
10447	5	10494	7	10546	9
10448	6	10495	7	10547	8
10449	6	10496	7	10548	8
10450	7	10497	7	10549	6
10452	2	10498	8	10551	8
10454	8	10327	6	10552	6
10455	5	10500	7	10553	7
10456	7	10501	7	10554	8
10457	6	10502	8	10555	7
10458	9	10503	5	10556	7
10459	7	10504	5	10557	5
10460	8	10506	3	10561	8
10461	6	10508	5	10562	6
10320	8	10509	4	10563	7
10464	7	10510	8	10564	8
10466	8	10511	7	10565	8
10467	8	10512	6	10566	6
10468	8	10513	5	10567	5
10469	8	10514	7	10568	8
10470	4	10515	7	10569	9
10471	5	10516	4	10570	7
10472	5	10517	5	10571	9
10473	4	10291	7	10572	8
10474	5	10519	5	10573	8
10475	4	10520	7	10574	4
10476	7	10326	5	48-019-10024	7
10477	8	10330	6	48-071-10575	5
10478	8	10523	5	10576	6
10479	3	10524	6	10577	7
10480	6	10525	5	10578	3
10297	8	10526	6	10579	9
10482	9	10527	8	10580	8
10483	8	10529	9	10581	8
10484	9	10530	8	10582	7
10485	7	10531	9	10583	6
10486	6	10532	5	10584	7
10487	5	10534	6	10585	9
10489	8	10535	8	10586	8

Accession No.	Virus rating	Accession No.	Virus rating	Accession No.	Virus rating
48-071-10587	6	48-071-10632	4	48-071-10696	4
10588	6	10633	3	10298	5
10589	7	10634	7	10698	5
10590	8	10635	7	10699	8
10591	6	10638	8	10700	5
10592	6	10639	7	10703	6
10593	8	10640	7	10704	6
10594	9	10641	8	10705	7
10595	6	10642	9	10710	4
10596	9	10643	7	10711	10
10597	6	10644	7	10712	8
10598	6	10645	8	10714	8
10599	6	10646	6	10716	2
10601	4	10647	7	10717	6
10602	7	10648	7	10719	5
10603	8	10649	7	10720	8
10604	8	10650	3	10721	7
10605	8	10651	5	10722	6
10606	8	10652	5	10724	10
10607	9	10653	10	10725	10
10608	5	10654	9	10726	5
10609	7	10655	-	10727	7
10611	4	10656	6	10728	7
10612	7	10657	8	10729	6
10614	3	10659	8	10730	7
10615	9	10660	6	10732	5
10616	7	10661	5	10733	7
10617	6	10662	5	10734	7
10618	5	10663	5	10735	7
10619	3	10664	4	10736	7
10620	8	10670	3	10737	7
10304	7	10671	5	10740	7
10321	3	10675	6	10742	4
10623	8	10685	6	10745	6
10624	9	10687	6	10746	8
10625	8	10688	6	10305	8
10626	5	10689	5	10748	6
10627	5	10690	5	10749	8
10628	4	10691	7	10750	8
10629	5	10693	5	10752	5
10630	6	10694	4	10753	8
10631	8	10695	4	10754	8

Accession No.	Virus rating	Accession No.	Virus rating	Accession No.	Virus rating
48-071-10755	7	48-071-10814	8	48-071-10875	2
10756	4	10815	7	10879	5
10758	6	10816	9	10881	9
10759	5	10817	7	10882	9
10760	8	10818	9	10883	6
10761	8	10819	8	10885	10
10762	8	10820	9	10886	10
10763	4	10821	5	10888	9
10764	9	10823	8	10889	7
10765	10	10825	6	10890	8
10766	6	10826	4	10891	8
10767	8	10828	5	10892	9
10768	9	10830	7	10893	9
10769	10	10831	8	10894	10
10770	9	10832	10	10895	8
10772	8	10303	10	10896	9
10773	8	10834	8	10283	9
10774	6	10835	10	10285	9
10775	10	10836	9	10899	7
10777	7	10837	10	10900	5
10778	7	10838	5	10901	9
10780	4	10839	10	10902	8
10781	8	10840	9	10903	7
10782	2	10841	7	10904	9
10783	7	10842	9	10905	6
10784	5	10843	10	10907	9
10785	8	10844	8	10908	10
10787	5	10845	7	10909	5
10788	6	10847	4	10916	9
10789	8	10848	5	10917	10
10791	9	10849	7	10918	10
10319	8	10850	10	10921	7
10328	5	10851	9	10922	4
10794	7	10852	10	10923	2
10795	8	10853	9	10924	9
10796	9	10854	8	10925	3
10797	8	10855	1	10926	3
10799	8	10858	4	10292	10
10800	6	10860	7	10300	10
10801	7	10863	6	10934	10
10802	7	10868	10	10935	8
10803	10	10869	8	10301	10
10804	8	10870	2	10937	9
10805	7	10871	4	10938	10
10811	6	10872	7	10310	10
10812	8	10873	3	10329	1
10813	8	10874	8	10941	7

Accession No.	Virus rating	Accession No.	Virus rating
48-071-10942	9	48-071-10976	9
10943	8	10977	9
10294	9	10978	9
10946	10	10980	10
10947	7	10985	8
10949	10	10987	9
10950	8	10991	6
10951	10	11051	8
10952	6	11065	8
10953	7	11086	10
10958	8	11089	2
10965	5	11090	10
10967	9	11091	10
10968	6	11093	10
10969	8	Hybrid 45	1
10973	8	Pusa Baisakhi	4
10975	8	Jalgoan 781	2

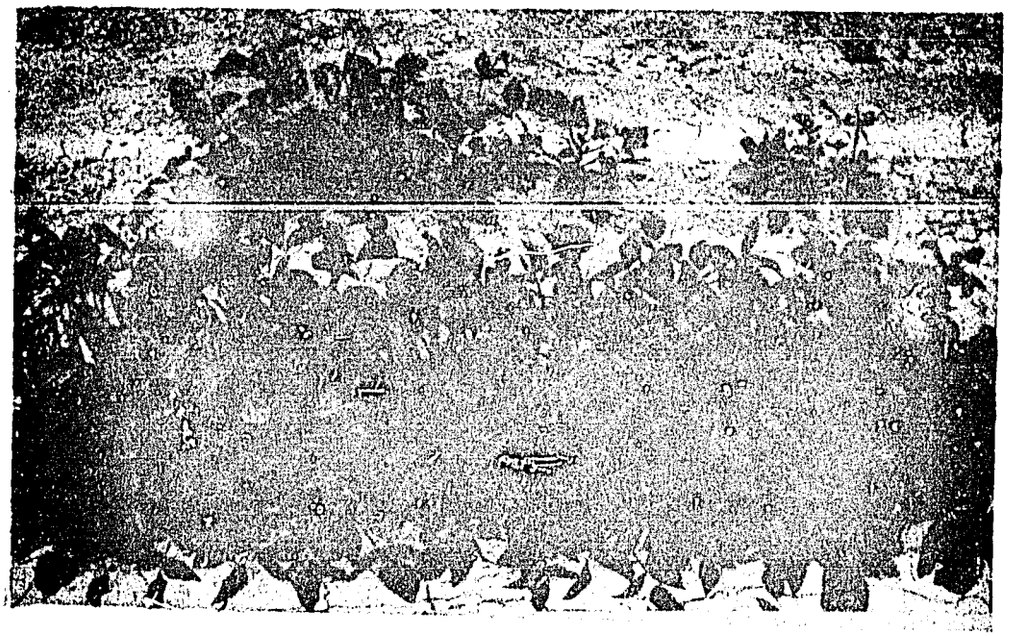

Figure 13. -- Effect of seed treatment fungicides on control of Rhizoctonia damping-off and stem canker disease of mungbean in field soil infested with a cornmeal-sand inoculum of the pathogen. Seed treated with Terraclor (foreground) had an average stand count of 79%, while seed receiving no seed treatment (background) had an average stand count of 14%.

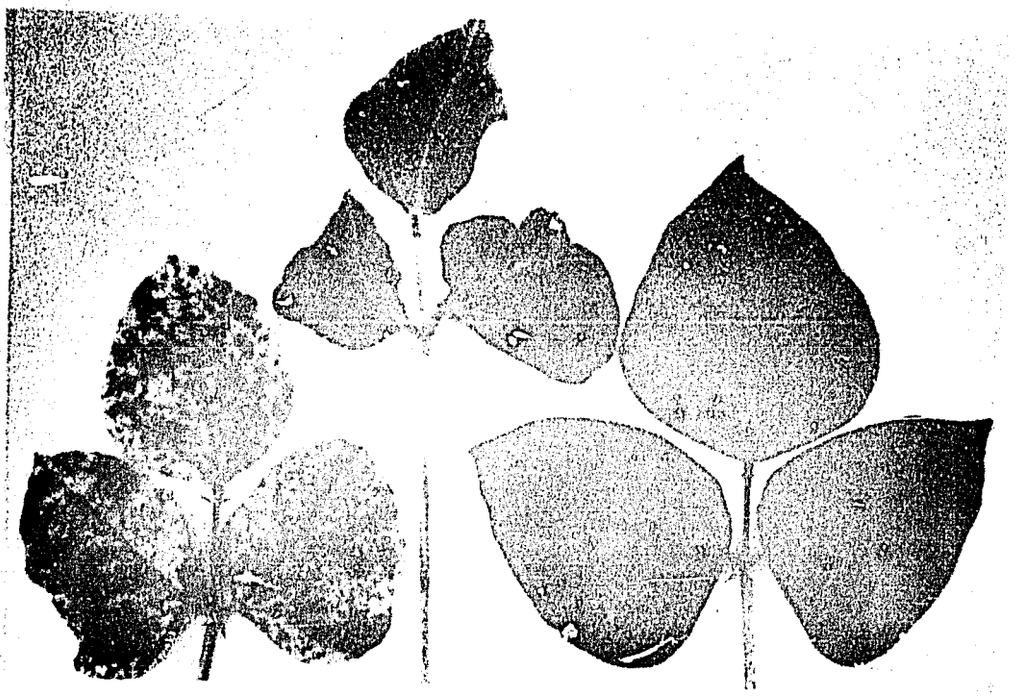

Figure 14. -- Foliar symptoms of two virus diseases of mungbean occurring in the Karaj area -- alfalfa mosaic virus (left), and mungbean mosaic virus (middle). Leaf from a healthy plant, on right.

Peas (Pisum sativum)

Peas are a relatively new cash crop being grown in Khuzestan Province (Southwestern Iran). At the Khuzestan Water and Power Authority Research Experiment Station located at Safiabad, emergence of several pea varieties planted in September, 1969 was erratic and poor. Most pea seed which failed to germinate was rotted and covered with a whitish mycelium. The roots of many seedlings were necrotic and dis-colored.

Several fungi were isolated from necrotic and rotted pea seeds and roots, including Fusarium spp., Pythium sp., and Rhizoctonia sp. Pythium was isolated frequently from diseased plant tissues. This isolate was subsequently identified as P. aphanidermatum.

Field soil was collected at Safiabad from areas where emergence of peas was poor. After mixing, the soil was divided into two parts -- one which was pasteurized and the other which remained as an untreated control.

Seeds of broadbean (Vicia faba), lentils (Lens esculenta), and peas were planted in both treatments and observations were taken at periodic intervals on emergence and disease development. Emergence of three pea varieties was greatly reduced in the non-treated field soil, while emergence exceeded 75% in pasteurized field soil. Emergence of broadbeans and lentils was over 85% in both treated and non-treated field soil (Table 51, Fig.15). Pythium was the predominant and most frequently isolated microorganism recovered from damped-off and rotted pea seed. No root rot developed in broadbean or lentil seedlings.

Pathogenicity tests were conducted in the greenhouse with various fungi which had been isolated from diseased peas. A cornmeal-sand or agar inoculum of each isolate was incorporated into pasteurized greenhouse soil and planted to Rondo pea seed. Several isolates of Pythium from different pulse crops were also included in these tests (Table 52) to determine their pathogenicity to pea. All isolates of Pythium were highly pathogenic to pea causing a pre-emergence damping-off of germinating seed or a root rot of surviving seedlings. Rhizoctonia and Fusarium (Fig. 16) failed to reduce germination of pea seed below that of the control, but both fungi were isolated occasionally from seeds which did not germinate. Under favorable conditions these fungi may become weak pathogens of pea.

Since poor emergence of peas at Safiabad was due to one or more microorganisms present in field soil, a fungicide trial was established at Safiabad in an area where pea emergence was poor and erratic.

Rondo pea seeds were treated with 10 fungicides and planted in plots, 4 m long and 2 beds wide (2 rows/bed). Two hundred pea seeds were planted in each plot. Treatments were replicated four times.

Seedling survival in the untreated control was reduced to 10% 75 days after planting (Table 53). Seed treatments with Captan and Arasan gave the highest stand counts of 63 and 53%, respectively. The performance of several systemic fungicides, e.g. Benlate, Plantvax, and Thiabendazole, was poor in this trial. A similar fungicide trial utilizing both seed and soil treatments will be conducted at Safiabad in February, 1970.

Table 51. -- Emergence of broadbean, lentil, and pea seeds in treated (pasteurized and non-pasteurized) field soil collected from the Khuzestan Water and Power Authority Research Experiment Station, Safiabad.

Test Plant	Pasteurized Field Soil			Natural Field Soil		
	No. Seeds	No. Emerged	% Emergence	No. Seeds	No. Emerged	% Emergence
Rondo Pea	45	41	91.1	60	5	8.3
Progress Pea	45	39	86.6	60	12	20.0
No. 40 Pea	45	34	75.5	60	6	10.0
Algerian Broadbean	45	41	91.1	60	58	96.6
Ghazvin Lentil	50	43	86.0	50	45	90.0

a/ Soil was pasteurized in a Dillon Soil Pasteurizer.

Table 52. -- Pathogenicity of seven isolates of fungi from different pulse crops grown in Iran to Rondo pea in greenhouse inoculation tests.

Fungi	Host	Location	Type of Inoculum a/	No. Seeds	No. Emerged b/	% Emergence
Fusarium sp.	Pea	Dezful	PDA	45	44	97.8
Fusarium sp.	Pea	Dezful	CS	45	42	93.3
Rhizoctonia sp.	Pea	Dezful	PDA	45	37	82.2
Rhizoctonia sp.	Pea	Dezful	CS	45	41	91.1
Pythium aphanidermatum	Pea	Dezful	PDA	45	1	2.2
Pythium aphanidermatum	Pea	Dezful	CS	30	0	0
Pythium aphanidermatum	Lentil	Dezful	PDA	45	0	0
Pythium aphanidermatum	Lentil	Shiraz	PDA	45	0	0
Pythium aphanidermatum	Mungbear	Dezful	PDA	45	11	24.4
Pythium ultimum	Lentil	Karaj	PDA	45	0	0
Control	--	--	PDA	45	42	93.3
Control	--	--	CS	90	87	96.7

a/ Pasteurized greenhouse soil was infested with fungus inoculum in the form of macerated potato dextrose agar (PDA) or cornmeal-sand (CS).

b/ Emergence readings were taken 19 days after planting.

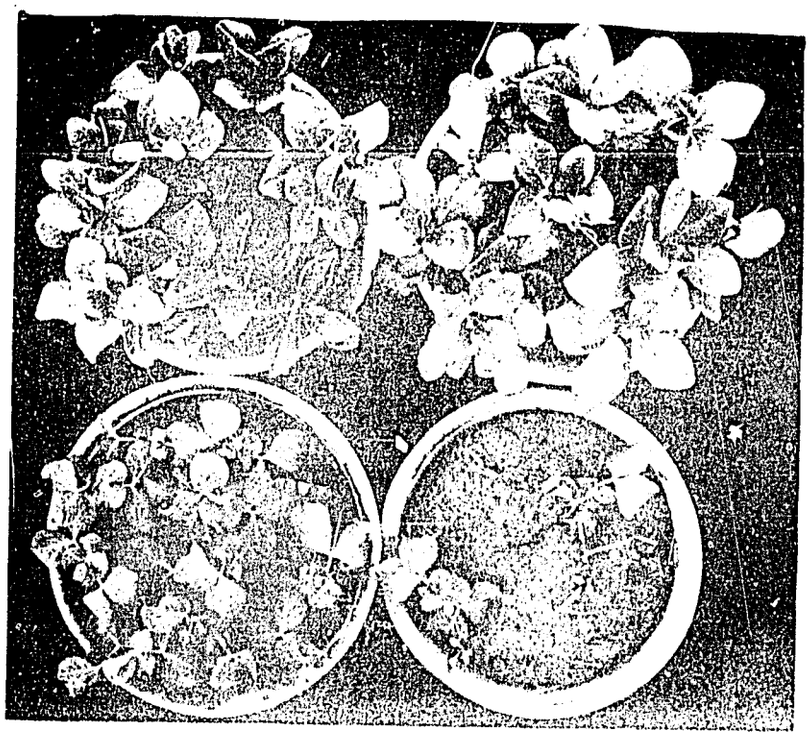

Fig. 15. -
Emergence of Algerian broadbean (top row) and Rondo pea (bottom row) in natural field soil from Safiabad, Khuzestan which had been pasteurized (upper and lower left) and untreated (upper and lower right). Fifteen seeds were planted in each pot.

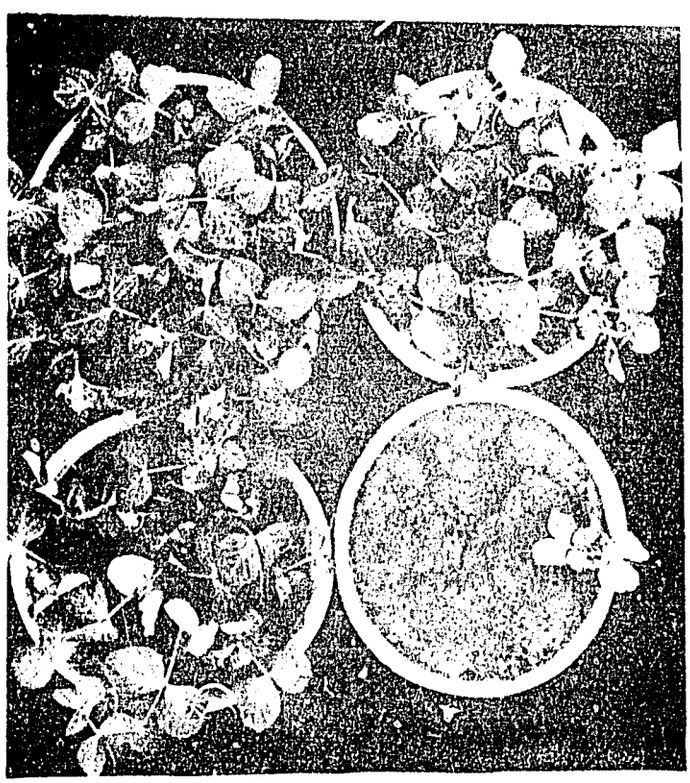

Fig. 16. --
Pathogenicity test with three fungi isolated from the roots or seed of diseased peas. The inoculum of each fungus consisting of macerated potato dextrose agar (PDA) was incorporated in pasteurized greenhouse soil. Pots were planted with 15 Rondo pea seeds. Treatments were: Control (sterile PDA), upper left; Rhizoctonia sp., upper right; Pythium aphanidermatum, lower right; Fusarium sp., lower left.

Table 53. -- Effect of seed treatment fungicides on control of damping-off and root rot of peas in field trials at the Khuzestan Water and Power Authority Research Experiment Station, Safiabad, Dezful, Iran a/

Seed Treatment	Dosage b/	Percent Stand Days after Planting 22	75	Yield d/
Captan 75 WP	2.5	69	63 a c/	508
Arasan 75 WP	1.9	65	53 ab	557
Dexon 70 WP	1.2	52	41 bc	405
Dexon-Terraclor 35-35 WP	2.5	43	37 c	308
Vitavax 75 WP	3.7	41	34 cd	358
Demosan 65 WP	3.7	29	22 de	219
Plantvax 75 WP	3.7	16	14 ef	171
Thiabendazole (TBZ) 60 WP	3.7	18	12 ef	169
Control	-	11	10 ef	156
Terraclor 75 WP	1.9	5	5 f	63
Benlate 65 WP	4.0	7	4 f	83

a/ Trial planted October 1, 1969 and stand counts were taken at two intervals and are the average of 4 replications. Plots were harvested in January, 1970.

b/ Grams fungicide/kilogram seed.

c/ All figures not followed by the same letter are significantly different at the 1% level.

d/ Average yield of seeds (grams) from 4, 4 row plots, 4 m long.

Pea Leaf Roll Virus

Most viruses infecting pulses in Iran are juice transmissible and spread by aphids in a stylet-borne (non-persistent) manner where the virus is acquired by the vector in brief probes (feedings) of less than two minutes. However, pea leaf roll virus (PLRV) differed from most of these viruses by not being transmitted by mechanical means. We have transmitted PLRV by grafting and with aphids. The vector-virus relationships of PLRV also differed markedly from those of several stylet-borne viruses infecting pulses, but were similar to those of other circulative (persistent) viruses. Aphids did not acquire PLRV in brief probes, but usually required a 2-6 hour feeding period on a virus-infected host before they became viruliferous. Once PLRV was acquired, vectors remained infective for several days, even after molting (ecdyse), indicating that the virus had entered the aphid's body cavity.

In the field, PLRV infected the following pulse crops: bean, broadbean, chickpea, cowpea, lentil, and pea. The virus is widely distributed in Iran and is present in most of the pulse growing areas surveyed in the country (Fig.17). Cowpeas were found to be a new host of PLRV in several localities of Iran. Infected cowpea plants are severely stunted (Fig. 18) and seed yields greatly reduced.

Most leguminous plants infected with PLRV are severely stunted and there is usually a proliferation of the axillary buds and a shortening of the internodes. There may be a twisting, thickening, and downward curling of the newly formed leaves. Pods generally fail to form on plants infected before flowering and seed yields are usually severely reduced on plants infected after flowering (Table 54).

Pulses in Iran are colonized by at least five aphid species. These are: Acyrthosiphon pisum (pea aphid), A. sesbaniae, Aphis craccivora (cowpea aphid), A. gossypii (melon aphid), and Myzus persicae (green peach aphid). All the above aphid species have transmitted PLRV in greenhouse trials, although M. persicae is a very poor and inefficient vector.

The vector-virus relationships of PLRV was studied in more detail with A. craccivora. Virus-free aphids acquired the virus from PLRV-infected broadbeans in three hours. The probability of aphids becoming viruliferous increased with longer acquisition access periods on diseased broadbeans (Table 55). Transmission of PLRV by viruliferous aphids also increased with the time aphids were allowed to feed on healthy test plants (Table 56). Aphids at different stages of development transmit PLRV, although the first and second instar nymphs were the least efficient vectors. Highest transmission of PLRV occurred with apterous (wingless) adults (Table 57).

Figure 17. -- The distribution of pea leaf roll virus infecting various pulse crops in Iran.

Figure 18. -- The stunted Meshed cowpea plant (lower left of photo) is infected with pea leaf roll virus. Virus infection results in a proliferation of the axillary buds and a shortening of the internodes giving diseased plants a stunted, bushy appearance. Flowering and pod formation are greatly restricted in virus-infected plants.

Figure 19. -- Virus-free aphids were placed in cages on cowpea plants in the field which were suspected of being infected with pea leaf roll virus. After a 48-72 hour feeding period, the aphids were transferred to healthy indicator plants (usually broadbean). Indicator plants show symptoms of pea roll virus in 7-14 days.

Table 54. — Effect of natural infection by pea leaf roll virus on yield of various pulse crops.

Crop	Variety	Yield Healthy	Yield a/ Diseased	% Decrease in yield
Bean	Isfahan, Red	387	1.2	99.7
Broadbean	Algerian	2055	0	100
Cowpea	Meshed	408	0.4	99.9

a/ Yield of seed (in grams) from 50 plants.

Table 55. — The length of time required for aphids (Aphis craccivora) to acquire pea leaf roll virus from diseased broadbeans. a/

Acquisition Access Period (Hours)	Number of Test Plants	Number of Diseased Plants	% Transmission
2	45	0	0
3	43	0	0
4	50	4	8
5	50	6	12
12	19	8	42
24	46	23	50
48	28	15	54

a/ At the termination of each acquisition period, aphids were transferred to healthy broadbeans (5 aphids/plant) in leaf cages for 72 hours.

Table 56. -- Transmission of PLRV by viruliferous aphids (Aphis craccivora) after different inoculation feeding periods on healthy broadbeans. a/

Inoculation Feeding Period	Number of Test Plants	Number of Diseased Plants	% Transmission
1 probe	75	0	0
10 minutes	108	6	5.6
1 hour	195	10	5.1
3 hours	111	19	17.1
6 hours	108	17	15.7
12 hours	77	17	22.1
24 hours	75	23	30.7
48 hours	77	33	22.9

a/ Viruliferous aphids were transferred to healthy broadbeans (1 aphid/plant) in leaf cages for the various inoculation feeding periods.

Table 57. -- Transmission of pea leaf roll virus by aphids (Aphis craccivora) at different stages of development. a/

Stage of Development	Number of Test Plants	Number of Diseased Plants	% Transmission
Alatae (Winged) Adults	91	48	52.8
Apterae (Wingless) Adults	91	65	71.4
3rd-4th Instar Nymphs	102	61	59.8
1st-2nd Instar Nymphs	111	33	39.7

a/ Viruliferous aphids were transferred to healthy broadbeans (1 aphid/plant) in leaf cages for 72 hours.

ENTOMOLOGY

Karaj College

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SUMMARY

RPIP Entomology activities during 1969 were to a large extent the responsibility of the Karaj College Pest Control Department and the RPIP/ Plan Organization Junior Scientists. The greater contribution has been due to the growing competence of the RPIP Junior Scientists, and the increased contribution by the Pest Control Staff. At the present time direct supervision is provided by Dr. Esmaeli with cooperation from Drs. Sepasguzarian and Morad-Saghi on specific pulse pests.

Control recommendations have been updated for pests of the pulse crops.

A lentil variety (Hamadan lentil) which shows a high degree of resistance to bruchids has been increased and will be available to the RPIP Plant Breeders for work in 1970.

Cowpea weevil, Callosobruchus maculatus, egg laying preference studies were conducted on a number of the pulses. Results indicate that feeding preference is not closely related to insect survival.

Insect Occurrence,,1969

During 1969 a number of pest infestations on pulses were recorded. In order of their appearance, the following pests occurred. On April 26, the adults and larvae of the seed corn maggot Hylemya cilicrura R. were observed in entomology dry bean date of planting plots. At this time average soil temperature at a 10 cm depth was 12.6° centigrade. Damage was 65% to the dry beans as a result of a high infestation of larvae in the young plant roots. Leaf miner Liriomyza congesta appeared on chickpea plots in Karaj and Ghazvin on June 4th. Defoliation ranged from 3% in Karaj to 10% in the Ghazvin plots.

On June 4th a light infestation of thrips Caliothrips impurus occurred in Karaj and Ghazvin RPIP lentil plots. First appearance of Acyrthosiphon sesbaniae was on June 8th in the Karaj lentil plots. These aphids were observed on cowpeas later, but populations never reached an economic level.

Bollworm Heliothis armigera larvae first appeared on chickpea plots June 9th in Karaj, but numbers were extremely low. Bollworm damage to the chickpea pods ranged from 10% in Meshed to 7.5% in the Ghazvin plots. On June 17th a few larvae of beet armyworm Spodoptera exigua Hb. were recorded on cowpea plots, but infestations of any significance did not develop in the plots during the 1969 crop season. Mites Tetranychus (complex) were observed in Karaj dry bean and mung bean plots on July 29. A serious infestation developed in the dry beans 10 days later.

Pesticide Trials of Significance

Table 58. - Effect of date of planting and soil temperatures on seed corn maggot, Hylemia cilicrura, damage in dry beans, RPIP Karaj, Iran 1969.

Date of Planting	Soil temperature 10 cm. depth (Centigrade) 1/	No. of larvae in 100 young plant roots 2/	% Damage	Seed Yield (grams)
April 26, 1969	12.6	82	65	3160
May 10, 1969	15.1	0 ++	5 ++	4320 ++
May 28, 1969	16.4	0 ++	0 ++	4710 ++

1/ Soil temperature: Average from 7 days before to 7 days after planting.

2/ Sampling: 100 newly emerged plants pulled from each treatment and number of larvae and damaged plants were counted.

++ Significant at 1% level.

Results of this indicate along with the previous trials in 1968 that good control of H. cilicrura on dry beans may be obtained by using the most favorable date of planting. The increase in seed yield on the last two date of plantings over the first planting is, however, probably due to a combination of two factors.

The last two date of plantings correlate with Dr. Horner s and Eng. Mostahidi's (RPIP Soil Scientists) data, which indicates the favorable response of dry beans to this period of planting. However, the increased yield is also due to the decrease in infestation of the seed corn maggot H. cilicura.

Table 59. - Effect of seed treatment before planting using two insecticides in different dosages on the seed corn maggot Hylemia cilicrura R. on dry bean plots - RPIP Karaj, Iran 1969.

Insecticides	No. damaged in 100 plants % damage 1/	No. larvae in 100 young plant roots	% Reduction of larvae	Seed Yield (grams)
Lindane 2 gr/kg seed	24+	11+	89.2	2080
Lindane 1.5 gr/kg seed	23+	21+	79.4	2195
Lindane 1.25 gr/kg seed	30+	37+	63.7	2930
Dieldrin 1 gr/kg seed	35+	26+	74.5	3710+
Dieldrin 1.5 gr/kg seed	41+	28+	72.5	3250+
Dieldrin 0.33 gr/kg seed	46+	30+	70.5	2650
Check (Untreated seed)	69	102	-	3560+

1/ Data was taken from 100 newly emerged plant roots.

\+ Significant at 5% level.

The seed yield in this table appears to be contrary to the reduction in damaged seedlings, which appears to be due to seed treatments. While it is speculative this may be due to the seed corn maggot H. cilicrura reducing the plant population to a more favorable number. A high seeding rate (500,000,000 plants/hectare) was used, which may have contributed to the increased yield where damage was the most severe. Through an error the recommended rate of 200,000,000 plants per hectare was not used. The odd response of the seed yield remains rather questionable, however, and additional work will have to be conducted to acertain the value of seed treatment as a control for seed corn maggot H. cilicrura.

Good control was obtained against thrips C. impurus populations infesting lentils. However, the need for controlling this insect remains open to question. In view of the rapid natural changes in the populations of this insect, and little or no evidence of actual damage due to it's presence, it is doubtful that control should be recommended at this time.

Table 60 Effect of insecticides on thrip populations on lentils, RPIP Karaj, Iran 1969

Insecticides	Number of thrips and % Reduction 1/									Mean % Reduction	Seed Yield (Grams)
	5 days Before Spray	2 days After Spray	% Reduction	5 days After Spray	% Reduction	9 days After Spray	% Reduction	11 days After Spray	% Reduction		
Dimethoate 250 gm/ha	447	16+	90.1	19+	94.5	44+	94.0	43+	92.9	92.9	4540
Malathion 1 kg/ha	457	13+	92.7	17+	95.2	40+	94.7	90+	85.4	92.0	3400
Thiodan 700 gm/ha	560	14+	93.6	31+	92.8	178+	80.6	250+	66.9	83.5	2870
Diazinon 600 gm/ha	592	16+	93.1	61+	86.6	353+	63.6	296+	62.9	76.5	3710
Check	434	169	-----	332	-----	710	-----	584	-----	-----	4460

1/ Number of thrips were counted on 10 single plants per plot x four replications.

\+ Significant at 1% level.

Table 61. - Effect of pesticides on mite populations (Tetranychus telarius) on dry beans, RPIP Karaj, Iran 1969.

Pesticides	Number of Mites per Treatment 1/			
	10 days After Spray	% Reduction	19 days After Spray	% Reduction
Kelthane 1 kg/ha	1+	97.0	39+	97.3
Schering 1143 1 kg/ha	1+	97.0	91+	93.7
Morocid 500 gr/ha	3+	91.5	52+	96.4
Neoron 200 gr/ha	4+	88.5	285+	80.3
Tedion V 18 500 gr/ha	7+	80.0	48+	96.6
Check	35	-	1449	-

1/ Number of mites were counted in 100 leaves/treatment.

\+ Significant at 1% level, and all pesticides are in one group.

In general, mite infestations have occurred on RPIP research plots late in the growing season. Because of the late infestation, mites usually are not a problem on pulse crops. When they do occur earlier, however, they are a serious problem.

Adequate control has been obtained in 1969 using all of the materials listed in the above table.

The availability and relative cost of the chemicals will probably be the criteria for the present use of these acaricides.

Table 62. - Effect of insecticides on bollworm (Heliothis armigera) on chickpeas, RPIP, Ghazvin, Iran 1969.

Insecticides	No. of pods Examined 1/	No. of Damage pods	% Damage	% Reduction
Sevin or Carbaryl 1.3 kg/ha.	1252	6+	0.5	93.3
Thiodan 700 gm/ha	1368	7+	0.5	93.3
DDT 2 kg/ha	965	10+	1.3	82.6
Supracid 600 gr/ha	1344	16+	1.2	84.0
DDT + Lindane (30-9) (1500 gr + 450 gr/ha)	1201	25+	2.0	73.3
Check	1134	85	7.5	-

1/ Sampling: Number of pods were counted in 40 chickpea plants/ treatment (10 plants per plot).

\+ Significant at 1% level, all insecticides are in 1 group.

Trials conducted in 1969 indicate adequate control can be obtained with the use of any of the pesticides listed in the above table. In view of the prevelent use of pulse thrashings for animal fodder, however, it is adviseable to use Carbaryl or Thiodan when ever possible to prevent residue problems.

Additional screening will be conducted in 1970 to verify subsequent work and a number of new materials will be included.

Table63 . - Egg laying and feeding preference of cowpea weevil Callosobruchus maculatus F. in different pulse crops. RPIP Karaj, Iran 1969.

Crop	No. of eggs 1/ laid in 1st Replication	No. of eggs laid in 2nd Replication	No. of eggs laid in 3rd Replication	Mean No. of Eggs	% adult Emergence
Cowpea	735	701	557	665+	62.5+
Mungbeans	578	593	447	539+	71.0+
White dry beans	327	540	357	408+	-
Chickpeas	39	60	53	51	97.5+

1/ Number of eggs in each replication were laid by 50 female weevils, which were released on the seeds.

\+ Significant at the 1% level.

The preference studies on cowpea weevil C. maculatus were of interest for a number of reasons. Cowpeas, which are the preferred host ranked third in adult emergence. Perhaps more surprising was the very high survival of the insect on chickpeas. While definately not a preferred host, although if it is the only pulse present they will lay readily on them, chickpeas provide what is apparently a favorable diet for the cowpea weevil C. maculatus.

Dry beans provide a very poor host for the insect, but they will readily lay eggs on them. In all cases, the emerging larvae failed to penetrate the seed coat on dry beans.

Studies of the physiology and morphology of pulses could well be of future importance in resistance work. Further investigations will be conducted.

Table 64. - Effect of Bromodan seed treatment on cowpea weevil *Callosobruchus maculatus* F. in stored cowpeas. RPIP Karaj, Iran 1969.

Bromodan actual rates gm/kg seed	Average lifetime of released weevils a/ in treated seeds.		Mean No. of adults emerging during three months after treatment	
	Dry treated Bromodan	Wet treated Bromodan	Dry treated Bromodan	Wet treated 1/ Bromodan
2 grams	34 hours+	87 hours	2+	10+
1.5 grams	45.5 hours+	89 hours	2+	3+
1 gram	46 hours+	79 hours	4+	28+
0.5 grams	57.5 hours+	90 hours	46+	129+
Untreated check	87.5 hours	87.5 hours	474	474

a/ Twenty-five adult males plus 25 females were released in each of four replications consisting of 1 kg of cowpea seed.

1/ Bromodan W.P. mixed with 25 cc of water to treat 1 kg of seed.

\+ Significant at 1% level.

Control of *C. maculatus* using Bromodan has been fair during experimental trials. However, lack of an assured source of material coupled with only fair results has resulted in a decision to discontinue all further testing of this material.

Table 65. - Treatment of cowpeas infested 1/ with cowpea weevil using methyl bromide to determine germination percentage using different levels of fumigation.

Fumigation rate/33 mm^3	Length of Fumigation (hours)	Number of Fumigations	% Germination	Insect Mortality
Infested Cowpeas				
453 grams	24	1	88	100%
453 grams	48	1	84	100%
453 grams	24	2	76	100%
453 grams	48	2	80	100%
906 grams	24	1	78	100%
906 grams	48	1	86	100%
906 grams	24	2	78	100%
906 grams	48	2	89	100%
1360 grams	24	1	83	100%
1360 grams	48	2	76	100%
1360 grams	24	2	70	100%
1360 grams	48	1	81	100%
Uninfested and Untreated Cowpeas				
---	--	--	98	

1/ Four replications consisting of 1 kg of seed in cloth sacks were used with each rate of fumigation.

The presence of the insect in the cowpeas was not considered to have an effect on the germination because the cowpea weevil was placed with the seed at a time which resulted in larval emergence just shortly before fumigation. In no instance did larval penetration result in lowered germination.

Table65A. - Treatment of mungbeans infested 1/ with cowpea weevil using methyl bromide to determine germination percentage using different levels of fumigation.

Fumigation rate/33mm^3	Length of Fumigation (hours)	Number of Fumigations	% Germination	Insect Mortality
Infested Mungbeans				
453 grams	24	1	96	100%
453 grams	48	1	97	100%
453 grams	24	2	98	100%
453 grams	48	2	99	100%
906 grams	24	1	89	100%
906 grams	48	1	88	100%
906 grams	24	2	92	100%
906 grams	48	2	95	100%
1360 grams	24	1	92	100%
1360 grams	48	1	79	100%
1360 grams	24	2	82	100%
1360 grams	48	2	88	100%
Uninfested and Untreated Mungbeans				
---	--	-	95	

1/ Twenty-five males and twenty-five females were placed with each of the 4 replications in all treatments. Fumigation was conducted early enough to prevent decreased germination due to larval injury.

The slightly decreased germination of mungbeans due to fumigation was not considered to be great enough to effect seedling rate.

The problem of pesticide residues has caused a great deal of concern to both the Iranian research entomologists and the RPIP entomologist. Since in many parts of Iran the custom is to feed all crop thrashings to sheep and goats, it has been stressed that these animals, when used for dairy or meat purposes must not be fed the pulse trash when treated with certain insecticides.

Crop	Pest	Pesticide	Rate	Remarks
Dry beans	mites	Dicofol or kelthana Tetradifon or Tedion	600 g/ha	Do not feed treated plant to livestock.

Crop	Pest	Pesticide	Rate	Remarks
Dry beans	Seed cor maggot			Plant when soil is warm enough for quick plant growth or soil temperature reaches 22° C.
		Dieldrin	0.33 g/ kg seed	Seed treatment is considered to be only partially effective.
		Lindane	1.5 g/kg seed	Later planting is preferable. Seed should be dried thoroughly after mixing with insecticide and used within 30 days of planting.
Dry beans	leaf-hoppers	Diazinon	½ kg/ha	
		Carbophen-othion	1 kg/ha	
		Malithion	1 kg/ha	
		Ethion	½ kg/ha	
		Dimethoate	1/2 kg/ha	Do not feed treated plants to livestock.
		Carbaryl or Sevin&Tedion	1+2 kg/ha	Do not feed treated plants to livestock.
Mungbeans	mite	Dicofol or Kelthane	1 kg/ha	Do not feed treated plants to dairy or meat animals.
		Tetradifon or Tedion	½ kg/ha	Do not feed treated plants to livestock
Lentils	aphids	Dimethoate or Cygon	250 g/ha	Do not feed treated plants to livestock.
		Malithion	1 kg/ha	
Chickpeas	old world bollworm	Thiodan	700 g/ha	
		Carbaryl or Sevin	1½ kg/ha	
		Supracide	600 g/ha	Control may not be adequate under heavy infestations.
Cowpeas	aphids	Dimethoate or Cygon or Rogor	½ kg/ha	Do not feed treated plants to livestock.
		Diazinon	600 g/ha	
		Malithion	1 kg/ha.	

The following trials were conducted, but data was not significant due to low infestations.

1. Cowpea weevil C. maculatus trials, Karaj
2. Bean butterfly trials, Karaj
3. Bollworm H. armigera trials, Karaj, Varamin, and Meshed.
4. Lentil weevil Bruchus lentis trials, Karaj and Ghazvin.
5. Aphid trials, Karaj.

Crop Protection

With the exception of old world bollworm Heliothis armigera, crop protection was not needed on the other disciplines trial plots in 1969. Protection was provided for the chickpea plots at the Varamin station when severe infestations occurred. In addition, the entomologists assisted the RPIP Plant Pathologists in keeping insect vectors to a minimum to keep disease incidence to a minimum.

Misc.

The lentil, Hamadan variety, which showed excellent resistance to the cowpea weevil C. maculatus, during extensive laboratory investigations has been increased and will be available in 1970 to the Plant Breeders for their work. The Hamadan lentil was increased during the winter in Khuzistan.

I N D I A

VARIETAL IMPROVEMENT

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SUMMARY

Seed supplies were maintained by collecting seed from several cooperating institutions. The collected seed was distributed to requesting institutions where seed supplies were sufficient.

A catalogue of germplasm accessions is being compiled giving accession number, source and origin.

Agronomic data on pigeon pea and chickpea is also being compiled.

Crosses have been made to study inheritance and produce improved varieties.

Germplasm

Maintenance of good, viable seed supplies of the extensive germplasm collection has presented serious problems. Many institutions have requested seed and agreed to return seed after harvest but in many cases the seed returned has been nil or low in quantity and quality. The facilities available at IARI, New Delhi, both for growing and storing seed have been inadequate to maintain all the collections there. As a result some of materials previously in the collections are no longer available. Samples of all the lines of which sufficient seed was on hand, have been prepared for storage in the USDA, National Seed Storage Laboratory, Fort Collins, Colorado, and it is hoped that these will be grown under good growing conditions very soon to provide fresh and larger seed supplies for future use.

The remaining seed stocks are with the Coordinator, All India Coordinated Pulse Project, IARI, New Delhi. Various institutions in India, particularly the Agricultural Universities, are making good use in their breeding programs of the germplasm collections provided them.

A catalogue of the pigeon pea germplasm lines in the collection, showing accession numbers, sources, and origins was prepared.

Work is now in progress to prepare catalogues of the pigeon pea and chickpea collections including evaluation data from several locations.

During 1969 the germplasm collection of pigeonpeas sent to Kampala, Uganda at the request of the Rockefeller Foundation and Makarere University. A representative collection of pigeon pea germplasm was sent to Puerto Rico at the request of Dr. Abrams. Germplasm was also sent to several requesting institutions within India.

Requests have been received for various pulse crop collections from the International Institute for Tropical Agriculture (IITA) in Nigeria and the International Center for Tropical Agriculture (CIAT) in Columbia.

Because of the problems of communication between India and Pakistan, chickpea germplasm was provided to West Pakistan from RPIP/Iran.

Chickpeas (Cicer arietinum)

In the 1968-69 rabi season 1500 chickpea (Cicer arietinum) accessions were planted in Delhi for seed increase, further screening and crossing purposes. Much of the material was lost before seed set due to salinity and associated factors. Germplasm seed was obtained from Pantnagar to replenish seed stocks and distribute. Small quantities of seed were sent to several locations to replace accessions lost in previous seasons.

Preliminary agronomic and disease evaluation data from Pantnagar, Hissar and Delhi are being assembled in a catalogue of chickpea data.

Diseases are at present the major limiting factors in chickpea production. Either gram blight caused by Ascochyta rabiei or gram wilt caused by a complex of probably several pathogens and environmental factors, reduce yields in most years in the major chickpea areas of India, Pakistan, and other countries. As a result of screening of the germplasm definite resistance to blight has been found (Accession No.12-074-06625, a black-seeded variety from Israel). During three years of field screening for gram wilt by breeders at the Hissar Agricultural University in Haryana some ten lines appear to have consistent field resistance at least at that location. These lines are now being tested at other locations.

Differences in survival and vigor between lines when grown under saline conditions have been observed.

Resistance to insect attack has been noted both in field and in storage (see Entomology section).

As a result of a recommendation made in the 1969 Workshop and breeders meeting to decentralize the work on the various pulse crops, bulk crosses are to be made in the 1969/70 season at Pantnagar, U.P., and Hissar, Haryana, and segregating material made available to interested breeders.

Chickpea crosses were made in Delhi in 1968/69 to incorporate disease resistance and improved yield using the following varieties and strains: NP 58, G 24, Gwalior 2, BG 482, Dohad Yellow, RS 10 and 12-074-06625. All crosses were harvested and advanced a generation at Simla by Dr. Jeswani. The F_2 generation is being grown at Delhi during the 1969-70 rabi season. A complete listing of successful crosses is not available, but 12-074-06625 was successfully crossed to NP 58 and RS 10.

Four parent diallel was made as part of a PhD thesis research to study the inheritance of yield components, protein, tryptophane and sulfur containing amino acids. The four parents selected were P-1713, P-3662, NP-58 and RS 10. The crosses were made in 1968-69 rabi, advanced a generation at Karaj, Iran, during summer 1969 and the F_2 planted at IARI, New Delhi, in 1969-70 rabi season.

An adaptability study using 35 strains with three irrigation and fertility treatments is being grown at four locations. A mutation study has been started including two rates of E.M.S. and gamma rays administered to varieties Pb 7, P 519 and P 6625. Disease resistance, seed coat color, seeds per plant and certain plant structure characteristics are of interest. These studies form part of Ph.D thesis research.

Lentils (Lens esculenta)

Seed of the lentil collection was received from Ludhiana to replenish seed stock. Germplasm sets were sent to Kanpur and Jabalpur for multiplication and evaluation.

Khesari (Lathyrus sativus)

The germplasm was grown at Delhi in Rabi 1968-69. Selections were made in low and high neurotoxin lines. A diallel cross was initiated using the following lines: P-10-1, P-10, P-17, P-105, (low neurotoxin) P-24 and P-648. F_1 seed was sent to Iran to advance one generation. None of the F_1 plants emerged after planting. Another set of F_1 seeds has been planted at IARI during rabi 1969-70.

With a good crop in 1968-69, seed of Lathyrus should be in good supply. The Lathyrus program has been taken over by a P.L.480 project. With the available material and knowledge, progress can be expected in a short time.

Peas (Pisum sativum)

The pea germplasm has been sent to Kanpur, U.P., where most of the peas of India are grown. The pea germplasm has been grown at Delhi by IARI entomologists to screen for insect resistance.

Pigeon peas (Cajanus cajan)

Seed from the 1968-69 crop was obtained from Jabalpur, (M.P.) and Varanasi, (U.P.). The material from Varanasi was a more complete set and was used for protein analysis. The remaining seed was used to replenish seed stocks.

The 579 accession, maturing in less than 170 days, were sent to Hissar and Pantnagar for seed increase and evaluation. Dr. Patel of IARI obtained representative set of 949 accession to test for blight resistance. The material not previously sent to Uganda was sent to Kampala. A collection of 938 accessions representing the variability present was sent to Puerto Rico at the request of Dr. Abrams. Missing accessions lost in the previous season were furnished to Jabalpur, M.P., (748 accessions) and Kanpur U.P., (167 accessions) to complete their collections. T-21 an early maturing variety from U.P. was furnished to several institutions requesting seed for evaluation of early maturing pigeonpea as a possible crop.

The entire germplasm collection was again planted at Jabalpur. At Varanasi in 1968-69 selections were made from each accession. These selections ranging from single plants to entire rows were planted again in the same location in 1969-70.

At Hyderabad, (A.P.) accessions low in seed supply, new accessions, and accessions selected to represent the range in variability were planted. The germplasm material was abandoned due to poor growth and loss of plants presumably caused by nematodes.

Accessions low in seed supply, promising selections and varieties were planted at Delhi and screened for Phythophtora stemblight resistance. The results are reported in the pathology section.

Natural crossing in Cajanus has been reported to be 5% to 20%. The extent of outcrossing has a bearing on germplasm maintenance, variety improvement and variety maintenance. With these factors in mind a natural crossing experiment was planted in Hyderabad and Delhi. The experiment in Hyderabad was abandoned due to reduction in personnel. The Delhi experiment has not been completed.

Crossing blocks were planted, but no crosses have been made. Three early maturing selections were included in the coordinated yield trial.

Mungbeans (Phaseolus aureus)

The germplasm was transferred from Iran again and multiplied in Delhi. The previous germplasm collection was divided into two sets. One set was kept for storage and the other set was sent to Ludhiana. Early maturing selections made in 1968 for the short summer season were grown in Ludhiana and New Delhi. Hail destroyed this material in Ludhiana.

A mutation study was continued in Delhi with 3 varieties, two rates of E.M.S. and two rates of gamma radiation. The M_2 generation was grown and M_3 seed harvested for further evaluation.

Urdbeans (Phaseolus mungo)

During previous seasons the Delhi location proved to be quite unsuitable for maintainance of urd germplasm due to disease and other factors. In the 1969 workshop it was decided to maintain the urd germplasm at Jabalpur. One set of the remaining urd germplasm was sent to Jabalpur for multiplication and evaluation. Some of the germplasm was also grown again at Delhi.

Cowpeas (Vigna sinensis)

443 accessions were grown at Delhi to replenish seed supplies. Selections made in 1968 Kharif were increased and evaluated for earliness, vigor, seed/pod, and seed size.

All-India Coordinated Yield Trials:

The staff of the All-India Coordinated Pulse Project have assumed the full responsibility for the conduct of these trials. Varieties and locations are decided during the annual workshop and the breeder's conference. The yield data and other pertinent information are to be sent to the project coordinator at IARI, New Delhi, for analysis. The following tables give some of the yield data obtained. They show the variations not only between locations but also among varieties within tests. Some of this is due to true varietal performance but much of it is caused by inadequate testing facilities, lack of crop management, poor stands, insect damage, severe disease incidence, etc.

Papers and Publications:

- Progress in collection, introduction and evaluation germplasm of pulse crops, K.H. Evans, Proceedings 3rd Annual Pulses Workshop, New Delhi, 1969.

- Progress of work on pulses at IARI Regional Research Center, Rajindernagar, Hyderabad, V.R. Gadwal, Proc. 3rd Annual Pulses Workshop, New Delhi, 1969.

- Red Gram germplasm, V.R. Gadwal. Proc. 3rd Annual Pulse Workshop, New Delhi, 1969.

- World germplasm collection of pulses and its utilization in crop improvement, R.K.Jayprakash, Proc. 2nd annual symposium on New Research Trends in Agriculture. Kanpur, 1969.

- Increasing the yield of Pulse Crops. P.H. van Schaik. Indian Science Congress, Bombay January 3-9, 1969.

- The latest in Pulse Crops - P.H. van Schaik. Seed Specialist Seminar, New Delhi, April 8-11, 1969.

- Germplasm Collection, Pigeon Peas (Cajanus cajan), USAID/Agriculture, RPIP, New Delhi, India, 1969.

Table 66. Yield in kilograms per hectare, lentil coordinated yield trial, India, rabi 1968/69

Variety Name	Origin	Punjab One location	Uttar Pradesh Seven locations	Rajasthan One location	Bihar Two locations	Assam One location
L-9-12	Punjab	2009	1545	497	1348	832
T 3	Punjab	1979	1504	609	1485	574
T 8	U.P.	1740	1315	881	1361	351
T 36	U.P.	1991	1511	769	1507	931
N.P. 11	IARI	1991	1020	625	1585	884
N.P. 47	IARI	724	1066	977	1211	1133
Pusa 1-1	IARI	-*	1844	769	1495	975
B 25	Bihar	1902	1481	621	1675	943
B 62	Bihar	-	1054	-	-	1072
B 77	Bihar	1160	1258	1137	1211	1199
C 31	W.Bengal	1447	1286	1233	1555	1117

Table 67. Yield in kilograms per hectare, pea coordinated yield trial, India, rabi 1968/69

Variety Name	Origin	Punjab One Location	U.P. Six Locations	Rajasthan One Location	Madhya Pradesh two Locations	Bihar One Location	Assam One Location	Andhra Pradesh One Locations.
Kanpur Sel.6115	U.P.	2184	2552	1969	1404	2153	- *	1888
T 19	U.P.	2139	1560	1894	1367	1917	268	2109
T 56	U.P.	1175	1710	1633	1240	1996	267	1266
T 61	U.P.	2278	1620	2526	1751	1794	288	2365
T 163	U.P.	2207	2526	2295	1475	2445	510	2180
T 6113	U.P.	1839	2556	2197	1822	2512	540	2458
BR.12	Bihar	2099	2199	-	1305	1794	-	2474
Patna queen		2251	2081	-	1466	-	-	1616
Early December		529	1280	132	1323	722	155	1[illegible]4
Boneville		1758	1009	1960	1481	1059	-	22[illegible]0

* No yield reported

Table 68. Yield in kilograms per hectare, rainfed chickpea coordinated yield trial, India, rabi 1968/69.

Variety Name	Origin	Uttar Pradesh: Three location	Rajasthan: Two location	Bihar: One location	Andhra Pradesh: One location	Mysore: Two location	Tamil Nadu: One location
B.G. 482	A.P.	931	1595	1301	1888	840	253
Chaffa	Gujrat	1196	910	1301	1967	-*	-
Gwalior 2	M.P.	1417	1913	1615	-	925	241
G 62-404	M.P.	1370	1665	1570	1839	995	577
S.T. 4	Bihar	1442	1857	1570	1872	517	327
B.R. 77	Bihar	1589	1624	1659	1455	620	37
R.S. 10	Rajasthan	1274	1614	1525	1144	448	46
R.S. 11	Rajasthan	1563	1677	1435	1203	760	130
Pb 7	Punjab	1536	1793	1435	1166	586	25
C 235	Punjab	1672	1846	1659	1659	684	198
G 24	Punjab	1765	1884	2063	-	601	34
S 26	Punjab	1874	1666	1973	780	445	99
N.P. 58	IARI	1102	1911	1570	961	375	160
T 1	U.P.	1200	1766	1435	-	711	213
T 2	U.P.	1346	1681	1435	1341	798	287
G 736-1	U.P.	1479	2122	1615	-	775	139
G 742-7	U.P.	1413	2140	1525	1495	696	284
B 98	U.P.	1491	1474	1704	-	488	80

* No yield reported

Table 69. Yield in kilograms per hectare, Irrigated chickpea coordinated yield trial, India, rabi, 1968/69.

Varieties Name	Origin	Punjab One location	Uttar Pradesh Five location	Rajasthan One location	Madhya Pradesh Two location	Bihar One location	Maharashtra Two location	Gujrat Two location	Andhra Pradesh One location	Mean
B.G. 482	A.P.	639	2073	1038	756	302	1537	1314	1510	1409
Chaffa	Gujarat	- *	2090	-	817	336	-	1523	1816	1576
Gwalior 2	M.P.	1065	2118	2019	689	505	1657	1570	1861	1600
G 62-404	M.P.	1536	2297	2142	822	471	1828	1660	2018	1756
S.T. 4	Bihar	1144	2266	2123	825	389	1548	1419	1779	1628
B.R. 77	Bihar	729	2195	2133	726	511	1198	1292	1540	1493
R.S. 10	Rajasthan	639	2141	2432	793	359	1204	1106	1495	1461
R.S. 11	Rajasthan	594	2106	2246	845	538	1187	1216	1450	1462
Pb 7	Punjab	1099	2383	1897	613	493	1124	1276	1271	1518
C 235	Punjab	1648	2743	2681	740	418	1276	1558	1801	1833
G 24	Punjab	1076	2350	2049	662	202	1111	1223	1600	1516
S 26	Punjab	1200	2303	2122	620	516	1192	1157	1824	1512
N.P. 58	IARI	886	2195	2202	735	493	1208	1417	1988	1555
T 1	U.P.	695	2180	1775	846	256	1803	1499	1779	1584
T 2	U.P.	762	2283	1882	640	314	1152	1557	1757	1606
G 736-1	U.P.	998	2342	1792	723	457	1452	1573	1837	1624
G 742-7	U.P.	1592	2214	1744	931	336	1641	1686	1973	1687
B 98	W. Bengal	1020	2174	2197	662	538	1129	1060	1037	1359

* No yield reported.

Table 70 . Yield in kilograms per hectare, Mungbean coordinated yield trials, India, summer, 1969.

Variety Name	Origin	Himachal Pradesh One Location	Haryana One Location	U.P. Two Locations	Bihar Three Locations	West Bengal One Location	Madhya Pradesh One Location	Orissa One Location	Madras One Location
Shining Moong	Punjab	*	336	154	747	369	-	461	1012
T 1	U.P.	374	841	521	868	972	541	731	984
T 2	U.P.	299	729	299	536	859	148	700	936
T 44	U.P.	448	799	619	788	954	294	785	999
T 51	U.P.	329	561	331	577	616	107	938	833
Pusa Baisakhi	IARI	269	897	364	717	808	489	961	986
B.1	W.Bengal	239	505	474	764	988	521	692	659
Hyb.45	M.P.	807	1205	281	872	747	-	613	811
Krishna-11	A.P.	688	406	47	725	736	515	515	959
Khargaon-1	M.P.	987	561	-	961	527	208	-	1233
Kopargaon	Mahar.	807	308	96	975	571	129	1006	1055
Jalgaon-78	Mahar.	837	785	118	942	885	-	410	1122

* No yield reported

Table 71. Yield in kilograms per hectare, medium maturing mungbean coordinated yield trials, India, kharif, 1969.

Variety Name	Origin	Punjab One Location	Haryana One Location	U.P. Two Locations	Bihar Two Locations	Madhya Pradesh Four Locations	Gujarat Two Locations	Mysore One Location	Andhra Pradesh One Location
No. 305	Punjab	363	1542	449	731	576	408	554	487
No. 54	Punjab	307	2271	217	374	645	443	- *	500
L.24-2	Punjab	194	1710	385	895	436	244	426	325
RS.4	Rajas.	190	1458	140	307	538	412	376	124
T51	U.P.	699	2523	962	403	903	642	-	418
N.P.18	IARI	746	1275	365	322	489	489	-	-
N.P.23	IARI	-	-	-	345	-	-	-	-
MG.636		-	179	202	415	87	64	-	-
Hyb.45	M.P.	474	2097	804	276	861	770	443	529
D.45-6	Gujrat	217	2299	365	309	611	634	324	555
525		611	1850	509	479	753	740	314	784
BR-2	Bihar	-	-	-	630	-	-	709	-

* No yield reported

Table 72. Yield in kilogram per hectare, early maturing Mungbean coordinated yield trials, India, Kharif, 1969.

Variety Name	Origin	Punjab One location	Rajasthan One loeation	U.P. Four location	Bihar Two location	W.Bengal Two location	Orissa One location	M.P. Two location	Maharashtra 4 location	Gujarat Three location	Mysore One location	Tamilnadu One location
Shining Moong	Punjab	198	95	313	591	178	558	778	1096	533	409	957
T.1	U.P.	577	178	941	749	943	1157	807	1319	685	432	888
T.2	U.P.	372	113	910	488	737	686	711	1228	585	558	940
T.44	U.P.	484	368	845	735	1222	1174	853	1286	745	524	955
T.51	U.P.	394	266	833	560	652	584	715	1176	462	866	854
Pusa Baisakhi	IARI	558	437	860	723	869	1256	714	1306	534	398	975
B.1	W. Bengal	411	106	592	658	812	773	499	867	426	499	1020
Hyb.45	M.P.	280	93	878	444	295	842	741	684	725	631	981
Krishna-11	A.P.	340	86	548	626	430	706	800	1165	557	541	998
Khargaon-1	M.P.	203	237	455	535	362	384	761	1103	488	455	1061
Kopargaon	Maharashtra	421	85	849	471	484	808	680	1197	382	566	1054
Jalgaon-781	Maharashtra	86	80	343	- *	180	537	670	971	476	524	798

* No yield reported

Table 73 Yield in kilograms per hectare, Urdbean coordinated yield trials, India, Kharif, 1969.

Variety Name	Origin	Haryana One location	Rajasthan One location	U.P. Five locations	Bihar Three locations	W. Bengal Two locations	M.P. Three locations	Maharashtra Three locations	Gujarat Three locations	Mysore One location
No. 1-1	Punjab	2803	549	1138	616	474	1109	735	970	530
Mash 48	Punjab	2158	768	1166	815	293	1111	772	1001	659
Mash 35-5	Punjab	2411	910	1096	650	637	1066	804	994	1004
Mash 41-13	Punjab	2635	412	981	835	370	1077	660	960	670
Mash 64	Punjab	2276	797	909	625	582	956	924	1022	572
T-9	U.P.	-*	593	1109	1408	1517	1033	1176	1330	701
T-27	U.P.	2242	-	788	805	746	588	539	602	617
T-65	U.P.	-	-	862	572	715	255	483	690	639
Khargaon-3	M.P.	1990	837	130	747	176	794	1373	1215	824
No.55	Maharashtra	2214	738	125	1096	47	1149	1346	1338	1455
Sindhkheda	Maharashtra	2147	1089	93	822	537	828	1321	1194	1479
D 6-7	Maharashtra	2060	910	167	897	-	775	1205	1071	950
T-122				263	168	-	-	725	191	59
CO.1		687	·302	76	334	-	424	432	601	454

* No yield reported

SOIL AND CROP MANAGEMENT

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SUMMARY

A book "Plans for conducting Agronomic Experiments with Pulse Crops" was prepared by the RPIP and AICPP staffs. It outlines in some detail the procedures for conducting agronomic trials, particularly for those whose primary training is not in agronomy.

Rabi 1968/69

Spacing experiments in which spacing between rows and between plants within the row were varied at three levels of fertilizer application and fertility experiments in which three levels each of N, P and K and rhizobia inoculation combined factorially were conducted at six locations.

Spacing experiments

The entire crop at Delhi and Varanasi was lost to salinity of soil and irrigation water.

At Hissar, there were no treatment effects. However, effects could have been masked due to shattering loss.

At Hyderabad, the crop was extremely good throughout the season with Var. T-3, Var. T-2 looked good until late in the season when it was moderately affected by root rot.

At Kanpur, the trial had to be abandoned because of poor stand.

At Pantnagar, 20 cm. between row spacing was better than 30 cm. row spacing in lentils (*Lens esculenta*). There was no response beyond 50 kg/ha each of N and P and 25 kg/ha. of K. 200,000 plants per hectare with a row spacing of 20 cm. gave the highest yield of lentils (2516 kg/ha).

Field peas (*Pisum sativum*) were planted at Hissar, Pantnagar and Varanasi. At Pantnagar, no useful data could be collected due to lack of sufficient plant population. At Varanasi, the crop was lost apparently due to salinity. At Hissar, there were no differences due to treatments, yields ranging from 2150 to 2662 kg/ha.

Fertility-Inoculum experiments

With chickpeas (Cicer arietinum), at Hissar, a linear response was obtained with increasing levels of P from 0 to 100 kg/ha., yields ranging from 2194 to 2496 kg/ha. At Hyderabad, potash alone had a depressing effect on the yield of chickpea, Var. T-2 (1148 kg/ha). If, however, applied with P, it has additive effect up to 50 kg/ha each of P and K (1585 kg/ha).

Lentils (Lens esculenta) were planted at two locations. At Delhi, residual effect of 100 kg. P_2O_5/ha. applied to previous crop of pigeon pea resulted in the highest yield of lentils (984 kg/ha).

At Hissar, with field peas (Pisum sativum) a linear response was obtained with increasing levels of P from 0 to 100 kg/ha., yields ranging from 2800 to 3287 kg/ha.

In chemical weed control trial at Delhi, Treflan at 0.5 lb/ac., Treflan + Eptam at 0.5 + 2.0 lb/ac. and Tok E -25 at 4 lb/ac. did not cause any injury to chickpea. Among the herbicides tested, Treflan, Eptam and Tok E -25 were found to be promising.

Summer 1969 (March-June)

In the 1969 summer, two varieties of mungbeans (Phaseolus aureus) were used in an experiment with varying between row and within row spacings at three levels of fertilizer application. Stand and growth was good. A fertility level of 50 kg/ha. yielded significantly higher (673 kg/ha) than no fertilizer (635 kg/ha). Among different within row spacings 2.5 cm. spacing has yielded significantly higher (683 kg/ha) than either 5.0 cm. (649 kg/ha) or 7.5 cm. (643 kg/ha) spacing. With var. Type-1, 30 cm. between row spacing was better than 20 cm. between row spacing, while with var. Pusa Baisakhi, 20 cm. between row spacing was better than 30 cm. between row spacing. This might be due to differential plant types in these two varieties.

In dates of planting trial, mid-April planting was found to be better than either March or early May plantings.

In fertilizer trial with mungbeans (var. Pusa Baisakhi), 25 kg N plus 66 kg P_2O_5/ha. yielded significantly higher (1326 kg/ha) than control (417 kg/ha).

In an irrigation experiment with mungbeans (var. Pusa Baisakhi) irrigation at 50 percent available moisture (two irrigations) yielded 981 kg/ha. as compared to 448 kg/ha. with no post-planting irrigation.

Kharif, 1969

In the 1969 Kharif season, spacing fertility trials and fertility-inoculation trials as described under rabi season were conducted on mungbean (Phaseolus aureus), uridbean (Phaseolus mungo) and pigeon pea (Cajanus cajan).

At Delhi, growth and yield were good in mungbean and Uridbean. At Hissar, the growth was poor and yields low. Trials at Kanpur were completely wiped out due to excessive and heavy rains. At Ludhiana, the problem of establishing a stand, encountered last season, was eliminated by the use of a soil fumigent and nematicide. At Varanasi, yields were poor.

Experiments with pigeon pea were conducted in the frost free (long and short term varieties) and frost danger zones (short term variety). Long term varieties are still in field and no date are reported here. At Hyderabad, the growth and yield in short term variety T-21 were poor. At Kanpur, the crop was lost due to waterlogging.

A date of planting trial was conducted at four locations. It had been noted in 1968 that early plantings of this variety made much more growth, the variety being photoperiodic causing early plantings to come into flower at about the same time as later ones. Data showed that the further south one goes the more severe the reduction in yield, caused by delayed planting is. Low yields at Jabalpur were caused by heavy rains.

In chemical weed control trial at Delhi, Treflan + Eptam at 0.5 + 1.0 lb/ac., and Treflan + Lasso at 0.5 + 2.5 lb/ac. and 1.0 + 5.0 lb/ac. were most effective in reducing weed infestation. The crop, however, was lost to disease at a later stage.

An experiment was conducted on the foliar application of phosphate fertilization with urdbeans (var. T-65) and pigeon pea (var. T-21). No data could be collected because of disease infestation in both the crops.

An experiment was conducted to evaluate the effect of flat sowing and ridge sowing on yield of urdbeans and pigeonpea. Under the conditions of the experiment, ridging gave higher yields than sowing on flat in both crops.

Rabi, 1969/70

Experiments were conducted at four locations during the rabi 1969-70 season. Spacing experiments in which spacing between rows and between plants within the row were varied at three levels of fertilizer application and fertility experiments in which three levels of N, P and K and rhizobia inoculation combined factorially were conducted at all the locations. The experiments were conducted with Chickpea (Cicer arietinum) at Hissar, Kanpur

and Varanasi. The crop is still in the field and no data could be collected. A fertility-inoculation experiment was conducted with Lentils (Lens esculenta) at Ludhiana. Besides, a dates of planting trial was conducted with lentils at Ludhiana, planting dates varying from October 15, thru December 10 coupled with levels of P. The crop is still in the field and no data could be collected.

Environmental Studies

A project on environmental studies on plant growth was initiated with the following objectives -

(a) Collection and recording as much environmental information as possible in the pulse experimental plots and obtaining other data from available sources.

(b) Constant surveillance of the crops for any abnormalities and attempting to correlate these with the environmental data collected.

(c) Judicious modification of the environment where possible in the field.

(d) Data on germination of seeds under saline condition was recorded.

The following papers were either presented or published by mbers of the Soil and Crop Management discipline during 1969-70.

Chowdhury, S.L., Davis, R.J., et. al. (1969) Plans for conducting agronomic experiments with pulse crops. USAID/Agriculture, New Delhi, India, 1969.

Chowdhury, S.L., (1969). Pulse Crops Are More Productive than you think. Ind. Fmg. XIX (6) : 23-25.

Bains, S.S., and Chowdhury, S.L.(1969). A strategy for Planning and Production of Crops on Rain-fed lands. Submitted for publication in Souvenir volume of the National Tonnage Club of Farmers (India).

Bains, S.S., and Chowdhury, S.L. (1969). Managing Soils on the Rain-fed Lands. Sent for publication in Indian Farming.

Bains, S.S., and Chowdhury, S.L. (1969). Managing Crops on the Rain-fed Lands. Sent for publication in Indian Farming.

Chowdhury, S.L., (1969). Improved Agronomic Practices For Raising Yields of Pulse Crops in India. Accepted for publication in Food Farming and Agriculture.

Singh, Ranbir and Chowdhury, S.L. (1969). Chemical Weed Control in Rabi Pulse Crops. Accepted for publication in the Indian Journal of Agronomy.

Chowdhury, S.L., (1969). Summerisation of Agronomic Research Work on Pulse Crops during 1967-68. Paper read at the Third Annual Workshop Conference on Pulse Crops, 3-5 February, 1969.

Chowdhury, S.L., Davis, R.J. and Bhatia, P.C., (1969). Results of Trials on Pigeon pea. Ibid.

Sharma, B.M., Chowdhury, S.L. and Bhatia, P.C. Effect of Ridge Planting and Inter-plant spacing on the performance of pigeon pea, urid beans and mung beans. Ibid.

Davis, R.J. and Saraf, C.S. (1969). Agronomic aspects in increasing pulse crop production in India. Paper presented at the 56th Session of the Indian Science Congress, Powai, Bombay, 1969.

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Clapp, C.E. and Davis, R.J. (1969). Properties of Extra cellular polysaccharides from Rhizobium. Soil Structure Laboratory, University of Minnesota, St. Paul. Paper No.6913, Scientific Journal Service, Accepted for publication in Soil Biology and Biochemistry.

Saraf, C.S. and Dastane, N.G. (1969). Water Use patterns in maize-cowpea mixtures under varying fertility conditions. Paper presented at the Seminar on Pulse Crops held at the University of Tehran, Iran, January, 1969.

Saraf, C.S. and Dastane, N.G. (1969). Role of advective energy in water use by crops - A Review. Paper presented at the Second Symposium on "New Research Trends in Agriculture" held at Kanpur, India, February, 1969.

Saraf, C.S. and Dastane, N.G. (1969) Role of advective energy in water use by crops. A Review. Paper Accepted for publication in the Indian Journal of Agronomy, New Delhi.

Saraf, C.S. and Dastane, N.G. (1969). Crop planning in relation to wind direction. Paper accepted for publication in the Indian Journal of Agronomy, New Delhi.

Saraf, C.S. and Dastane, N.G. (1969). Use mini-shelter belts for reducing advection effects. Paper accepted for publication in "Krishak Samachar", New Delhi.

Saraf, C.S. (1969). Results of All India Coordinated agronomic trials - Spring and Kharif, 1968. Paper presented at the Third Annual Workshop Conference on pulse crops held at I.A.R.I., New Delhi.

Saraf, C.S. and Davis, R.J. (1969). Water Management for Pulses. Paper presented at the Symposium on water Management held at Haryana Agricultural University, Hissar, March, 1969.

Saraf, C.S. and Dastane, N.G. (1970). Moisture extraction patterns under shallow and deep rooted crops grown singly & mixed. Paper sent for publication in the Indian Journal of Agronomy, New Delhi.

Kapoor, S.N. (1969). Agronomy work during rabi, 1967-68. Paper presented at the Third Annual Workshop Conference on Pulse Crops held at I.A.R.I., New Delhi.

Sharma, B.M. (1969). A note on the effect of sowing dates, seed rates and spacings on the grain yield of black gram (Phaseolus mungo). Ind. J. Agron. XIV, (3), 1969.

Sharma, B.M. (1969). Response of lentil to N,P and K fertilization. Accepted in Ind. J. Agri. Sci.

Sharma, B.M. (1969). Effect of dates of sowing, spacing and seed rates on the performance of black gram (Phaseolus mungo). Accepted in Ind. Agrist.

Sharma, B.M. (1969). Influence of sowing dates and seed rates on the performance of lentil (Lens esculenta). Sent to Ind. J. Agron.

Tilak Raj and Sharma, B.M. (1969). Response of rainfed Til to levels and methods of nitrogen application. Sent to Ind. J. Agri. Sci.

Tilak Raj and Sharma, B.M. (1969). Effect of sowing dates, spacings and levels of nitrogen application on the grain yield of Til in dry farming areas. Sent to Ind. J. Agron.

Rabi, 1968-69

During rabi 1968-69, the soil and crop management program included studies on fertilization, plant spacing, rhizobial inoculation and weed control. The work was done at Delhi, Hissar, Hyderabad, Kanpur, Pantnagar and Varanasi.

A. Fertility-spacing experiments:

1. Chick pea (*Cicer arietinum*)

In the rabi season (1968-69) a fertilization-spacing experiment on chickpea (*Cicer arietinum*) was planted at Delhi, (Var. T-2 and K-4 and K-5), Hissar (Var.T-1 and G-24), Hyderabad (Var. T-2 and T-3), Kanpur (T-1 and K-4) and Varanasi (Var.T-3). The experiment consisted of three between row spacings (25 cm., 37.5 cm. and 50 cm.) three plant spacings within rows (5 cm., 7.5 cm., and 10 cm.) and three levels of fertility (N,P and K at the rate of 0, 50 and 100 kilogram per hectare). A split plot design was used with fertility levels as main plot treatments and between and within row spacings as sub plot treatments. All the treatments were replicated four times. Fertilizer was broadcast and worked in before planting. All plantings were completed in October. Harvesting and threshing operation from mid-March to late April. The crop at Delhi was lost due to salinity of soil and irrigation water. Samples of soil and irrigation water were collected from various spots in the field and analysed in the I.A.R.I., Soil testing laboratory. The results are presented in Table 74.

Table 74. Results of Soil Tests.

Sample No. (Dept.-0-15cm)	Soil reaction (pH)	Soluble salts (E.C.) m.mhos/cm (1:2 ratio)	Org. matter Org.C %	$CaCo_3$
1 (Soil sample)	7.5	0.5	0.46	Nil
2	8.2	1.3	0.23	Slight
3	7.6	0.65	0.17	Nil
4	8.4	1.8	0.27	High
5 (Irrigation water)	7.4	2.6	-	-

Analysis of soil samples from Delhi field, which had been recently levelled, shows that conductivity of area exclusive of white spots is 0.5 and of white spots 1.8. Salinity Hand book No.60 indicates that conductivity below 2 is generally suitable for crop growth but for chickpea, it is considered to be a danger zone.

Analysis further shows that tube-well irrigation water has E.C. of 2.6. According to Salinity Handbook No. 60, E.C. above 2.2 is highly saline and water should be used with great care. The land assigned to the Project for this experiment was made available late after the optimal time for planting. It was said to be good land without salinity problems. The soil was a fine pulverised dry sand and had to be irrigated liberally for planting and germination of the crop. As it turned out, the incipient soil salinity plus that from irrigation water proved too much for this crop which died away after some growth.

A. Hyderabad

At Hyderabad varieties T-2 and T-3 of chick pea from U.P. were grown. The crop was very good but late in the season T-2 was hit by a root rot. No treatment effects were found with var. T-2, perhaps because of the desease problems. With T-3, however, the effects due to row and plant spacings were highly significant. These data are presented in Table 75 . and Fig. 20 .

Table 75. Effects due to different between row and within row spacings on yield of chickpea (Var. T-3) at Hyderabad, Rabi, 1968-69.

Between row spacing (cm)	Within row spacing (cm)	Yield of chickpea (kg/ha)
25	5	2709 a
25	7.5	2735 a
25	10	2644 abc
37.5	5	2677 a
37.5	7.5	2539 bc
37.5	10	2669 ab
50	5	2334 d
50	7.5	2135 c
50	10	2137 e
	S.Em ±	49
	C.D. 5%	137

Data in Table 75 show that narrow row spacing of 25 cm. and plant to plant spacing of 7.5 cm. has given maximum yield of 2735 kg/ha. as compared to wider spacing of 50 cm. row to row and 7.5 cm. plant to plant (2135kg/ha).

Among different row spacings in 50 cm. spacing the yield was significantly less (2202 kg/ha) as compared to 25 cm. and 37.5 cm. row spacing (2707 and 2628 kg/ha) respectively. Among different plant spacings, there was no significant difference, the highest yield being with 10 cm. (2583 kg/ha).

There was significant interaction between different between and within row spacings and fertility levels. These data are tabulated in Table 76 and are depicted graphically in Fig. 21

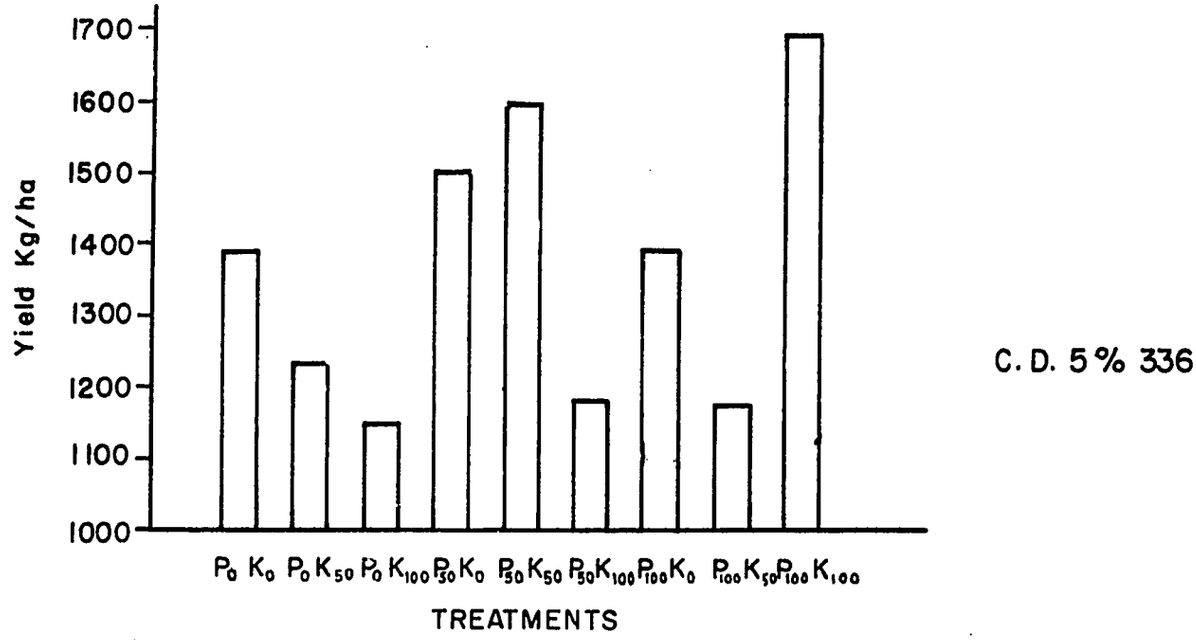

Fig. 20 Interaction effect of different levels of P and K on the yield (Kg/ha) of chick pea (Var T-2) at Hyderabad, Rabi, 1968-68

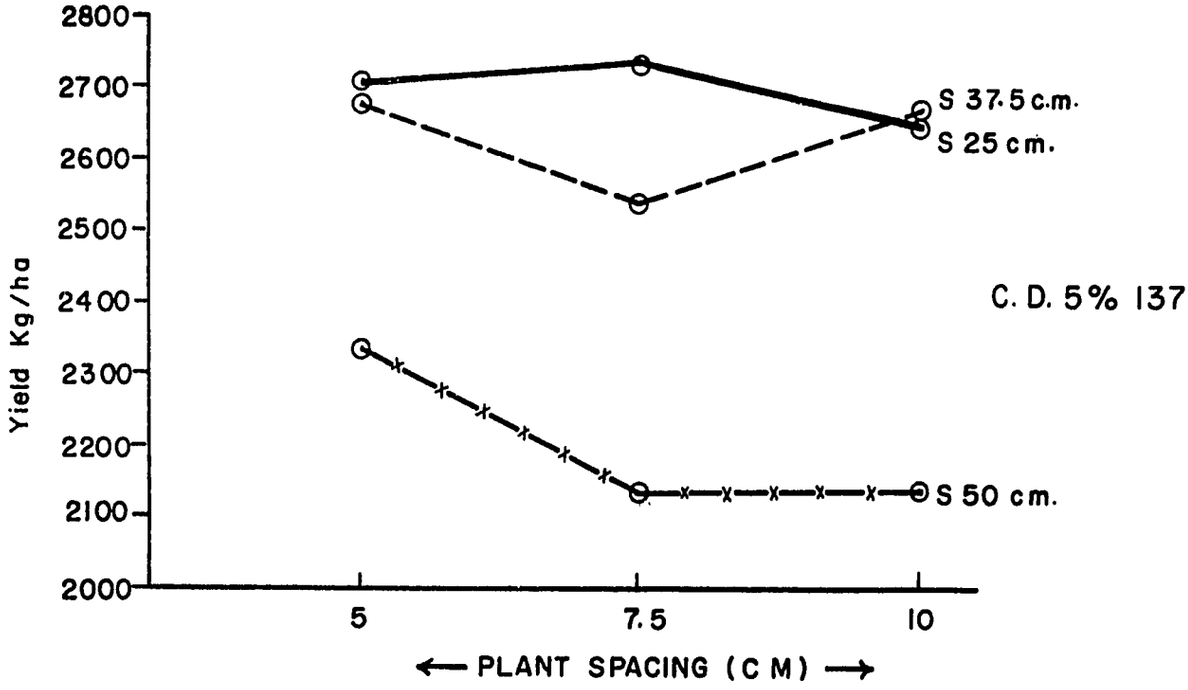

Fig. 20 Effect of different between row and within row spacing (cm.) on the yield of chick pea (Var. T-3) at Hyderabad, Rabi, 1968-69

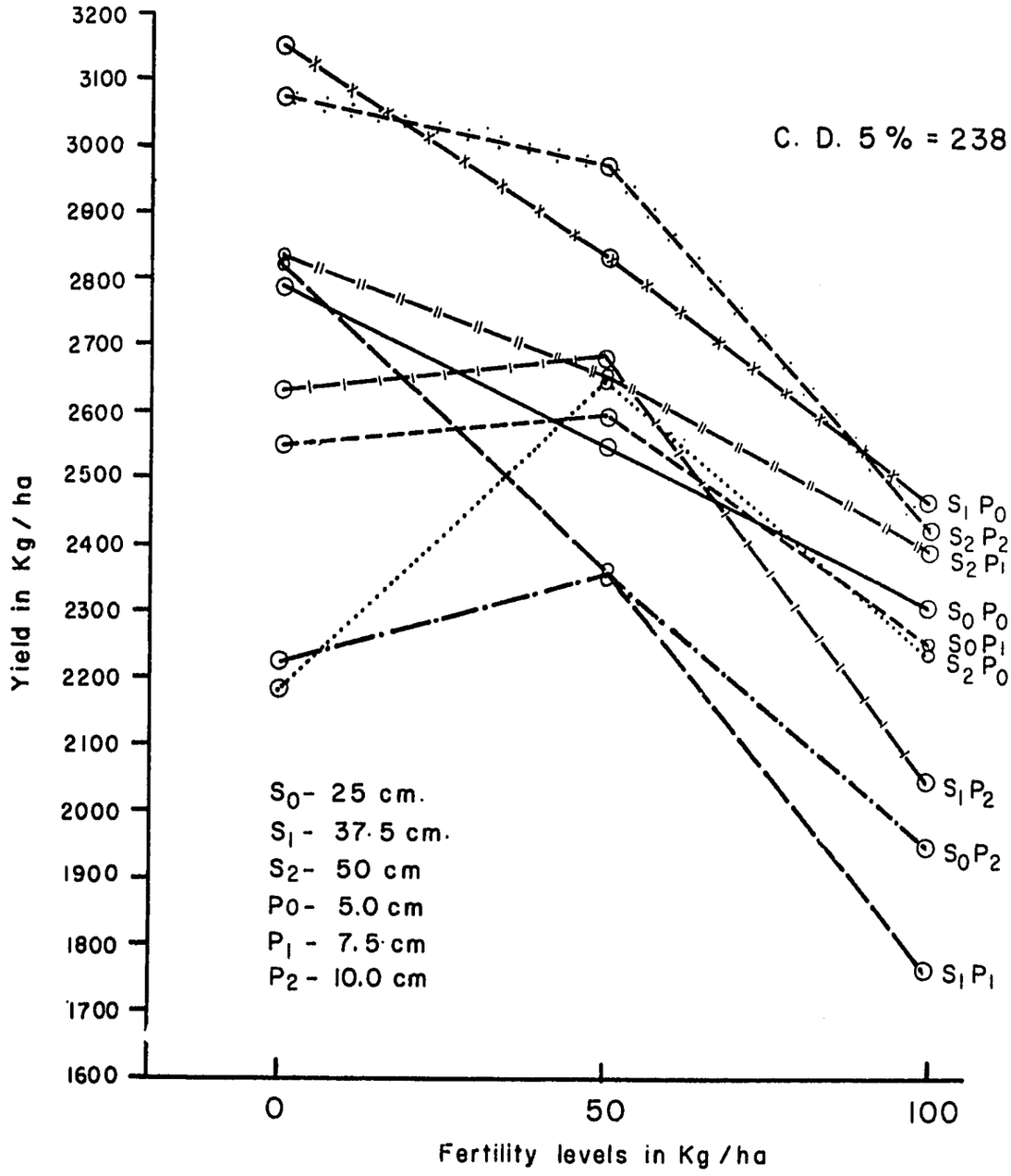

Fig. 21 .Interaction effect of different levels of fertility (Kg / ha) row (S) and plant spacings (P) (cm) on yield (Kg/ha) of gram (Var T-3) at Hyderabad, Rabi 1968-69

Table 76. Effects due to different row and plant spacings and fertility levels on the yield of chickpea (Var. T-3) at Hyderabad during Rabi 1968-69.

Between row spacing (cm)	Within row spacing (cm)	Fertility level (kg./ha) 0	50	100
25	5	2789	2549	2306
25	7.5	2549	2597	2252
25	10	2221	2351	1950
37.5	5	3152	2834	2465
37.5	7.5	2822	2365	1762
37.5	10	2634	2685	2041
50	5	2182	2647	2231
50	7.5	2834	2654	2389
50	10	3076	2970	2420
	S.Em. ± 86			
	C.D. 5% 238			

Data in Table 76 show that there was depressing effect on chickpea yield after 50 kg/ha level in all the treatments. Row spacing of 37.5 cm. with 5 cm. plant to plant spacing with no fertilizer gave the highest yield of 3152 kg/ha. followed by a spacing of 50 cm. within row and 10 cm. within plants with no fertilizer (3076 kg/ha.).

Kanpur

At Deegh Farm (Kanpur), with Kabuli Type-4 there were no treatment effects. Yields ranged from 600 kg/ha to 1425 kg/ha. With Type-3 the trial had to be abandoned because of poor stand.

Varanasi

At Chandauli Farm (Varanasi) with Variety - Type-3, there was no treatment effect. The yields ranged from 1325 kg/ha. to 2050 kg/ha. in different row and plant spacings and from 1512 kg/ha. to 1850 kg/ha in different fertility treatments. Many bad spots appeared in this crop which appeared to be typical salinity - poor germination stunted growth and salts on the surface after harvest of previous kharif crop, although soil samples did not indicate salinity in addition plots on one side of the field remained in a vegetative condition long after the rest was ready for harvest because of seepage of irrigation water from adjacent area.

Hissar

At Hissar, none of the treatment effects were significant. The yields ranged from 2812 kg/ha. to 4212 kg/ha.

2. Lentils (Lens esculenta) (Var. L-9-12)

A fertility plant population experiment with lentils (Var. L-9-12) was conducted at Pantnagar. The treatments comprised of three row spacings (10 cm., 20 cm. and 30 cm.), three fertility levels (No fertilizer, 50 kg/ha. each of N and P_2O_5 and 25 kg/ha. K_2O) and three plant population rates (100,00,00; 150,00,00 and 200,00,00 plants/ha.). The planting was completed on Oct. 13, 1968 and the crop was harvested on April 1, 1969.

The interaction between fertility and row spacing and the interaction between row spacing and plant population were significant. Data are tabulated in Table 72 and presented graphically in Fig. 22 .

Table 77 . Interaction of different fertility levels and between row spacings on the yield of Lentils (Lens esculenta) Pantnagar, Rabi 1968-69.

Between row spacing (cm)	Fertility level (kg/ha.) 0	50	100
10	2344 abcde	2243 de	2529 abc
20	2518 abcd	2199 e	2548 ab
30	2183 e	2672 a	2264 cde

S.Em. ± 100

C.D. 5% 278

Data in Table 77 reveal that a fertility level of 50 kg/ha. each of N, P, K and a row spacing of 30 cm. yielded 2672 kg/ha. of lentils.

Table 78 . Interaction effect due to different row spacings and plant population on the yield of Lentils Lens esculenta during Rabi 1968-69 at Pantnagar.

Row spacing (cm)	Plant population/ha. 100,000	150000	200,000
10	2313	2394	2408
20	2415	2334	2516
30	2364	2446	2309

S.Em. ± 100

C.D. 5% 278

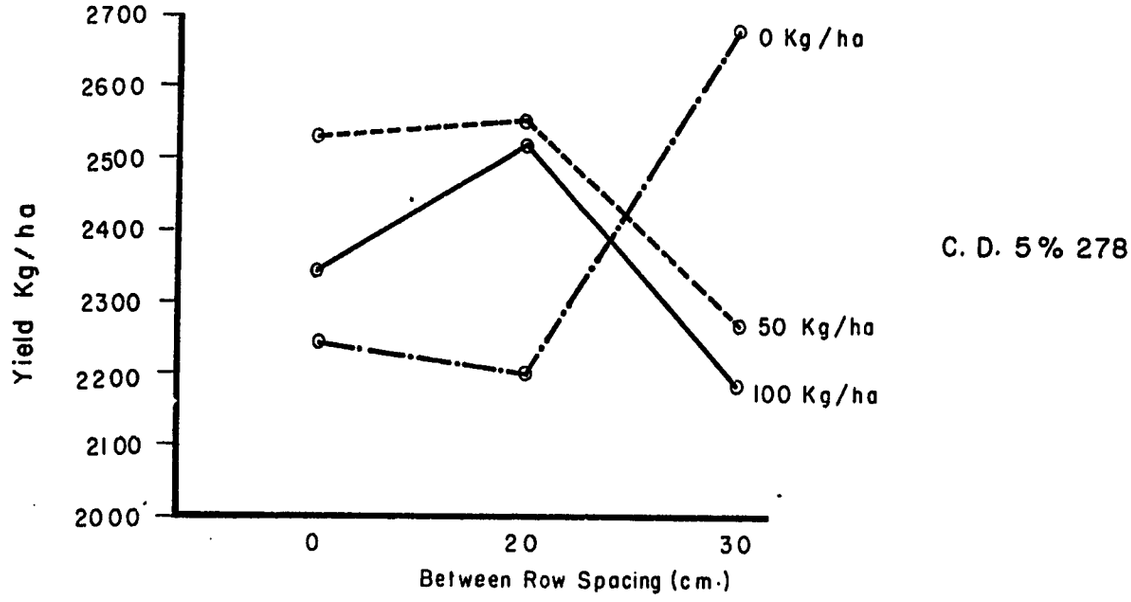

Fig. 22 Interaction effect of different levels of N. P. K (Kg/ha) and row spacings (cm) on the yield (Kg/ha) of Lentils (Lens culinaris) Var. L-9-12 at Pant Nagar, Rabi, 1968-69.

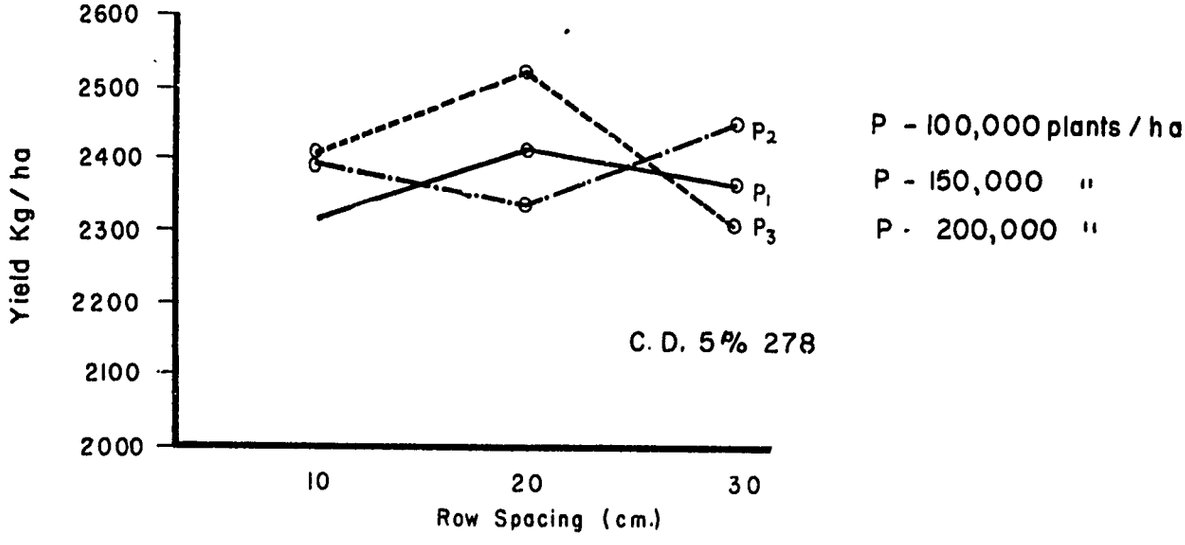

Fig. 22 Interaction effect of different row spacings (cm) and plant populations (100,000) on yield (Kg/ha) of Lentils (Lens culinaris) Var. L-9-12 at Pant Nagar, Rabi, 1968-69.

Data in Table 78 show that a plant population of 200,000 plants per hectare with row spacing of 20 cm. gave the highest yield of 2516 kg/ha. while the same plant population of 200,000 plants per hectare with row spacing of 30 cm. gave only 2309 kg/ha. yield. This low yield may be attributed to too much crowding of plants within the row. These data are graphically presented in Fig. 22.

3. Peas (Pisum sativum) (Var. T-163)

With similar treatments as chickpeas, a fertilization-spacing experiment was conducted at Hissar, Pantnagar and Varanasi. At Pantnagar no useful data could be collected for lack of sufficient plant population. At Varanasi, the crop was lost apparently due to salinity as described under chickpeas.

At Hissar, there were no differences due to treatments, yields ranging from 2150 kg/ha. to 2662 kg/ha. in different treatments.

B. Fertility Inoculum experiments :

A fertility-Inoculum experiments on chickpeas (Cicer arietinum) at Delhi, (Var. T-2 and K-4 and K-5), Hissar, (Var. T-1 and G-24), Hyderabad, (Var. T-2 and T-3), Kanpur, (Var. T-1 and K-4), Varanasi, (Var. T-3); on peas (Pisum sativum) at Hissar, Pantnagar and Varanasi and on Lentils (Lens esculenta) at Pantnagar were conducted during rabi 1968-69. The experiment was a factorial with four levels of nitrogen (0, 50, 100 kg/ha. of actual element) and rhizobial inoculum and three levels of P(0, 50 and 100 kg/ha). A randomised block design was used with four replicates. Fertilizer was broadcast and worked into soil. Plot size used was 4.0 M x 2.0 M. At Kanpur the experiment was duplicated with a "Kabuli" variety of chickpea K-4.

The crop at Delhi was lost due to salinity as described earlier. At other locations, the data were collected and statistically analysed and are interpreted in the following pages.

1. Chickpea (Cicer arietinum)

At Hissar, variety G-24 was used. Effects were found due to different levels of P and then N, P, K interaction. The results are presented in Table 79.

Table 79. Effects due to different levels of P on the yield (kg/ha) of chickpea (Cicer arietinum) at Hissar, during Rabi 1968-69.

Levels of P (kg/ha)	Yield (kg/ha)
0	2194 a
50	2266 ab
100	2496 a
S.Em. ±	70
C.D. 5%	194

Data in Table 79 show that chickpea yields increased linearly with increasing levels of P. These data are also graphically presented in Fig. 23.

N P K interaction was also significant, yields ranging from 1875 to 2900 kg/ha.

Kanpur

At Kanpur, with chickpea (Cicer arietinum) variety T-1 from U.P., there was interaction between NK and NPK. The data are presented in Table 80.

Table 80. Interaction due to different levels of N and K on yield (kg/ha) of chickpea (Cicer arietinum) Var. T-1 at Kanpur, Rabi 1968-69.

Levels of K (kg/ha)	Levels of N (kg/ha)			
	0	50	100	Inoculum
0	3425 ab	3475 a	3312 ab	3312 ab
50	2850 b	3650 a	3312 ab	3725 a
100	3350 ab	3062 b	2925 b	3375 ab
S.Em. ±	209			
C.D. 5%	579			

Data in Table 80 reveal that inoculum plus 50 kg/ha of K gave the highest yield of 3725 kg/ha. followed by 3650 kg/ha. in N_{50} K_{50} treatment. The lowest yield was obtained with K_{50} treatment of the order of 2850 kg/ha.

Interaction effect due to different levels of N P K was also significant, yields ranging from 2290 to 4106 kg/ha. with Var. T-1. With Kabuli Var. K-4, the yields were comparatively poorer as compared to T-1, ranging from 1247 to 2553 kg/ha.

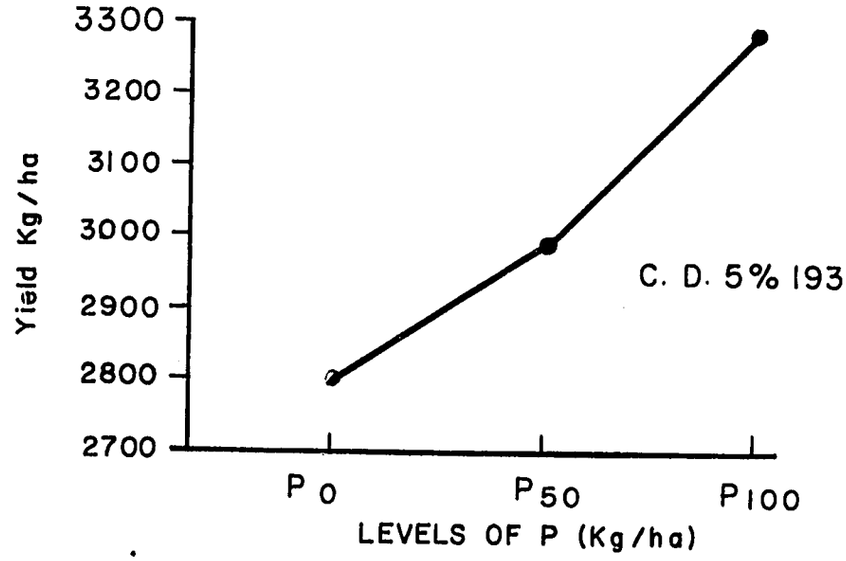

Fig. 23 Effect of different levels of P (Kg./ha) on yield of Peas (Pisum sativum) var T-163 at Hissar, Rabi, 1968-69

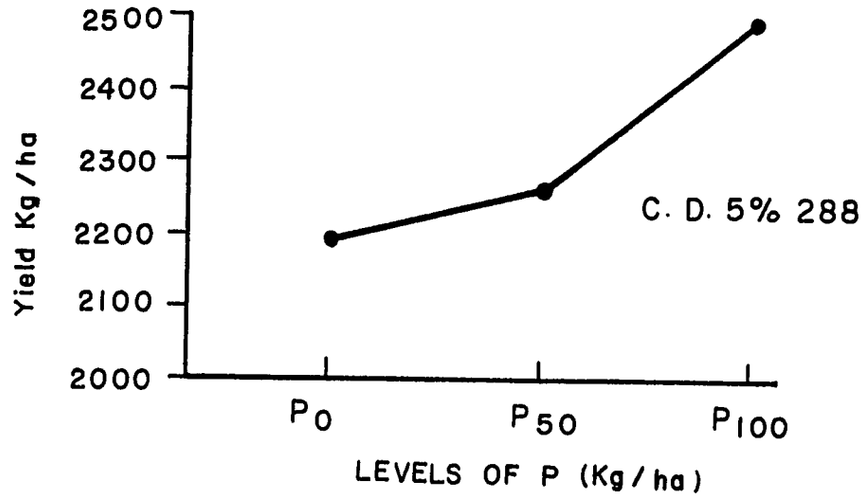

Fig. 23 Effect of different levels of P (Kg/ha) on yield (Kg/ha) of chick pea (Cicer arietinum) var G-24 at Hissar, Rabi, 1968-69

Varanasi

At Varanasi, most of the plots of chickpea (Cicer arietinum) Var. T-3 were lost due to salinity. Data obtained reveal that the interaction effects due to NPK treatments were significant, yields ranging from 815 to 2800 kg/ha.

Hyderabad

At Hyderabad location, Var. T-2 and T-3 were used. There were interaction effects due to PK and NPK in T-2 and N K and N P K in T-3. These data are presented in Table 81.

Table 81. Interaction effect due to different levels of P and K (kg/ha) on the yield (kg/ha) of chickpea (Cicer arietinum) Var. T-2, Hyderabad, Rabi 1968-69.

Levels of K (kg/ha)	Levels of P (kg/ha)		
	0	50	100
0	1386 abc	1500 ab	1387 abc
50	1233 bc	1585 a	1175 bc
100	1148 c	1178 c	1693 a
	S. Em. ±	121	
	C.D. 5%	336	

Potash alone had a depressing effect on the yield of chickpea at Hyderabad location (Table 81.). If, however, applied with P_2O_5, it has additive effect to a certain extent. These data are graphically depicted in Fig. 20. Interaction of different levels of N, P and K was significant, yields ranging from 783 to 2079 kg/ha. with Var. T-2 and from 2437 to 3438 kg/ha. with Var. T-3.

There was interaction between different levels of N and P with T-3. These data are given in Table 82.

Table 82. Interaction between different levels of N and P (kg/ha) on the yield of chickpea (Cicer arietinum) Var. T-3, Hyderabad, Rabi 1968-69.

Levels of P (kg/ha)	Levels of N (kg/ha)			
	0	50	100	Inoculum
0	3082 ab	2949 ab	3115 ab	2865 bc
50	2732 c	2699 c	3282 a	3232 a
100	3065 abc	3132 ab	3048 abc	2715 c
	S.Em. ±	121		
	C.D. 5%	337		

Data in Table 82show that the highest yield of 3282 kg/ha. was obtained with $N_{100} P_{50}$ treatment and the lowest yield of 2699 kg/ha. was obtained with $N_{50} P_{50}$ treatment.

Table83 . Response of chickpea (NP 58) to different levels and method of phosphate application.

A. Levels of $P_2 O_5$ /ha.	Grain yield (Q/ha.)
Control	23.4
25 kg.	22.8
50 kg.	23.7
75 kg.	22.2
100 kg.	22.9
S.Em. ±	0.55
C.D. 5%	-
B. Method of application	
Broadcast and mixed	23.4
Placed at plough sole	22.4
S.Em. ±	0.39
C.D. 5%	-

The results show that the crop failed to benefit from phosphatic fertilization at any level. The two methods also gave about the same grain yield. The chemical analysis of the soil indicated $P_2 O_5$ availability to be about 40 kg/ha. At the yield levels reported no added $P_2 O_5$ was required by the crop.

Table83A. Response of four varieties of chickpea to different fertilizer treatments.

A. Main plot (Fertilizer treatments)	Grain yield (Q/ha.)
Control	29.48
30 kg. N/ha.	31.70
30 kg. N+33.3 kg. P_2O_5/ha.	29.85
30 kg. N+66.7 kg. P_2O_5/ha.	30.40
30 kg. N+100 kg. P_2O_5/ha.	29.66
30 kg. N+ 30 kg. K_2O /ha.	28.37
30 kg. N+66.7 kg. P_2O_5 + 30 kg. K_2O/ha	29.66
S.Em. ±	0.93
C.D. 5%	-
B. Sub plot (Varieties)	
G-24	30.40
Early 53	31.70
N.P. 58	29.66
$B.G.S_1$	27.44
S.Em. ±	0.59
C.D. 5%	-

No significant effect of the fertilizer treatments on the grain yield of chickpea was observed. This soil analysis showed that it was of medium status in respect of nitrogen. P_2O_5 and K_2O were available at a rate of 38 and 366 kgs/ha. respectively. The total amount of N, P_2O_5 and K_2O removed in grain and straw at the yields reported averaged 136, 31 and 82 kgs/ha. respectively. The lack of response of the crop to the fertilizer treatments is, thus, understandable. Selection Early 53 gave the highest yield of 31.70 q/ha. and was found significantly superior to all except G.24. No material difference existed between the yield of G-24 and NP 58 but both were significantly superior to $B.G.S_1$ which gave the lowest yield of 27.44 q/ha.

2. Lentils (Var. L-9-12)

Table 84. Residual effect on the yield of lentil (L-9-12) of farmyard manure and phosphate applied to the preceding crop of pigeon pea (T.21)

Levels of F.Y.M./P_2O_5 applied to the preceding crop of pigeon pea	Grain yield (Q/ha) of the succeeding crop of lentil
Control, no manure/fertilizer	3.71
F.Y.M. @ 15 tonnes/ha.	6.71
F.Y.M. @ 30 tonnes/ha.	7.42
F.Y.M. @ 45 tonnes/ha.	9.70
P_2O_5 @ 33.3 kgs./ha.	5.85
P_2O_5 @ 66.7 kgs./ha.	7.86
P_2O_5 @ 100 kgs./ha.	9.84
S.Em. ±	0.21
C.D. 5%	0.65

The yield data show that significant and substantial benefits accrued to the lentil crop from the different levels of farmyard manure and phosphate applied to the preceding crop of pigeon pea. These results take on added importance in view of the high direct response of the preceding crop shown to both manure and phosphate at the three levels used. It is estimated that a net profit of Rs. 1600/ha. from the two crops over than above the grain from control treatment can be secured by using farmyard manure at the highest level. The net income, similarly, from the two crops amounts to Rs. 1800/ha. if the phosphatic fertilizer is used at the same level.

3. Peas (Pisum sativum) (Var. T-163)

At Hissar, there was significant difference due to different levels of P. Data are presented in Table 85. and Fig. 23 .

Table 85. Effect of different levels of P (kg/ha) on yield (kg/ha) of peas (Var. T-163), Hissar, Rabi, 1968-69.

Levels of P (kg/ha)	Yield of peas (kg/ha)
0	2800 b
50	2927 b
100	3287 a
S.Em. ±	104
C.D. 5%	288

Data in Table 85 show that there was a linear response to different levels of P under study. 100 kg/ha yielded, significantly higher than the other treatments. 0 and 50 kg/ha were at par in respect of yield of peas. The same trend was observed in case of chick pea at this location.

Weed control trial - Delhi.

A weed control trial was conducted at Delhi to assess the losses due to unrestricted weed competition in chickpea (Cicer arietinum). In between these lines, four lines of Lentils (Lens esculenta) and four lines of peas (Pisum sativum) were also sown to study the toxicity of the herbicides on these pulses crops. Seventeen treatments consisting of seven herbicides in different doses and combinations were used. The herbicides tried were Treflan (Trifluore, 2, 6-dinitre, N.N. dipropyl - p - toludine) at 0.5 lb/ac and 1 lb/ac, Eptam (S-Ethyl dipropyl-thiocarbamate) at 2 lb/ac and 4 lb/ac, knoxweed (S-Ethyl-dipropyl-thiocarbamate 46.9% + iso Octylester of 2, 4-D 35-4%) at 1, 2 and 4 lb/ac. Amiben (3, amno, 2, 5-dichlorobenzoic acid) at 6 lb/ac, Tok E -25 at 4 lb/ac and Lasso (2-chloro -2, 6 -diethyl-N-(Methoxy-methyl) acetanilide) at 5 and 7 Litres/ha. Lasso (6 tertbutyl-2-chloro-N-Methoxymethyl)-O-acctotoluidide was also used at 5 and 7 litres per hectare.

These seventeen treatments were replicated six times in a simple randomised block design. Plot size used was 4Mx3.6M. One meter alleys between plot Herbicides except Tok and amiben were sprayed on October 17, 1968 and immediately mixed into the soil to a depth of 10 to 15 cm. Sowing was done on October, 18, 1968. Tok and amiben treatments were applied as soon as crop was planted.

After twenty days injury rating were noted . Data are presented in Table 86.

Table 86 Crop injury rating in Chick pea (Var. G-24), Peas (Var. NP 56) and Lentils (Var. L-9-12), Delhi, Rabi 1968-69.

Treatment.	Crop		
	Chick pea	Peas	Lentils
Treflan	0.8	2.7	2.8
Eptam	5.1	7.3	7.8
Tok	0.0	1.0	2.7
Amiben	1.0	0.5	1.8
Knoxweed	8.8	9.8	9.8
$Lasso_1$*	1.3	2.8	5.8
$Lasso_2$	1.3	2.3	5.0
$Lasso_1$**	3.3	4.8	8.7
$Lasso_2$	3.0	6.1	9.5
$Treflan_1$ + $Eptam_1$	2.1	5.3	5.5
$Treflan_2$ + $Eptam_2$	4.1	8.0	8.7
$Treflan_1$ + $K.weed_1$	3.5	6.1	6.5
$Treflan_2$ + $K.weed_2$	6.6	9.1	9.8
Treflan -1+Lasso-1	2.5	5.5	7.5
Treflan-2 +Lasso-2	4.5	7.1	9.0
Control	0.0	0.0	0.0
Hand weeding	0.0	0.0	0.0

* Soil incorporation
** Surface application
0= No injury; 1-3= slight; 4-6=Moderate; 7-9= Sevre; 10=Death.

Data in Table 86 indicate that knoxweed and Treflan + knoxweed in higher doses have high toxic effects on chickpea, Treflan, Treflan + Eptam at low doses caused slight injury to chickpea. Tok EC 25 caused no injury to the crop.

In case of peas also knoxweed, Eptam, Treflan + knoxweed, Treflan + Eptam at higher doses have very high toxic effects and in some plots there was complete kill of plants.

Similarly, Eptam, knoxweed, Lasso at low and higher doses, Treflan + Eptam, Treflan+knoxweed and Treflan + Lasso at higher doses, had very toxic effect on lentils (Var. L-9-12).

On the whole Treflan, Treflan + Eptam at low doses and Tok E 25 were found efficient herbicides for chick pea, pea and lentil at the low levels of use.

Crop stand rating 39 days after sowing was recorded and the data are presented in Table 87.

Table 87. Crop stand rating 39 days after sowing in herbicidal trial, Delhi, Rabi, 1968-69.

Treatment	Chick pea	Peas	Lentil
Treflan	81.4	62.3	58.3
Eptam	85.1	66.6	68.0
Tok EC.25	92.2	70.6	84.6
Amiben	70.8	65.3	72.0
Knoxweed	13.7	1.3	4.2
$Lasso_1$	76.1	57.0	54.0
$Lasso_2$	83.4	59.6	66.6
$Lasso_1$	76.1	51.3	13.6
$Lasso_2$	61.2	14.0	7.3
$Tr_1 + E_1$	83.2	70.0	76.6
$Tr_2 + E_2$	64.2	43.3	33.3
$Tr_1 + K_1$	55.2	45.0	23.6
$Tr_2 + K_2$	26.1	20.0	7.0
$Tr_1 + L_1$	67.8	50.0	78.0
$Tr_2 + L_2$	55.8	39.0	20.0
H.W	100.0	100.0	100.0
N.W	100.0	100.0	100.0

Data in Table 87 indicate that Tok E 25 Eptam and $Treflan_1$+ $Eptam_1$ and Treflan had positive effect on crop stand. Knoxweed, however, had very toxic effect on all crops.

Final weed rating was done on Jan. 8, 1969 (82 days after sowing). Data are recorded in Table 88.

Table 88. Weed control ratings of different herbicidal treatments 82 days after sowing, Delhi, Rabi, 1968-69.

Treatment	Rate lb/ac.	R I	R II	R III	R IV	R V	R VI	TOTAL	Mean
Treflan	0.5	4	3	3	9	5	6	30	5.0
Eptam	2.0	3	5	2	3	2	10	25	4.1
Tok EC-25	4.0	4	4	3	6	6	3	26	4.3
Amiben	6.0	5	2	2	4	7	6	26	4.3
Knoxweed	1.0	6	5	7	5	10	8	42	7.0
$Lasso_1$*	5.0	4	4	8	9	4	8	37	6.1
$Lasso_2$*	7.0	5	5	7	10	4	6	37	6.1
$Lasso_1$**	5.0	5	7	5	4	9	6	36	6.0
$Lasso_2$**	7.0	3	3	4	7	3	8	28	4.7
Tr_1+E_1	0.5+2	3	3	2	6	1	2	17	2.8
Tr_2+E_2	1.0+4	2	1	1	1	6	3	14	2.3
Tr_1+K_1	0.5+2	6	7	2	3	4	6	28	4.7
Tr_2+K_2	1.0+4	5	3	2	4	10	3	27	4.5
Tr_1+L_1	0.5+5	8	5	3	7	6	4	33	5.5
Tr_2+L_2	1.0+7	4	3	3	6	2	7	25	4.1
Hand weeding		10	10	10	10	10	10	60	10
No weeding		0	0	0	0	0	0	0	0

* Soil incorporation (Lit/ha.) 0 = No weed control.
** Surface application(Lit/ha.)10 = Complete weed control.

Data in Table 88 indicate that Treflan-2 + Eptam-2 and Treflan-1 + Eptam-1 herbicide treatments had effectively controlled weeds. Knoxweed as seen from table 88, did not control the weed population effectively.

Yield of chickpea (Cicer arietinum) Var. G-24 in kg. per hectare are tabulated in Table 89.

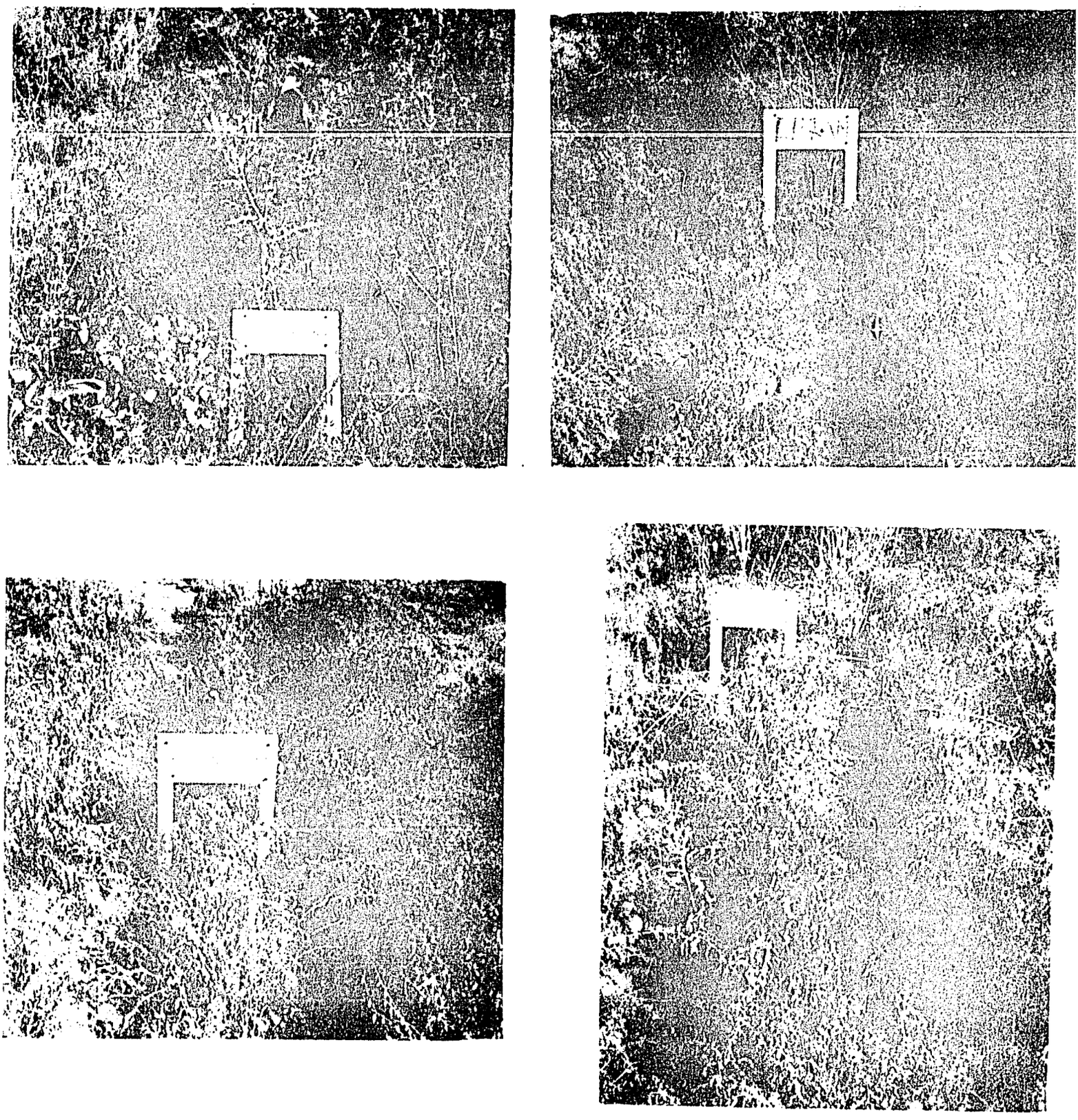

Fig. 24. Weed control in chickpeas with chemical herbicides, Delhi, rabi, 1968-69.

Table 89 . Effect of different herbicides on yield (kg/ha) of chickpea Var. G-24 at Delhi, Rabi, 1968-69.

Treatment	Yield (kg/ha.)
Treflan	290 abc
Eptam	287 abc
Tok E -25*	363 a
Amiben*	No yield was obtained.
Knoxweed	119 e
Lasso-1 (L)	275 abcd
Lasso-2 (L)	193 bc
Lasso-1*(H)	322 ab
Lasso-2*(H)	284 abc
Treflan-1 + Eptam-1	323 ab
Treflan-2 + Eptam-2	255 abcde
Treflan-1 + Knoxweed-1	245 abcde
Treflan-2 + Knoxweed-2	172 bcde
Treflan-1 + Lasso-1	248 abcde
Treflan-2 + Lasso-2	243 abcde
Hand Weeding.	267 abcde
No Weeding. (Control)	130 de
S.Em. ±	55
C.D. 5%	152

* Applied as post-plant, pre-emergence.

Data in Table 89 show that Tok EC-25 at 4 lb/ac. Treflan + Eptam (at low doses) at 0.5 + 2.0 lb/ac. and Lasso at 7 Litres/ha. gave higher yields of the order of 363, 323 and 322 kg per hectare respectively. These yields were, however, at par statistically No Weeding (Control) treatment has given the lowest yield (130 kg/ha). Amiben had completely destroyed the crop. No yield was obtained in this treatment.

Out of these various herbicides tried, Treflan + Eptam at low doses appears to have some promise in future trials. Tok though it controls weed population and increases the yield, has some toxic effect on plants in the initial stages.

Effect of Simazine on protein content of pulses.

Recent literature shows that simazine at low doses increases the protein content of crops. With this object in view, an experiment was designed and conducted at Delhi and Hyderabad to find out the effect of simazine on protein content of pulses crops(chickpeas Var. G-24 at Delhi and Var. T-2 at Hyderabad and Peas Var. T-163 at Delhi and Hyderabad) during rabi, 1968-69.

Treatments consisted of no simazine, 1/64 lb/ac., 1/32 lb/ac. and 1/16 lb/ac. There were different times of application treatments as - No spray, at the time of planting at prebloom stage and at planting + prebloom stage. A uniform dose of N, P and K was applied in the experiment area. A split plot design was used with time of application as main plot treatments and simazine doses as sub-plot treatments. There were four replicates. Gross plot size used was 24'x15'. The crop was planted on October 31, 1968, at Hyderabad and on Nov. 4, 1968 at Delhi. Chickpeas (Var. G-24) at Delhi failed completely due to salinity.

Percentage protein is given in Table 90. Results on enhancement of protein percentage are erratic. Yield data also could not be collected because of non-uniform stand of the crop at both the places.

Table 90. Effect of different doses and time of application of simazine on protein percentage in chickpea at Hyderabad and in peas at Delhi, Rabi, 1968-69.

Rate lb/ac.	Time	Protein Percentage	
		Peas (Var. T-163)	Chickpeas (Var. T-2)
0	D_0	19.9	23.9
1/64	D_1	24.3	22.7
1/64	D_2	23.5	23.9
1/64	D_3	22.1	23.3
1/32	D_0	23.1	22.9
1/32	D_1	22.9	20.5
1/32	D_2	22.7	22.3
1/32	D_3	21.9	23.5
1/16	D_0	21.5	21.3
1/16	D_1	22.5	23.3
1/16	D_2	20.5	22.9
1/16	D_3	23.9	23.7

D_0 = No simazine, D_1 = All applied at planting, D_2 = All applied at pre-bloom, D_3 = 1/2 at planting, 1/2 at pre-bloom.

B. Life-lite Experiment.

Lifelite flexible 4/12 is a plastic film produced by Radiant Color Company U.S.A. This is used as a seasonal field crop cover in order to transform the sunlight into the specific wave bands of light (blue and intensified red) which are required for efficient photo synthesis and vigorous growth of plants like beans, tomatoes, tobacco, lettuce, spinach etc. Besides, it eliminates substantially the green and harmful ultra-violet radiations. The results with lifelite reported by the manufacturing

company are very much encouraging. In summer (March through June) the availability of sunlight is abundant in India. The utilisation of this available radiant energy to achieve better growth and yield in pulse crops is very important.

With these advantages of lifelite, an exploratory trial was carried out on two mung bean varieties at Delhi during Summer 1969 to (i) Study the effect of light quality (blue and intensified red) on the growth and yield of two mung bean (Phaseolus aureus) varieties(Pusa Baisakhi and Type-1) and (ii) to investigate the influence of green and partially screened U.V. radiations on the diseases of these varieties. Treatments were two varieties of mung bean - Pusa Baisakhi and Type-1 and two light treatments (a) covered with lifelite and not covered with lifelite. Gross plot size used was 3.0x1.2 M with four replicates. An uniform dose of fertilizer (N-25 kg/ha and P-50 kg/ha) was applied. The spacing was 20 cm. between rows and 5 cm. within rows. Planting was completed on March, 17, 1969. Irrigation was applied on March 18 for proper germination and another irrigation was applied at flowering on April, 15, 1969. For control of jassids and other insects Thiodan + DDT was sprayed on April, 8, 1969. After the emergence of the crop, lifelite was put first at crop level, then raised at 25 cm. and 100 cm. height from the ground level as the crop advanced in its growth. The crop was harvested in two pickings. The first picking was on May, 19, 1969 and the second 10 days after.

Observations were recorded on dry weight (gm) of plants cut close to ground level and dried at 80°c for 8 hours, number of pods per plant, number of seeds per pod. Light intensity in Foot-Candles was measured on April 10, 1969 at 11-15 A.M. at crop level under both treatments 50 cm., 75 cm. and 100 cm. height under the lifelite treatment. Data of these characters along with yield (kg/ha) of mung beans are presented in Table 91

Table 91. Response of mung beans (Phaseolus aureus) with and without lifelite covering on yield and yield contribution characters, summer, Delhi, 1969.

Treatment	(Character studied)			
	Dry weight (gm) per 10 plants.	Pods/Plant	Seeds/pod	Yield (kg/ha)
Lifelite:				
Pusa Baisakhi	5.88	6.80	7.96	660 a
Type-1	4.33	6.65	8.40	544 ab
Control:				
Pusa Baisakhi	5.52	5.12	9.00	428 b
Type-1	4.14	5.75	8.24	385 b
				S.Em. ± 51
				C.D. 5% 162

Data presented in Table 91 show that under lifelite dry weight (gm), pods per plant and yield of mung beans increased significantly as compared to control treatment.

Among the varieties tested, Pusa Baisakhi was more responsive to lifelite (660 kg/ha) compared to Type-1 (544 kg/ha). This shows that Pusa Baisakhi is more effecient in utilising the available radiant energy for better growth and yield as compared to Type-1

The light intensity at crop level with no lifelite was 9500 FC and the same under the lifelite was 4500 FC. At 50 cm. from the ground level, it was 3500 FC, at 75 cm. it was 3000 FC and at 100 cm. from the ground level, it was 2500 FC.

Plans Book

A book on "plans for conducting Agronomic Experiments with Pulse Crops" was prepared by the RPIP and AICPP staffs. The need for this package of plans was evidenced by the fact that many pulse workers in India were not primarily agronomists but felt the need to conduct some agronomic trials.

This book explains in some detail the various types of agronomic trials that might be needed, considers proper sequence of operations, gives details on various operational details, provides useful facts and figures and gives various experimental designs suitable for the various types of trials considered.

It was the aim in preparing this book to both bring as much uniformity as possible into the agronomic trials being conducted in cooperation with the All India Coordinated Pulse Project and to provide step by step instructions for laying out trials, so that persons with little training in planning field experiment or persons whose primary training was not in agronomy could layout all the trials.

Each experimental design has a worksheet so that by filling in the worksheet from data and calculations given all necessary information for putting out the trial is at hand.

This book was sent out to all persons showing interest in the 1969 Pulse workshop and was distributed at the 1970 Pulse Workshop. Additional copies are still available from the Agronomist on the AICPP.

Summer, 1969

A. Spacing-fertility trial

An experiment for testing the performance of Mung beans (*Phaseolus aureus*) at different between row spacings, within row spacings and fertility levels was conducted at Delhi during the 1969 summer (March-June) season.

Mung bean varieties tried were Type 1 and Pusa Baisakhi between row spacings were 20 cm. and 30 cm., withing row spacings were 2.5, 5 and 7.5 cm. and fertility levels were no fertilizer, 50 kg N and P and 100 kg N and P per hectare on actual element basis.

A split plot design was utilized with varieties and between row spacings as main plot treatments and within row spacing and fertilizer levels, as sub-plot treatments. Plot size was 3.0 M x 1.8 M.

Fertilizer was applied as broadcast and mixed thoroughly with a rotospader. The crop was planted on April 16, 1969 and harvested in two pickings. Both the varieties made good growth. The crop was irrigated thrice during the growing season - first before planting, second at flowering and the third at pod formation stage.

Effect due to different fertility levels, within row spacings, their intraction and the interaction between the main treatments (VR) and sub treatments (SF) are statistically significant. Data pertaining to the same are presented in the following pages.

Table 92. Effects due to different fertility levels (kg/ha) and within row spacing (cm) on yield (kg/ha) of Mung beans (*Phaseolus aureus*) Delhi, Summer, 1969.

Fertility levels (kg/ha) (N and P on actual element basis)	Yield (kg/ha)	Within row spacing (cm)	Yield (kg/ha)
0	635 b	2.5	683 a
50	673 a	5.0	649 b
100	669 a	7.5	643 b
S.Em. ±	11 kg per ha.		11 kg per ha.
C.D. 5%	31 "		31 "

Data in Table 92 reveal that there was no significant difference between 50 and 100 kg/ha fertility level in respect of yield of Mung beans. However, these two treatments were significantly superior to no fertilizer treatment which yielded only 635 kg per ha.

Within row spacing of 2.5 cm responded significantly better (683 kg/ha) than 5.0 cm and 7.5 cm (649 and 643 kg/ha respectively) in respect of Mung bean yields. Treatment differences between 5.0 cm and 7.5 cm were statistically at par in respect of yield of Mung bean.

Intraction between different fertility levels and within row spacing was also statistically significant and data of the same are presented in Table 93 and graphically shown in Fig. 25.

Table . Interaction of different fertility levels (kg/ha) and within row spacing (cm) on yield (kg/ha) of Mung bean (Phaseolus aureus), Delhi, 1969.

Fertility levels (kg/ha) of actual element of N and P	Within row spacing (cm) 2.5 cm	5.0 cm	7.5 cm
0	715 a	580 d	610 cd
50	657 b	680 ab	680 ab
100	679 ab	688 ab	640 bc
S.Em ±		19 kg/ha	
C.D. 5%		53 kg/ha	

Data in Table 93 indicate that within row spacing of 2.5 cm without any fertilizer gave highest yield of 715 kg/ha and the lowest yield was obtained without fertilizer with 5.0 cm. within row spacing (580 kg/ha).

Interaction between the main treatments (Varieties x Row spacing) and sub-treatments (Fertilizer levels x within row spacing) was also statistically significant. Data are presented in Table 94 .

Table 94. Interaction between different varieties x row spacing (cm) and fertility levels (kg/ha) x within row spacing (cm) on yield (kg/ha) of Mung beans (Phaseolus aureus), Delhi Summer, 1969.

Within row spacing (cm) x Fertility level (kg/ha) of actual element.		Variety Type 1 Row Spacing (cm) 20 cm.	30 cm.	Variety Pusa Baisakhi Row Spacing (cm) 20 cm.	30 cm.
2.5	0	685	883	690	597
2.5	50	709	616	730	569
2.5	100	714	740	697	559
5.0	0	459	626	583	645
5.0	50	642	711	711	652
5.0	100	666	657	785	640
7.5	0	611	733	654	435
7.5	50	604	659	876	578
7.5	100	642	666	830	416
	S.Em ±	38 kg/ha			
	C.D. 5%	106 "			

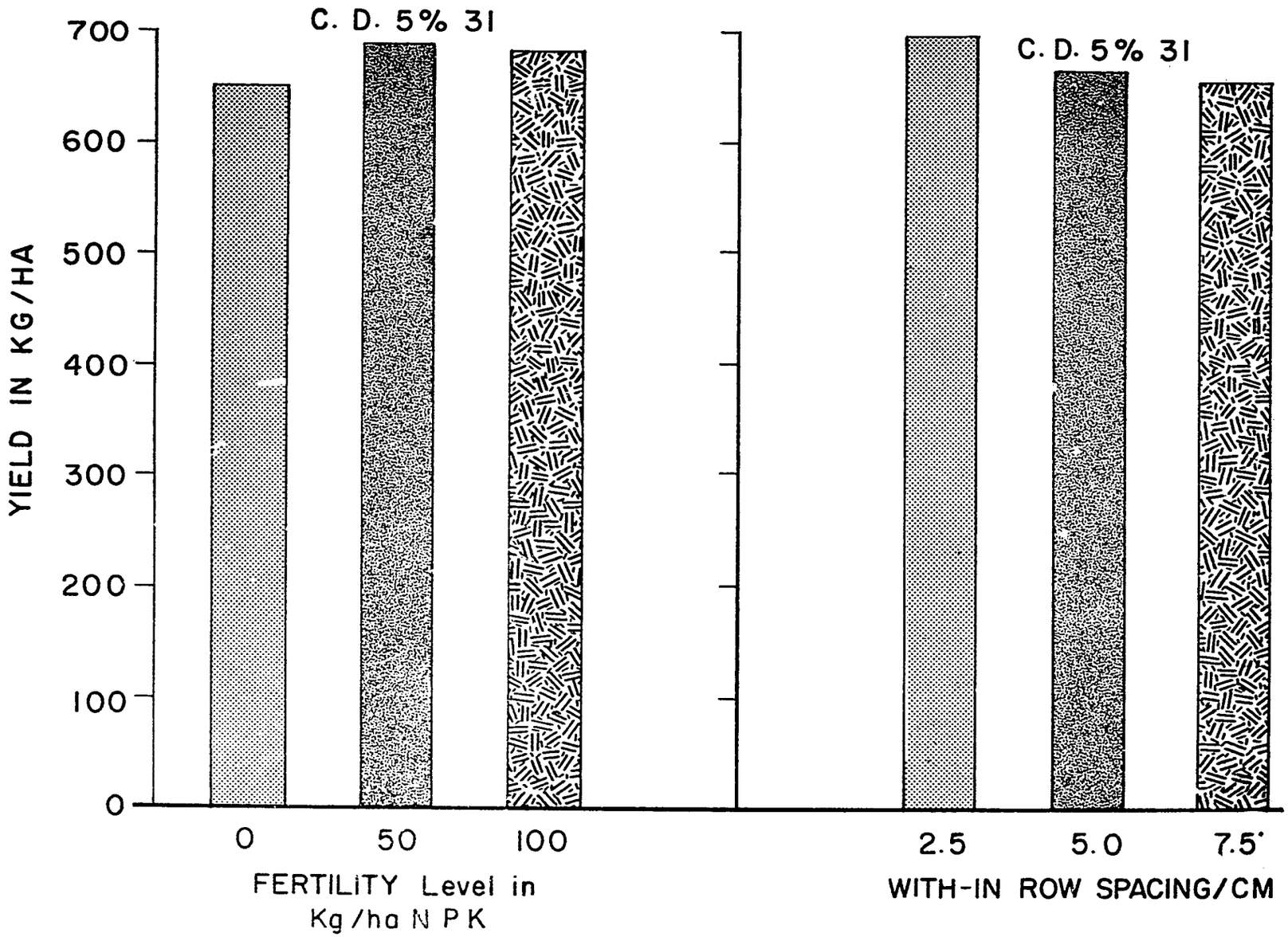

Figure: Effects due to different fertility levels (kg/ha) and with in row spacing (cm) on yield of Mung beans, Delhi, Summer 1969

25

Data in Table 94 show that the maximum yield was obtained with variety Type 1 with between row spacing of 30 cm., within row spacing of 2.5 cm. and without any fertilizer (883 kg/ha). In case of Pusa Baisakhi, the maximum yield of 876 kg/ha was obtained with 20 cm x 7.5 cm spacing and using 50 kg/ha of fertilizer level of N and P. One interesting observation is that in Type 1, between row spacing of 30 cm. has given higher yield of mung bean than 20 cm. between row spacing. In case of Pusa Baisakhi, however, between row spacing of 20 cm. has given higher yield than 30 cm. between row spacing. This might be due to differential plant types in these two varieties.

Table 95 . Performance of two mung varieties planted on four different dates and with different planting patterns, Summer, 1969.

		Grain yield (Q/ha)
A. Main plot treatments		
(a) Dates of planting		
15th March		6.21
30 March		7.68
15th April		12.00
3rd May		7.76
	S.Em ±	0.81
	C.D. 5%	2.44
(b) Varieties		
Pusa Baisakhi		8.83
Type 1		8.00
	S.Em ±	0.57
	C.D. 5%	—
B. Sub plot treatments		
(a) Row spacings		
Rows 20 cm. apart		8.23
Rows 30 cm. apart		8.60
	S.Em ±	0.29
	C.D. 5%	—
(b) Inter-plant distance		
Plants 5 cm. apart		8.32
Plants 10 cm. apart		8.50
	S.Em ±	0.29
	C.D. 5%	—

The maximum yield of 12.00 q/ha. was obtained when the crop was planted on 15th April. Earlier or later plantings yielded significantly less. No significant yield differences were observed between the two varieties tested. Between and within row spacings tested also showed no marked yield differences.

Table 96 Comparative performance of some new mung selections.

Selection/variety		Grain yield (Q/ha.)
Pusa Baisakhi		7.52
S. 5		6.31
S. 8		5.71
S. 9		9.29
S.10		2.93
S.11		3.63
S.12		13.73
S.16		5.78
	S.Em ±	1.79
	C.D. 5%	5.40

Selection 12 gave the highest yield of 13.73 q/ha. which was significantly larger than the yield of any other selection except S.9. It was, however, observed that the true potential of the selections tested was vitiated by an attack of stem borer and further testing is necessary for final yield estimates.

Table 97 . Response of mung (Pusa Baisakhi) to N and P fertilization and the method of application.

Levels of N/P_2O_5	Method of application		
	Broadcast	With seed	Below seed
	(Grain yield in Q/ha.)		
1. 25 kg. N/ha.	5.69	6.38	7.38
2. 25 kg. N + 33 Kg. P_2O_5/ha.	7.73	8.77	10.32
3. 25 kg. N + 66 Kg. P_2O_5/ha.	9.73	9.70	13.26
		S.Em ±	0.37
		C.D. 5%	1.11

All fertilizer treatments caused significant increases in the grain yield over the control treatment and further substantial increments in yield accrued when the fertilizer amounts at any level were drilled below the seed. Nitrogen alone @ 25 kg/ha. increased the yield from 1.5 to 3.21 q/ha. under the three methods of application. When P_2O_5 @ 33 kg/ha. was added to this amount of N, the increase in yield went up further from 2 to 3 q/ha. When the P_2O_5 level was increased to 66 kg/ha. further increases in yield from 1 to 3 q/ha. were obtained. It may thus be observed

that the control yield of 4.17 q/ha. increased to 13.26 q/ha. when a mixture of 25 kg N + 66 kg. P_2O_5 was used per hectare. This is more than three-fold increase in the yield and may bring in an estimated net profit of Rs.700/ha. over the control treatment.

Table. 98. Response of mung (Pusa Baisakhi) to four irrigations and three row spacings.

Treatments (Irrigations x row spacings)		Grain yield (Q/ha.)
(a) Irrigations:		
1. No post-planting irrigation		4.48
2. Irrigation at 75% available moisture (3 irrigations)		9.10
3. Irrigation at 50% available moisture (2 irrigations)		9.81
4. Irrigation at 25% available moisture (1 irrigation)		7.61
	S.Em ±	0.108
	C.D. 5%	0.34
(b) Row spacings		
Rows 20 cm. apart		8.89
Rows 30 cm. apart		7.63
Rows 40 cm. apart		6.77
	S.Em ±	0.092
	C.D. 5%	0.26

It seems two irrigations are the optimal requirements for the crop instead of the usual one irrigation. The second irrigation caused a significant yield increase of 220 kg/ha. over the first irrigation. Planting the crop in closer rows of 20 cm. than the usual distance of 30 cm. also gave significantly higher yield.

Table 99. Response of mung (Pusa Baisakhi) to phosphate levels and irrigations at different stages of crop growth.

Treatments (P_2O_5 levels x Irrigations)		Grain yield (Q/ha.)
(a) Levels of P_2O_5		
1. Control		5.75
2. 33 kg/ha.		7.14
3. 66 kg/ha.		9.91
	S.Em ±	0.70
	C.D. 5%	2.05

(b) Irrigations	Grain yield (Q/ha.)
1. Irrigation at 50% available moisture	8.02
2. Pre-flowering irrigation	7.43
3. Post-flowering irrigation	6.72
4. Pre-plus post-flowering irrigation	8.14
S.Em ±	0.81
C.D. 5%	———

Application of 33 kg. P_2O_5/ha. yielded about 1.49 q/ha. more than the control treatment but the difference was not found to be significant statistically. The second level of P_2O_5 was found more effective in its influence on the yield and gave 4.16 and 2.77 q/ha. more of grain than the control and first level, respectively. These yield differences were statistically significant. No significant differences in the yield of irrigation treatments were observed and, it seems, two irrigations are all that the crop needs.

Table 100. Effects of moisture regimes, fertilization and seed rate on the yield of mung (Pusa Baisakhi)

Treatments (Moisture regimes x fertility levels x seed rates).		Grain yield (Q/ha.)
(a) Moisture regimes		
0.3 atm. upto flowering 8.1 atm. after flowering	)Total three)irrigations	6.94
0.9 atm. upto flowering 8.1 atm. after flowering	)Total two)irrigations	6.24
2.7 atm. upto flowering 8.1 atm. after flowering	) One irrigation)	4.92
(b) Fertility levels:		
20 kg. N + 40 kg P_2O_5/ha.		5.28
20 kg. N + 60 kg. P_2O_5/ha.		5.07
20 kg. N + 80 kg. P_2O_5/ha.		4.41
	S.Em (moisture & fertility) ±	0.492
	C.D. 5%	1.37
(c) Seed rates		
6 kg./ha.		5.04
12 kg./ha.		7.03
	S.Em. ±	0.401
	C.D. 5%	1.11

Again, it appears that two irrigations are needed for the mung crop. While three irrigations were found ineffective over two, one irrigation gave significantly lower yield than two. No marked differences in yield could be detected under different fertilizer treatments. Use of the higher seed rate, and this difference was significant statistically.

Kharif, 1969

During Kharif, 1969, Soil and Crop management experiments were conducted on fertilization, dates of planting, plant population density, foliar nutrition and chemical weed control. These trials were conducted at Chhattarpur DLF , Delhi, Hissar, Hyderabad, Jabalpur, Kanpur, Ludhiana, Pantnagar and Varanasi. The crops studied were mung beans (*Phaseolus aureus*), urd beans (*Phaseolus mungo*) and Pigeon pea (*Cajanus cajan*).

A. Fertility Spacing Trials

(1) Pigeon pea (*Cajanus cajan*)

A fertility spacing trial was conducted at Hyderabad (Var. T-17 and T-21), Kanpur (three varieties T-7, T-17, T-21), and Varanasi (Var. T-21). The details of the experiment were same as last year for Hyderabad. At Kanpur and Varanasi, the design was slightly modified. Main treatments consisted of a combination of row spacing and fertility level and sub-treatments maintained were plant spacing. The three row spacings were 60 cm, 90 cm, and 120 cm. and fertility levels were 0, 50 and 100 kg/ha. each of N, P and K of actual element. Plant to plant spacings maintained were 20, 40 and 60 cm. A split plot design with four replicates was used. There were effects due to different row spacings and fertility levels. These data are presented in Table 101.

Table 101. Effects due to different row spacings (cm.) and fertility levels (kg/ha) on yield (kg/ha) of Pigeon pea (*Cajanus cajan*) at Hyderabad, Kharif, 1969.

Main Treatment (Row spacing in cm. and Fertility levels in kg/ha. of actual element)			Yield (kg/ha)
60	0		1023 ab
60	50		1210 a
60	100		1206 a
90	0		859 bc
90	50		1010 ab
90	100		1021 ab
120	0		797 b
120	50		708 c
120	100		601 c
		S.Em ±	94 kg/ha.
		C.D. 5%	274 kg/ha.

Data in Table 101 show that 60 cm. row spacing has out yielded the 90 and 120 cm. spacing. Yields with 120 cm. row spacing were lower than the 60 cm. row spacing. As regards the fertility effects, there was no positive response beyond 50 kg/ha. of each of the nutrient. With narrow spacing of 60 cm., all the three fertility levels were equal. With 90 cm. row spacing, however, 50 kg/ha and 100 kg/ha fertility levels were significantly better than no fertilizer treatment. With wide row spacings of 120 cm., yield is reduced with increase in the fertility level. At Kanpur the crop was lost due to water-logging.

Table 102. Effect of methods of planting, row spacings and inter-plant distance on the yield of pigeon pea (T-21) under wet conditions of soil.

Treatments (Method of planting x row spacings x Inter-plant distance)		Grain yield (Q/ha.)
(a) Method of planting		
1. Crop planted on ridges		29.87
2. Crop planted on flat beds		22.50
	S.Em ±	0.96
	C.D. 5%	2.65
(b) Row Spacings		
1. Rows 50 cm. apart		28.87
2. Rows 75 cm. apart		22.50
	S.Em ±	0.96
	C.D. 5%	2.65
(c) Inter-plant distances		
1. Plants 20 cm. apart		31.25
2. Plants 30 cm. apart		25.75
3. Plants 40 cm. apart		21.62
	S.Em ±	1.18
	C.D. 5%	3.27

The results obtained this year are confirmatory of those of last year. The ridge-planted crop yielded substantially and significantly more than the crop planted on flat beds. The extra yield of over 7 q/ha. (value Rs.700) more than pays for the cost of ridging(about Rs.50). The narrower distance of 50 cm. between rows also gave about 6 q/ha. more than the standard distance of 75 cm. The closer spacing of 20 cm. between plants also gave a significantly higher yield of 31.25 q/ha. than the usual practice of spacing plants 30 cm. apart (25-75 q/ha.). The widest inter-plant distance of 40 cm. yielded the lowest (21.62 q/ha.).

Table 103 Response of three pigeon pea varieties to three row spacings and three rates of population.

Treatments (Combinations of varieties x row spacings x rates of population)		Grain yield (Q/ha.)
(a) Varieties		
T.21		19.71
A.S. 3		23.52
A.S. 5		21.94
	S.Em. ±	0.79
	C.D. 5%	2.18
(b) Row spacings		
Rows 50 cm. apart		22.59
" 75 cm. apart		21.79
" 100 cm. apart		20.80
	S.Em. ±	0.79
	C.D. 5%	———
(c) Rates of population		
25,000 plants/ha.		20.18
50,000 plants/ha.		22.11
75,000 plants/ha.		22.88
	S.Em. ±	0.79
	C.D. 5%	2.18

The crop was sown in late July and suffered from a prolonged drought from late September onwards. The varietal yield potential, consequently, could not be realised in full. However, selection No.3 yielded significantly higher than either T.21, the established variety, or selection No.5. In terms of yield/day, nevertheless selection 5 which matured in 135 days produced 16.2 kg/day, while T.21 and Selection 3 which matured in 130 and 172 days, respectively, gave 15.1 and 13.7 kg./day only. The yield from the narrowest row spacing of 50 cm. averaged more than the yield either from 75 or 100 cm. row spacings, but the differences were not found to be significant. The highest rate of 75,000 plants/ha. also gave significantly more yield (about 2.7 q/ha.) than the lowest rate of 25,000 plants/ha. No significant yield difference was observed to exist between the rates of 50,000 and 75,000 plants/ha.

(2) Mung bean (Phaseolus aureus) and Urid bean (Phaseolus mungo)

These two crops will be considered in one section, because of similarity in growth and cultural practices. Fertility-spacing experiments were conducted at Hissar, Kanpur, Ludhi and Varanasi. Details of the experiments were the same as last year. A split plot design with three row spacings (15 cm., 25 cm. and 35 cm.) and three plantispacings (2.5 cm., 5.0 cm. and 7.5 cm.) were tested as main plot treatments and 0, 50 and 100 kg/ha each of N, P and K on an actual element basis were tested as sub-plot treatments having a plot size (Gross) of 4.0 Mx 2.0 M. Fertilizer was broadcast before planting and worked in with a rototiller. Varieties tried were Urid T-9 and Mung Jalgaon 781 at Hissar, Urid No. 64 and mung Hybrid-45 at Ludhiana, Urid T-9 and Mung T-1 at Kanpur and Varanasi.

Trials at Kanpur were completely wiped out due to excessive and heavy rains. Data from Hissar and Ludhiana locations are collected, analysed and interpreted in the following pages.

At Hissar, none of the effects were statistically significant. The yields ranged from 1794 kg/ha to 2422 kg/ha. of Urid (Var. T-9) (Phaseolus mungo). With mung var. J-781 (Phaseolus aureus), the yields ranged from 965 kg/ha to 1775 kg/ha.

At Ludhiana with mung (Phaseolus aureus) variety Hybrid-45, none of the treatment effects were statistically significant.

In fertility-spacing trial with Urid (Phaseolus mungo) Variety No.64, effects due to different fertility levels were significant. Data are presented in Table 104 & the same are graphically shown in Fig. 26.

Table 104. Effects of different fertility levels (kg/ha) on yield (kg/ha) of Urid (Phaseolus mungo) Var. No. 64 at Ludhiana Kharif - 1969.

Fertility levels (kg/ha) (N,P,K on actual element basis)				Yield (kg/ha)
0	0	0		2125 a
50	50	50		1937 ab
100	100	100		1775 b
			S.Em. ±	86 kg/ha.
			C.D. 5%	238 "

Data presented in Table 104 show that there is no significant difference between yields (kg per hectare) of no fertilizer treatment (2135 kg per hectare) and treatment $N_{50}P_{50}K_{50}$ (1937 kg/hectare). Treatment $N_{50}P_{50}K_{50}$ was at par with treatment $N_{100}P_{100}K_{100}$ (1775 kg/ha) in respect of yield.

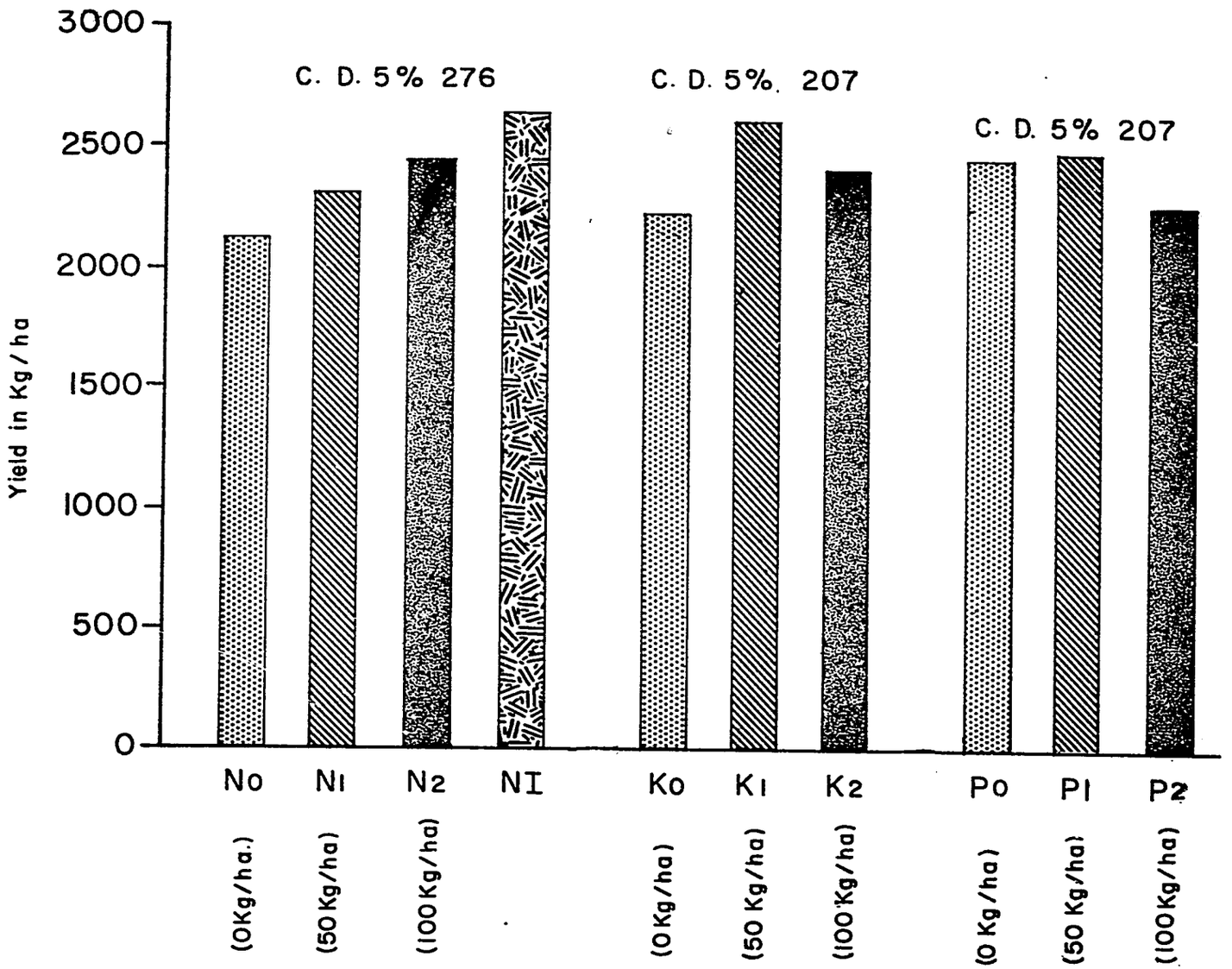

Figure 26. Effect of fertilizers at different levels on yield (kg/ha) of Urdbean (var. No.64), Ludhiana, Kharif, 1969.

Table 105. Effect of methods of planting, row spacings and interplant distance on the yield of mung (T.1) under wet soils conditions.

Treatments (Method of planting x row spacings x inter-plant distance)		Grain yield (Q/ha.)
(a) Method of planting		
1. Crop planted on ridges		10.01
2. Crop planted on flat beds		6.32
(b) Distance between ridges		
1. Ridges 30 cm. apart (Crop planted on top)	)	8.57
2. Ridges 60 cm. apart (Crop planted on both sides of ridge)	)	7.70
	S.Em. ±	0.08
	C.D. 5%	0.28
(c) Inter plant distance		
1. Plants 5 cm. apart		9.36
2. Plants 10 cm. apart		7.87
3. Plants 15 cm. apart		7.00
	S.Em. ±	0.13
	C.D. 5%	0.41

Some lands are subject to short periods of waterlogging due to heavy spells of rain in late July and August, It may be observed that on such lands ridge planting of mung may pay handsomely. The ridge planted crop yielded about 3.69 q/ha. more than the crop planted the usual way on flat beds. The extra yield is valued at Rs.370/ha., while the cost of ridging comes to about Rs.50 to Rs.60/ha. It was also observed that the crop yielded significantly less than the ridge distance was increased to 60 cm. to facilitate the operation of ridge making even though population was not reduced due to this distance as planting was done on both sides of the ridge. A plant to plant distance of 5 cm. was found to give the maximum yield of 9.36 q/ha. which was significantly higher than the yield under either 10 or 15 cm. inter-plants distance.

Table 106. Effect of methods of planting, row spacing and inter-plant distance on the yield of urd (T-65) under wet soil conditions.

Treatments (Method of planting x row spacings x inter-plant distance).		Grain yield (Q/ha.)
(a) Method of planting		
1. Crop planted on ridges		8.81
2. Crop plantedon flat beds		7.82
	S.Em. ±	0.12
	C.D. 5%	0.39
(b) Distance between ridges		
1. Ridges 30 cm. apart (Crop planted on top)		8.82
2. Ridges 60 cm. apart (Crop planted on both sides of ridges)		8.57
	S.Em. ±	0.12
	C.D. 5%	———
(c) Inter-plant distance		
1. Plants 5 cm. apart		9.62
2. Plants 10 cm. apart		8.57
3. Plants 15 cm. apart		7.87
	S.Em. ±	0.35
	C.D. 5%	1.07

These results are more or less similar to those obtained in the trial on mung above. Ridge planting gave significantly higher yield than the standard practice of planting on flat beds. The two distances between ridges yielded about the same. This makes ridging easier and cheaper. The smallest distance between plants gave the maximum yield which was significantly larger than the widest distance of 15 cm. tried. The crop suffered seriously from virus diseases and the treatment effects were probably masked. Last year the yields were higher and the treatment effects more marked.

At Varanasi, in spacing-fertility trials on mung beans, T-44 and Urid beans, T-65, interaction between different row and plant spacings and fertility levels were significant. Data of the same are presented in Table 107 and 108.

Table 107. Interaction of row and plant spacings (cm.) and fertility levels (kg/ha) on yield (kg/ha) of mung beans, Varanasi, Kharif, 1969.

Row and Plant Spacings (cm.)		Fertility levels (kg/ha) of actual element.		
		0	50	100
15	2.5	237	229	334
15	5.0	500	304	354
15	7.5	232	200	221
25	2.5	366	379	221
25	5.0	181	287	279
25	7.5	429	341	359
35	2.5	484	250	412
35	5.0	375	346	329
35	7.5	416	379	316

S.Em. ± 72 kg/ha.
C.D. 5% 200 "

Data presented in Table 107 reveal that there was no trend in the results obtained. However, highest yield of 500 kg mung beans per ha. was obtained with row and plant spacing of 15 cm. and 5.0 cm. respectively without any fertilizer application. Row and plant spacing of 25 cm. and 5 cm. respectively without any fertilizer yielded only 181 kg of mung beans per ha.

Table 108. Interaction of row and plant spacings (cm.) and fertility levels (kg/ha) on yield (kg/ha) of Urid beans, Varanasi, Kharif, 1969

Row and Plant Spacing (cm.)		Fertility levels (kg/ha) of actual element		
		0	50	100
15	2.5	716	1025	939
15	5.0	806	1009	822
15	7.5	1069	1069	431
25	2.5	756	675	612
25	5.0	478	490	394
25	7.5	703	550	1070
35	2.5	825	753	772
35	5.0	553	734	737
35	7.5	1153	800	831

S.Em. ± 119 kg/ha.
C.D. 5% 330 "

Data presented in Table 108 show that the highest yield of 1153 kg/ha. of Urid beans was obtained with row and plant spacing of 35 cm. and 7.5 cm. respectively without addition of any fertilizer, while the lowest yield of 394 kg/ha. was obtained with row spacing of 25 cm. and plant spacing of 5.0 cm. with 100 kg/ha. each of N, P and K fertilizer treatment. It is further seen that with narrow row spacing of 15 cm. Urid beans did not respond beyond 50 kg/ha. of fertility level. With increasing row and plant spacings thereafter there was no response to any fertilizer level.

B. Fertility-Inoculum Trials:

(1) Pigeon pea (Cajanus cajan)

Fertility-Inoculum experiments were conducted at Hyderabad, Pantnagar, Kanpur and Varanasi. Details of the experiments were the same as described for the rabi, crops - a factorial randomised block design with 0, 50 and 100 kg/ha. of each of N, P and K nutrients on actual element basis and rhizobial inoculum having a plot size of 4 M x 3.6 M was used. Fertilizer was broadcast before planting and worked in with a rototiller. Inoculum was standard commercial peat base product applied immediately before planting with a sticking agent (supplied by Nitrogen Co., Milwaukee, Wisconsin, USA). Between row spacing was 60 cm for short term and 90 cm. for long term varieties Within row spacing was 20 cm. for short term and 40 cm. for long term. Variety T-21 was used for short term arhar and T-17 for long term arhar.

At Hyderabad, the growth and yield were poor in T-21 due to unknown reasons. Effects due to different levels of K and NPK interaction were statistically significant. Yield as affected due to different levels of K is tabulated in Table

Table109. Effects of different levels of K (kg/ha) on the yield (kg/ha) of pigeon pea (Cajanus cajan) at Hyderabad, Kharif, 1969.

Levels of K (kg/ha)	Yield (kg/ha)
0	349 a
50	329 ab
100	278 b

S.Em. ± 20 kg/ha.
C.D. 5% 56 "

Data in Table109 indicate that increasing levels of potash reduced the yields.

Effects due to NPK interaction were obtained, yields ranging from 204 kg/ha. to 499 kg/ha.

At Jabalpur, the fertility-inoculum experiment was conducted in a modified form. Pigeon pea variety T-21 was tested. A split plot design was utilized having four replicates with rhizobial inoculation and no inoculation as main plot treatments. In sub-plots different levels of fertility - N at 0, 25 and 50 kg. per hectare and P at 0, 50, 100 and 150 kg/ha. on actual element basis were tested. Gross plot size was 4.0 M x 3.0 M. Fertilizer was broadcast before planting and worked in with a rotospader. Inoculum was standard commercial peat base product applied immediately before planting with a sticking agent (supplied by Nitragin Co., Milwaukee, Wisconsin, USA). Between row spacing was 75 cm. and within row spacing was 20 cm. The crop was sown on July2,1969 and harvested on November 20, 1969.

Due to heavy rains in August, the crop suffered a set back and ultimately it reflected in poor yield of the crop. Because of heavy and continuous rains two replicates were washed out completely and the data were recorded from only two replicates. Statistical analysis based only on two replicates, show that none of the treatment effects were statistically significant. Yields ranged from 467 to 1404 kg/ha.

At Varanasi, in fertility-inoculum trial interaction effect due to different levels of NK and N, P and K combination were statistically significant. The results are tabulated in Table 110 & 111.

Table 110. Interaction of different levels of N and K (kg/ha) on yield (kg/ha) of pigeon pea, (Type-21), Varanasi, Kharif, 1969.

Levels of K (kg/ha)	Levels of N (kg/ha) 0	50	100	Inoculum
0	875 d	1173 abc	1253 ab	1360 a
50	1141 ac	1216 abc	989 cd	1035 bcd
100	1058 bcd	1084 bcd	982 cd	1214 abc

S.Em. ± 88 kg/ha.
C.D. 5% 243 "

Data presented in Table 110 indicate that the highest yield of 1360 kg/ha. with inoculum treatment. Inoculum treatment has given significantly higher yield than N_0K_0 treatment. Nitrogen at 50 and 100 kg/ha. was at par with inoculum treatment, in the absence of any potash.

There was interaction between different levels of N, P and K, yields ranging from 724 to 1430 kg/ha.

Table.111. Response of pigeon pea (T.21) to three levels each N, P and K.

Treatments (Combinations of N,P&K)	Grain yield (Q/ha.)
Levels of N	
No applied nitrogen	19.62
25 kg. N/ha.	21.24
50 kg. N/ha.	21.83
Levels of P_2O_5	
No applied P_2O_5	19.83
50 kg. P_2O_5/ha.	21.06
100 kg. P_2O_5/ha.	21.81
Levels of K_2O	
No applied K_2O	19.80
25 kg. K_2O/ha.	21.60
50 kg. K_2O/ha.	21.30
S.Em. for N,P,K ±	0.41
C.D. 5%	1.15

Only the low levels of each nutrient gave significant increases in yield of about 2 q/ha. over the control treatments. The high level of each failed to affect the yield over the low level. The experimental field was affected by water erosion several times during August and September. The crop was also planted in late July and was seriously affected by the prolonged drought in October and November at the time of maturing. The treatments effects seem to have been masked by the unfavorable conditions of growth. The treatments need to be further tested.

Table112 . Response of pigeon pea (T.21) to three levels each of farmyard manure and phosphate and method of application.

Main plot treatments		Grain yield (Q/ha.)
Method of application		
1. Broadcast and mixed		21.99
2. Placement at 20-25 cm. depth		26.55
	S.Em. ±	0.88
	C.D. 5%	4.22
Sub-plot treatments (Combinations of F,Y,M and P_2O_5 levels plus one control)		
Levels of F, Y, M.		
F_1 F.Y.M. @ 15 tonnes/ha.		21.43
F_2 F.Y.M. @ 30 tonnes/ha.		25.55
F_3 F.Y.M. @ 45 tonnes/ha.		29.33
Levels of P_2O_5		
P_1 33.3 kg. P_2O_5/ha.		21.88
P_2 66.7 kg. P_2O_5/ha.		24.78
P_3 100.0 kg. P_2O_5/ha.		29.77
Control		13.66
	S.Em. ±	0.56
	C.D. 5%	1.55

Confirmatory of last years results, the yield data above show a very pronounced linear responses of pigeon pea to both manure and phosphatic fertilization on a sandy loam soil of low fertility under rainfed conditions of farming. All yield differences are substantial and significant. Manuring at the first level increased the control yield of 13.66 q/ha. to 21.43 q/ha., the yield went up to a high of 29.33 at the third level. The use of phosphate at the three levels had about the same effects on yield. At the current prices of manure, fertilizer and pigeon pea, these yield responses are highly profitable at all levels of use. The fertilizer is relatively more profitable at any use level. It is estimated that at the highest level of application manuring will yield a net profit of about Rs.1100/ha. and fertilization about Rs.1400/ha. over and above the net gain from the control treatment.

The placement method of application yielded significantly higher than the broadcast method this year only. Last year the difference was very small but significant and in favour of broadcast application. This year a hard clay pan was found over most of the experimental site at a depth varying from 15 to 25 cm. May be, breaking of this pan under the placement method benefited the crop receiving this treatment.

A significant interaction between manure and phosphate was also observed this year. This is shown below:

Levels of manure	Grain yield (Q/ha.) Levels of P_2O_5			
	P_1	P_2	P_3	
F_1	15.98	19.66	28.76	
F_2	23.21	25.21	28.44	W.Em. ± 0.93
F_3	26.44	29.66	31.98	C.D. 5% 2.57

Control yield 13.66 q/ha. ± 0.93

The maximum yield of 31.98 q/ha. was obtained under F_2 P_3 and was significantly superior to all combinations except F_3 P_2. However, the yield of 28.76 q/ha. from F_1 P_3 was found to be the most remunerative in economic terms.

Table 113. Effect of micronutrients on the yield of pigeon pea (T.21)

	Treatments	Average grain yield (Q/ha)
1.	Control	18.21
2.	50 kg. N + 100 kg. P_2O_5/ha.	25.47
3.	2 above + Iron @ 20 kg./ha. (as $FeSO_4$ $7H_2O$)	27.54
4.	" " + Zinc @ 15 kg/ha. (as $ZaSO_4$ $7H_2O$)	23.39
5.	" " + Copper @ 10 kg/ha. (as $CuSO_4$ $5H_2O$)	24.73
6.	" " + Boron @ 1 kg/ha. (as $Na_2B_4O_7$ $10H_2O$)	25.02
7.	" " + Molyodenum @ 250 gm/ha (as Na_2MoO_4 $2H_2O$)	25.62
8.	" " + Manganese @ 15 kg/ha. (as $MnSO_4$ H_2O)	22.06
9.	" " + Spartin @ 30 kg/ha.	24.58
10.	" " + Nutramin @ 10 kg/ha.	23.54

The above are average value of two replicates only as the crop in the other two replicates was completely wiped out by wilt and phytophthora. The applications of iron at the rate of 25 kg/ha. appears to have benefited the crop yield by about 2 q/ha. over and above the effect of fertilization but this apparent improvement has no statistical validity.

Exploratory plantings of arhar-mung and arhar-urid mixture

Since arhar is planted in rows 75-100 cm. apart and its initial growth for sometime does not fully cover the surface in between the rows, it is but expedient that this space be used for growing a short term variety of mung or urad. This attempt was made during the Kharif season of 1969 and the results of a non-replicated trial are summarised below:-

(a) Arhar (T.21) - mung (T.2) mixture:

1. Date of planting:	5th August, 1969
2. Date of harvesting:	Arhar: 4.12.69 (121 days to maturity) Mung: 9.10.69 (65 days to maturity)
3. Average grain yield:	Arhar: 25.76 q/ha. Mung : 8.10 q/ha.
4. Average total grain yield:	33.86 q/ha.

(b) Arhar (P4785) - mung (T.2) mixture

1. Date of Planting:	5th August, 1969
2. Date of harvesting:	Arhar: 14.1.70 (162 days to maturity) Mung: 9.10.69 (65 days to maturity)
3. Average grain yield:	Arhar: 26.80 q/ha. Mung : 8.83 q/ha.
4. Average total grain yield:	35.63 q/ha.

(c) Arhar (T.21) - urd (T.9) mixture:

1. Date of planting:	5th August, 1969
2. Date of harvesting:	Arhar: 4.12.69 (121 days to maturity) Urad. 7.11.69 (94 days to maturity)
3. Average grain yield:	Arhar: 27.35 q/ha. Urad : 6.50 q/ha.
4. Average total grain yield:	33.85 q/ha.

(d) Arhar (P4785) - Urad (T.9) mixture

1. Date of planting:	5th August, 1969
2. Date of harvesting:	Arhar: 14.1.70 (162 days to maturity) Urad : 7.11.69(94 days to maturity)
3. Average grain yield:	Arhar: 26.67 q/ha. Urad : 7.90 q/ha.
4. Average total grain yield:	34.57 q/ha.

The above results show that the average yield of the two pulse crops in the mixture did not deviate much from normal yield obtained when sown as pure crops. The combined yield, however, was much higher than usually obtained from pure crops. The maximum yield of 35.63 q/ha. was obtained from Arhar (P4785) + Mung (T.2) mixture. In case of urad, the best yield of 34.57 q/ha. was given by the arhar (P4785) + urad (T.9) mixture. The land vacated by arhar (T.21) - mung (T.2) mixture has been sown to wheat (Sharbati Sonora) which is coming up well, and will be followed by summer mung, thus completing a sequence including four crops a year - three pulses and wheat.

Performance of late-sown arhar (Strain P4785)

This promising strain was planted at the I.A.R.I. farm as a general crop on 3rd August, 1969. The crop came up well, but considerable unevenness in maturity was observed. The crop had, therefore, to be harvested twice, first on 10th January, 1970 and second on 31st January, 1970. This crop was also planted with two row spacings of 50 and 100 cm. The average yield from 50 cm. row spacings amounted to 25 q/ha. and that from 100 cm. row spacings 16 q/ha. No wilt or Phytophthora disease was observed in the crop.

Mungbeans (Phaseolus aureus) and Urid beans (Phaseolus mungo)

Fertility-Inoculum experiments were conducted at Hissar, Kanpur, Ludhiana and Varanasi. Details of the experiments are the same as described for fertility-inoculum experiment in Arhar except the spacing which was 25 cm x 5 cm. Varieties tried, the same varieties were used as also mentioned in detail in the fertility-spacing experiments.

Trials at Kanpur were completely wiped out due to heavy and continuous rains. Data from Hissar and Ludhiana locations are collected, analysed and interpreted in the following pages.

At Hissar, with urid T-9 variety, effects due to N levels and interaction between P and K and NPK are statistically significant.

Table 114. Effect of different levels of N on yield (kg/ha) of Urid bean (Var. T-9) Hissar, Kharif, 1969.

Levels of N (kg/ha)	Yield kg/ha	
0	2663	ab
50	2846	a
100	2751	ab
Inoculum	2536	b

S.Em. ± 79 kg/ha.
C.D. 5% 219 "

Data in Table 114 indicate that 50 kg/ha of N significantly increased the yield of Urid as compared to inoculum treatment (2536 kg/ha). There was, however, no significant difference between 0, 50 and 100 kg/ha of N. in respect of yield of urid (Phaseolus mungo) as shown in Fig. 27.

PK interaction, as reflected in the yield of Urid (T-9) is presented in Table 115.

Table 115. Effect of different levels of P and K (kg/ha) on yield (kg/ha) of Urid (Phaseolus mungo) at Hissar, Kharif - 1969.

Levels of P (kg/ha)	Levels of K (kg/ha)		
	0	50	100
0	2522 bcd	2885 ab	2982 a
50	2795 ab	2622 bcd	2772 abc
100	2550 bcd	2755 a	2404 d
	S.Em. ± 119		
	C.D. 5% 329		

Data in Table 115 indicate that the highest yield of 2982 kg/ha was obtained with 100 kg/ha of K. In the absence of any P, the yields increased with increasing levels of K. The lowest yield of 2404 kg/ha was obtained with 100 kg/ha each of P and K. This shows that K has a depressing effect with increasing levels of P.

There was interaction between different levels of N, P and K, yields ranging from 2184 to 3153 kg/ha.

With the variety Jalgaon 781 (Phaseolus aureus) none of the effects were significant. The yields in different treatments ranged from 1369 kg/ha to 1675 kg/ha.

On Pulses Breeder's Block at Ludhiana a blanket application of Nemagon (60%) for control of nematodes at 7.5 gal./hectare and Brassicol (PCNB) for control of root rot and other fungal diseases at 20 kg per acre were made on a total areas of six acres. Nemagon was applied through irrigation water after calibration and Brassicol was applied broadcast.

At Ludhiana, growth in mung Hybrid-45 was good. Mung trial was planted on July 18, 1969 and harvested on November 5, 1969. Since the soil at Ludhiana is sandy, high doses of Nitrogen in one application would be subject to leaching. The 50 kg and 100 kg N per hectare treatments were applied as split applications in two doses - half at sowing and the other half five to six weeks after sowing. Effects due to interaction of N and P are statistically significant.

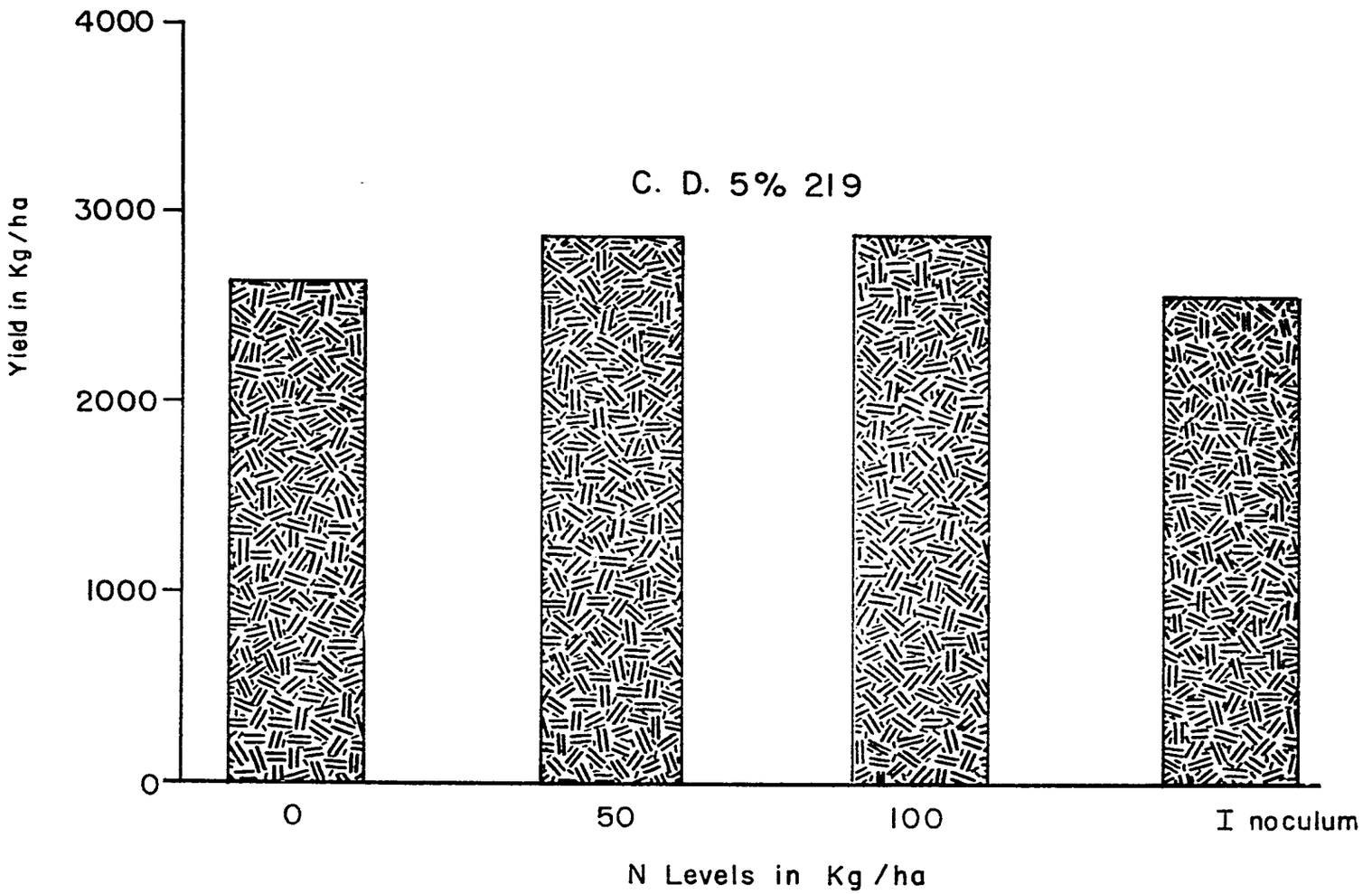

Figure: Effect of Nitrogen application on yield of Urid beans Var-T.9 in Kg/ha at Hissar Kharif 1969.

Table 116. Effects of different levels of N and P (kg/ha) on yield (kg/ha) of Mung (Phaseolus aureus) at Ludhiana, Kharif, 1969.

Levels of P (kg/ha)	Levels of N (kg/ha)			
	0	50	100	Inoculum
0	989 abcd	1016 abcd	1031 abcd	981 d
50	1050 abcd	1171 a	894 cd	1102 abc
100	1170 ab	1009 abcd	1111 abc	939 d

S.Em. ± 67

C.D. 5% 186

Data in Table 116 indicate that 50 kg/ha each of N and P on actual element basis has given significantly higher yield (1171 kg/ha) as compared to 100 kg N per hectare and 50 kg per hectare. Yield due to inoculum treatment plus 50 kg P per hectare (1102 kg/ha) were the same as the N_{50} P_{50} treatment. Increasing levels of P do not seem to have any significant effect on mung yield in the absence or presence of N.

In fertility-Inoculum experiment with Urid (Phaseolus mungo) var. No.64, effects due to different levels of N, P, K and the interaction between NP, NK and NPK were statistically significant. Yield as affected due to different levels of N, P and K are presented in Table 117.

Table 117. Effect of different levels of N, P and K (kg/ha) on yield (kg/ha) of Urid (Phaseolus mungo) at Ludhiana, Kharif - 1969.

Levels of N (kg/ha)	Yield (kg/ha)	Levels of P (kg/ha)	Yield (kg/ha)	Levels of K (kg/ha)	Yield (kg/ha)
0	2166 b	0	2406 ab	0	2395 a
50	2281 ab	50	2464 a	50	2561 a
100	2411 a	100	2212 b	100	2126 b
Inoculum	2584 a				
S.Em. ±	99		74		74
C.D. 5%	276		207		207

Data in Table 117 show that all the three nutrients had significantly affected yield of Urid (Phaseolus mungo). With nitrogen levels, 50 and 100 kg/ha were at par and significantly better than no nitrogen. There was no difference between no nitrogen treatment and nitrogen at 50 kg per hectare.

With regard to P levels, 50 kg P per hectare on actual element basis had given significantly higher yield (2464 kg/ha) as compared to 100 kg P per hectare (2212 kg/ha). In case of K also, 50 kg K per hectare on actual element basis had given significantly higher yield (2561 kg/ha) as compared to 100 kg K per hectare (2126 kg/ha).

Interaction effect of different levels of N and K are tabulated in Table 118.

Table 118 Interaction effect of different levels of N and K (kg/ha) on yield (kg/ha) of Urid (Phaseolus mungo) Var. No. 64 at Ludhiana, Kharif, 1969.

Levels of K (kg/ha)	Levels of N (kg/ha)			
	0	50	100	Inoculum
0	2137 cde	2581 b	2467 bc	2391 bcd
50	2427 bcd	2237 bcde	2455 bc	3124 a
100	1935 e	2025 de	2311 bcde	2235 bcde
			S.Em. ±	148
			C.D. 5%	411

Data in Table 118 reveal that inoculation plus K at 50 kg/ha has given significantly higher yield (3124 kg/ha) of urid as compared to other treatments. With increasing levels of K, nitrogen had a depressing effect on yield. Highest dose of potash (100 kg/ha) has given significantly lowest yield (1935 kg/ha) in the absence of any nitrogen.

Different levels of N and P and their interaction had significantly affected the urid (Phaseolus mungo) yield. Data of the same are presented in Table 119.

Table 119. Interaction of different levels of N and P (kg/ha) on yield (kg/ha) of urid (Phaseolus mungo) Var. No. 64 at Ludhiana Kharif - 1969.

Levels of P (kg/ha)	Levels of N (kg/ha)			
	o	5o	1oo	Inoculum
0	2428 bc	2241 bcd	2046 cde	2910 a
50	2277 bcd	2557 ab	2582 ab	2436 bc
100	1794 e	2045 cde	2605 ab	2404 bc
			S.Em. ±	148
			C.D. 5%	411

Data in Table 119 show that inoculation without any P has given the highest yield of urid (2910 kg/ha) as compared to any other treatment. Inoculation has a depressing effect with increase in the levels of P. In the absence of any nitrogen, increasing levels of P seem to be depressing effect on the yield of urid (P_o- 2428 kg/ha and P_{1oo}- 1794 kg/ha). Similarly without any P, increasing levels of N had shown reduction in yield from 50 kg N per hectare (2241 kg/ha) to 100 kg N per hectare (2046 kg/ha). Increasing levels of both N and P seem to have additive effect in respect of yield of urid in kilogram per hectare. There was interaction of different levels of N, P and K, yields ranging from 1451 to 3906 kg/ha.

At Jabalpur, the fertility-inoculum experiment for mung bean (Phaseolus aureus) and urid beans (Phaseolus mungo) was modified. Design of experiment, treatments and number of replicates were the same as described for pigeon pea (fertility-inoculum experiments). Gross plot size was 4.0 Mx2.4 M. Between row spacing for mung and urid was 30 cm. and within row spacing was 10 cm. For mung beans variety Hybrid 45 and for urid beans variety Khargaon 3 were tested. Mung beans were sown on June 27. First picking was done on September 13, 1969 and harvested on October 10, 1969. Urid beans were planted on June 28, 1969 and harvested on September 23, 1969.

During August, due to very heavy rains, both mung and urid suffered a set back and knee deep water was standing in the field for a pretty long time. That is why the growth and yield were poor. None of the effects were statistically significant in neither mung (Phaseolus aureus) nor Urid (Phaseolus mungo) experiment. Mung trial had two pickings - first on September 13 and second on October 10, 1969 - were taken. In mung experiment the yields ranged from 391 kg/ha. with 25 kg. N/ha plus 100 kg per hectare to 927 kg/ha with 25 kg N/ha plus 150 kg per hectare. Both these treatments received inoculum. In Urid trial the yields ranged from 608 kg/ha. with 25 kg N per hectare to 1022 kg per hectare with 150 kg P per hectare and inoculum.

At Delhi location, fertility - inoculum and fertility - spacing experiments on mung beans and urid beans were modified and combined in one experiment as fertility-spacing-inoculum trial. This was done to accommodate all the trials in the area available. The fertility and spacing treatments were the same as described under fertility-spacing and fertility-inoculum experiments for mung beans and urid beans.

In mung beans (Phaseolus aureus) var. T-2, effects due to between and within row spacings were statistically significant. Data of the same are tabulated in Table 120.

Table 120. Effects due to between row and within row spacings (cm.) on yield (kg/ha) of mung beans, Delhi, Kharif, 1969.

Within row spacing (cm.)	Between row spacing (cm.) 15	25	35
2.5	1197 a	912 bcd	845 cd
5.0	1096 ab	896 bcd	1027 abc
7.5	956 bcd	815 bcd	786 d

S.Em. ± 75 kg per ha.
C.D. 5% 219 "

Data in Table 120 indicate that the highest yield of 1197 kg/ha. was obtained with 15 x 2.5 cm. spacing and was significantly better than the yield in 25 x 2.5 cm. spacing (912 kg/ha.) and in 35 x 2.5 cm. (845 kg/ha.). As the within row spacing increased, there was gradual decrease in yield in 15 cm. and 25 cm. row spacing.

Further splitting of the main treatment (Between and within row spacing) show that the effects due to between row spacings are highly significant. Data are presented in Table 121.

Table 121. Effects due to between row spacing (cm) on yield (kg/ha) of Mung beans (Phaseolus aureus), Delhi, Kharif, 1969.

Between row spacings (cm.)	Yield (kg/ha.)
15	1084 a
25	874 b
35	886 b

S.Em. ± 43 kg.per ha.
C.D. 5% 120 "

Data in Table 121 show that 15 cm. row spacing treatment has given significantly higher yield (1084 kg/ha and 886 kg/ha) than 25 and 35 cm. row spacing treatments (874 kg/ha and 886 kg/ha) respectively. The latter two treatments were at par.

Effects due to different fertility levels were also statistically significant. Data are shown in Table. 122.

Table 122. Effects due to different fertility levels (kg/ha) on actual element basis on yield (kg/ha) of Mung beans (Phaseolus aureus), Delhi, Kharif, 1969.

Fertility level (kg/ha on actual element basis each of N,P,and K)	Yield of Mung beans (kg/ha)
0	915 b
50	1010 ab
100	1087 a
Inoculum	779 c

S.Em. ± 45 kg/ha.
C.D. 5% 124 "

Data in Table 122show that the yields of Mung beans increased with increasing level of fertility. Inoculum treatment has given the lowest yield of 779 kg/ha. Yields due to 50 and 100 kg/ha were statistically at par (1010 kg/ha. and 1087 kg/ha). However, yields due to 100 kg/ha. treatment were significantly superior than no fertilizer treatment (915 kg/ha.).

In case of Urid beans (Phaseolus mungo) Var. T-9, effects due to between row and within row spacings were statistically significant. Data pertaining to the same are presented in Table 123.

Table 123. Effects due to between row and within row spacings (cm.) on yield (kg/ha) of Urid beans (Phaseolus mungo) Var. T-9, Delhi, Kharif, 1969.

Within row spacing (cm.)	Between row spacing (cm.)		
	15	25	35
2.5	1236 a	1069 ab	1029 ab
5.0	1240 a	1000 ab	1159 ab
7.5	1032 ab	1064 ab	934 b

S.Em. ± 89 kg. per ha.
C.D. 5% 261 "

Date in Table 123indicate that the highest yield of 1236 kg. per ha. was obtained from 15 x 2.5 cm.spacing and the lowest yield (934 kg/ha) was from 35 x 7.5 cm. spacing.

At Varanasi, in fertility-inoculum trials on mung beans (Phaseolus aureus) and Urid beans (Phaseolus mungo), interaction of different levels of N,P and K is significant. In mungbeans, yields ranged from 293 to 534 kg/ha. and in Urid beans from 231 to 697 kg/ha.

Chemical Weed Control (Delhi)

A chemical weed control trial was conducted at Delhi during Kharif 1969 to (a) assess the losses due to unrestricted weed competition in three important Kharif pulses, viz; Mung beans (Phaseolus aureus), Pigeon pea (Cajanus cajan) and cowpea (Vigna sinensis) and (b) to study the tolerance of these pulse crops to Treflan (trifluore 26-dinitre, N.N. dispropyl -p-toluidine) at 0.5 and 1 kg. per hectare; Eptam (5-Ethyl dipropyl-thiocarbamate) at 1 and 2 kg per hectare, treflan + Eptam at 0.5 + 1 kg/ha. and 1+2 kg per hectare, Lasso CP 50144 (2-Chloro-2', 6 - diethyl - N - (methoxymethyl) acetanilide at 2.5 and 5 kg. per ha. Treflan + Lasso at 0.5 + 2.5 and 1+5 kg. per hectare; knoxweed (5-Ethyl dipropyl thio carbamate 46.9% + iso-octyl ester of 2, 4-D 35.4%) at 1 and 2 kg. per hectare and Daconate at 0.5 and 1 pint per acre (as post-emergence spray). Hand weeding and no weeding were also included as check treatments. The sixteen treatments consisting of five herbicides at different doses and combinations were laid out in a randomised block design with four replicates. Pigeon pea and cowpea were sown in between mung beans for toxicity studies only. Mung beans were sown 50 cm. apart in a plot size of 4.0 M x 3.6 M.

Requisite amounts of herbicides, except daconate, were sprayed before the final cultivation and incorporated into the soil with a roto-tiller. Immediately there was a very heavy downpour, and hence the crop was sown after about a week.

Observations showed that except in knoxweed treated plots the emergence of these pulse crops was not affected by the herbicides treatment.

Data in Table 124gives an idea of weed population count taken from five random spots in each plot.

Table 124. Weed Population count per one square meter (Total in all the four replicates)

Treatment	Nutgrass	Other monocots	Dicot	Total weed population
Treflan 1 *	114	25	27	166
Treflan 2 *	101	2	27	130
Eptam 1	71	46	41	158
Eptam 2	89	29	34	152
Lasso 1	51	62	15	128
Lasso 2	39	57	22	118
Knoxweed 1	101	54	29	184
Knoxweed 2	72	59	30	161
Daconate 1	21	33	25	79
Daconate 2	32	41	13	86
Treflan 1 + Eptam 1	49	-	23	72
Treflan 1 + Eptam 2	85	1	25	111
Treflan 1 + Lasso 1	27	1	12	40
Treflan 1 + Lasso 2	23	1	3	27
Hand weeding	-	-	-	
No weeding	96	71	32	199

* 1 and 2 are low and high doses respectively.

Data in Table 124indicate that Treflan + Lasso at both low and high concentrations and Treflan 1 + Eptam 1 were most effective in reducing weed infestation. The weed population under these treatments ranged from 27 to 199.

Crop injury rating due to various herbicides to Mungbean, Cowpea and Pigeon pea was done one month after planting. Data are presented in Table125 .

Table125. Crop injury rating of various herbicides to Mungbean (Var. T-2) Cowpea (NP2) and Pigeon pea (T-21) one month after planting, Delhi, Kharif, 1969.

Treatment	Rate (kg/ha)	Mungbean	Cowpea	Pigeon pea
Treflan	0.5	0.9	3.4	2.4
Treflan	1.0	0.7	2.9	2.5
Eptam	1.0	0.9	2.1	2.4
Eptam	2.0	0.8	3.0	3.2
Lasso	2.5	1.0	2.6	2.3
Lasso	5.0	0.7	3.2	2.2
Knoxweed	1.0	0.8	3.0	2.7
Knoxweed	2.0	1.0	2.6	1.9
Daconate	0.5 pints/ac. (Pe)*	X	Toxic to plants and weeds too.	
Daconate	1.0 " " "	X	" " " " "	
Treflan + Eptam	0.5 + 1	0.8	2.2	2.7
Treflan + Eptam	1.0 + 2.0	1.1	2.3	2.2
Treflan + Lasso	0.5 + 2.5	1.2	3.2	1.9
Treflan + Lasso	1.0 + 5.0	1.6	3.4	4.0
Hand weeding	-	0	0	0
No weeding	-	0	0	0

* Post emergence: 0=No injury, 1-3=Slight, 4-6=Moderate, 7-9=Severe,10=Death.

Data in Table 125showed that in all crops except daconate all other herbicides caused slight to moderate injury. During Kharif 1968, the injury was more, since the doses were high. This year the injury is less because the doses were reduced to a great extent. In general Treflan + Lasso at higher dose had shown some toxic effect in pigeon pea, and cowpea.

Yield data of these crops were not collected because of disease incidence at a later stage in the season.

Pigeon Pea

Dates of planting - cum plant population trial.

An experiment to study the effect of different dates of planting and plant population was studied on pigeon pea (Var. T-21) at Chhattarpur, a village south of Delhi on land provided by DLF, Hyderabad, Jabalpur and Pantnagar during Kharif, 1969. The object of this study was to assess the optimum date of planting, plant population and row spacing for arhar (T-21) at different locations. At Pantnagar this experiment was initiated in Kharif 1969 and at other locations during Kharif 1969.

Planting dates were 15th May, 5th June, 20th June, 5th July, and 20th July. Plant populations were 40,000, 50,000 and 60,000 plants per hectare. Row spacings were 75 cm. and 100 cm. A split plot design with three replications was used with dates of planting as main plot treatments and plant population as sub plot treatments. A uniform fertilizer dose was applied.

At Hyderabad the last date July 20, 1969 was rejected since there was no yield. However, date pertaining to four dates are presented in Table 126.

Table 126. Effect of date of planting on flowering, maturity and yield (kg/ha) of Arhar (T-21), Hyderabad, Kharif - 1969.

Treatment	Days to flower	Days taken from flowering to maturity	Days to maturity	Yield (kg/ha)
May 16, 1969	79	68	147	1663 a
June 5, 1969	83	55	138	1243 b
June 20, 1969	71	52	123	532 c
July 5, 1969	72	26	98	415 d
			S.Em. ±	16
			C.D. 5%	56

Data in Table 126 show that the yields of pigeon pea (Var. T-21) differences were highly significant in different dates of plantings. With subsequent sowing dates the yields were reduced. Data further indicate that as the planting dates were delayed, the number of days to maturity of the crop was also re uced, (147 in the first date to only 98 days in the fourth date of planting). However, there was no much difference in the number of days to flowering from each sowing date. The number of days taken from flowering to maturity reduced considerably with each date. The reduced number of days from flowering to maturity in each date might have reflected in significant reduction in yield. Thus pigeon pea variety T-21 appears to be sensitive to temperature and photoperiod. There was no significant difference in different plant populations under study.

At Jabalpur location, out of three replicates, one replicate was completely washed out due to heavy and continuous downpour during the month of August 1969. Statistical analysis of the data, therefore, was based on two replicates only. Days taken to flowering and maturity, besides yield are tabulated in Table 127.

Table 127. Effect of date of planting on flowering, maturity and yield (kg/ha) of arhar (T-21) Jabalpur, Kharif, 1969.

Treatment	Days to Flowering	Days taken from Flowering to Maturity	Days to Maturity	Yield (kg/ha)
May 20, 1969	107	58	165	1376
June 5, 1969	91	55	146	1202
June 20, 1969	79	64	143	1008
July 5, 1969	75	59	134	760
July 20, 1969	Did not flower at all. Hence no yield			
			S.Em. ±	157 kg/ha.

Data in Table 127 indicate the same trend of reduction in yield as at Hyderabad with the advancement of each sowing date, though statistically not significant. The number of days taken to flowering and maturity reduced gradually. Since there was no much difference in the number of days from flowering to maturity, the yields of pigeon pea might not have differed much and this might be one reason for not getting any significant differences in different dates of planting. The varying plant populations under study did not differ significantly.

At Chhattarpur (Delhi), data from all the planting dates and replicates were recorded and presented in Table 128.

Table 128 Effect of date of planting on flowering, maturity and yield (kg/ha) of arhar (T-21) Chhattarpur (Delhi), Kharif, 1969.

Treatment	Days to flowering	Days taken from flowering to maturity	Days to Maturity	Yield (kg/ha.)
May 16, 1969	95	84	179	2574
June 5, 1969	92	71	163	3308
June 20, 1969	86	70	156	2306
July 5, 1969	78	74	152	3658
July 20, 1969	72	76	148	2674
			S.Em. ±	604 kg/ha.

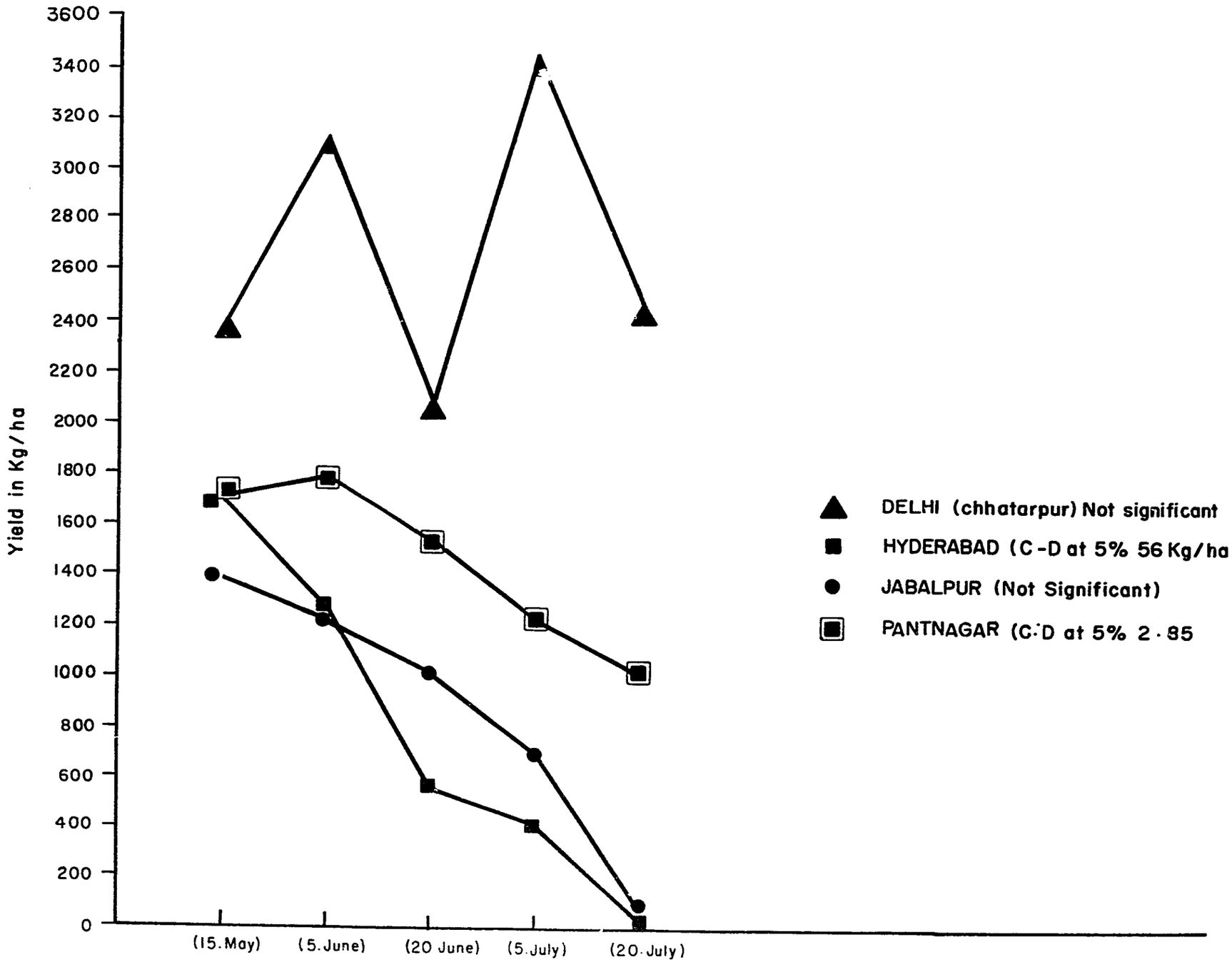

Fig. Effect of dates of sowing on yield of Pigeon peas — variety - T-21 - Kharif - 1969

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Data in Table128from Chhattarpur location indicate that the pigeon pea yields were statistically at par. However, the number of days taken to flowering and maturity reduced gradually from first date of planting (May 16) to the last date of planting (July 20). In the first, second and third dates, there was lot of flower shedding in late September because of rains and in third replicate, there was lot of attack of phytophthora disease, particularly in the corner plots. Severe attack of pod borers was also noticed in the first three dates of planting. The crop in the fourth (5th July) and fifth (20th July) dates of planting was relatively free from flower shedding and insect attack. These could be the two probable reasons for not getting any significant response in different dates of planting. Differential plant population also did not show any significant response in respect of pigeon pea yields. These data are presented in Fig.

Salt tolerance studies at germination of pulses:

Procedure -

Sandy loam soil was collected from field and air dried. The soil was then passed through 2 mm sieve and then mixed thoroughly to provide homogeneity. Enough such soil was prepared so as to last throughout the experiment. 100 grams of above soil was added to plastic petri-plates (100x15 mm). Ten seeds per plate were sown and 20 ml of various salt solutions were added. Distilled water was used as control. The solutions used were:

Salt solution	:NaCl g/litre	:CaCl2 g/litre	:Total g/litre	:EC in mmhos/cm.
S_1	1.7	1.7	3.4	4
S_2	3.4	3.4	6.8	8
S_3	5.1	5.1	10.2	12
S_4	6.8	6.8	13.6	16

As four replicates for each salt concentrations were used the number of seeds per treatment was 40. These petri-plates were then transferred to a germinator maintained at 30° C. The germination count was taken 24 hours after planting.

Table 129. Percentage germination after 24 hours in various mung varieties.

Variety	Control	S_1	S_2	S_3	S_4
T_2	100	97	97	29	70
T_{51}	100	100	100	100	100
T_{45}	100	95	95	92	92
Jalgaon-781	100	100	100	100	100
Hyb.-45	100	100	105	105	100
B-1	100	100	102	97	97
T-44	100	100	100	100	100
Kopergaon	100	97.5	100	100	100
24-2	100	102	100	100	100
RS-4	100	100	89	79	80

There was no difference in the rate of germination, and whatever insignificant differences were observed after 24 hours disappeared in another day so that the germination was hundred per cent after 48 hours. However, there was negative correlation between the rate of growth and salt concentration. After 48 hours the seedlings in control were about 4 cms. tall with 1st leaf unfolding where-as in S_4 the cotyledons were still confined within the soil or even seed coat.

Table 130. Percentage germination after 24 hours in some pigeonpea varieties.

Variety	Control	S_1	S_2	S_3	S_4
S-103	100	103	72	44	39
NPWR-15	100	95	97	87	20
Udgir	100	111	103	42	39
NP-82	100	74	47	18	0
ST-1	100	100	86	71	63
N-84	100	97	95	90	38

There was marked inhibition in germination of pigeonpea seeds after 24 hours, but here again complete germination occurred after 48 hours.

PLANT PATHOLOGY

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SUMMARY

Chickpea - Blight - Three potential sources of resistance to blight have been identified in the chickpea germplasm collection. Crosses between susceptible and resistant lines have been made, but no evaluation of the F_2 is available.

Treating soil with several fungicides, nematicides and insecticides resulted in better vegetative growth of chickpeas at Delhi but not in increased yield.

After two years testing, 25 chickpea lines have been identified as having resistance to chickpea wilt at Hissar.

Cowpea - An outbreak of *Cercospora cruenta* on cowpea occurred at New Delhi when a planting was irrigated 3 times in 4 days. The disease was present but not serious on unirrigated cowpea. Repeated sprinkler irrigation was effective in forming epiphytotic conditions.

An apparently new virus disease, causing a vein-banding of cowpea was mechanically transmitted to cowpea but not to several other test plants. Seed transmission in cowpea was suspected.

Mung - Soil insecticides, but not nematicides, increased yields of mungbean at New Delhi.

The mungbean germplasm was evaluated for resistance to yellow mosaic, Cercospora leaf spot and bacterial blight. Resistance to the three diseases was found.

Urid - A number of uridbean lines were resistant to yellow mosaic virus under severe test conditions.

Leaf crinkle was transmitted mechanically from diseased to healthy plants, indicating that the disease is virus-induced. Resistance has been found and reported in previous RPIP Progress Reports.

A virus disease of urid, found in Uttar Pradesh in 1968, was seed and mechanically transmissible. It caused local lesions on snap bean, so is probably not Bean Common Mosaic Virus, which has been reported in India on uridbean.

Pigeon pea - stem blight - Extensive tests are reported for Phytophthora stem blight of pigeon. Irrigation increased disease incidence at New Delhi. Six lines from the germplasm were found to have relative resistance to stem blight. Disease reactions following inoculation with the stem blight pathogen are reported for about 175 cultivars and lines.

Fusarium wilt - Pathogenicity of 34 isolates of the pathogen was tested on several varieties. The results show that there is an interaction between varieties and isolates. Isolates that were highly pathogenic to all resistant varieties were found, indicating the need for development of varieties by combining sources of resistance.

Papers

1. Phytophthora stem blight of *Cajanus cajan*. By Williams, Amin and Baldev. Submitted to *Phytopathology*.

2. Distinguishing between Phytophthora stem blight and Fusarium wilt of pigeon pea. By Williams. Prepared, to be submitted to *FAO Plant Protection Bull*.

3. An outbreak of angular leaf spot of irrigated cowpea in India. By Amin, Baldev and Williams. Prepared, to be submitted to *Plant Disease Reporter*.

Cicer arietinum (Chickpea)

Blight - In 1969 two lines of chickpea (Accession numbers 12-074-06625 from Israel and 12-100-01528 from Moracco) were most resistant to blight caused by Ascochyta rabiei when 160 lines of germplasm were inoculated with pathogen cultures from 60 varieties at New Delhi. We crossed --- 6625 with 12-069-00629 (Punjab 7) an old variety with no known resistance to blight. The resultant seed was grown in the glasshouse in Iran and not tested for blight resistance. The seed produced by the F 1 plants was given to the Division of Mycology and Plant Pathology at IARI.

Blight has been a major deterrent to chickpea production for many years. Apparently the earliest resistance came from "F8" (our accession 12-069-00637) a variety obtained from France, where it had been obtained from the U.S. F8 was crossed with Punjab 7. C-235 (12-069-00631) is one of several varieties developed in India and Pakistan containing blight resistance from F8. By 1968 it was obvious that the resistance from F8 has failed, suggesting a new race of pathogen.

Recently, 3 potential sources of new resistance have been identified. Solel and Kostrinski (Phytopath. Mediterranea 3:119-120) reported variety "Bulgarian" (accession 12-074-06628) immune to blight, and we have found the resistance mentioned above. The complete germplasm collection has never been screened for other sources of blight resistance. The collection should be planted in an area where blight epiphytotics occur every year. Punjab 7 (no resistance) and C-235 (res. from F8) should be interplanted to host different races. A crossing program, using resistance from as many sources as available, should be started to develop varieties with multi-gene resistance.

A poor alternative is to combine the known sources of resistance (-00637, -01528, -06625, -06628) in an acceptable variety. If the parents and progenies are tested for resistance to specific isolates the races can be identified and the genetics of resistance can be learned.

Nematicide treatment -

In cooperation with the Department of Nematology, IARI, we treated a suspected nematode-infested field with 1, 2 and 3 gal/A of Nemagon and with 10, 20, 40 and 60 gal/A of DD. Nemagon was applied in irrigation water and DD by soil injection on 1 ft. centers on Oct. 18, 1968. Cultivar Bonneville of pea, T-1 mung, T-21 pigeon pea, NP53 chickpea and 9-12 lentil were planted one month after treatment. Pigeon pea and mung did not grow well. Pea, chickpea, and lentil showed phytotoxicity of DD at 60 gal/A. There was no other effect noted.

Chickpea - Soil treatment -

The effect of soil fungicides, insecticides, and nemat cides on chickpea (NP.58) was tested in a RCB trial at New Delhi. The data are in Table 131.

Table 131. - Effect of soil treatment on yield of chickpea at New Delhi.

	Treatment	Rate (actual)	Yield kg/plot
1.	Control	-	4.4
2.	Brassicol	18.5 kg/ha	4.6
3.	Thiram	19 "	4.6
4.	Captan	21 "	5.1
5.	Zineb	18.5 "	4.9
6.	Methyl Bromide	453 g/9.75 sq.m.	5.7
7.	Temik	10 kg/ha	4.6
8.	Temik + Brassicol	10 kg+18.5 kg/ha	4.7

Treatments except methyl bromide were applied on October 29 and the area rotovated. Methyl bromide was applied on October 30 and NP 58 seed planted on November 4. Methyl bromide treatment resulted in excellent weed control. Plants in methyl bromide treated plots grew faster, had longer internodes and larger leaflets than controls. There was no evidence of phytotoxicity of methyl bromide to chickpea at the rate used, which is in sharp contrast to our experience with methyl bromide phytotoxicity to other pulse crops.

The plots were harvested on April 9 to clear the field. At the time of harvest the plants had dried in all plots except those treated with methyl bromide, wherein the plants were still growing. There were no significant differences in yields. Chickpea wilt did not develop in this test.

Chickpea wilt:- In 1967/68 225 lines from the chickpea germplasm collection were selected at Hissar for field resistance to wilt. These were planted in 1968 at Delhi and Hissar. At Delhi they died from salinity, but at Hissar, with the kind cooperation of Dr. Satish Chandra, an evaluation of wilt resistance was made. Plants having the following accession numbers had notable resistance to wilt (cause unknown) at Hissar:

12-069-00426	12-069-01226	12-071-03703	12-071-04441
12-069-00516	12-069-01636	12-071-03887	12-071-04492
12-069-00589	12-071-02149	12-071-04404	12-071-04537
12-069-00654	12-071-02199	12-071-04405	12-071-04591
12-069-00658	12-071-02464	12-071-04421	12-071-05059
12-069-00664	12-071-02652	12-071-04422	12-071-05084
12-069-00790	12-071-02692		

Lines 426, 1636, 4405, 4421 and 5084 had relatively better pod set.

All the above lines should be tested in wilt-sick plots or sections of fields where wilt is a known problem. They should be tested for resistance to a known pathogenic culture of *Fusarium orthoceros*.

Vigna sinensis (cowpea)

Seed treatment - An unknown cultivar of cowpea seed was purchased from the market and portions treated with Ceresan-M, Arasan, Captan, Brassicol, Copper carbonate, Demosan, Panogen-15, Rhizoctol, Vita-vax and left untreated. The treated seed was planted at IARI on Aug. 19 . Germination ranged from 83 to 95%. No treatment differed significantly from the control, which had 93% germination. Considering previous results, and the dependency of germination on very localized conditions, the recommendation of treating cowpea seed with Captan or a similar fungicide should be made.

Angular leaf spot - The seed treatment trial of cowpea (cultivar unknown) was sprinkler irrigated from 4 P.M. to dusk 3 times in 4 days while the plants were flowering in early October. An angular leaf spot disease spread rapidly in the planting and soon caused complete defoliation of the plants. Yield was nearly nil. The leaf spots were 7-10 mm diameter, sometimes restricted by leaf veins, chocolate to dark brown in color, first visible on the lower surface and without a holo of chlorotic tissue. When the spores were scraped from the diseased leaves, placed in water and brushed on healthy leaves, the disease symptoms appeared on the inoculated leaves. The symptoms resemble those of angular leaf spot of Phaseolus vulgaris, but the pathogen is Cercospora cruenta sacc. Specimens have been sent to CMI and given the number IMI146445. Fig. 29.

The disease was serious only in the irrigated planting of cowpea, but was present on the older leaves of cowpea in a planting that had not been irrigated. The pathogen may be seed-borne. This disease may be a serious threat to cowpea in India during rainy periods or if sprinkler irrigation is used.

Testing cowpea germplasm collections for resistance to Cercospora cruenta by inoculation requires culturing the pathogen, is laborious and often fails if environmental conditions are not conducive to disease development. Dense plant populations, interplanting of known susceptible cultivars, and timely, successive, sprinkler irrigations could be used to develop epiphytotic conditions for this disease.

Virus - An apparently new virus disease was seen on a few lines of cowpea at New Delhi. The striking symptom is a vein-banding (F . 30). The pathogen was mechanically transmitted to cowpea cultivars Blacke, 7, and K-14. Tobacco, (white Burley) tomato, Nicotania glutinose, petunia, Chenopodium amaranticolor, and Cucumber (Natl. pickling) were inoc., but no symptoms developed. On cowpea, vein clearing was followed by vein banding. The distribution of the diseased plants in the field suggested possible seed transmission.

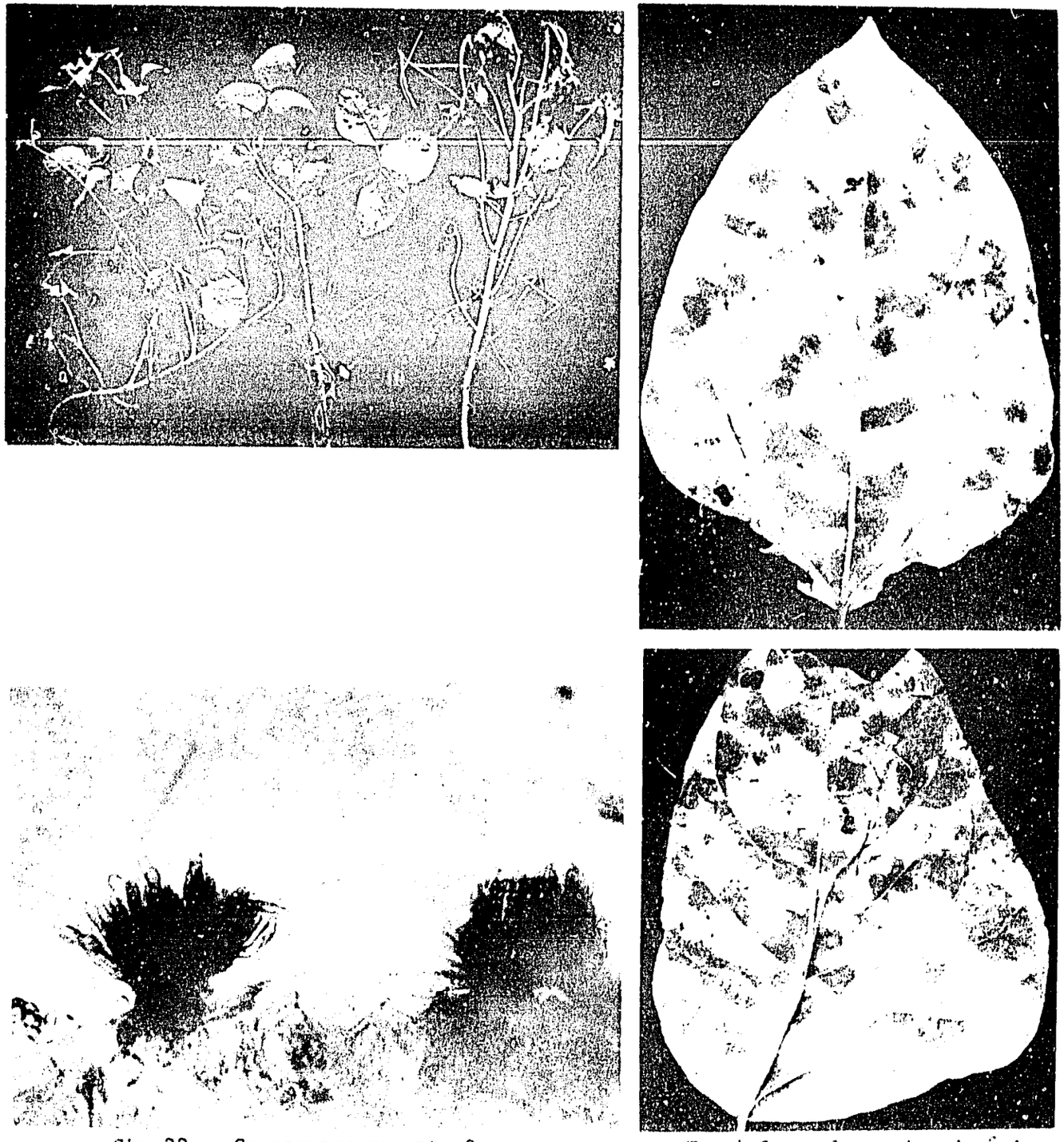

Fig. 29 . Cercospora cruenta Sacc. on cowpea. Top left - plants in advancing stages of defoliation. Top and lower right, - symptoms on leaflets. Bottom left - conidiophores emerging from leaf tissue.

Fig. 30 . Unknown, mechanically transmissable virus on cowpea. Symptoms on 3 leaves of same plant.

Phaseolus aureus (Mung)

Soil insecticide and nematicide test - In 1968, application of granular formulations of systemic insecticides for flea beetle control caused an unexplained growth response in mung (see pp. 214 of RPIP Progress Report No. 6, 1968). Some of the insecticides used were known to have nematicidal properties. The field had fairly high nematode populations, so we designed a test to learn whether the growth response was from nematode control.

We treated soil with 2 systemic insecticides (one a known nematicide), 2 common nematicides, one fungicide and one soil fumigant. We used the same area of the field that had been used in 1968. The plot design was a latin square, plots were 10x13 ft. and row spacing 20" The dry materials, pentachloronitrobenzene (PCNB), Temik and Disyston were distributed on the plot surfaces and the entire area rotovated about 5 in. deep. DD and Nemagon were then injected on 1 ft. intervals and the methyl bromide applied under sealed platic covers. The plastic covers were removed after 48 hours. The plot was planted to mung cultivar T-2 on August 4, 50 days after treatment.

Treatment with methyl bromide resulted in phytotoxicity, although the rate was low and planting was fifty days after treatment. Treatment with Disyston resulted in most rapid plant growth. The effect was obvious within 2 weeks after planting. Yellow mosaic virus incidence was high and there were no differences in YMV incidence among treatments. Plots were harvested on November 14 and the data are in Table132.

Table 132. Effect of soil treatment on yield of mung (T-2) at New Delhi in 1969.

Material	Rate (actual)	Yield (lbs/A)
Disyston	15 lbs/A	482* a
Temik	15 lbs/A	454 a
Nemagon	2 gal/A	399 b
Control	-	388 b
DD	30 gal/A	351 b
Methyl bromide	0.8 lbs/100 sq. ft.	343 b
PCNB	27 lbs/A	284 c

* Means followed by a common letter are not different at the 5% level according to Duncan's multiple range test.

Treatment with nematicides (Nemagon, DD or methyl bromide), did not increase yield in comparison to the control, but treatment with systemic insecticides (Disyston and Temik), increased yield. PCNB treated plots did not show phytotoxicity and the apparent reduction in yield by PCNB is unexplained. All yields were low because of the high incidence of yellow mosaic virus. Resistance to yellow mosaic virus is essential for acceptable yields of either mung or urid where YMV is a problem.

Seed treatment - Seed of mung cultivar T-2 was treated with several fungicides (see *Vigna sinensis* seed treatment) and planted at Delhi. No treatment resulted in germination different from the control, although mean germination varied from 63 to 88%.

Germplasm evaluation for disease resistance -- The mung germplasm was planted at Ludhiana by Dr. K.B. Singh. With his kind cooperation we evaluated the material for disease resistance during the first week of Oct. 1969. Yellow mosaic virus, Cercospora leaf spot caused by *Cercospora canescens*, and bacterial blight (Xanthomonas) were rated, but bacterial blight was less severe than the other rated diseases. The data are presented in Table133. Fig. 31 shows the symptoms of Cercospora leaf spot.

Table 133. Disease ratings of mungbean germplasm at Ludhiana in 1969.

Accession Number	Disease Index *			Accession Number	Disease Index *		
	Yellow mosaic	Cercospora leaf spot	Bacterial blight		Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-069-00001	3	5	3	48-069-00028	7	7	3
2	3	5	5	29	7	5	3
5	7	3	3	30	5	5	2
6	5	3	3	31	5	5	7
7	3	5	5	32	7	5	5
8	5	3	3	35	3	7	3
9	7	3	3	36	9	5	5
10	7	7	3	37	7	3	7
11	3	7	3	38	7	3	7
12	7	3	3	39	7	5	3
13	7	3	3	40	7	3	5
14	7	5	7	41	5	5	3
15	5	2	2	42	3	7	1
16	7	5	5	43	3	7	3
17	8	3	3	44	9	5	3
19	5	8	3	45	7	5	5
20	9	5	3	46	7	5	2
21	9	5	3	47	7	5	3
22	7	7	5	48	7	5	2
23	7	7	1	49	9	5	3
24	5	7	5	48-113-00050	7	9	3
25	5	5	5	51	9	7	5
26	7	5	5	54	3	9	3
27	3	7	5	55	3	7	2

* Explanation of disease index. 1 = no disease, 2 = trace, 3 = slight incidence and severity, 4-7 = increasing in incidence and severity, 8 = severe-very damaging, 9 = dead or nearly dead.

Accession Number	Disease Index: Yellow mosaic	Disease Index: Cercospora leaf spot	Disease Index: Bacterial blight
48-113-00056	7	5	2
57	5	5	2
59	7	5	2
60	7	5	2
61	9	5	3
63	7	5	1
64	7	5	1
65	7	3	5
66	7	5	3
68	3	5	2
69	7	5	3
70	7	5	3
71	5	5	2
72	4	7	2
73	7	5	3
74	7	5	3
78	8	7	3
79	7	5	2
80	7	7	5
81	5	5	3
82	7	5	3
83	7	5	7
84	5	5	3
48-033-00086	7	5	3
88	7	5	3
94	7	5	5
96	5	5	5
98	7	7	5
48-157-00100	7	7	7
101	5	5	3
102	7	3	5
118	3	7	3
48-019-00122	7	5	3
48-069-00123	9	7	5
124	9	7	5
125	7	5	3
126	9	5	5
127	7	7	5
128	7	7	3
130	7	5	3
131	3	7	2
132	9	7	2
134	9	7	5
135	2	5	1
136	9	9	-

Accession Number	Disease Index: Yellow mosaic	Disease Index: Cercospora leaf spot	Disease Index: Bacterial blight
48-069-137	7	7	5
138	9	-	-
139	9	-	-
140	9	-	-
141	3	5	2
143	7	5	5
146	7	9	5
148	7	5	3
149	3	5	3
150	9	5	7
153	7	5	2
154	8	3	-
155	7	7	5
156	3	5	-
157	9	-	-
158	4	2	2
159	9	-	-
160	9	-	-
161	7	5	3
162	9	7	-
163	9	7	-
165	9	5	5
166	9	-	-
168	9	-	-
169	7	5	2
171	3	1	2
175	7	9	1
176	9	5	-
178	7	5	-
179	3	5	-
181	7	7	-
182	7	5	3
188	9	-	-
190	7	9	-
196	9	-	-
197	3	3	-
200	7	5	5
206	9	5	5
207	7	7	3
48-113-210	9	9	-
211	9	-	-
212	7	5	5
213	3	3	2
214	3	3	2
48-002-215	9	-	-

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-002-00217	7	5	3
220	7	5	7
221	9	-	-
222	9	-	-
48-071-00224	9	-	-
48-002-00225	9	-	-
226	3	3	-
229	5	5	3
48-069-00230	9	-	-
231	9	-	-
232	9	-	-
48-157-00233	9	-	-
234	7	5	2
235	7	5	2
48-062-00236	9	-	-
48-157-00238	9	-	-
48-069-00240	5	5	2
241	7	5	3
48-090-00242	3	7	3
48-071-00244	3	5	2
246	7	7	5
48-072-00247	9	5	5
48-002-00248	9	9	-
249	9	9	-
250	9	9	-
251	9	9	-
252	5	7	2
253	3	2	1
254	9	9	-
48-002-00256	9	9	-
48-113-00257	9	7	2
258	9	-	-
259	9	7	-
48-069-00261	9	7	-
262	9	7	-
263	9	7	-
264	9	7	-
265	9	7	-
266	9	7	-
267	9	7	-
269	7	5	-
270	7	5	2
271	3	5	-
272	5	7	2
273	9	7	-

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-113-00274	9	7	-
48-082-00275	7	7	-
48-069-00276	7	7	3
277	7	5	3
278	7	5	3
48-076-00281	7	5	3
282	9	7	5
48-071-00284	7	5	3
285	7	5	3
287	9	7	3
48-113-00290	3	5	2
291	9	7	-
48-071-00292	3	5	2
293	3	5	2
294	9	7	3
295	4	7	3
296	9	7	3
297	9	7	3
298	9	3	7
299	7	7	5
300	9	5	7
301	3	2	2
304	9	-	-
310	9	-	-
316	9	5	3
319	9	7	3
48-069-00325	3	2	2
326	3	2	2
327	3	5	3
328	4	3	2
329	4	3	1
330	5	3	3
331	5	3	3
332	5	3	2
333	5	3	3
335	3	2	2
338	3	2	2
339	5	2	3
340	5	5	3
341	5	3	2
342	5	3	2
343	3	3	3
344	3	3	3
345	6	3	2
346	3	-	-

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-069-00349	4	3	2
351	7	3	2
352	3	3	3
353	7	4	5
355	3	3	2
356	6	5	5
358	7	5	2
359	7	5	2
360	5	5	2
361	5	5	3
362	5	3	2
363	5	5	2
364	3	3	2
365	3	3	2
366	3	5	2
367	3	3	2
369	3	3	2
370	3	3	2
371	3	2	3
372	5	3	2
373	5	3	2
374	3	3	2
375	7	3	2
378	3	3	4
48-157-00379	7	5	5
380	7	5	2
381	7	3	7
382	7	2	7
383	3	3	2
384	7	3	2
385	7	3	2
386	7	3	5
387	7	9	3
388	9	7	-
48-069-00389	5	5	2
390	5	5	2
391	7	9	5
392	3	2	2
393	3	1	1
394	7	7	3
395	7	7	5
396	7	9	5
397	7	7	5
399	4	7	5
400	3	7	3

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-069-00401	7	5	3
403	3	7	3
404	7	7	3
405	3	7	3
406	7	7	5
410	7	9	3
411	7	5	2
412	7	5	2
415	3	2	1
417	3	9	3
418	7	5	3
419	7	7	2
420	3	7	2
421	7	9	3
422	7	5	2
424	7	5	2
425	8	3	2
426	2	5	2
430	7	7	5
432	3	9	2
433	7	9	3
441	5	9	3
446	7	9	3
447	7	9	3
448	7	9	3
450	7	9	5
451	7	7	2
453	7	3	3
455	7	3	2
456	7	7	7
457	7	2	2
458	7	5	2
464	7	7	2
465	7	3	2
466	7	3	2
467	7	3	2
469	7	3	2
470	7	7	3
471	7	5	3
472	7	3	3
473	7	3	3
475	7	7	2
476	7	7	5
477	7	5	3
487	5	7	5

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-069-00488	5	3	2
492	7	7	2
494	7	7	2
496	7	3	2
498	7	7	5
501	7	7	5
507	5	3	2
508	7	7	5
510	7	7	2
513	7	7	2
514	9	5	3
515	5	5	3
516	7	3	5
517	7	7	5
518	7	7	5
519	7	7	3
525	7	7	5
526	7	5	3
529	7	7	5
530	7	5	2
532	7	3	5
534	7	3	3
535	7	5	2
538	7	7	7
543	7	7	5
544	7	7	3
545	5	9	5
547	7	9	5
553	3	2	2
555	7	7	5
562	7	3	2
563	7	3	2
567	3	5	3
570	7	3	3
574	7	3	3
575	7	3	5
586	5	2	3
592	3	5	3
595	7	3	5
596	7	5	3
601	7	3	3
604	3	9	5
613	3	7	3
614	3	3	5
617	3	5	3

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-069-00618	9	-	-
619	5	3	2
620	2	5	3
622	3	5	3
624	7	3	5
625	7	5	5
626	7	5	5
627	7	5	3
628	7	7	3
629	7	7	2
631	7	7	3
633	7	9	3
635	7	7	3
640	7	7	3
641	5	2	2
642	7	3	3
644	5	2	3
645	7	7	3
646	7	7	3
649	7	7	3
651	7	7	3
652	7	5	3
656	7	5	3
660	7	7	3
661	7	7	5
663	9	7	3
664	9	7	3
666	5	9	3
668	9	7	2
670	5	7	3
671	7	9	3
672	7	7	3
674	9	7	5
681	9	5	2
682	7	7	2
684	7	7	3
48-157-10004	7	7	7
10006	7	7	3
10009	7	7	3
10019	7	7	3
10022	7	7	3
10023	7	7	3
48-033-10045	7	7	3
48-069-10046	7	7	3
10050	7	7	3

Accession Number	Disease Index: Yellow mosaic	Disease Index: Cercospora leaf spot	Disease Index: Bacterial blight
48-069-10063	7	7	3
10066	7	7	3
10067	7	7	3
10076	7	7	3
10078	7	7	3
48-071-10087	7	7	3
48-002-10097	7	7	3
48-071-10102	7	7	3
48-069-10104	7	7	3
10105	7	7	3
10106	7	7	3
48-071-10107	7	7	3
48-069-10129	7	7	9
48-113-10138	7	5	7
48-002-10148	7	7	7
48-062-10170	7	7	-
48-071-10171	9	7	7
48-069-10203	9	7	5
48-071-10218	9	7	5
48- -10283	7	7	7
48-071-10284	9	7	7
48- -10285	8	7	7
48-071-10286	8	7	7
10288	8	7	7
10289	8	7	7
48-076-10290	8	7	7
48- -10292	8	7	7
48-071-10293	8	7	7
48- -10294	8	7	7
48-071-10295	8	7	7
48- -10298	8	7	7
48- -10301	8	7	7
48- -10303	8	7	7
48-071-10306	8	7	7
48-157-10307	8	7	7
48- -10308	8	7	7
48- -10314	8	7	7
48-071-10315	8	7	7
48- -10318	8	7	7
48-071-10325	8	7	7
48- -10326	8	7	7
48- -10328	8	7	7
48-071-10333	8	7	7
10334	8	7	7
10335	8	7	7

Accession Number	Disease Index: Yellow mosaic	Disease Index: Cercospora leaf spot	Disease Index: Bacterial blight
48-071-10348	8	7	7
10352	8	7	7
10353	8	7	7
10354	8	7	7
10361	8	7	7
10377	8	7	7
10378	8	7	7
10381	8	7	7
10382	8	7	7
10383	8	7	7
10384	8	7	7
10385	8	7	7
10386	8	7	7
10391	8	7	7
10392	8	7	7
10393	8	7	7
10395	8	7	7
10396	8	7	7
10405	8	7	7
10406	8	7	7
10408	8	7	7
10410	8	7	7
10411	8	7	7
10414	8	7	7
10421	8	7	7
10422	8	7	7
10423	8	7	7
10424	8	7	7
10429	8	7	7
10441	8	7	7
10446	8	7	7
10453	8	7	7
10462	8	7	7
10465	8	7	7
10507	8	7	7
10509	8	7	7
10528	8	7	7
10539	8	7	7
10558	8	7	7
10560	8	7	7
48- -10567	8	7	7
48-071-10629	8	7	7
10659	8	7	7
10665	8	7	7
10667	8	7	7

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-071-10668	9	5	5
10669	9	5	5
10672	9	5	5
10673	9	5	5
10676	9	5	5
10677	9	5	5
10678	9	5	5
10679	9	5	5
10681	9	5	5
10682	9	5	5
10683	9	7	5
10690	9	7	5
10698	9	7	5
10702	9	7	5
10706	9	7	5
10707	9	7	5
10709	9	9	5
10713	9	9	5
10718	9	9	5
10722	9	9	5
10723	5	5	2
48- -10733	7	7	5
48-071-10739	9	7	5
10757	9	7	5
10765	9	7	5
10780	7	3	2
10783	9	7	5
10786	9	7	5
10790	9	7	5
10798	9	7	5
10806	9	5	5
10807	9	5	5
10808	9	5	5
10809	9	5	5
10810	9	5	5
10811	9	5	5
10822	9	5	5
10827	9	5	5
10846	9	5	5
10855	9	5	5
10856	8	7	5
10857	8	7	5
10861	8	7	5
10864	8	7	5
10865	8	7	5

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-071-10866	8	7	5
10870	8	7	5
10875	8	7	5
10876	8	7	5
10877	8	7	5
10880	5	5	3
10911	9	7	5
10912	9	7	5
10913	9	7	5
10915	9	7	5
10919	9	7	5
10920	9	7	5
10923	9	7	5
10925	9	7	5
10926	9	7	5
10929	9	7	5
10931	9	7	5
10933	9	7	5
10935	9	7	5
10938	9	7	5
10948	9	7	5
10951	9	7	5
10954	9	5	3
10955	7	5	5
10956	9	7	7
10957	5	7	7
10959	9	5	5
10960	7	5	5
10961	7	5	5
10962	7	5	5
10963	7	5	5
10965	7	7	5
10966	7	7	5
10981	7	7	5
48-069-10983	7	7	5
10986	9	5	5
10989	9	5	5
10990	9	5	5
10991	9	5	5
10992	9	5	5
10993	9	5	5
10995	9	5	5
10996	9	5	5
10998	9	5	5
10999	9	5	5

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-069-11000	9	3	4
11001	9	3	4
11002	9	3	4
11003	9	3	4
11004	9	3	4
11005	9	3	4
11006	9	3	4
11007	9	3	4
11008	9	3	4
11009	9	3	4
11010	9	3	5
11011	9	3	5
11013	9	3	5
11014	9	3	3
11015	9	3	5
11016	9	3	5
11017	9	3	5
11018	9	3	5
11019	9	3	5
11020	9	3	5
11021	9	3	5
48-157-11022	9	3	5
48-069-11023	9	3	5
11024	9	3	5
11025	9	3	5
11026	9	3	5
11027	9	3	5
11028	9	3	5
11029	9	3	5
11030	9	3	5
11031	9	3	5
11032	9	3	5
11033	9	3	5
11034	9	3	5
11035	9	3	5
11036	9	3	5
11037	9	3	5
11038	9	3	5
11039	9	3	5
11041	9	3	5
11042	9	3	5
11043	9	3	5
11044	9	3	5
11047	9	3	5
11048	9	3	5

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-069-11049	9	3	5
11052	9	3	5
11053	9	3	5
11055	9	3	5
11056	9	3	5
11057	9	3	5
11058	9	3	5
11059	9	3	5
11061	9	3	5
11062	9	3	5
11063	9	3	5
11064	9	3	5
11066	9	3	5
11067	9	3	5
11068	9	3	5
11071	9	3	5
11073	9	3	5
11074	9	3	5
11075	9	3	5
11076	9	3	5
11077	9	3	5
11078	9	3	5
11079	9	3	5
11080	9	3	5
11081	9	3	5
11083	9	3	5
11084	9	3	5
48-157-11085	9	3	5
11086	9	3	5
11087	9	3	5
48-071-11103	9	3	5
48-078-11142	9	3	5
11144	9	3	5
48-071-11146	9	3	5
48-153-11148	2	7	2
11149	3	7	2
11150	3	7	2
11151	3	7	2
48-157-11152	9	3	5
11153	9	3	5
11154	9	3	5
11156	9	3	5
11157	9	5	5
48-071-11158	9	5	5
11160	3	1	2

Accession Number	Disease Index		
	Yellow mosaic	Cercospora leaf spot	Bacterial blight
48-071-11161	3	1	2
11162	9	7	3
11163	9	7	3
11165	9	5	3
11166	7	5	3
11168	7	5	3
11169	9	5	3
11171	9	5	3
11173	3	5	2
11174	3	5	2
11175	9	-	-
11176	3	1	1
11178	9	-	-
11179	9	-	-
11180	1	1	1
48- -11869	9	5	5
48-069-11990	9	5	5

The following listed material is from the collection of Dr. K.B. Singh, P.A.U., Ludhiana.

Accession Number	Disease Index		
	Yellow mosaic	Cercospora leaf spot	Bacterial blight
EC 227-11	7	7	3
EC 2971	7	7	3
EC 16165-2	7	7	3
EC 16200	9	7	3
EC 16273	9	7	3
EC 16563-3	9	7	3
EC 16563 A-3	9	7	3
EC 16563-2	9	7	3
EC 16565-5	7	5	3
EC 16566	9	9	5
EC 16569	9	9	5
EC 16569 A-1	7	7	3
EC 16569-5	9	7	3
EC 16732-A	9	7	3
EC 213012	9	7	3
EC 214032	9	5	3
EC 25971-4	7	5	2
EC 27087-2	9	7	5
EC 27128-2	9	7	5
EC 27185-1	9	7	3
EC 27255-5	7	7	5
EC 27264	7	7	2
EC 27285-3	7	7	3
EC 27295-3	7	5	2
EC 27515	5	5	2
EC 27574	3	5	2
EC 28513	7	5	2
Mirsty	9	7	2
MS-1	9	7	5
MS-2	9	7	5
MK-18	7	5	3
M 21-1	3	5	2
Malukal MK-26	7	2	2
M 34	9	7	5
M 41(Pb.)	7	7	2
M-41(Kulu)	7	7	2
M 50L	7	7	3
M 50	7	9	3
M 54	7	7	2
M 59-318	9	7	5
Mg-63	9	3	2
M 107	9	-	-
M 108	9	7	-
M 110	9	-	-
M 116-1	9	7	2
M 124	9	7	7
M 124-1	9	5	7
M 131	9	5	5
M 134-1	9	5	5
M 152	9	-	-
M 152-1	9	-	-
M 154	9	5	3
M 156(Pb.)	7	3	2
M 156(Kulu)	7	5	5
M 267	7	5	5
M 305(Kulu)	7	5	7
M 305	7	7	2
T-65 (Urid)	1	1	2
T-51	7	3	2
T-44	3	3	2
T-2	7	5	3
T-1	7	7	5
Triloved	9	7	3
Baisakhi Mung	9	9	5
BR-2	3	5	3
B-1	9	7	5
Kulu local	9	7	7
Kulu Beri	3	1	2

Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight	Accession Number	Disease Index: Yellow mosaic	Cercospora leaf spot	Bacterial blight
Pb-321	7	5	2	MC 9	5	7	5
Pb-297	3	5	3	MC 19	5	7	5
Pb-294	5	2	3	MC 10	5	7	5
Pb-238	3	5	2	MC 82	5	7	5
NP 18/NP 28	7	9	3	MC 89	5	7	5
NP 23	7	9	3	MC 90	5	7	5
NP 18	7	9	3	MC 91	5	7	5
RS-4	9	5	2	MC 92	5	7	5
RS-5	9	7	3	MC 93	5	7	5
RS-9	9	7	3	B-1	5	7	5
RS-37	9	7	3	CSB	7	7	5
DT-55	9	7	3	CSB 1-2-5	7	7	5
D_2-15	9	7	2	CSB 3-1-5	7	7	5
D_2-16	9	7	2	CDB 3-1-3	7	7	5
D_{45}-6	7	7	3	CCB 4-4-4	7	7	5
Hyb-45	7	3	2	CSB 14-53	7	7	5
Hyb-4	2	5	2	CDB 15-2-3	7	7	5
Green Gram-1	7	5	3	Selection-1	7	7	5
Green Mung	7	3	3	Selection-7	7	7	5
Green Mung Hyb	7	3	3	Selection-18	7	7	5
Dhalidaita	2	5	3	Selection-19	7	7	5
Dhalbir	4	7	3	Selection-20	7	7	5
Khaporgaon	7	7	2	Selection-23	7	7	5
Khaporgaon-1	7	5	2	Selection-24	7	7	5
Jalgaon 781	7	5	2	C 2	7	7	5
J-1134	7	7	3	C 4	7	7	5
25971-4	7	7	3	C 8	7	7	5
27087-2	7	5	7	C 9	7	7	5
114-52	7	3	7	M 13	7	7	5
119-52	7	7	3	M 29	7	7	5
24-3	7	7	2	T 156	7	7	5
24-2	1	5	2	K-11	7	7	5
Krishana-11	7	5	2	RS-5	9	5	5
Kalaberi	1	2	2	24-2	5	7	2
ADTI	3	5	2	No. 1-1-2.29	7	9	5
Go-1	1	3	3	No. 214-1	3	5	5
ST-7	3	5	3	No. 224-1	3	5	3
No. 50	3	5	3	No. 225-1	5	3	2
35 A	5	3	2	No. 225-3	7	5	3
Pb 297	1	3	2	No. 250-1	7	5	5
Early Erect	3	3	2	NP 18	7	7	3
Late Spreading	5	3	2	NP 26	7	7	3
MC 2	9	5	5	D 3.7	7	7	3
MC 4	9	5	5	D 23	7	7	3
MC 5	9	5	5	D-38	7	7	3

Accession Number	Disease Index			Accession Number	Disease Index		
	Yellow mosaic	Cercospora leaf spot	Bacterial blight		Yellow mosaic	Cercospora leaf spot	Bacterial blight
D 41-9	7	7	3	RS-12	7	5	2
D 51-6	7	7	3	RS-20	7	5	2
D 52-2	7	7	3	RS-38	7	5	2
4-4-5	9	7	3	7.28.3	7	5	2
No. 25-2	9	5	3	111-52	7	5	2
TB-180	7	5	3	192-1	7	5	2
Mukiant 1-32	9	3	5	14-AI-11	7	5	2
Calakli	7	5	3	JB-5-36-B	7	5	2
Kandhar-1	7	5	3	P 572	3	2	2
Khargaon	7	5	3	P 336-68	7	5	5
Nadhera	7	5	3	P-686	7	7	3
RS-1	7	5	2				
RS-5	7	5	2				
RS-11	7	5	2				

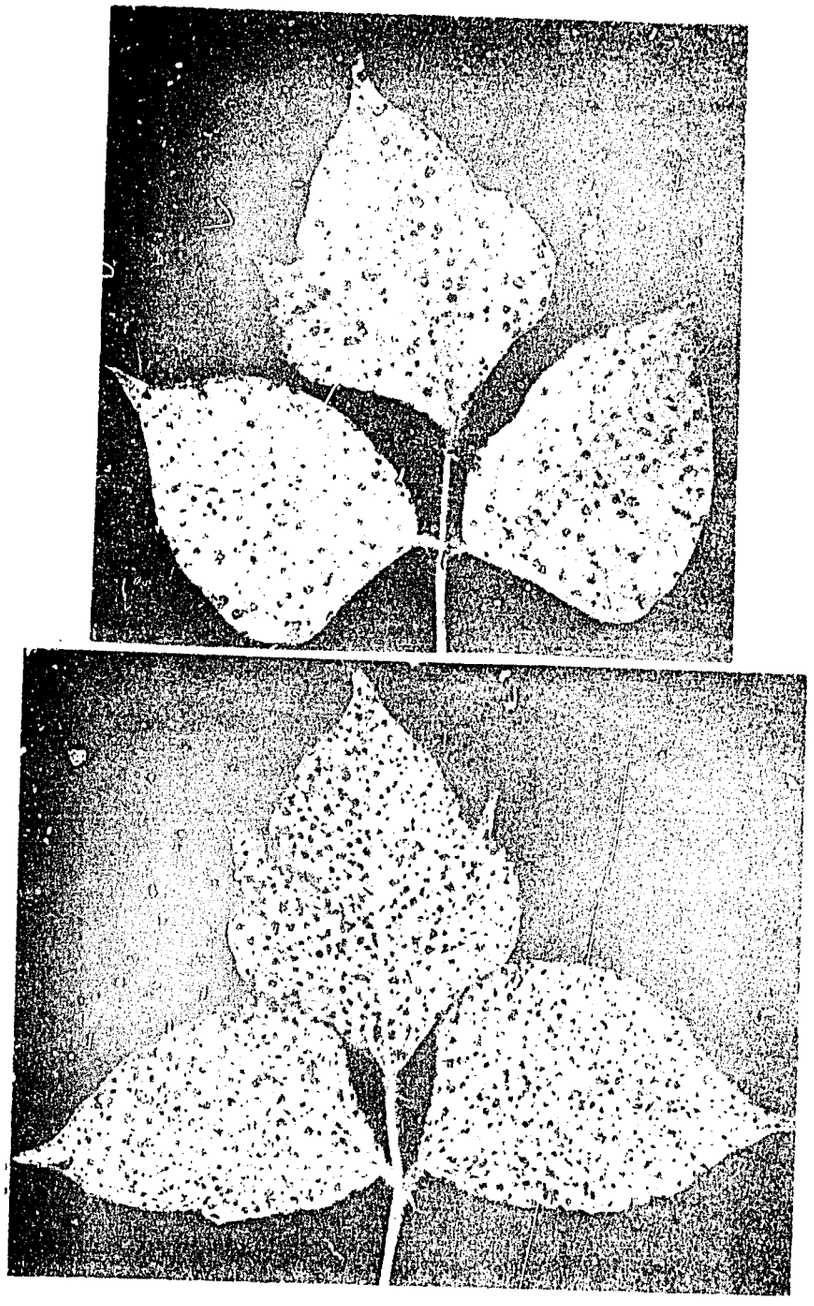

Fig. 31 . Cercospora canescens on mungbean. Top - upper leaf surface, bottom - lower leaf surface.

Phaseolus mungo (Urid bean)

Yellow mosaic was severe on the urid bean germplasm at Ludhiana. With the exemplary cooperation of Dr. K.B. Singh the material was evaluated for yellow mosaic resistance.

The data are in Table134 .

Table134. - Yellow mosaic ratings of germplasm of Phaseolus mungo at Ludhiana in 1969.

Accession No.	Disease * Index	Accession No.	Disease Index
49-069-00004	1	49-069-00041	9
5	1	43	1
6	1	44	9
7	1	45	9
8	1	46	9
9	1	47	9
10	1	48	9
12	1	49	9
13	1	50	9
14	1	51	7
15	1	52	9
17	1	54	9
18	1	55	9
20	1	56	3
21	1	57	3
22	1	58	9
23	1	59	9
24	1	60	9
25	1	61	9
26	1	62	9
27	1	63	9
28	1	64	9
29	1	65	9
30	1	66	9
31	9	67	9
37	9	69	9
38	9	70	9
39	3	71	9
40	9	72	9

* Explanation of disease index. 1 = no disease, 2 = trace, 3 = slight incidence and severity, 4-7 = increasing in incidence and severity, 8 = severe-very damaging, 9 = dead or nearly dead.

Accession No.	Disease Index	Accession No.	Disease Index
49-069-00073	9	K 1313	3
76	9	Kd-2	9
78	9	Kd-3	9
79	9	Kd-13	9
80	9	Kd-1325	9
83	9	Kd-21	9
84	9	Kd-20	9
88	9	Kd-22	2
90	9	Gwalior-18	2
93	1	PB-55	9
94	3	PB-57	2
95	9	Kalaberi	2
96	9	K 1947	9
97	9	M 1-1	1
98	9	NP 14	9
99	9	K 4861	9
102	9	Krishna 11-2	1
103	9	Kd 853	1
105	9	Kd 93822	9
107	9	Kd 9351	9
108	9	Mash sathi	9
109	9	D 6-7	9
110	9	Sindhkheda 1-1	9
111	9	8-2	9
112	9	26-58	1
113	9	M 41-13	1
114	9	35-5	1
115	9	T-21	1
116	9	T-65	1
118	9	T-9	1
119	9	Br 68	3
121	9	Br 61	3
122	3	Br 18	3
		Pb.50	3
The following listed material is from the collection of Dr.K.B. Singh, P.A.U., Ludhiana		No.55	9
		No. 1766	9
		M 48	3
		M 64	1
Kulu No. 4	9	Br 65	1
Khargaon No. 3	9	M 50	9
Kulu No. 3	9	No. 55	9
Kulu 16832	9	M 60	3
N.P. 14	9	No.57	3
Kd	3	M 47	3

Accession No.	Disease Index	Accession No.	Disease Index
M 46	3	G 27	1
Krishna Nagar local	3	G 30	1
Ph 57	1	G 24	1
Ph 55	1	G 39	1
Ph 49	9	G 36	1
M 59-318	3	G 29	1
G 5	3	G 22	1
G 6	3	G 32	1
G 34	3	G 16	1
G 35	3	G 19	1
G 26	2	G 21	1
G 1	2	G 10	1
G 7	1	G 12	1
G 20	1		
G 9	1	Mash local Jammu	
G 14	2		
G 31	1	Collection No.1	1
G 38	1	Jammu Collection No. 3	1
G 25	1		
G 2	1		
G 4	1		
G 37	1		
G 33	1		
G 28	1		
G 23	1		
G 8	1		
G 13	1		
G 18	1		

Leaf crinkle -- Urid cultivar T-65 was used in several trials at New Delhi in 1969 and was severely damaged by leaf crinkle.

Grafts between healthy and diseased plants were made. In several instances the healthy plants developed typical leaf crinkle symptoms. The healthy plants grew in a screenhouse (40 mesh), and the diseased plants were sprayed with insecticide and miticide when transplanted into pots. These tests suggest that leaf crinkle of urid and mung is virus induced. Critical studies on identification of the virus and vector should be made and those cultivars which have had low incidence of leaf crinkle (see previous RPIP Progress Reports) should be tested for resistance under controlled conditions.

New Virus -- A small planting of urid Cultivar T-65 at Kanpur, had 100% incidence of a virus disease with symptoms like Bean Common Mosaic Virus (BCMV). Seed was collected by Dr. S.S. Saxena from the diseased plants and given to RPIP pathologist. We planted the seed in the screenhouse at New Delhi and several seedlings developed symptoms. The virus was mechanically transmitted to *Phaseolus mungo* (T-65) and *P. vulgaris* (Bountiful). The symptoms on urid were as seen at Kanpur. BCMV has been reported on urid in India (K.C. Shahare and S.P. Raychaudhuri. Indian Phytopath. 16:316-318). The report does not mention the symptoms on *P. vulgaris*, but states that their virus resembled BCMV in physical properties and host range. Since the virus we found on urid caused local lesions on *P. vulgaris* (Bountiful), it is probably not BCMV.

Pigeon pea - Phytophthora stem blight -

The new disease of pigeon pea mentioned in the 1968 Progress Report has been called Phytophthora stem blight. The pathogen is tentatively identified as Phytophthora drechsleri Tucker.

A paper entitled Phytophthora Stem Blight of Cajanus cajan has been written by Williams, Amin and Baldev and submitted to Phytopathology. The paper describes symptomatology, occurrence, and epiphytotic potential of the disease; pathogen isolation and identification, and inoculation techniques. Figures on symptoms and inoculation are included. A paper on Distinguishing between Phytophthora stem blight and Fusarium wilt of pigeon pea by Williams will be submitted to FAO Plant Protection Bulletin for publication. This paper describes the distinguishing symptoms of the two diseases, and a technique for screening for resistance to Phytophthora stem blight.

Symptoms of PSB -

Pigeon pea plants are susceptible to Phytophthora stem blight (PSB) from the seedling to the mature fruit stage. Symptoms are a rapid wilting of the plant parts above the invasion site; dessication and upward rolling of leaflets, usually without chlorosis; withering of petioles and small stems; and dark brown to black necrotic lesions partially to entirely encircling the stem at the base or up to a meter or more above soil level. Lesions at the plant base frequently extend 15-20 cm. up the stem. Necrotic lesions on the upper parts of the plant occur on the main stem, branches or petioles. They have definite margins, and initially have a plane surface which later becomes slightly depressed. They are often centered on a leaf scar and may extend several cm. in each direction from the apparent invasion site. Examination of necrotic areas reveals brown to black discoloration of the bark and cambium, but the discoloration does not extend deeply into the xylem. Later, xylem tissue may become discolored and the stem may break at the lesion.

Pathogen isolation - The pathogen can be isolated from PSB diseased pigeon pea stems. Stem pieces, including a necrotic lesion and adjacent symptomless tissue, are washed in running tap water and immersed in 2.6% v/v sodium hypochlorite solution for 3 minutes. Small wedges of tissue are cut from the symptomless tissue near the lesion edge and transferred aseptically to sterile slants or plates of potato dextrose agar. The pathogenicity of the isolates must be tested by inoculating pigeon pea plants. See Fig. 32 .

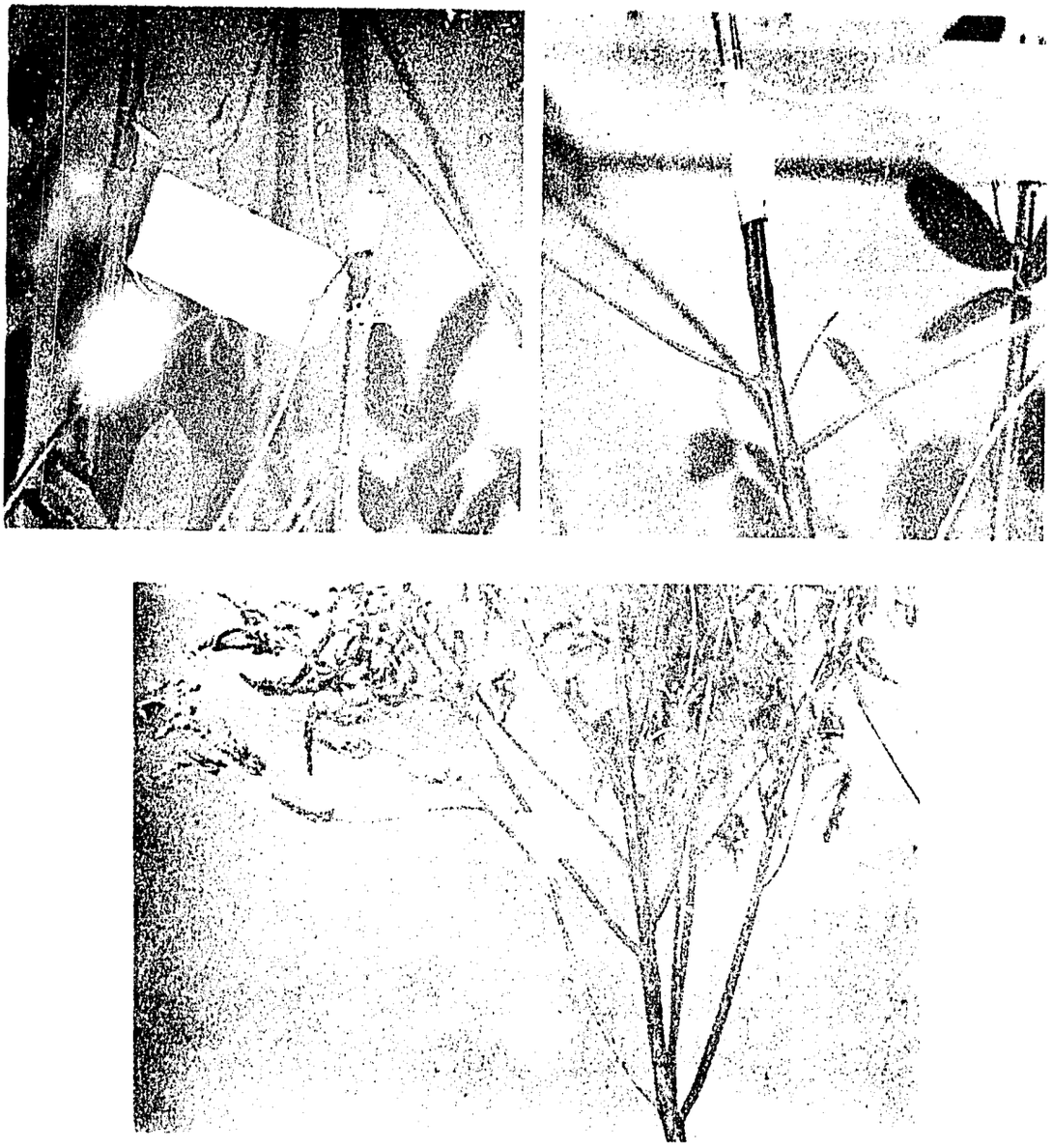

Fig. 32 . Inoculation of pigeon pea with Phytophthora drechsleri. Top-control (left) and inoculated plants, showing lesion formation. Bottom-The pathogen has spread from a lateral branch to the main stem.

Inoculation techniques:

Stem inoculation (with and without injury) root dip inoculation and soil infestation were used in several tests. Soil infestation resulted in the lowest percentage kill and was not considered an adequate test. Root dip inoculation was effective, killing all plants. Stem inoculation, with or without injury, was effective and this technique is adapted to extensive testing. For this test, the pathogen is isolated by standard techniques and allowed to grow on potato dextrose agar at 25-30 C. When the colony covers the plate a 4-5 mm cork borer is used to cut small discs from the colony. The plant stem can be injured by lightly scraping with a blade before inoculation if desired. A disc of mycelium with agar is placed on the plant stem and covered with masking tape to retard dessication. When temperatures are high, the stem lesion develops rapidly and is visible above and below the masking tape in 4-5 days. Many plants so inoculated die within 2 weeks. Inoculated plants that do not develop PSB can be reinoculated, but PSB develops more slowly during cool weather.

The effects of inoculation and flood irrigation on the incidence and spread of Phytophthora stem blight (PSB) were tested in a latin square design at New Delhi. Variety T-21 pigeon pea was planted on Aug. 5 with a 25x25 cm plant spacing. The treatments were:

Treatment	Inoculation	Flood irrigation
A	12 plants in center inoculated on Sept.22	Oct. 28, 29 Nov.5-8.
B	None	Nov. 5-8, with water from "A"
C	None	None
D	None	Oct. 28, 29
E	12 plants in center inoculated on Sept. 22.	None

After the disease was established in the inoculated plots, the entire area was sprinkler irrigated 3 times in 4 days from 4 p.m. until dark. No significant spread of PSB from sprinkler irrigation was seen.

When the crop was mature, data on the incidence of PSB was taken and the location of each diseased plant plotted. No significant pattern of diseased plants in relation to inoculated plants or source of flood irrigation water was evident. The data on disease incidence and yield are presented in Table135.

Table 135 - Effect of inoculation and irrigation on Phytophthora stem blight incidence and yield of T-21 pigeon pea at New Delhi.

Treatment	Disease incidence	Yield kg/ha.
A. Inoculated & flooded	27.3 x*	3200
B. Flooded with water from "A"	19.8 y	3300
C. Not inoculated, not flooded	14.7 y	3600
D. Not inoculated, flooded	17.9 y	3500
E. Inoculated, not flooded	20.4 y	2800

Treatment	C	D	B	E	A
Mean Disease Incidence	14.7	17.9	19.8	20.4	27.3
p :	2	3	4	5	
Rp:	5.4	5.7	5.9	5.9	(5%)

* Means followed by a common letter are not different at the 95% confidence level according to Duncan's multiple range test.

Disease incidence was higher in Treatment A (inoculated and flooded), than in other Treatments, but the yields were not correlated with disease incidence. The Rp and p values are included in Table135. to show the near-significance of Treatments B and E compared to C. The experiment should be repeated, in a test area where the disease incidence in the control (C) would be less, and the treatments should be applied earlier to test their effect on yield.

Resistance to PSB --

Several lines from the pigeon pea germplasm collection were planted on July 19 and tested for resistance to PSB at New Delhi. Five plants of each line were stem inoculated (Sept. 17-20). Data on the inoculation effect were taken in early Oct. Additional plants from lines judged possibly resistant were inoculated in Oct., and data recorded on Nov. 17.

The data are in Table

Table 136. - Relative resistance of pigeon pea germplasm lines to Phytophthora stem blight.

Accession No.	Origin	Name of che variety	Ratio of diseased plants/Total plants
- 954	U.P., India	-	3/5
-1204	Delhi, India	N.P. 12	2/5
-1289	Burma	NE38-63	3/5
-1294	Pakistan	Dacca 3812A	5/5
-1589	A.P., India	-	5/5
-1944	"	-	11/25
-2177	"	-	5/5
-2249	"	-	2/15
-2353	"	-	2/3
-2357	"	-	3/15
-2402	"	-	2/5
-2425	"	-	5/5
-2428	"	-	2/5
-2441	"	-	2/5
-2449	"	-	1/5
-2520	"	-	4/5
-2590	"	-	5/5
-2618	"	-	4/5
-2676	"	-	2/5
-2683	"	-	5/5
-2691	"	-	13/25
-2703	"	-	12/25
-2733	"	-	4/5
-2780	"	-	4/5
-2783	"	-	3/5
-2798	"	-	3/5
-2887	"	-	3/5
-2908	Maharashtra, India	-	3/15

* The first five digits, coding crop and origin, of the accession numbers are not listed. For additional information see Germplasm Collection, Pigeon peas by RPIP.

Accession No.	Origin	Name of the variety	Ratio of diseased plants/Total plants
-2924	Maharashtra, India	-	3/5
-3662	Bihar, India	-	3/5
-4557	Maharashtra, India	D.T.202	5/5
-4571	Maharashtra, India	251-13-2T	5/5
-4649	Jabalpur, India	I-30	2/5
-4657	"	T-56-310	4/5
-4658	"	T-56-42	4/5
-4664	"	E.B.3	3/5
-4665	"	Nizamabad,India	2/5
-4678	Mysore, India	Tur 13-3	5/5
-4706	"	Tur Baralli 372-16-2-1	5/15
-4714	"	Tur 72	4/5
-4723	"	Tri carpet 1-2	4/5
-4739	"	Niphad Local white 7	3/5
-4783	"	14-2	5/5
-4812	Bihar, India	6230-1	5/5
-4999	Maharashtra, India	I.P.16 Red	5/5
-5001	"	I.P.24-51 Red	5/5
-5002	"	I.P.51	4/5
-5004	"	I.P.	3/5
-5009	"	I.P.80 Red	5/5
-5012	"	I.P. Red grain B	2/5
-5013	"	I.P.Yellow grain B	4/5
-5016	"	D.K. A-19	5/5
-5020	"	Irdi-3-36-5-13-3	5/5
-5021	"	Shinding-6-36-5-32-2	5/5
-5040	"	BR-59	5/5
-5043	"	Madras-37	3/5
-5071	"	N-24	3/5
-4758	Bihar, India	BR-183-5	5/5
-4785	Rajashthan, India	5-3	2/5
-4839	U.P., India	15/65/2A-3	5/5
-1052	Andhra Pradesh,India	R.G.72	2/5
-1060	Bihar, India	B.R.60	4/5
-1518	"	B-7	5/5
-1519	"	T-7	16/25
-1520	"	T-17	2/5
-1521	"	T-21	5/15
-1522	"	GWL-3	3/5
-1523	"	7-S	5/5
-1524	"	2E	5/5
-1525	"	C-11	5/5
-1526	"	N-84	12/15

Accession No.	Origin	Name of the variety	Ratio of diseased Plants/Total Plants
-1527	Bihar, India	N-290-21	3/5
-1528	"	PT301	2/5
-1529	"	NPWR-15	3/5
-1530	"	S-101	5/5
-1531	"	S-103	4/5
-1532	"	No.148	4/5
-1533	"	NP-69	5/5
-1534	"	T.V.R.15-15	14/27
-1537	"	ST-1	5/5
-1538	"	R.G.434	5/5
-1539	"	S.A.-1	3/5
-1541	"	NP-24	5/5
-3725	West Bengal, India	D-74	5/5
-3726	"	B-33	4/5
-3727	Brazil	Brazil P-2	2/15
-3728	West Bengal, India	9-B	5/5
-3729	"	RG37	5/5
-3731	"	T-48	4/5
-3732	"	T-76	4/5
-3739	"	Jaipur-2	4/5
-3740	"	E-7	5/5
-3741	"	No.7	5/5
-3743	"	E-11	3/5
-3747	"	T-4-B	2/5
-3748	"	F-184	3/5
-3752	"	Akola Local	4/5
-3753	"	Jaipur-1	4/5
-3754	"	WB-62	2/5
-3756	"	T-54	3/5
-3757	"	E-9-2	5/5
-3758	"	T-72	3/5
-3761	"	1141 Red gram	10/15
-3762	"	T-1 Kanpur	5/5
-3764	"	T-5B	5/5
-3799	"	Khargaon-2	3/5
-3986	Andhra Pradesh, India	R.G.104	5/5
-3993	"	R.G.123	3/5
-4037	Coimbatore, India	Adoni	5/5
-4169	"	VZM488	5/5
-4174	"	PLS200	5/5
-4390	Maharashtra, India	N-6-2	5/5
-4397	"	NP-4	5/5
-4412	"	HY-11	5/5
-4415	"	T-10	5/5
-4448	"	T-6-C	5/5
-4449	"	K-132	5/5
-4450	"	66-K	4/5
-4451	"	G.D.M.2	5/5
-4455	"	Arhar-132	4/5
-4456	"	T-36	5/15
-4458	"	T-26	4/5
-4460	"	T-35	5/5

Accession No.	Origin	Name of the variety	Ratio of diseased Plants/Total Plants
-4462	Maharashtra, India	No.282-7	4/5
-4465	"	N256-29	4/5
-4466	"	Hy-5	5/5
-4467	"	Patur-4	5/5
-4468	"	Patur-14	4/5
-4469	"	N-23-10	4/5
-4470	"	T-14-A	7/10
-4471	"	NP-41	8/20
-4472	"	T-28	6/20
-4474	"	N-85-2	13/20
-4477	"	T-30	5/20
-4479	"	Hy-4	6/20
-4480	"	Hy-3	7/20
-4481	"	Hy-2	10/20
-4482	"	Savanti	9/20
-4484	"	Mottled white	10/20
-4486	"	F.52	11/20
-4500	"	EC16209	6/20
-4511	"	Kanpur-14	7/10
-4516	"	Kallon-23	3/5
-4523	"	T'pur 2-7	3/5
-4542	"	D.T.73	2/5
-4575	"	PBN-6	4/5
-4596	Assam, India	Tno-16	4/5
-4607	"	BR-34	4/5
-4629	"	NP-42	4/5
-4639	"	NP-62	5/5
-4649	Jabalpur, India	I-30	2/5
-4664	"	E-6-3	5/5
-4686	Mysore, India	Tur-8	5/15
-4711	"	NP-64	3/5
-4712	"	Tur 37	5/5
-4737	"	NP-16	4/5
-4739	"		5/5
-4861	Maharashtra, India	M4	5/5
-4972	U.P., India	Fatehabad local	3/5
-4995	Maharashtra, India	N-74	5/15
-5033	"	Ugain-7	3/15
-5070	"	N-8	7/15
-5114	Mysore, India	M-7-E-Arbhavi	3/5
-5118	"	Kolaba-2-18-1	4/5
-5120	"	Tur 127	2/5
-5121	"	2827 Nihad	3/5
-1079	Gujarat, India	Surat 144	5/5
-1088	Madras, India	Madras-17	5/5
-1750	Andhra Pradesh,India	-	3/5
-1751	"	-	4/15
-1837	"	-	5/15
-1907	"	-	3/5
-1931	"	-	4/5
-2059	"	-	4/5
-2150	"	-	5/5
-2161	"	-	5/5
-2192	"	-	2/5

Accession No.	Origin	Name of the variety	Ratio of diseased Plants/Total Plants
-3746	West Bengal, India	Kakai-1/3	Not inoculated
-3840	"	EC13693	5/5
-3930	A.P., India	R.G.64	3/5
-3970	"	R.G.34	12/15
-3986	"	R.G.104	2/5
-3993	"	R.G.123	5/5
-4390	Maharashtra,India	N-6-2	4/5
-4392	"	X-Z	6/15
-4397	"	NP-4	3/5
-4401	"	D-19	2/5
-4410	"	T-22	3/3
-4412	"	Hy-11	5/5
-4415	"	T-10	2/5
-4419	"	T-31	5/15
-4422	"	T-4-A	5/5
-4436	"	NPC-38-3-1	5/5
-4445	"	NPC-16	4/5
-4455	"	Arhar-132	4/5
-4465	"	N.256-29	4/5
-4466	"	Hy-5	5/5
-4468	"	Patur14	5/5
-4477	"	T-30	5/5
-4482	"	Savanti	2/5
-4483	"	Baigani	5/5
-4484	"	Mottled white	4/5
-4492	"	Hyderabad	5/5
-4500	"	EC-16209	5/5
-4523	"	T'pur 2-7	5/5
-4542	"	D.T.73	4/5
-4548	"	D.T.137	4/5
-4553	"	D.T.185	3/5
-4554	"	D.T.187	3/5

The information in Table 136 should be used for preliminary judgement. Accession numbers -2249, -2357, -2449, -2908, -3727 and -4419 may have usable resistance to PSB and should be tested again by stem inoculation and in infested soil with flood irrigation. Any line otherwise of interest should be tested for PSB resistance. Variation in resistance to PSB within a given line should be tested by reinoculation of plants and inoculation of selfed single plant progenies.

Stem inoculation is a severe test, but should be used until possible sources of resistance are exhausted. Any field soil infestation procedure, on "sick plots", will result in too great a probability of accepting susceptible plants as resistant unless the tests are repeated. Test plants should be inoculated early in the season while temperatures are high.

Pigeon pea - Fusarium wilt :- Reports of susceptibility of "wilt-resistant" varieties of pigeon pea when planted in locations other than where developed, suggest variation in pathogenicity of the causal fungus (Fusarium udum). The discovery of Phytophthora stem blight of pigeon pea (PSB), with gross symptoms similar to those of Fusarium wilt, may explain some cases of "breaking" of wilt resistance. A variety need not be resistant to PSB if resistant to wilt. If the two diseases are not distinguished and PSB is prevalent, wilt resistance appears to have failed. It is imperative that the two diseases be treated separately in breeding programs.

We tested several isolates of Fusarium udum for pathogenicity to several varieties of pigeon pea. The results are in Table 137 and 138 .

Table 137. - Disease incidence in several varieties of pigeon pea inoculated with 9 isolates of Fusarium udum.

Isolates	Varieties							
	ST-1	T-21	RG-72	N-84	S-101	C-11	NPWR-15	S-103
509	100*	95	93	83	10	25	3	0
631	85	100	98	83	13	13	3	0
585	83	100	68	85	10	20	15	8
266	93	58	60	85	20	20	20	15
381	88	60	93	58	25	0	8	15
695	83	100	78	68	8	30	8	0
150	65	45	73	72	38	0	23	30
309	48	63	68	35	15	0	3	13
746	45	58	53	45	8	0	5	10
N-1	9	0	0	9	4	0	0	0
Control	8	0	0	0	0	8	0	0

* Percentage of plants killed. F test for varieties, isolates and varieties x isolates interaction indicated significance at the 1% level. Differences in means of 33% are significant at 5% level.

From the data in Table 137 , cultivars S-101, C-11, NPWR-15 and S-103 can be classified as having useful resistance to Fusarium wilt, but none are immune. Making single plant selections, and testing the progeny under severe wilt conditions, could probably produce cultivars having more resistance. Such selections and testing will probably have to be done by soil infestation.

Isolate N-1 is interesting because it was highly pathogenic when first made and is now essentially non-pathogenic. Isolates 309 and 746 are definitely less pathogenic than 509.

Table 138. - Disease incidence in 3 varieties of pigeon pea inoculated with 24 isolates of *Fusarium udum*.

Isolate No.	Variety		
	C-11	T-21	NPWR-15
8	14*	0	0
99	0	67	9
154	18	33	38
218	0	44	11
219	0	11	10
243	0	29	21
277	0	38	44
284	0	25	0
316	0	67	10
329	0	22	50
375	17	11	7
501	0	55	0
522	0	38	0
542	14	88	11
553	25	100	25
572	0	40	9
623	50	80	8
641	8	50	7
688	0	13	25
700	88	50	43
715	0	13	25
717	17	50	40
732	0	14	0
736	0	44	0
Control	0	19	8

* Percentage of plants killed. Test was not replicated

The data from a non replicated test in Table 138 show extreme variation in pathogenicity of isolates. Isolate 329 is non-pathogenic to C-11 and highly pathogenic to WR-15, isolate 623 is converse, and isolate 700 is highly pathogenic to both varieties.

The data in Table137and138 are not sufficiently extensive or precise to show how many races there are of the pathogen, their distribution, or information on genes involved in resistance. They do show that testing for resistance in a breeding program must be done carefully, if the resulting variety is to be resistant to many isolates. Diseased plant material for establishing wilt-sick plots should be taken from as many varieties as possible, and a large proportion of it should come from "resistant" varieties. New material should be added each year because of the selective factor for saprophytic growth of the pathogen.

Wilt-sick plots are a poor second choice to inoculation for a breeding program. The distribution of pathogenic races within an area should be learned and new cultivars should contain resistance to all those races and as many other known races as possible. Development of new races should be expected, requiring new varieties.

Pigeon pea - Soil treatment : In 1968, a planting of pigeon pea cultivar T-21 at Hyderabad grew poorly. The soil was reportedly infested with nematodes. We used Nemagon (2 gal./acre), DD (20 gal/A) and methyl bromide (2 lbs/150 sq. ft.) in a replicated test for nematode control. Soil treatment was done on March 12 and cultivars pigeon pea T-21, Mung T-6009 and Urid T-9 planted on April 22. No treatment was better than the controls, but methyl bromide was severely phytotoxic to all 3 crops, although planting was done about 5 weeks after treatment. Soil samples from all plots were screened in the Nematology division at IARI. No serious nematode populations were found.

ENTOMOLOGY

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SUMMARY

Rabi 1968-69

During the last 2 months of 1968 and first 4 months of 1969 3 field trials were conducted. Of these two were at New Delhi and one at Hyderabad. The screening of chickpea germplasm for possible resistance to pod-borer and aphids was done at IARI fields at New Delhi as also was the trial for the control of leaf miner and aphids in peas. A trial for the control of thrips and pod borers in pigeon pea was conducted at Hyderabad. Besides these protective sprays were applied to chickpeas, Lathyrus and lentils at New Delhi against aphids. 50 lines of chickpeas, selected from last years screening program were planted for further testing. These were lost due to highly saline land. However a germplasm planting of plant breeders, consisting of 1307 lines was screened for resistance to cutworms and aphids. Seven promising lines were found. A second screening for pod borers was not possible because the entire plot received a protective spray against the increasing menace of aphids.

In pea leaf miner and aphid control trial, 4 insecticides were used. Metasystox at ½ lb/acre proved to be the most effective in this experiment.

There were 9 treatments against thrips and pod-borers in pigeon peas at Hyderabad. Diazinon and Metasystox at 1 lb/acre and ½ lb/acre respectively were the best for thrips, whereas DDT + Thiodan at 1 lb of each/acre gave very good control of the various pod borers. The highest yield was obtained in plots treated with DDT 1 lb/acre.

Kharif 1969

During the 1969 Kharif season, 4 field trials were conducted; all at IARI fields in New Delhi. In the first trial 4 insecticides were tested for the control of bruchids in the field. Mungbeans (*Phaseolus aureus*) were planted for this purpose. The experiment had two sets of plots; one set was sprayed once and the second set received 2 sprays. Acombination of DDT 0.2% and Thiodan 0.05% gave the most although not very effective control

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* Left India July 1969.
** Joined the Project on Sept. 30, 1969.

There were enough adults to build up a large population within a few months. This trial should be repeated.

Insect pathogenic fungi cultures ie. Beauveria and Metarrhizium were secured from the U.S.A. for use in experiments for the control of the pulse beetle Madurasia obscurella Jacoby. Mungbeans planted for this trial were dusted with the spores in replicated plots. Unfortunately the experiment could not be continued.

367 lines of cowpea ger plasm were screened for possible resistance to various insects. Two screenings were made; one assessing them for pulse beetle, and jassids infestation and damage and a second one for pod borer damage at the time of harvest. A few promising lines were identified although none of them exhibited resistance to the pulse beetle and the jassid. 4 lines had no pod borer damage.

The fourth experiment was to study the effect of date of sowing on insect infestation in mung beans. Four planting dates at weekly intervals were used. Observations were taken every week. There was no significant effect of sowing date on pulse beetle infestation. The pod borer damage in the four sowings ranged from 1.7 to 2.9%.

Laboratory studies were conducted on different aspects of bruchids. Detailed biological studies of the three species of Callosobruchus ie. C. maculatus, C. chinensis and C. analis were conducted. Observations recorded were total number of eggs laid by a female, eggs laid on each day, developmental period and mortality of eggs laid on successive days and interspecific competition between the three species. Studies were conducted on mung bean seed at 30°c and 70% R.H.

A simple method was developed to find selective preference of bruchids for different pulses. Seventeen varieties of urdbeans (Phaseolus mungo) were used in tests with C. maculatus using this method. Although none of the varieties proved resistant, Mash 35-5 was least prefered by these bruchids for egg laying and the highest mortality in the developing insects was in BR-61. Using same technique as in the previous experiment, seed of eight major pulse crops were tested against three species of Callosobruchus using three varieties of each pulse. The primary purpose was to test the preference for egg laying and to check a possible correlation with further development. The results are being analysed statistically.

During earlier studies a strain of chickpea, G 109-1, appeared to be resistant to bruchids in storage. To confirm this 14 standard varieties in addition to this strain were tested against the three species of Callosobruchus. Two different methods were used, single choice and selective preference. This work has shown that the strain 109-1 is fairly resistant to all three species. The nature of resistance appears to be in the physical characteristics of the seed coat.

In another experiment the effect of bruchid infestation on germination of 7 pulses was tested. The studies showed that different pulses behave differently, depending primarily on seed size and the insect species involved.

Efficacy of different insecticides was tested against C. chinensis in stored pulses in another experiment. Six insecticides, Bromodan 5% Dust at 1 gm/kg, Bromodan 50% WP at 0.1 gm/kg, Malathion 5% Dust at 0.2 gm/kg, DDT 5% Dust and BHC 5% Dust, both at 4 gms/kg and Neem seed powder at 2 gms/kg. Malathion and DDT were quite effective, with the latter giving 100% control. Bromodan, BHC and Neem seed were ineffective.

A survey of the pulse fields in various parts of the country yeilded about a dozen bruchid species, some of which are definitely associated with pulses in the field. Most of these are new records from India.

An abnormal form of C. maculatus reported from various parts of the world including India was found in cultures of this species. Some observations on this form were recorded and have been submitted for publication.

A lentil variety from Hamadan, Iran, reported as resistant to bruchids was tested. It was found that the Indian strain of C. maculatus used does not attack any lentil seed. The Iran variety was however found susceptible to both C. chinensis and C. analis.

Biology of the blue butterfly Euchrysops cnejus (Fab) a serious pest of kharif pulses, was studied in the laboratory. The species infesting pigeonpeas is a different one, identified as Lampides boeticus Lin. (Identifications by the Taxonomist, IARI, New Delhi).

Black-light trap for collection of insects in pulse fields was continued during the earlier part of the year.

Different places in north and north eastern India were visited to observe insect damage to pulse crops in the kharif season. Of the pulse beetle complex Madurasia obscurella was chiefly responsible for the damage in mungbeans, urdbeans and cowpeas.

Papers and Publications

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Several additional publications are in various stages of prepration by K.E. Gibson, formerly entomologist RPIP, H.P. Saxena, entomologist AICPP and A.K. Raina, senior research assistant RPIP.

Rabi 1968-69

1. Objective : Screening chickpea germplasm for resistance to pod borer and aphid.

During the rabi season of 1967-68, 918 lines of chickpea were planted for screening against various insects particularly the pod borer (Heliothis armigera). The assessment was done on the basis of pod damage at the time of harvest. 50 lines, all having less than 5% pod damage were selected from these. These were planted again in 1968 in single rows 15 feet long. This crop however failed early in the season due to high salinity in the soil.

Table139. Pod damage in selected lines of chickpea germplasm, New Delhi, Rabi, 1967-68.

Accession No.	% Pod damage.	Accession No.	% Pod damage.	Accession No.	% Pod damage.
12-069-00095	4.4	12-069-00565	3.4	12-069-01305	2.6
12-069-00107	0.6	12-069-00589	3.8	12-069-01321	2.5
12-069-00191	0.0	12-069-00615	0.0	12-069-01343	0.0
12-069-00242	3.7	12-069-00635	4.2	12-069-01699	3.1
12-069-00298	0.0	12-069-00743	3.1	12-071-04128	4.7
12-069-00299	4.3	12-100-00833	0.0	12-071-04251	4.0
12-069-00301	3.2	12-069-00869	2.4	12-071-04277	4.6
12-069-00307	4.9	12-113-00995	4.6	12-071-04285	4.8
12-069-00325	5.0	12-069-01134	4.6	12-071-04558	2.0
12-069-00333	4.6	12-069-01151	1.7	12-071-04920	4.1
12-069-00334	1.7	12-069-01164	4.0	12-071-04970	2.5
12-069-00338	2.3	12-069-01182	3.8	12-071-04985	4.9
12-069-00351	2.6	12-069-01191	0.0	12-071-04986	4.7
12-069-00365	4.3	12-069-01194	3.3	12-069-06052	2.6
12-069-00448	3.9	12-069-01254	0.0	12-069-06058	4.7
12-069-00481	3.2	12-069-01256	0.9	12-069-06062	3.8
12-069-00514	2.0	12-069-01264	3.2		

Instead 1307 germplasm lines in the breeding nursery were evaluated for insect resistance. Three plants at a distance of 1 meter from each other were selected in each row and tagged. The first screening was done about the middle of February 1969 when the plants were in flowering stage. This was primarily for tolerance or resistance to the aphid Aphis craccivora Koch. and the cut-worm Agrotis ypsilon Rott. The aphid population was fairly high. 138 lines were found to be aphid free. Of these the following 7 lines had no cut-worm damage, either to the branches or to the pods if these were formed.

Table 140. Germplasm lines of chickpea without aphid or cutworm damage.

Accession No.	Origin
12-069-01178	India, Kanpur (U.P.)
12-069-01574	India, Kanpur (U.P.)
12-071-02149	Iran.
12-071-04746	Iran.
12-071-04781	Iran.
12-071-04920	Iran.
12-069-06218	India. (U.P.)

Subsequent observations could not be taken since the field received a protective spray of Diazinon against increasing aphid populations.

It will be worthwhile to test the 50 lines from the 1967-68 screening as well as the above 7 lines preferably in replicated plots, to verify the resistance observed.

2. Objective : To determine the effectiveness of various insecticides, for the control of pea leaf miner (*Phytomyza horticola* Gourean) and aphids *Aphis craccivora* Koch. (black species) and (*Macrosiphum pisum*) (Harris). (green species).

The pea leaf miner is a common pest of peas in India. The leaves of the pea plants are mined from the time the plants are very young by the larvae of this insect. As many as 7 larvae have been found in a single leaf. During the peak infestation 70-80% of the leaves are mined. Besides leaf miners two species of aphids were also found to cause damage to the pea plants. The field trial for the control of these pests was laid out in mid-December 1968. Bonneville variety of pea was used. Each plot was four rows 15 feet long. Four insecticides, Dipterex, $\frac{1}{2}$ lb., Diazinon, 1 lb., Dimethoate, $\frac{1}{2}$ lb. and Matasystox, $\frac{1}{2}$ lb. per acre were tested. Each treatment was replicated 4 times. First observations were made on February 7, and the first spray application given on the next day. The second observation was made on February 23, and the second spray applied on March 7. For the purpose of observations, 4 plants were selected in each row and the total number of leaves, number of leaves with leaf miner and number of black and green aphid colonies counted. The experiment was not continued further.

Table 141 Observations on infestation and control of pea leaf miner and 2 species of aphids; before and 15 days after spray, New Delhi, Rabi, 1968-69.

Treatment.	No. of plants examined.	Leaf Miner. Before-spray No. of leaves examined.	Before-spray % of leaves infested.	15 days after spray. No. of leaves examined.	15 days after spray. % of leaves infested.	Black aphid No. of colonies Before spray.	Black aphid No. of colonies 15 days after-spray.	Green aphid No. of colonies Before spray.	Green aphid No. of colonies 15 days after-spray.
Dipterex	64	1156	8.7	2096	3.6	64	236	6	39
Diazinon	64	1021	8.2	1934	3.9	53	137	3	46
Dimethoate	64	1337	8.1	2846	2.0	67	114	7	22
Metasystox	64	1107	8.5	2139	1.4	56	65	3	13
Check	64	1453	7.9	2914	9.4	60	332	5	67

Dimethoate or Rogor caused phytotoxicity to the plants immediately after the first spray. The plants however recovered. First observation before spraying indicated that an average 8.3% of the leaves were infested with the leaf miner. The aphid infestation was not very high, being about 1 colony per plant. Fifteen days after the first spray the incidence of the leaf miner was the lowest, ie. 1.4% in plots sprayed with Metasystox, while it was highest, ie. 9.4% in the control. There was also a significant decrease in aphid population, in the Metasystox treated plots, compared to the aphid build-up in the other plots.

Even though the experiment was not continued, it is expected that 2-3 sprays of Metasystox at $\frac{1}{2}$ lb/acre would be needed to give effective control of the leaf miner as well as the aphids. The sprays should be given every three weeks, starting when the plants are about one month old.

3. Objective : To evaluate different insecticides for the control of thrips and pod borers in pigeon peas.

The thrip *Taeniothrips nigricornis* Schmitz is very common among the blooms of pigeonpea, all over India. There is a doubt regarding its role as a potential pest of this crop. However, since as many as 63 thrips were found in a single flower, it is considered that such high populations would definitely be doing some damage to the developing pod. Pod borers of pigeon peas are most important pests and are known to reduce yeilds considerably. Three of these, *Heliothis armigera*, *Agromyza obtusa* coq. and *Exelastis atomosa* W. are serious and wide spread. A field trial for control of both thrips and pod borers was conducted at Hyderabad.

The crop was sown on July 21, 1968. There were 30 plots, each 4 rows wide and 50 feet long. Nine different insecticide treatments were used besides the control. Each treatment was replicated 3 times. The plots received 3 sprays on 10 and 24 October, and 9 November, 1968. Samples of blooms were picked on 24 October, immediately following the second spray, preserved in alcohol and the thrips later counted from these. The population was lowest in Diazinon, Metasystox and DDT + Diazinon treated plots. The other treatments were not significantly different from the control.

On 4 December, pod samples were collected at random from all plots and examined for pod borer damage. 1200 pods were examined from each of the 10 treatments. These were later threshed and the seed examined for damage.

Table 142. Pod and seed damage and yeild from thrip and pod borer control trial in pigeon pea, Hyderabad, 1968-69.

Treatment.	% of pods damaged.	% of seed damaged.	Seed yield gms/treatment.	Seed yield gms/plant (aver. about 500 plants.)
DDT 1 lb./acre	1.5	0.06	18,946	38.6
Diazinon 1lb./acre	6.5	0.24	14,760	27.0
Metasystox ½ lb./ac.	3.3	0.06	17,353	32.3
Dimethoate ½ lb./ac.	7.3	0.19	15,495	29.0
Carbaryl 1½ lb./ac.	0.9	0.03	10,409	20.0
Thiodan 1lb./acre	1.1	0.06	13,482	25.4
DDT + Diazinon 1 lb. + 1 lb./acre	1.9	0.02	16,213	30.1
DDT + Thiodan 1 lb. + 1 lb./acre	0.4	0.02	13,410	25.3
Carbaryl + Thiodan 1½ lb. + 1 lb./acre	0.5	0. 0	10,883	20.0
Untreated check.	11.0	0.63	14,673	27.6

Table 142 shows that DDT and Thiodan, alone or in combination, seem to be promising treatments for checking damage by this insect complex. Carbaryl both alone and in combination with Thiodan also appears to have been quite effective. The least damage is shown consistently where a combination of 2 insecticides was used, but whether the amount of reduction below the level of some of the better single insecticides, is worth the increased cost, remains to be seen. The greatest amount of damage on pods

and seeds, was shown by the untreated check.

The two lowest yields were obtained with Carbaryl alone or in combination with Thiodan. In the Kharif season of 1967, Carbaryl, when used for the control of pulse beetle on mungbeans, urdbeans and cowpeas showed considerable Phytotoxicity. Although the climatic conditions during the present experiment were different, as was also the crop, and the plants at spray time were well established, the results may be symptoms of an insidious phytotoxicity. This should be further investigated.

Kharif - 1969.

1. Objective : Pre-harvest Bruchid control trial.

It has been established that field infestation of bruchids is an important source of infestation of stored seed, or in other words the initial infestation many times comes almost certainly from the fields. This is also supported by the fact that appreciable numbers of adults of *Callosobruchus maculatus* and *C. chinensis* were swept from the fields of cowpeas, mungbeans and urdbeans. Once this infestation from the fields is checked and the seed stored under sanitary conditions without any chances of subsequent infestation it is very much possible to keep the seed free of bruchids. With this objective a field trial was laid to find the most effective insecticides and the number of sprays needed to give an effective control of the insect.

Four insecticides, DDT at 0.2%, Lindane at 0.1%, Thiodan 0.1% and DDT + Thiodan at 0.2 + 0.05% respectively were used. The plots measured 5x3 meters. The experiment was devided into two sets, one was sprayed only once while the other received two sprays. Sowing was done on July 10, 1969, using T_2 variety of mungbean. The first spray was applied on Sept. 3, (only to one set) and the second on Sept. 18, (to both sets); 55 and 70 days respectively after sowing. Pods were picked twice; on Sept. 30 and Oct. 15. From the first picking 250 grams of seed from each plot was stored in plastic jars with screw caps. Similarly from the second picking 125 grams of seed from each plot were kept. Observations of these jars were taken after one and two months of storage and the adult bruchids removed, separated into various species and counted.

Table 143. Average number of Bruchid adults recovered after one and two months of seed storage, from mungbean seed of first picking after one spray treatment in field, New Delhi, 1969.

Treatment.	One month		Two months	
	C. maculatus	*C. chinensis*	*C. maculatus*	*C. chinensis*
DDT.	2.00	10.75	8.50	5.00
Lindane.	18.50	13.25	35.00	86.00
Thiodan.	24.25	23.00	3.25	312.75
DDT+Thiodan.	3.75	8.50	24.75	41.00
Control.	30.25	119 .75	164.25	429.00

It is evident from Table 143 that although most of the treatments are significantly different from the control, the populations in these are sufficient to build up a high infestation.

Table 144. Average number of Bruchid adults recovered after one and two months of seed storage, from mung bean seed of first picking after two spray treatments in the field, New Delhi, 1969.

Treatment.	(One Month)		(Two Months.)	
	C. maculatus	C. chinensis	C. maculatus	C. chinensis
DDT.	1.25	2.50	21.25	112.25
Lindane.	28.50	89.50	195.00	172.25
Thiodan.	3.25	5.75	52.50	51.25
DDT + Thiodan.	0.75	1.00	5.75	0.00
Control.	16.75	56.25	71.75	163.00

The results in Table 144 show some positive differences attributable to two applications of the combination DDT + Thiodan. Although a few adults of C. maculatus were still present after two months perhaps a third spray might provide still better control. The seed stored from the second picking had very few bruchids. The results of observations on these are summarised in Table 145 .

Table 145. Average number of bruchid adults recovered after one and two months of storage from mungbeans seed of second picking after one and two spray treatments in field, New Delhi, 1969.

Treatment.	(One spray.)				(Two sprays.)			
	One month		Two months		One month		Two months	
	C.mac.	C.ch.	C.mac.	C.ch.	C. mac.	C. ch.	C. mac.	C. ch.
DDT.	0.50	0.00	0.00	0.00	0.50	0.25	0.00	0.00
Lindane.	0.25	0.50	0.00	23.25	0.00	0.25	0.00	0.00
Thiodan.	0.25	1.25	0.00	10.75	0.75	0.00	0.00	0.00
DDT + Thiodan.	0.25	2.00	0.00	6.00	0.50	0.25	0.00	0.00
Control.	0.50	0.75	26.50	0.00	0.25	1.00	0.00	20.75

There can be two reasons for the generally very low populations in the second picking. One is that a persistent insecticide like DDT killed most of the bruchids in the field, which fly about from plant to plant. A second reason may be the pods in the second picking had not shattered thus exposing no seed for the oviposition of these insects. It has been observed that these bruchids do not generally lay eggs on the pods and even if a few eggs are laid they are not able to develop into adults.

Table 146. Total yield per treatment, compared in the two sets.

Treatment.	Yield from Set 1. (1 spray) in gms.	Yield from Set 2. (2 spray) in gms.
DDT	2313.4	2485.7
Lindane.	2386.7	2878.5
Thiodan.	2526.0	2943.7
DDT + Thiodan.	2550.4	3182.7
Control.	2429.2	2633.6

It is evident from the yield data that the highest yield was obtained in plots which had received a spray combination of DDT + Thiodan in both sets. The yields in the second set are numerically higher than in the first. However the yield differences between treatments are not significant.

The results of these experiments are promising and this approach to bruchid control should be continued.

2. Objective : The control of the pulse beetle Madurasia Obscurella Jacoby by the use of pathogenic fungi.

M. obscurella, a Galerucid beetle of the family Chrysomalidae, was until recently incorrectly called a flea-beetle. It is suggested this insect be called the 'pulse beetle'. It is very serious pest of khrif pulses from the time the seedlings appear; feeding on, and severely injuring the foliage.

In 1968 four systemic gramilar insecticides were used at 4 difference rates in 3 crops for experimental control of this insect. In each group of insecticidal treatments, the highest dose of

2 kg/ha proved most effective. Among the four, 2 kg/ha of Thimet was most effective.

This year spore cultures of two insect pathogenic fungi, ie. Metarrhizium and Beauveria were made a available by the Nutrilite Products, Co. in the United States. A trial was set up in 12 plots of mung beans, each 5x3 meters in size. The crop was sown on 17 July, 1969 and the first observation made for the assessment of damage on 26 August. This was done by counting the number of leaves of plants selected at random in each plot and then counting damaged leaves and the number of holes. The plots were dusted with spores at 20 gms. per plot, with a plunger duster after mixing with an equal amount of inert talc powder. No further observations could be taken because the plots were inadvertantly flood irrigated which probably washed away the spores virtually leaving no checks.

It is suggested that a more careful experiment be planned for next season with these fungi cultures which have been refrigerated. Their use against other noxions insects, such as cutworms, should also be investigated.

3. Objective : Screening of cowpea germplasm for possible resistance to various insects.

This work was carried on by the Pulse Entomologist at IARI, New Delhi. He was assisted in planting operations and recording the observations. 367 early and medium maturing lines were planted in single unreplicated 5 meter rows, on 17 July with T_2 as check. The insects for which the crop was screened to determine possible resistance or tolerance, included the pulse beetle (Madurasia obscurella), the jassid (Empoasca kerri) and pod borers. Three plants were selected in each row and tagged. The following observations were recorded; total number of leaves, number of leaves with pulse beetle injury, number of holes in 3 leaves, number of jassid nymphs and adults per plant. A single observation was recorded on 17 August. When mature, the pods were picked and damaged due to pod borers assessed.

On the basis of the percentage of leaves damaged the germplasm material was graded in the following 4 categories.

i. Strains having 1-30% damaged leaves - 0
ii. Strains having from 31-50% damaged leaves - 15
iii. Strains having from 51-70% damaged leaves -102
iv. Strains having above 70% damaged leaves -250

None of the lines were found to be free from the beetle attack. Strain, Acc. No. 62-096-01078, appeared to be the most promising with the lowest percentage of damaged leaves. The check, T-2, fell in the fourth category with an average of 74.5% damaged leaves.

On the basis of average number of holes per damaged leaf, the strains were also placed under 4 categories as under:

i. Strains with 0-5 holes per leaf - 34
ii. Strains with 6-10 holes per leaf - 133
iii. Strains with 11-15 holes per leaf - 109
iv. Strains with above 15 holes per " - 91

The average number of holes per leaf ranged from 0.7 in Acc. No. 62-069-01147 to 30.9 in Acc. No. 62-137-00177. In check, T-2, there was an average 10.2 holes per leaf. In Acc. No. 62-96-01078, having lowest percentage of leaves damaged there was an average 6.2 holes per leaf. Acc. No. 62-069-00710 and 62-069-01145 were common in both the groupings ie., the lowest range of damaged leaves and the minimum number of holes per leaf.

The strains were again categorised into 5 groups based on the counts of jassid nymphs and adults.

i. Strains with 0-5 jassids per plant - 4
ii. Strains with 6-10 jassids per plant - 13
iii. Strains with 11-40 jassids per plant -265
iv. Strains with 41-70 jassids per plant - 76
v. Strains with above 70 " " " - 9

None of the lines were found to be free from jassids and the population of jassids per plant ranged from 2.7 in Acc. No. 62-110-00081 and 62-069-00273 to 113.3 in Acc. No. 62-062-01257. The check T-2, was classified in the third category with an average number of 34.6 jassids per plant.

For the damage due to pod borers the strains were categorised into the following 4 groups:

i. Strains with no pod borer damage - 4
ii. Strains with 1-5% of damaged pods - 112
iii. Strains with 6-10% of damaged pods - 157
iv. Strains with above 10% damaged pods - 93

The percentage of damaged pods ranged from 0 to 44, and the lines with no damage were Acc. No. 62-069-00167, 62-002-00172, 62-137-00182 and 62-157-00408. In T-2 there were 5.4% pods damaged.

4. Objective : To study the effect of date of sowing on insect infestation in mungbeans.

This trial was also conducted in cooperation with the Pulse Entomologist at IARI, New Delhi. Mungbeans were planted in unreplicated plots, each 10x4 meters, on 11, 18, 25 July and 1 August, at one week intervals.

Weekly observations were recorded in the same way as in cowpea germplasm screening, till the crop was mature. Pods were then examined for pod borer damage.

There was maximum infestation of jassids in the first sowing during the last week of August. An average of 11.4 jassids per plant were observed in the subsequent three sowings. The population of these insects was very much reduced during September. As regards the percentage of damaged leaves by the pulse beetle, there was almost no difference in the first and second sowings during the period under observation, whereas, the damage was comparetively less in the subsequent two sowings upto the third week of August (82%, 83%, 72.3% and 54.0% in the four sowings respectively). Thereafter there was no significant difference in the percentage of leaves damaged in all the four sowings. During the second week of September, there was a little increase in the damaged leaves in the third and fourth sowings when 89.0 to 92.3% damaged leaves were observed, whereas, in the second sowing it was only 75.4%. The crop in the first sowing had already been harvested by that time. There was little difference in the percentage of pods damaged by pod borers in the crops sown on various dates and it ranged from 1.7 to 2.9%. The last planting date (1 August), was apparently too late to produce normal vegetative growth.

Laboratory - Experiments

1. Objective : To study the biology of three species of Callosobruchus on mungbean seed.

Mungbean seed was found to be most suitable medium for rearing all three species ie. C. chinensis, C. maculatus and C. analis. Studies were conducted on their biology at 30°c and 70% RH. The following observations were recorded.

Adults of all three species mate immediately after emergence from seed. this is followed by oviposition. The eggs, which are oval and translucent are attached to the seed surface. Smooth seeds are preferred for egg laying. The average number of eggs laid by a single female of each of the three species is given in table 147. The eggs hatch in 3.5 to 5 days at 30°c and 70% RH. The larva bores into the seed immediately underneath the egg and starts feeding. The larvae in all cases undergo 4 instars before pupating near the seed coat. Just before pupation a window is cut, which later on forms the emergence hole of the adult bruchid. The combined average larvae and pupal periods for the three species are also given in table 147. These observations in the case of each species were made on 100 eggs laid onindividual seeds which were then glued to card strips.

Table 147. Average number of eggs laid, incubation period, total developmental period, sex ratio and adult longivity of Callosobruchus chinensis, C. maculatus and C. analis, on mungbean seed at 30°c and 70% RH.

Observations	C. chinensis	C. maculatus	C. analis
Av. No. of eggs laid per female.	78	128	96
Incubation period in days.	3.5	4	5
Larvae + pupal period in days.	18.8	20.0	23.5
Sex ratio Male : Female	6:5	7:6	1:1
Adult longivity in days:			
Males :	7.6	8.2	6.8
Females :	7.4	7.6	8.0

Ten freshly emerged pairs of all three species were each provided with 150 seed. Eggs laid by the females were counted and removed every day, and held for emergence of adults of the next generation. This provided information on the number of eggs laid on each day of oviposition, the effect of parental age on the developmental period, if any, and finally the viability of eggs laid on different days. It was found that the largest number of eggs is laid on the first day of oviposition in all three species. About 90% of the viable eggs are laid during the first 3 days by C. chinensis and C. maculatus. In case of C. analis the egg laying is more uniformly spread over a period of 6-9 days. There is no marked difference in the developmental period of eggs laid on different dates, although there is a gradual increase, the difference being 2-3 days for eggs laid on first and last day of oviposition. As regards viability, it is highest for eggs laid on the first day, those laid on the last day being mostly nonviable.

2. Objective : To develop a simple method for determining the preference of bruchids for different pulses for oviposition and development.

Earlier work on selective preference was carried out in petri dishes partitioned into several compartments. In the method developed a styrofoam (Thermocole) disc of an appropriate size is used and circular cavities (depending upon the number of host samples to be tested) made along its circumference. (Fig33 .) The seed material is then put in these cavities. Only mated females of the bruchid species are released from a central releasing hole. The disc is then placed in a dessicator maintained at the required temperature and humidity, the latter maintained with the use of potassium hydroxide. Females oviposit on the seed, which is removed after all of them are dead; usually 10 days, and the eggs laid on each type of seed counted. The seed can be kept in individual vials for development and emergence of adults.

To illustrate the method seventeen varieties of urdbeans (Phaseolus mungo) were tested with Callosobruchus maculatus, using this method. Only this species was tested since the other important species C. chinensis, is not able to develop in urdbeans seed. The experiment was run in three replications, at 30°c and 70% RH. Twenty five seed of each variety were used in each replicate. The results are shown in table 148.

Table 148. Percentage of seed with eggs, number of eggs laid on 25 seed, eggs hatched and developmental mortality of C. maculatus on 17 varieties of urdbeans.

S. No.	Variety	% of seed with eggs	No. of eggs laid on 25 seed.	% of eggs hatched.	% developmental mortality.
1	Sindkheda 1-1	82.7	24	85.6	40.9
2	Khargoan-3	88.0	25	89.4	73.9
3	Mash 41-13	88.0	25	83.3	74.2
4	Mash-48	69.3	20	89.5	77.3
5	BR-61	69.3	19	79.2	80.4
6	T-27	64.0	20	68.1	76.7
7	NP-14	68.0	19	81.6	74.0
8	NP-4	69.3	19	79.9	79.5
9	N -1766	78.7	22	84.0	57.4
10	T -65	94.7	30	84.0	71.5
11	N -212	78.7	22	82.3	67.4
12	BR-68	62.7	19	91.3	68.3
13	Mash 1-1	77.3	22	81.1	75.8
14	T-9	82.7	24	87.9	77.7
15	D 6-7	64.0	17	77.9	57.0
16	Mash 35-5	58.7	15	79.8	69.6
17	No. 55	78.7	23	82.3	54.3

The results indicate that minimum number of eggs were laid on Mash 35-5. There is no significant difference in the hatching of eggs on different varieties. Even though developmental mortality was highest in BR-61, it was not at all significantly different from many other varieties. Whereas negative preference for oviposition indicates a sort of repellancy it is the developmental mortality that will show off a variety as resistant.

If a seed variety is not prefered for egg laying by bruchids it has even chances of escaping infestation in storage. Therefore, similar experiments conducted with other pulses and in particualr with germplasm may yield valuable data regarding the occurence of such strains.

3. Objective : To study the selective preference of three species of Callosobruchus for 8 pulses, 3 varieties of each.

A similar method as in the previous experiment was used. 24 Cavities each with a diameter of 2 cm. were made in the styrofoam disc and 3 varieties

of each of the 8 pulses ie. mungbeans, urdbeans, chickpeas, cowpeas, pigeonpeas, lentils, Lathyrus and peas were placed in these, in single layers. The three species tested were C. chinensis, C. maculatus and C. analis. Mated, fresh females were released as usual from the center. The experiment was run at 30°c and 70% R.H. For each bruchid species there were 3 replicates. The seed in each replicate was removed after 10 days, the eggs counted and examined for hatching and kept in individual vials for the emergence of adults. This way preference for egg laying between 8 pulses and between 3 varieties of same pulse were determined.

The results, although not yet analysed, indicate differences in preference exhibited for different pulses. There also differences inbetween the varieties of the same pulse. Gererally smooth and larger seeds were favoured for oviposition . It was further observed that oviposition and later development were not corelated. In certain cases where large number of eggs had been laid by a species, the seed was not suitable for further development.

Separately another experiment was run, in which females of each of the three species were allowed to lay eggs on 5 seeds of all 24 varieties used before. Only one egg per seed was allowed to remain, the others being destroyed by a pin. These individual seed were then kept in small plastic vials covered with cotton and examined every day for hatching and adult emergence. This indicate the period of time required by the three species to complete the life cycle on different pulses at the above temperature and humidity combination. It was found that the shortest time to complete life cycle was required in mungbeans and cowpeas and the longest in urdbeans and peas. Further, results are being analysed.

It will be worth while to study the fecundity of these three species of bruchids when reared on different pulses.

4. Objective : To determine the relative susceptibility of 15 varieties of chickpeas to Callosobruchus spp. in storage.

In an earlier experiment to find the selective preference, a strain of chickpeas G 109-1 (Accession No. 12-069-06629), seemed to be resistant to bruchids in storage. To test this more conclusively, 14 standard varieties of chickpeas together with G 109-1 were subjected to screening tests for three species of Callosobruchus; ie., C. chinensis, C. maculatus and C. analis. Two methods were used; selective preference and single choice. In the selective preference method, 5 seed of each variety were put in a cavity of the styrofoam disc. (Fig 33.) Mated females of one species were released from the center. Seed was removed after 10 days and eggs laid on each variety counted. The seed was then kept in individual vials for the emergence of adults. This was replicated three times for each species of the insect. In the single choice method, plastic pickle pots were used. Nine containers with 25 seed in each represented one variety. These were divided into 3 sets, each container in one set receiving 2 males and 2 females of one species. Here also eggs were counted after 10 days and seed kept for the emergence of adults. All the experiments were conducted at 30°c.

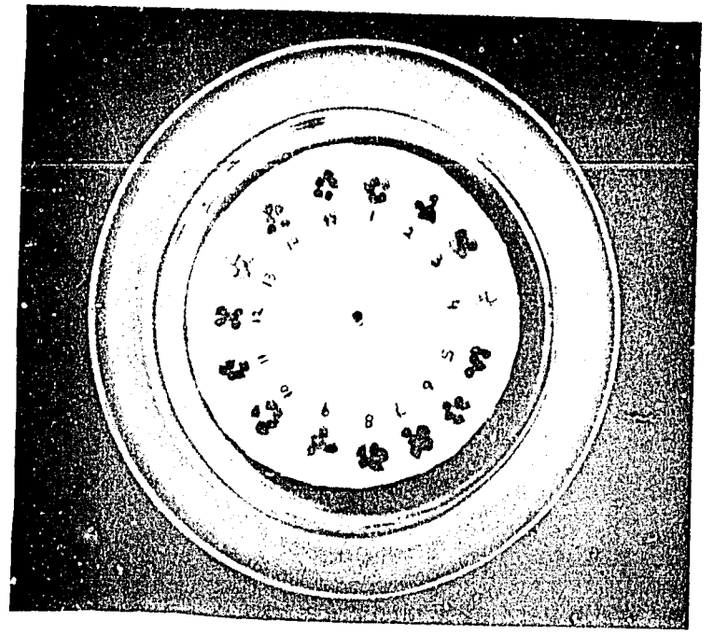

Figure 33. - Arrangement of the 15 varieties of chickpea seed on the 'styrofoam' disc for screening by selective preference method.

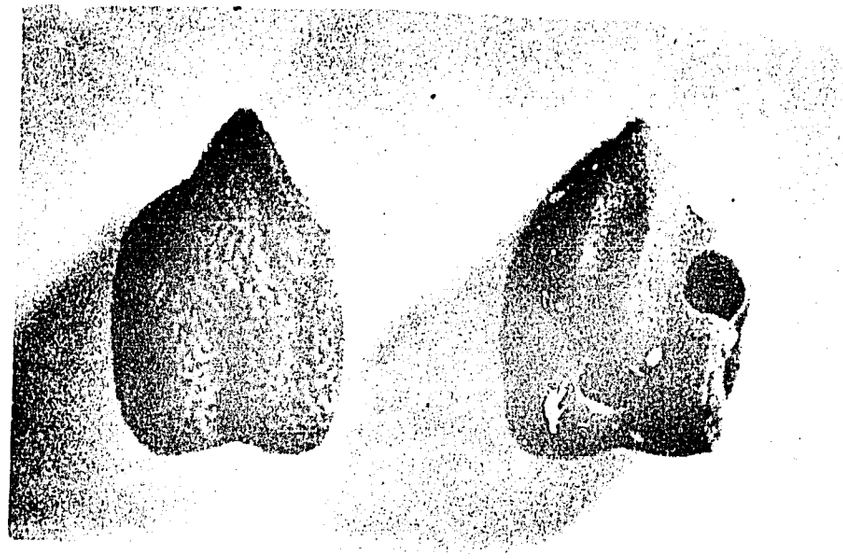

Figure 34. - A close view of the seed coats of G 109-1 (left) and a susceptible variety of chickpea.

The strain G 109-1 showed the greatest resistance to all three species (Table149.). C. maculatus females would not lay eggs on this seed even if there was no other choice. C. chinensis and C. analis females however laid a few eggs which hatched and developed into adults. From the number of adults emerged, the developmental mortality was determined for each species of bruchid on each variety of seed. There was significant difference in the developmental mortality of C. chinensis and C. analis between G 109-1 and other varieties. This could not be compared in case of C. maculatus since it did not lay eggs on G 109-1 as indicated earlier.

Table149. Average number of eggs laid by three species of Callosobruchus on 15 chickpeas varieties.

Variety	Selective preference method (5 seed/var.-10 females/disc)			Single choice method (25 seed/2 pairs)		
	C.analis	C.maculatus	C.chinensis	C.analis	C.maculatus	C.chinensis
NP - 53	11.7	18.3	28.3	67.7	17.7	22.0
B-98	15.7	18.7	28.0	37.0	24.7	27.3
G-62-404	6.7	10.0	10.7	28.3	8.0	6.7
L-144	14.0	28.3	36.3	61.3	24.3	30.7
NP - 58	15.3	14.7	34.7	39.3	11.3	37.0
NP - 100	13.0	10.0	15.0	52.7	14.0	23.0
G-736-1	10.3	40.0	55.7	35.7	52.7	13.0
G-109-1	0.7	0.0	4.7	8.3	0.3	1.3
Gwalior - 2	10.7	30.0	37.0	31.3	35.3	31.0
Chaffa	10.0	23.7	35.0	35.0	23.7	23.0
G-24	12.0	14.3	21.0	80.0	17.3	26.3
C-235	18.0	16.7	23.7	40.3	14.0	4.3
C-104	18.7	30.0	29.7	55.0	32.7	44.7
RS - 11	15.0	25.3	28.7	67.0	24.0	26.0
BG-482	15.0	12.3	22.0	73.0	12.3	49.3

With the help of Dr. A.K. Kaul of the Division of Genetics at IARI, sections were cut of the seed coats of G-109-1 and NP-53 a succeptible variety and it was found that the former has a rough almost spiny seed surface. It is this character of the seed coat (Fig 34 .) which is mainly responsible for undesirability of this strain for oviposition by the bruchids. C. chinensis and C. analis which are smaller species are probably able to place their eggs between the projections on the seed coat, though not always so. Once the eggs are firmly attached to the seed, there appears to be nothing to inhibit its further development. This work has been submitted for publication.

5. Objective : To determine the effect of bruchid infestation on the germination of seeds of seven pulses.

The seven pulses selected for this work and their respective varieties were, mungbeans (T_2), urdbeans (T 27), cowpeas (NP_2), chickpeas (Strain 197), pigeonpeas (T_{21}), lentils (9-12) and Lathyrus (Rewa-2). These were tested with Callosobruchus chinensis and C. maculatus.

Females of each species were allowed to oviposit on about 2000 seed of each pulse. Seeds with 1, 2 and 3 eggs were sorted and removed. About 500 seed in each group were kept for the emergence of adults. Soon after emergence, the seed was sown in germination trays at the rate of 100 seed per tray, according to the international rule of seed testing. Four such trays formed one treatment. Germination counts were made after 5 days. The seedlings were separated into healthy and deformed ones. This procedure was repeated for the second species.

Table 150 Germination of seven pulses as affected by emergence of 1-3 adults of Callosobruchus chinensis and C. maculatus.

Pulse Seed	Treatment	Percentage germination			
		C. chinensis		C. maculatus	
		Normal seedlings	Deformed seedlings	Normal seedlings	Deformed seedlings
Mungbeans	Control	93.00	3.25	92.75	4.50
	1 adult/seed	10.75	36.25	0.25	0.25
	2 adults/seed	0.00	0.50	——**	——**
	3 adults/seed	0.00	0.00	——**	——**
Urdbeans	Control	——*	——*	93.00	4.00
	1 adult/seed	——*	——*	0.25	0.75
Cowpeas	Control	93.75	3.00	92.00	4.75
	1 adult/seed	43.25	39.50	16.00	54.25
	2 adults/seed	16.25	37.00	10.25	48.75
	3 adults/seed	4.00	32.00	3.75	21.25
Chickpeas	Control	91.75	4.00	91.50	4.00
	1 adult/seed	49.25	13.00	5.75	35.00
	2 adults/seed	11.75	21.25	0.00	0.50
	3 adults/seed	4.75	12.50	——**	——**
Pigeonpeas	Control	93.00	3.25	92.50	4.00
	1 adult/seed	13.75	7.00	2.75	4.75
	2 adults/seed	0.00	0.25	0.00	0.00
Lentils	Control	86.75	5.25	——*	——*
	1 adult/seed	0.25	4.00	——*	——*
Lathyrus	Control	78.00	3.75	78.75	5.25
	1 adult/seed	23.00	23.00	5.50	12.75
	2 adults/seed	0.75	9.25	0.00	0.50
	3 adults/seed	0.00	0.00	——**	——**

* The bruchid is not able to develop on this seed.

** The seed was not big enough to allow the development of these many individuals.

The results in Table 150 indicate that germination is affected by two factors; the number of bruchid adults emerging from a seed and the species involved. In mungbeans, for example, when a single adult of C. maculatus emerged from a seed, it could not germinate. In the same pulse as many as three adults of C. chinensis developed in one seed and the emergence of a single adult caused only about 50% reduction in total germination. Even in cowpeas and chickpeas, which are larger in seed size than mungbeans, emergence of one adult of C. maculatus or two of C. chinensis greatly reduced the germination capability of the seed. C. maculatus females did not lay any eggs on lentil seed, however emergence of a single adult of C. chinensis from this seed affected the germination almost 100%. C. chinensis although laid eggs on urdbean seed, the larvae could not develop any further than first instar. C. maculatus however developed normally and had the same effect as C. chinensis on lentils.

The studies indicate that if the infestation is checked in the initial stages by fumigation, use of insecticides or heat treatment, the seed can still be utilized for planting. It will however be unfit for human consumption, there being no effective and economical method of separating infested from uninfested seed.

6. Objective : To test the efficacy of different insecticides for the control of C. chinensis in stored pulse.

Experiments primarily with Bromodan have been conducted for the control of bruchids in storage for the past two years. Bromodan is a comparatively new chlorinated hydrocarbon insecticide developed by Hoechst, Germany. It is reported to have a very high oral LD 50 of about 5,000 mg. per kg. of body wieght. It was made available for research purposes as a 50% wettable powder and 5% dust. Earlier experiments showed that only a comparatively hight rate of 2 gms of 50% WP/kg. of seed gave a good control of both C. chinensis and C. maculatus for a period of about 6 months. However this rate would not be economical, since the manufacturers recommendations were only 0.1 gm of 50% WP or 1.0 gm of 5% dust per kilogram of seed. It was suggested that the wettable powder be used as a slurry and mixed with the seed for 5 minutes. In addition to the two formulations of Bromodan, three other insecticides, Malathion 5% dust at 0.2 gm/kg, BHC 5% dust at 4 gms/kg and DDT 5% dust at 4 gms/kg as well as a natural product. Neem seed as a powder at 2 gms/kg were included in the trial. Neem (Azadirach'a indica) is a common tree in India, the parts of which are often used for various purposes. Each treatment was replicated 4 times. 300 grams of fresh mungbeans seed was thoroughly mixed with the insecticides in a glass jar, which was shaken for about 5 minutes. The 50% WP of Bromodan was made into a slurry by adding 0.1 ml. of water to the insecticide and then mixed with the seed, till it was well coated. The seed was then placed in glass jars and covered with voil cloth. Fifteen pairs of freshly emerged C. chinensis were put in each jar at about the same time. Mortality counts were taken after 1, 3, 5 and 7 days. The seed was then kept for the recovery of adults of the next generation. After 40 days when all the second generation emerged adults were dead, these were counted. The seed was also weighted and the reduction in weight determined. The results are shown in Table 151.

Table 151. Average perentage mortality 1, 3, 5 and 7 days after the liberation of adults, average number of adults recovered in next generation and percentage reduction in seed weight in different treatments.

Treatment	Percentage mortality after				Av. No. of second generation adults recovered.	Av. % reduction in seed weight in grams.
	1 day	3 days	5 days	7 days		
Bromodan 5% Dust	4.1	62.7	100.0	-	278	9.1
Bromodan 5% WP	5.0	55.8	100.0	-	289	7.5
Malathion 5% Dust	99.2	100.0	-	-	36	2.2
BHC 5% Dust	35.8	100.0	-	-	122	4.5
DDT 5% Dust	99.2	100.0	-	-	0	2.7
Neem seed powder	2.5	22.5	71.7	100.0	472	8.5
Untreated check	2.5	13.1	73.3	100.0	540	8.8

It is evident from these results that only DDT gave rapid and complete control of the bruchid. Malathion which was used at a much lower rate gave a similar kill as DDT in the initial infestation but did not kill fast enough to completely check oviposition and emergence of a second generation. The DDT application rate was quite high, which, with the present trend against chlorinated hydrocarbons and long life insecticides does not warrant its recommendation. The malathion application rate amounts to 10 ppm, which, within a few days after application should be reduced sufficiently below the presently permissable level of 8 ppm. It will be worthwhile to try a slightly higher dose of melathion for more effective control and then analyse the seed for possible toxic residues. BHC appears to be non effective against the bruchid. Neem seed powder which has been reported as very effective against C. maculatus at 20 gms/kg did not give good control of C. chinensis at 2 gms/kg. The higher rate was not used since it was considered to involve a large amount of adulteration. However to check the efficacy at 20 gms/kg is in progress against C. chinensis in a separate experiment. Both formulations of Bromodan were not sufficiently effective.

7. Objective : Identification of different bruchids infesting pulses in the field.

Bruchids are well known as storage pests of pulses all over the world. Their importance as field pests in India was investigated. The following species of bruchids were recorded from growing pulses crops at different places in India.

I. Bruchus emarginatus Allard was found infesting field peas Pisum sativum var. arvensi. It is the first record of this bruchid from India.

It closely resembles B. Pisorum which is an important pest of peas in several Asian and European countries. Adults appear in the month of March and feed on pollen and honey dew. Eggs are laid on pods. Larvae upon hatching from the eggs, enter the pods and feed on the seed. Development is completed in the seed. The bruchid is not able to breed in storage.

II. Bruchus lentis Frœl infests lentil pods in the field. It was collected from experimental lentil plots at New Delhi, and is the first record from India. The infestation in New Delhi was about 5%. Like B. emarginatus it lays eggs on the pods; resulting larvae feeding on the seed. The adults hibernate in the seed, there is only one generation a year and they are not able to breed in the stored seed.

III. Bruchidius spp. Two species of this small bruchid were swept from lentils, peas, Lathyrus and chickpeas at New Delhi. It is the first record of their occurence on pulses in India. The population of one of the species was quite high, 112 adults in 5,000 sweeps from lentil crop. Not much is known about their biology.

IV. Spermophagus latescenta sp. nova (identified by Prof. Arora of P.U. Chandigarh) was common among flowers and pods of Pusa Baisakhi variety of mungbeans grown at New Delhi. Whether it infests the seed or pods is not known.

V. Caryedon sp. was swept from cowpeas at New Delhi. It is a new record for this host. It was also collected on Ceasalpinea bocalla at Pusa (Bihar) where it was found laying eggs on the pods of this weed. It was later successfully reared on cowpea pods in the laboratory.

VI. Specularius maindroni Pic . was swept from growing lentils at New Delhi. It has not been established as a pest of this crop. It is also the first record of this bruchid in India.

VII. Conicobruchus albopubens Pic . was reared from the pods of guar (cyamopsis tetragenoloba) collected at Mathura (U.P.). Females laid eggs on the pods , the resulting larvae feed on the developing seeds. The infestation was quite heavy.

VIII. Tuberculobruchus sp. Adults of this species were swept from chickpeas in the month of April at New Delhi. It is the first record of this bruchid from India. Their role as a pest of this crop is doubtful.

IX. Callosobruchus spp. Only 3 of the 5 species of Callosobruchus known from India were encountered in growing pulses. These are C. maculatus, C. chinensis and C. theobromae. Whereas thefirst two were regularly swept from cowpeas, mungbeans, urdbeans and chickpeas, the third one was only swept from pigeonpeas at Coimbatore, Pantnagar, Pusa and Sabour (Bihar). The adult females of C. maculatus and C. chinensis were observed to lay eggs on half shattered pods in which a few seed lay exposed. In the laboratory when they

had no choice but to lay eggs on whole pods, they readily did so but the resulting larvae in almost 95% of the cases could not develop further and died in the space between the pods and the seed. A large number of pigeonpea and mungbean pods that had partly split open were found to have bruchid eggs on the exposed seed. This indicates the mechanism by which bruchid infestation is carried from field to storage.

8. Objective : To record some observations on the obnormal form of Callosobruchus maculatus.

During the studies on bruchids an abnormal form of C. maculatus was observed in its cultures. This form has earlier been reported from several parts of the world including India. It has also been known as the 'flying form' and the 'sterile form'. It was observed that this abnormal form is not totally sterile and that a few eggs may be laid. These eggs are generally nonviable. It was also observed that females of both normal and abnormal form are equally good fliers. There is no clear answer why this form occurs. It has been considered that crowding and consequent rise in temperature and humidity produce this form. In one experiment when there was no crowding, single eggs per seed having been kept individually in vials at 30°c and 70% humidity, a few adults of the abnormal form emerged. Utida (1956) has described it as a primitive form living in the fields. However in two years all sweepings in various pulse crops have yeilded only normal adults. A manuscript of this abnormal form has been prepared and submitted for publication.

9. Objective : To test a lentil variety from Hamadan, Iran reported as resistant to bruchids in storage.

A lentil variety grown in Hamadan, Iran reportedly was never attacked by bruchids in storage, in that part of the world. A small sample of seed was obtained and tested against Callosobruchus chinensis and C. maculatus. It was found that while C. chinensis laid large number of eggs on this seed, C. maculatus laid very few and these did not develop into adults. Since C. maculatus is the most prevalent species in Iran, for some time it was logically assumed that this variety was resistant. Later on when some Indian lentil varieties were also tested, it was found that C. maculatus females did not normally oviposit on these. A few eggs that were laid, did not develop into adults. Reports from Iran indicate that lentils are quite susceptible to bruchid attack. The RPIP Entomologist in Iran was requested for seed of one of the most susceptible varieties and he sent one known as Ghazvin lentil. The females of C. maculatus did not oviposit even on the seed of this variety.

There appears therefore a possible difference in preference or ability to attack lentils between the forms of C. maculatus occuring in India and Iran. This will need further investigation.

10. Objective : To study the biology of the blue butterfly (Euchrysops cnejus Fab.) under laboratory conditions.

The small blue butterfly belonging to the family Lycanidae is very common during the months of September and October when cowpeas, mungbeans and urdbeans, of which it is a serious pest , are in bloom. (Fig 35.) It's life history was studied in laboratory at 30°c and 70% R.H.

Adults were collected from the field and allowed to lay eggs on flower buds and pods of cowpea in cages. These eggs were removed twice every day and kept in batches of 25 in vials. These vials were then placed at the above temperature and humidity combination. Eggs were bluish green round and about 1 mm in diameter. These hatched in about 2-3 days, turning grey before hatching. The young larvae penetrated the flower and fed on its parts. In the field however if the ovary was not eaten, a pod developed so that the larvae then started feeding on the seeds. The larvae is oval plano-convex and very sluggish. The larvae period was about 9-11 days. Pupation in the field occurs in soil. Pupal period in the laboratory was 7-9 days. The entire life cycle was completed in 18-22 days at 30°c and 70% R.H. 3-4 overlaping generations were observed in the field at New Delhi.

Although the adults of this species visit blooming pigeonpeas, a different genus and species, Lampides boeticus Lin. is responsible for most of the damage to this crop. There seems to be some host specificity though not very marked.

Other activities : A black-light trap was operated nightly during the first six months of 1969. It was placed in pulse fields at IARI, and insect catches removed every morning. These were then sorted out and a record of the incidence of important pests maintained. Pinned specimens from these were sent to the U.S. National Musuem, Washington, D.C. for identifications. A large number of these were also pinned and arranged in insect storage cabinets as a permanent collection.

Out station collection work : Several field trips were made in northern India to observe insect damage to pulse crops in the Kharif season. Crops observed included cowpeas, mungbeans, urdbeans, pigeonpeas, soybeans and guar. Of particular interest was the 'pulse beetle' complex, which appears to consist of at least three species of chrysomalid beetles. Of these the most important one representing about 90% of the entire population is Madurasia obscurella Jacoby. It causes damage to the leaves of cowpeas, urdbeans, mungbeans, pigeonpeas and soybeans. It was also found feeding on the flowers of guar at Meerut, (U.P.) (Fig 36.) Two others, Longitarsus belguamensis and Chaetocnema sp. are true flea beetles. These were more common on pigeonpeas and mothbeans (Phaseolus acontifolius).

A large variety of caterpillars caused extensive damage to these crops. The Bihar hairy caterpillar (Diacrisia obliqua W.), was responsible for very heavy damage to urdbeans in Pusa (Bihar), and at several other places in the eastern region (Fig37 .). Cowpea leaf miner (Accrocercops sp.) was also very common in several location. (Fig 38.). A heavy infestation of a Lepidopterou leaf binder was noticed on pigeonpeas at Pantnagar (U.P.). The oil beetle

Figure 35 . - Copulating adults of the blue butterfly (Euchrysops cnejus Fab.)

Figure 36. - Pulse beetle (Madurasia obscurella) adult feeding on guar (Cyamopsis tetragonoloba) flowers.

Figure 37. - The Bihar hairy caterpillar (Diacrisia obliqua).

Figure38 . - Cowpea leaf miner (Accrocercops sp.) larvae mining cowpea leaves.

(Mylabrus pustulata) (Fig 39.) caused significant damage to flowers of cowpeas and mungbeans at several places. Aphid were noticed on pigeonpeas at Pusa (Bihar). Coccinellids were abundant and were probably responsible for keeping the aphid population in check (Fig40 .). A precise information on all the pests can be give only after these are identified.

At New Delhi larvae of the blue butterfly (Euchrysops cnejas) caused considerable damage to cowpea pods. Larvae of Spodoptera exigua and another unidentified Noctuid caused extensive damage to cowpea foliage, the later being very abundant. M. pustulata adults were also quite numerous. A catalogue should be compiled of all pests of different pulses and a collection of these maintained at a central place for easy reference. Provision should be made for suitable and proper care of such a collection.

Figure 39. - The oil beetle (Mylabrus pustulata) feeding on cowpea flowers.

Figure 40. -'Face to face with enemy'. An aphid and its coccinellid predator on pigeonpea.

QUALITY

RPIP

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Most of the work in quality testing has been in (1) analyzing samples from the All India Coordinated Variety Trial to identify high protein varieties, (2) screening of germplasm collections to identify high-protein breeding material and (3) a limited amount of work was done on method for the determination of the amino acids, tryptophan and methionine, which are reported to be deficient in most of the pulse proteins.

Coordinated Varietal Trials:

The protein content was determined in all samples of the pulse crops from the All India Coordinated Variety Trials which were suitable for chemical analysis. Many seed lots from the various locations were incomplete with several varieties missing. However enough of them were nearly enough complete to allow a statistical analysis on the data.

Results are shown in tables 152 to 158.

In chickpeas (table 152) both location and variety had significant effects. The location general means showed a range from 15.8% to 20.2% in protein content with a critical difference of 1.2%. The range of the variety means was somewhat less; from 18.4% to 20.3% and with a critical difference of 1.3%. The variety T-1 ranked high in many locations but very low at Kota, Rajasthan.

The varietal differences in protein content were not consistent enough to be significant in lentils although there were significant differences due to location (table 153).

Both location and variety affected the protein content of pigeon peas (Cajanus cajan) as shown in table 154. Gwalior-3 variety ranked highes in protein content. Samples from Berhampur, West Bengal were high in protein content.

Mungbean (Phaseolus aureus) varieties T-51 and BR2 were highest in protein content (table 155). Both variety and location significantly affected the protein content.

Likewise the data for the protein content of urdbean (Phaseolus mungo) (table 156) show large and significant differences due to location effects. There was a range in protein content general means from 22.7 to 27.9% with a C.D. of 1.0%. However varietal effects were not consistent enough to be significant.

Table152. Protein content (%) All India Coordinated Varietal Trials, Chickpeas, Rabi 1968-69.

Variety	Dholi Bihar %Protein	Kota Rajasthan %Protein	Pantnagar U.P. %Protein	Varanasi U.P. %Protein	Hyderabad A.P. %Protein	Gurdaspur Punjab %Protein	Junagadh Gujarat %Protein	Niphad Maharashtra %Protein	Gwalior M.P. %Protein	Behrampur W.B. %Protein	Variety General Mean.
NP 58	14.2	21.7	19.8	19.4	19.5	23.6	19.1	18.9	19.9	16.8	19.3
RS 10	17.5	19.7	18.5	20.0	19.1	22.5	20.8	18.0	16.2	19.4	19.2
ST 4	16.7	18.4	20.2	21.0	17.3	25.2	17.6	21.5	17.1	17.4	19.9
C 235	14.8	21.5	18.5	21.2	16.7	24.6	19.6	20.1	18.2	17.4	19.3
G 24	14.1	19.0	20.3	20.5	18.3	24.3	21.9	17.6	18.0	21.4	19.5
RS 11	14.8	19.7	22.5	20.5	19.5	22.7	23.0	20.3	18.7	17.3	19.9
T 1	17.7	17.2	22.5	18.8	20.4	25.6	19.6	20.5	18.2	22.1	20.3
BG 482	15.9	21.1	19.9	18.8	20.4	24.4	20.1	18.5	16.7	20.1	19.7
742-7	16.9	20.3	19.3	18.8	16.9	24.1	19.8	16.0	17.9	18.6	18.7
736-1	14.2	21.7	19.9	17.3	16.9	22.0	16.6	21.1	17.8	19.4	18.7
T 2	20.0	20.7	21.6	21.3	18.4	24.4	18.3	20.7	17.6	18.9	20.2
G62-404	13.5	20.1	18.9	17.1	22.3	23.1	19.3	14.8	17.3	18.0	18.4
Location G. Means	15.8	20.1	20.2	19.6	18.8	23.9	19.8	19.0	17.8	18.9	

Location C.D 1.2

Variety C.D. 1.3

Table 153. Protein content (%) All India Coordinated Varietal Trials Lentils, Rabi 1968-69.

Variety	Dholi Bihar	Varanasi U.P.	Hyderabad A.P.	Berhampur W.B.	Pusa Bihar	Bareilly U.P.	Pantnagar U.P.	Variety G.Mean	Rank
T 3	25.9	26.9	23.5	24.9	24.7	24.6	25.9	25.2	3
Pusa 1-1	27.5	28.4	24.3	25.8	25.9	26.2	22.5	25.8	1
T 8	24.1	30.5	26.5	22.5	21.3	20.7	23.2	24.1	7
NP 11	26.0	28.2	25.5	22.4	24.3	24.2	25.4	25.1	4
B 77	25.2	21.5	21.2	29.7	28.2	21.5	25.0	24.6	6
T 36	24.9	27.7	22.7	25.4	25.0	23.8	25.0	24.9	5
NP 47	25.1	27.1	23.3	26.5	25.4	24.2	25.9	25.4	2
Location G. Mean	25.5	27.2	23.9	25.5	24.9	23.6	24.7		
Rank	2	1	6	2	4	7	5		

Location C.D. 2.2

Variety N.S.

Table 154. Protein content (%) All India Coordinated Varietal Trials Pigeon peas, 1968-69.

Variety	Hyderabad A.P.		Pusa Bihar		Berhampur W.B.		Dholi Bihar		Variety G.Mean	Rank
	% Prot.	Rank	% Prot.	Rank	% Prot.	Rank	% Prot.	Rank		
NP 69	20.2	5	20.6	4	22.8	6	21.2	6	21.2	5
2 E	22.4	1	20.2	5	21.9	8	21.9	4	21.6	4
Gwl 3	21.0	4	22.4	1	26.3	1	22.3	3	23.1	1
T 17	16.6	8	19.8	8	23.6	4	19.3	8	19.8	8
NP(WR) 15	18.4	7	21.0	7	22.6	7	21.9	4	20.9	6
BR 183	21.2	3	20.7	3	23.7	2	22.5	2	22.0	3
BG 72	19.6	6	20.1	6	23.0	5	20.9	7	20.9	6
Khargeon 2	21.4	2	21.6	2	23.7	2	23.6	1	22.6	2
Location G. Mean	20.1		20.8		23.4		21.7			

Location C.D. 1.1

Variety C.D. 1.6

Table 155 Protein content (%) All India Coordinated Varietal Trials Mungbeans, Kharif 1969.

Variety	Ludhiana Punjab		Vishwavidalya, B.P.		Malda W.B.		Berhampur W.B.		Hyderabad A.P.		Variety G.M.	Rank
	% Prot	Rank	% Prot	Rank	% Prot	Rank	% Prot	Rank	% Prot	Rank		
D45-6	26.6	5	27.5	4	30.6	2	24.6	4	22.8	5	26.4	3
B 1	26.1	6	27.7	3	29.4	3	21.6	9	24.0	1	25.8	5
T 51	28.8	1	26.6	6	31.1	1	24.7	2	23.6	4	26.9	1
24-2	25.2	7	25.7	8	25.7	8	23.2	6	22.0	6	24.4	7
24-3	24.8	9	26.0	7	23.9	7	22.8	7	21.9	7	23.9	9
BR 2	28.2	2	29.3	1	28.1	5	24.9	1	24.0	1	26.9	1
RS 4	28.1	3	27.5	4	27.9	6	24.7	2	20.8	9	25.8	5
Hyb 45	27.7	4	28.6	2	29.0	4	22.2	8	23.9	3	26.3	4
No.305	25.2	7	24.9	9	25.0	9	23.6	5	21.5	8	24.0	8
Location G.Mean	26.7		27.1		27.9		23.6		22.7			

Location C.D. 1.2
Variety C.D. 1.6

Table 156. Protein content (%) All India Coordinated Varietal Trials Urdbeans, Kharif 1969.

Variety	Hyderabad A.P.		Kanke Bihar		Ludhiana Punjab		Gwalior M.P.		Dholi Bihar		Malde W.B.		Variety G.Mean	
	% Prot	RK	% Prot	RK	% Prot	RK	% Prot	RK	% Prot	RK	% Prot	RK		RK
No. 1-1	22.5	3	23.0	3	25.5	3	27.5	2	25.6	4	28.3	2	25.4	3
T 9	24.0	1	22.3	5	25.3	5	26.2	6	27.3	1	26.3	6	25.2	5
Mash 48	22.3	5	21.3	6	23.7	6	27.2	3	25.0	5	28.0	4	24.6	6
Khergaon 3	23.3	2	24.0	2	28.0	1	28.1	1	25.0	5	27.8	5	26.0	1
T 27	21.5	6	24.4	1	26.1	2	27.2	3	26.2	3	28.3	2	25.6	2
T 65	22.5	3	22.6	4	25.4	4	26.9	5	26.4	2	28.4	1	25.4	3
Location G.Mean	22.7		22.9		25.7		27.2		25.9		27.9			

Location C.D. 1.0

Variety C.D.N.S.

In peas both location and variety had significant effects. The variety Bonneville ranked high in protein content at most locations. (table157).

Few samples of cowpeas were received but both variety and location showed significant effect (table158). At all locations the variety K11 was highest in protein content.

In summary, data in all crops show a significant effect of locatior on protein content. In almost all of the tables samples from Hyderabad rank lowest in protein content or are not significantly higher than the lowest.

This data shows the importance of location in the evaluation of strains for protein content. Varietal differences were significant in most cases but not for lentils and black gram.

Better evaluation of this data would be possible if information on cultural practices, fertilizer, irrigation, stands, insects and diseases were available. The location effect on protein content may be due to any of these factors as well as the specific local conditions of climate and soils.

The data have been forwarded to the respective plant breeders who furnished the samples. It should be useful in breeding programs for high protein content.

Pigeon Pea Germplasm Screening:

Samples from the germplasm collection of pigeon pea were analyzed for protein.

As samples of all lines could not always be obtained from the same location, a set of 35 samples from two locations (Varanasi, U.P. and Hyderabad, A.P.) were analyzed for comparison of the location effect. With very few exceptions the protein contents were sufficiently close that for initial screening purposes samples could be used from either of these locations.

Protein content was determined by the Udy dye-binding method. The top ten percent were re-checked using the micro-kjeldahl method.

In 1891 lines analyzed a range in protein content from 16.1% (accession No. 09-069-00901) to 32.0% (No. 09-069-01903) occurred. One other sample analyzed 30.2% (No. 09-069-01360) while several had over 23 percent.

Table 157. Protein content (%) All India Coordinated Varietal Trials Peas, Rabi 1968-69.

Variety	Dholi Bihar		Varanasi U.P.		Gurdaspur, PB.		Kota Rajasthan		Hyderabad A.P.		Gwalior M.P.		Variety G.Mean	Rank
	%Prot	RK	%Prot	RK	%Prot	RK	%Prot	RK	%Prot	RK	%Prot	RK		
T 61	29.8	2	27.7	1	25.8	1	23.4	2	24.1	3	25.7	3	26.1	2
T 19	28.4	4	26.5	2	25.4	2	22.9	3	25.5	1	24.3	4	25.5	3
Boneville	31.1	1	26.2	3	24.6	4	23.5	1	25.3	2	26.6	1	26.2	1
T 163	26.5	5	23.3	5	24.2	5	17.2	5	19.1	5	24.0	5	22.4	5
KS 6115	28.8	3	25.2	4	24.8	3	21.2	4	22.1	4	25.8	2	24.6	4
Location G.Mean	28.9		25.8		24.9		21.6		23.2		25.3			

Location C.D. 1.4

Variety C.D. 1.5

Table158. Protein content (%) All India Coordinated Varietal Trials Cowpeas, Kharif 1969.

Variety	Hyderabad A.P.		Kanke Bihar		Ludhiana Punjab		Variety G.Mean	Rank
	% Prot.	Rank	% Prot.	Rank	% Prot.	Rank		
R 59	22.6	4	24.1	2	28.0	2	24.9	4
K 11	25.2	1	24.6	1	30.5	1	26.8	1
Black-eye7	21.4	7	21.2	7	27.6	4	23.4	6
Mashed Early	24.3	3	23.2	4	27.5	5	25.0	3
Ramshorn	22.5	5	21.9	6	26.4	6	23.6	5
K 14	25.1	2	23.3	3	28.0	2	25.5	2
T 2	21.9	6	22.0	5	24.9	7	22.9	7
Location G.Mean	23.3		22.9		27.5			

Location C.D. 1.0

Variety C.D. 1.5

Table 159. Protein content (%). Pigeon pea germplasm, India 1968 crop.

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
00002	22.4	00082	23.6 *	00173	21.7	00251	22.7
3	21.6	83	21.6	174	21.5	253	18.7
4	22.1	84	21.3	179	21.7	254	21.5
8	21.1	85	21.8	181	20.7	257	23.0 *
11	21.9	91	20.6	183	21.8	262	20.5
15	22.7	92	22.2	184	20.3	264	21.5
16	21.5	93	20.4	185	19.6	271	22.8
17	22.7	95	22.0	189	21.8	276	21.7
18	22.0	103	21.0	191	22.0	277	21.0
19	21.6	104	20.5	192	20.8	283	20.7
21	20.9	105	21.8	193	20.2	286	22.6
23	22.9	106	21.9	194	21.5	287	22.0
24	21.5	107	22.0	195	20.8	289	20.9
26	23.0 *	108	21.6	196	21.1	290	21.8
27	19.8	110	20.4	199	21.9	291	21.2
28	21.1	112	21.1	201	22.2	292	22.2
29	21.3	113	21.5	202	20.8	293	21.1
33	20.6	114	20.7	205	20.6	295	21.4
35	19.7	116	20.6	206	21.2	296	21.6
39	21.8	118	20.9	207	20.5	297	21.8
40	20.9	119	20.8	208	21.9	298	21.7
42	21.7	122	21.4	211	21.0	300	20.9
43	21.9	124	20.0	213	20.7	301	20.0
47	21.7	127	20.9	214	21.3	303	20.8
49	21.9	130	22.6	216	20.9	305	22.7
50	22.3	131	22.4	217	22.4	306	21.9
54	21.9	134	22.2	218	20.9	307	21.2
55	21.8	135	21.7	219	22.3	309	21.4
56	22.2	137	21.5	220	23.1 *	311	22.3
57	21.1	138	20.9	221	21.0	313	21.1
58	21.7	139	22.7	223	20.2	315	21.0
61	22.8	141	21.2	226	21.4	316	21.3
62	21.2	142	21.6	228	21.2	317	21.0
64	20.9	143	23.3 *	229	20.2	318	22.4
65	21.0	144	21.5	231	21.8	319	21.4
67	21.4	145	21.5	232	22.9	320	22.5
68	20.4	147	23.7 *	233	20.6	322	21.5
69	22.3	148	21.2	237	21.4	323	21.0
71	22.0	150	21.5	238	21.5	325	21.2
73	21.3	151	23.3 *	241	22.2	327	20.3
74	20.4	153	22.7	242	23.3 *	328	20.7
75	20.7	159	20.6	244	22.2	330	21.7
77	22.1	161	21.2	245	22.3	331	21.1
80	21.1	171	23.0 *	247	21.2	333	20.0
81	21.2	172	21.1	248	21.9	334	19.9

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
00337	21.1	00428	20.4	00525	21.2	00609	20.2
338	20.6	431	22.2	526	20.5	610	20.1
339	22.2	432	21.6	528	20.8	611	20.5
343	23.5*	434	21.6	529	19.6	612	20.6
344	20.1	435	19.3	532	20.8	613	20.1
348	21.5	436	21.6	535	20.4	615	20.1
349	21.7	441	21.2	536	20.9	617	21.5
352	21.2	442	20.8	538	22.1	622	21.4
354	21.4	443	19.5	542	21.3	623	20.3
356	21.7	444	18.9	543	21.1	625	20.0
359	21.1	446	21.9	547	21.4	635	22.6
360	21.3	451	21.9	548	21.0	637	22.6
361	20.6	452	21.8	551	22.0	641	21.3
363	20.4	454	22.9	552	22.5	649	21.4
365	20.2	455	22.2	553	21.6	651	20.9
367	21.3	456	21.6	554	21.3	652	21.3
369	20.9	457	22.1	556	21.4	653	20.8
373	19.6	460	21.1	558	20.5	654	20.1
375	19.0	466	21.5	559	21.5	655	21.1
377	21.5	468	22.0	563	21.3	656	20.7
378	20.2	469	21.3	566	20.3	657	21.6
380	19.0	470	20.6	567	20.9	658	21.3
385	21.7	471	21.1	570	21.8	660	22.7
388	20.6	474	21.0	571	17.8	661	20.5
390	20.6	479	23.9 *	572	19.9	667	20.8
391	20.8	480	21.8	574	21.2	669	21.5
394	20.6	481	22.3	575	20.1	672	20.1
395	23.1*	483	21.2	577	20.0	673	20.8
396	21.1	484	22.0	578	21.5	674	20.9
397	21.9	488	21.9	579	19.6	676	22.0
400	21.5	494	21.1	581	21.8	678	22.7
401	21.9	498	21.3	583	20.7	679	21.4
403	20.4	499	20.7	584	23.0 *	682	21.9
404	21.5	501	21.9	585	20.5	683	22.0
405	21.1	503	21.4	587	20.9	685	20.4
408	21.3	507	24.1 *	588	20.5	688	20.8
409	21.3	508	22.1	590	21.6	689	20.9
410	20.9	509	22.9	591	21.0	690	20.6
412	21.5	510	21.6	592	20.8	691	20.9
413	21.2	511	23.2 *	598	21.3	692	23.9 *
414	21.3	512	21.6	599	19.0	693	21.6
415	19.6	513	21.6	600	22.5	695	21.2
421	21.8	515	21.4	606	21.2	698	20.9
422	21.4	520	21.3	607	21.5	699	21.4
427	20.8	521	23.1 *	608	20.5	701	21.4

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
00702	21.7	00783	19.8	00885	19.5	00963	21.0
703	21.0	784	20.9	887	20.9	966	20.7
704	19.3	785	21.1	888	18.3	967	19.5
707	21.2	787	23.3 *	891	18.6	969	19.3
709	21.5	788	19.5	892	18.4	970	19.8
713	21.7	791	21.2	897	21.5	972	22.0
715	21.4	792	22.4	898	21.4	973	21.2
716	20.3	796	21.5	901	16.1	975	18.3
721	20.2	797	23.0 *	903	20.3	976	22.5
723	20.2	798	21.4	904	19.8	977	19.5
726	22.1	799	20.2	905	18.7	978	20.3
727	20.6	803	19.6	907	20.2	979	20.0
728	20.7	804	20.4	908	20.1	980	19.6
729	21.6	805	21.1	909	21.3	982	21.7
730	21.9	807	22.1	911	20.8	983	19.2
731	21.8	808	23.3 *	914	21.4	985	20.0
732	20.2	809	21.7	915	20.1	986	20.7
733	20.5	810	22.3	916	21.2	987	19.8
736	21.1	815	23.0 *	918	21.1	988	20.0
739	23.5 *	816	21.1	923	20.5	990	20.4
741	21.2	817	23.0 *	925	20.3	992	19.4
742	23.3 *	818	21.1	927	20.2	993	19.1
744	20.8	820	20.9	928	21.3	995	19.4
747	21.9	822	20.7	929	21.9	997	20.5
748	21.6	826	21.6	930	21.1	998	20.3
749	19.9	828	19.2	931	22.0	999	18.6
750	23.3 *	829	20.4	932	22.3	1001	20.0
751	20.9	834	21.2	937	21.0	1002	19.3
753	21.6	842	21.5	939	21.1	1003	17.7
754	21.7	850	21.5	940	18.9	1004	18.3
759	22.1	854	20.7	942	19.3	1005	20.6
761	22.3	856	19.3	943	19.8	1007	20.7
762	21.2	858	21.3	945	20.5	1008	20.2
763	21.4	859	20.5	946	19.8	1009	20.0
764	22.1	861	20.9	947	18.6	1010	19.8
765	21.7	862	21.2	948	20.2	1011	21.7
768	21.9	864	20.5	949	19.1	1013	19.5
771	20.5	865	20.7	950	20.6	1014	19.8
772	20.0	868	21.1	951	18.6	1015	20.0
774	21.4	871	19.5	955	20.4	1016	20.0
775	20.3	875	20.0	956	19.6	1018	20.2
776	21.5	878	20.0	957	19.5	1020	18.9
778	20.0	880	22.5	959	20.3	1021	20.2
779	21.2	881	20.5	960	20.2	1023	18.9
781	20.9	882	19.5	962	20.3	1024	19.8

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-110-		09-069-	
01025	20.2	01096	19.7	01181	20.2	01243	20.8
1026	18.4	1100	21.0	09-123-		1244	20.2
1027	20.0	1103	21.0	01183	20.4	1246	20.4
1028	19.8	1106	19.9	1185	19.1	1247	20.2
1031	19.5	1107	20.1	1186	20.6	1248	20.3
1032	18.6	1109	20.3	-157-01187	19.7	1250	19.3
1033	19.6	1110	19.5	-019-01188	20.6	1251	20.0
1034	21.5	-023-01111	20.7	-051-01190	20.1	1252	19.2
1037	20.6	1112	20.3	-057-01192	22.5	1253	20.8
1038	19.5	1115	20.6	-008-01193	20.4	1255	19.5
1040	19.6	1117	19.1	1194	20.1	1256	19.1
1041	19.6	1118	20.3	-069-01195	19.6	1257	19.1
1042	19.4	1119	21.3	1197	19.0	1259	20.0
1043	20.0	1124	20.3	1198	19.2	1260	20.4
1045	20.9	1125	19.4	1199	20.0	1261	20.3
1046	21.1	1128	18.6	1200	19.9	1262	20.4
1047	20.6	1129	21.4	1201	20.1	1263	20.2
1049	19.8	1130	20.7	1202	21.5	1264	20.0
1051	19.7	1131	19.5	1205	20.3	1266	23.4 *
1052	19.7	1135	20.8	1206	21.3	1268	19.4
1054	19.2	1136	21.1	1210	20.9	1271	21.1
1055	19.8	1141	20.2	1211	20.0	1273	20.4
1056	19.8	1142	20.6	1213	19.7	1274	19.6
1057	21.2	1143	19.6	1214	20.4	1275	19.9
1058	20.4	-113-01145	19.6	1215	20.8	1276	20.0
1059	20.3	1146	19.5	1216	19.6	1277	19.1
1066	19.4	1147	18.9	1219	20.2	1278	18.7
1069	19.8	1149	19.1	1220	20.8	1279	18.8
1071	20.3	1150	18.8	1221	20.8	1280	20.4
1072	18.6	1151	19.1	1224	20.6	1281	19.9
1075	18.1	1154	18.9	1225	20.6	1282	20.3
1076	18.9	-030-01160	20.2	1226	18.9	1283	20.3
1078	18.1	1164	20.5	1227	19.2	1284	19.2
1080	19.5	-020-01165	20.8	1228	20.1	-023-01287	21.0
1081	19.5	1166	20.5	1229	20.4	1289	19.5
1082	19.8	1167	19.2	1230	19.3	1290	20.9
1083	19.7	-077-01171	19.2	1232	19.5	1291	20.5
1085	19.8	1172	20.3	1233	20.6	1292	20.4
1087	21.0	1173	18.6	1235	19.2	1293	18.4
1088	20.0	1175	19.5	1236	21.4	-113-01294	20.1
1090	19.2	1176	18.6	1237	20.1	1295	22.0
1092	19.8	-110-01177	19.2	1238	21.4	1296	19.1
1093	18.6	1178	20.0	1240	21.4	1297	20.1
1094	19.2	1179	20.8	1241	18.2	1298	21.0
1095	19.6	1180	20.8	1242	21.4	-069-01303	19.1

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
01306	19.4	01540	19.1	01607	17.8	01659	19.6
1307	19.3	1543	19.0	1609	19.7	1661	19.3
1308	19.2	1545	21.6	1610	18.6	1662	19.2
1309	20.3	1546	19.2	1611	20.5	1663	19.1
1311	20.1	1547	18.6	1613	18.6	1664	18.6
1313	23.1 *	1548	20.1	1614	18.6	1665	19.6
-023-01315	21.0	1550	19.3	1616	19.6	1667	19.7
1316	20.3	1554	20.3	1617	19.4	1668	18.1
-069-01320	19.7	1555	18.2	1618	19.5	1669	18.8
1321	21.1	1556	21.5	1619	20.3	1670	18.5
1322	20.0	1557	22.1	1620	19.6	1671	19.3
1323	20.9	1558	20.5	1621	19.4	1672	17.9
1324	18.8	1559	23.4 *	1622	19.9	1673	19.9
1326	21.1	1560	21.7	1623	20.2	1674	21.1
1327	19.7	1561	22.3	1626	19.1	1676	20.0
1328	20.4	1562	19.1	1627	18.6	1678	19.5
1329	19.2	1564	21.1	1628	18.9	1679	17.8
1360	30.2 **	1565	20.6	1629	18.4	1681	19.7
1363	19.7	1567	17.9	1630	18.2	1682	19.5
1364	19.4	1568	17.0	1631	19.4	1684	20.1
1410	24.5 *	1569	22.8	1632	19.5	1686	19.2
1416	18.6	1570	22.4	1633	19.5	1687	20.5
1432	18.4	1573	19.7	1634	19.0	1688	19.5
1447	19.5	1574	17.6	1635	19.7	1689	19.6
1450	18.2	1575	19.3	1636	19.1	1690	19.8
1460	19.6	1577	18.2	1637	18.7	1691	18.2
-123-01516	18.9	1579	17.9	1638	19.5	1692	18.2
-069-01519	19.6	1580	19.0	1640	19.7	1693	20.6
1520	20.0	1581	18.9	1641	20.1	1694	20.8
1522	19.9	1582	19.7	1642	18.6	1696	21.0
1523	22.8	1584	20.0	1643	20.6	1697	19.1
1524	20.6	1585	19.7	1645	19.3	1698	20.7
1525	20.8	1586	20.9	1646	19.5	1699	21.3
1526	21.7	1587	19.2	1647	18.7	1700	20.4
1527	20.1	1590	19.5	1648	18.7	1701	20.8
1528	19.0	1591	19.7	1649	20.0	1704	20.5
1530	20.1	1592	19.2	1650	19.3	1705	20.0
1532	20.1	1594	20.6	1651	18.9	1711	21.8
1533	19.6	1595	19.1	1652	19.1	1712	17.8
1534	19.7	1596	18.5	1653	18.8	1716	19.5
1535	20.1	1599	18.6	1654	18.6	1717	20.6
1536	20.6	1600	18.1	1655	19.1	1718	20.6
1537	19.6	1604	20.0	1656	20.0	1719	20.2
1538	17.6	1605	19.4	1657	20.0	1720	20.0
1539	20.1	1606	19.0	1658	20.3	1721	19.8

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
01722	21.3	01782	19.9	01833	20.2	01889	20.7
1723	19.8	1783	20.0	1834	18.6	1890	20.6
1729	19.6	1784	19.7	1835	18.2	1894	18.4
1730	19.8	1785	19.5	1836	18.6	1895	19.1
1731	19.7	1786	20.6	1838	18.5	1897	20.0
1732	19.3	1787	20.3	1839	20.0	1899	20.8
1733	20.6	1788	18.6	1840	20.3	1900	19.9
1734	20.3	1789	20.3	1841	19.1	1901	20.3
1735	20.3	1790	18.6	1843	23.0 *	1903	32.0**
1737	20.3	1791	19.5	1844	20.6	1904	19.5
1738	19.5	1792	20.6	1846	19.5	1905	20.2
1739	20.3	1793	20.3	1847	20.5	1906	20.3
1740	19.5	1794	18.9	1848	21.4	1908	20.0
1741	19.3	1795	20.3	1849	19.2	1909	21.3
1742	19.5	1796	18.6	1850	21.0	1910	19.8
1743	18.4	1797	19.8	1851	21.0	1911	19.5
1744	20.6	1798	20.6	1852	21.0	1912	21.0
1745	20.3	1799	19.8	1853	20.3	1913	20.6
1746	20.1	1800	20.3	1854	20.3	1914	19.5
1749	18.2	1801	18.9	1855	20.6	1916	18.4
1752	18.7	1802	20.2	1856	20.6	1917	19.3
1753	19.2	1803	18.6	1859	19.5	1918	20.3
1756	19.5	1804	19.5	1860	26.1 *	1920	20.5
1757	19.5	1805	19.5	1861	20.3	1921	20.1
1758	20.2	1806	19.8	1862	19.1	1922	21.0
1759	21.1	1807	18.2	1863	21.1	1923	21.0
1760	19.5	1809	19.5	1866	21.5	1925	20.0
1761	20.3	1810	20.5	1867	19.7	1926	18.6
1762	19.4	1811	19.3	1868	20.0	1927	20.6
1763	19.8	1812	19.9	1870	20.0	1928	20.1
1765	20.0	1813	19.5	1871	20.0	1929	19.5
1766	20.0	1814	19.6	1872	20.4	1930	20.3
1767	19.5	1815	20.0	1873	20.6	1933	20.0
1768	20.3	1816	19.5	1874	20.3	1934	20.0
1769	21.6	1817	20.1	1875	19.5	1935	19.5
1770	19.9	1818	20.2	1876	18.9	1936	19.8
1773	20.3	1819	20.6	1877	19.2	1939	20.6
1774	18.8	1820	18.4	1878	20.5	1941	20.0
1775	19.3	1826	19.7	1879	21.0	1944	21.5
1776	17.8	1827	18.2	1880	20.0	1945	19.1
1777	19.7	1828	19.5	1881	20.8	1946	21.0
1778	19.6	1829	20.8	1883	19.5	1948	22.1
1779	20.0	1830	19.8	1886	20.6	1949	20.0
1780	20.0	1831	20.3	1887	20.2	1950	20.6
1781	19.5	1832	20.0	1888	20.3	1951	20.1

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
01953	20.2	02039	21.1	02182	21.2	02416	21.6
1956	20.3	2045	20.7	2188	22.6	2422	22.2
1957	22.1	2052	21.2	2191	22.1	2464	22.3
1958	20.6	2053	20.6	2193	22.9	2466	23.2*
1959	19.5	2055	20.2	2196	19.4	2479	22.7
1960	18.4	2056	21.6	2198	22.2	2484	21.2
1961	20.3	2060	20.4	2212	21.8	2494	19.0
1962	20.5	2061	20.6	2223	17.8	2512	18.8
1963	20.1	2062	21.1	2235	20.9	2514	19.5
1964	21.0	2063	19.1	2238	18.3	2515	20.3
1965	21.0	2064	21.8	2241	21.2	2529	20.9
1966	20.0	2065	17.7	2243	18.8	2539	18.7
1967	18.6	2073	21.6	2244	21.8	2552	19.5
1968	20.7	2076	21.4	2246	22.2	2555	21.8
1969	20.1	2078	22.1	2250	21.9	2566	23.2*
1970	19.6	2079	17.7	2253	22.7	2576	18.1
1971	20.0	2080	20.7	2256	22.1	2590	20.4
1972	19.1	2081	20.2	2259	18.5	2591	20.4
1973	18.7	2083	21.4	2261	17.8	2594	22.1
1974	19.1	2085	21.1	2262	22.3	2596	21.3
1976	21.3	2088	19.9	2298	22.4	2598	20.1
1977	23.1 *	2089	20.7	2308	20.5	2627	21.9
1979	20.7	2091	20.1	2311	17.1	2629	20.9
1980	18.6	2096	21.5	2316	20.8	2651	19.6
1981	20.6	2102	18.9	2320	18.8	2653	21.5
1982	19.8	2112	20.6	2343	21.8	2671	20.1
1983	20.7	2113	20.4	2352	20.1	2676	21.7
1984	19.9	2116	19.9	2354	19.1	2687	18.6
1985	20.3	2121	19.9	2355	21.6	2696	22.3
1986	20.2	2122	20.4	2358	19.6	2717	20.0
1987	20.4	2123	20.7	2360	22.4	2721	19.3
1989	20.6	2130	20.5	2362	21.6	2730	20.8
1990	19.0	2133	18.9	2363	19.5	2746	19.9
1991	21.0	2135	19.6	2365	21.1	2775	20.1
1994	20.8	2138	20.5	2366	21.9	2788	21.9
1996	20.6	2142	21.7	2367	18.8	2794	21.9
1997	18.0	2143	21.1	2379	19.6	2808	22.9
1998	19.8	2145	18.7	2388	19.3	2809	19.1
1999	19.6	2152	21.7	2390	19.3	2815	21.3
2003	20.4	2154	20.5	2392	19.5	2819	18.8
2014	19.3	2166	20.7	2393	19.7	2824	20.4
2019	22.0	2167	20.6	2394	20.0	2881	20.5
2023	20.6	2169	18.5	2396	21.6	2903	18.1
2025	19.9	2180	20.0	2399	19.8	2914	21.5
2030	19.8	2181	22.2	2404	18.8	2929	20.0

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-C69-		09-069-		09-069-		09-069-	
02954	22.0	03106	21.9	03233	22.6	03421	23.0 *
2958	23.8 *	3107	21.6	3234	22.5	3427	23.0 *
2960	21.7	3108	22.4	3236	22.0	3428	22.7
2963	22.6	3117	21.1	3245	22.9	3430	21.2
2987	19.4	3120	21.7	3251	19.5	3435	22.7
2995	19.7	3122	21.8	3252	23.1 *	3436	21.3
2997	20.7	3123	21.6	3253	20.5	3439	20.0
3000	18.3	3124	23.5 *	3254	20.8	3441	19.7
3002	22.4	3125	22.0	3256	22.3	3449	20.7
3004	21.1	3127	21.7	3258	23.1 *	3450	19.2
3007	22.6	3134	21.3	3259	20.4	3452	21.3
3008	22.1	3135	23.3 *	3261	23.6 *	3457	18.2
3010	21.6	3136	20.6	3262	22.0	3463	21.3
3011	21.5	3139	19.9	3263	22.2	3467	18.9
3017	21.1	3140	18.7	3267	23.4 *	3474	22.3
3019	21.5	3144	22.3	3275	22.4	3475	20.5
3020	20.6	3145	22.9	3283	21.0	3480	20.4
3022	20.9	3151	20.4	3284	21.0	3483	20.4
3027	20.0	3152	22.0	3293	19.4	3486	20.2
3028	20.8	3157	22.8	3297	19.6	3487	22.5
3033	20.6	3161	24.5	3299	20.4	3489	22.3
3034	18.8	3164	19.2	3304	22.3	3492	21.3
3037	21.3	3165	18.9	3312	22.2	3498	21.5
3042	20.4	3168	22.5	3316	23.3 *	3501	21.8
3043	20.7	3173	21.9	3319	21.5	3505	22.0
3045	22.3	3184	21.6	3324	22.4	3509	20.6
3048	21.3	3185	23.0 *	3332	20.6	3514	21.6
3049	21.8	3137	21.5	3333	20.9	3515	21.0
3054	21.3	3188	23.4 *	3334	20.4	3516	23.0 *
3055	23.3 *	3189	22.8	3335	21.8	3518	20.5
3061	21.4	3194	22.8	3341	23.5 *	3520	23.6 *
3065	22.4	3198	18.4	3348	22.0	3521	21.9
3066	21.9	3202	22.1	3359	21.9	3522	22.8
3068	22.8	3203	20.5	3370	22.3	3526	20.9
3076	23.5 *	3206	21.3	3373	21.0	3529	24.4 *
3078	23.8 *	3213	22.0	3379	19.9	3533	19.3
3079	20.0	3215	20.7	3381	23.4 *	3538	21.5
3086	21.4	3217	21.9	3388	21.7	3541	22.6
3088	22.7	3218	24.3 *	3391	19.5	3542	23.0 *
3089	21.6	3222	21.7	3400	19.6	3543	24.6 *
3095	22.5	3223	23.7 *	3405	22.3	3544	20.7
3100	22.8	3225	24.2 *	3407	20.0	3553	21.5
3102	22.6	3228	22.3	3408	21.7	3561	19.6
3103	23.3 *	3229	23.6 *	3409	21.4	3562	20.7
3104	23.5 *	3232	23.4 *	3420	21.7	3563	20.8

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
03566	22.7	03948	21.2	04206	20.6	04457	20.0
3569	21.7	3996	19.6	4207	21.8	4458	18.5
3570	22.6	3997	18.9	4208	22.0	4460	21.9
3575	22.6	4007	19.7	4209	23.7*	4461	19.6
3579	23.7*	4008	18.9	4215	22.9	4464	18.6
3598	22.3	4013	18.9	4217	22.2	4465	20.4
3614	22.2	4014	19.6	4219	23.3	4467	20.0
3616	19.9	4017	19.4	4220	23.2*	4470	20.0
3619	20.4	4033	19.0	4224	22.8	4472	19.5
3624	20.4	4034	19.4	4241	23.2*	4473	18.6
3625	21.4	4042	17.8	4242	19.5	4481	19.0
3627	21.2	4043	19.6	4246	21.5	4482	20.0
3631	20.8	4049	19.7	4247	19.9	4483	19.3
3632	19.7	4060	19.9	4252	22.8	4485	18.6
3633	21.0	4061	20.1	4268	21.9	4486	18.6
3636	21.5	4103	20.3	4292	21.1	4491	19.2
3640	19.4	4107	20.6	4314	20.5	4494	23.0
3641	20.0	4112	21.6	4326	20.0	4496	19.7
3642	21.1	4134	20.3	4328	21.6	4497	20.5
3643	22.3	4140	20.7	4344	20.1	4502	20.1
3644	21.0	4144	20.6	4345	22.2	4503	19.7
3654	21.7	4145	20.0	4353	21.0	4505	20.8
3661	19.7	4146	20.8	4392	21.9	4512	20.5
3662	22.8	4149	19.2	4401	18.9	4513	19.6
3667	21.8	4152	22.0	4403	20.8	4514	20.7
3668	21.7	4153	20.6	4408	19.6	4516	20.2
3669	20.4	4155	19.2	4411	20.2	4517	21.3
3670	22.3	4157	19.0	4412	17.9	4519	19.7
3672	20.0	4159	18.6	4415	19.6	4520	19.0
3677	20.4	4160	20.1	4416	19.7	4521	21.7
3681	21.8	4161	20.7	4420	19.7	4523	18.5
3727	20.3	4162	18.7	4423	18.5	4524	18.4
3742	21.0	4164	21.2	4426	19.9	4526	20.8
3750	20.4	4168	19.4	4428	20.2	4527	20.1
3754	21.0	4171	18.8	4430	19.3	4529	21.7
3759	20.1	4174	19.8	4432	18.8	4530	20.1
3764	20.2	4175	21.0	4436	21.1	4533	20.2
3778	20.4	4185	18.6	4438	22.0	4534	19.6
3789	21.2	4186	19.9	4443	18.7	4540	21.6
3816	24.1*	4197	20.6	4447	19.5	4543	19.7
3819	19.4	4198	19.6	4450	20.6	4546	21.2
3838	20.5	4201	23.0 *	4452	18.9	4548	19.7
3847	21.5	4203	22.2	4453	20.6	4549	21.8
3870	20.3	4204	21.9	4455	20.0	4550	21.0
3877	18.5	4205	20.8	4456	20.0	4554	20.9

Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-		09-069-		09-069-	
04556	21.4	04649	21.8	04781	18.9	04912	22.2
4558	21.7	4650	21.5	4783	19.4	4914	20.8
4559	20.1	4651	20.7	4785	21.8	4916	18.6
4560	20.7	4653	19.0	4786	21.7	4920	20.1
4562	22.3	4655	23.2	4787	20.8	4921	18.6
4564	22.0	4656	21.5	4788	21.5	4922	20.8
4569	20.1	4659	19.9	4790	22.1	4924	20.6
4570	19.4	4667	19.5	4791	21.9	4925	21.1
4574	19.5	4670	19.9	4792	20.8	4938	21.4
4576	22.0	4673	18.9	4793	19.6	4939	20.6
4577	20.2	4674	20.6	4795	21.8	4940	19.5
4579	20.6	4679	19.4	4796	20.5	4941	21.2
4580	24.2	4680	19.7	4798	19.1	4943	22.2
4581	20.7	4681	20.1	4799	21.3	4946	21.7
4583	20.3	4683	22.3	4810	19.1	4947	21.5
4589	21.0	4686	19.7	4812	19.9	4948	22.6
4590	21.5	4688	19.2	4815	20.9	4950	21.8
4591	20.7	4689	20.2	4816	21.1	4951	20.5
4592	20.4	4692	19.0	4817	19.8	4952	22.2
4597	20.3	4693	18.5	4818	18.5	4953	22.1
4598	20.1	4694	20.0	4819	20.6	4957	21.7
4600	18.6	4697	18.1	4822	20.4	4959	22.1
4601	19.4	4698	18.9	4823	20.0	4961	19.8
4603	18.8	4699	20.1	4825	21.9	4964	20.1
4607	22.2	4701	19.0	4826	21.1	4965	19.1
4608	17.9	4702	19.4	4829	19.5	4966	16.8
4609	18.4	4711	21.5	4830	18.1	4967	19.5
4611	21.5	4716	20.6	4834	20.0	4971	21.8
4612	16.9	4722	21.6	4835	20.0	4972	20.8
4614	17.3	4723	22.1	4836	20.3	4977	22.2
4615	21.2	4725	19.5	4839	21.1	4978	23.7*
4616	17.5	4730	19.8	4855	20.8	4984	19.1
4620	17.3	4731	18.9	4858	20.8	4990	19.9
4623	21.1	4742	20.0	4859	21.4	4992	21.1
4624	18.6	4746	21.1	4860	20.6	4995	18.9
4627	20.3	4747	20.6	4873	21.9	4996	18.7
4632	20.9	4751	19.5	4876	24.2*	4999	17.3
4633	19.8	4758	20.5	4878	20.1	5000	20.3
4634	18.5	4764	20.5	4879	23.6*	5001	19.1
4636	21.2	4771	19.9	4880	23.9*	5003	18.9
4638	20.3	4773	19.9	4882	22.2	5004	19.5
4639	18.6	4776	19.7	4885	21.9	5006	19.0
4642	20.2	4777	21.0	4902	19.9	5007	19.0
4645	19.5	4778	19.9	4907	22.6	5008	18.9
4647	21.6	4779	20.4	4910	22.1	5009	20.0

Accession No.	% Protein	Accession No.	% Protein
09-069-		09-069-	
05011	20.5	05068	19.3
5012	20.1	5070	19.5
5013	19.4	5074	20.0
5014	19.4	5076	19.3
5016	19.0	5077	20.0
5017	19.8	5085	19.3
5018	20.5	5087	20.3
5019	18.6	5089	19.3
5021	18.6	5094	20.3
5022	20.8	5095	20.5
5023	20.3	5096	21.0
5024	19.1	5100	19.9
5026	20.6	5101	20.3
5028	19.5	5104	22.1
5029	19.1	5105	20.5
5030	19.6	5106	20.3
5031	19.6	5108	20.0
5032	20.2	5110	19.9
5033	18.8	5112	18.9
5035	19.1	5113	17.8
5037	19.7	5114	19.3
5038	18.9	5115	19.3
5039	19.2	5118	19.5
5042	19.8	5121	19.2
5046	20.0	5122	18.2
5047	19.1	5123	17.8
5049	19.5	5124	18.1
5056	20.6	5125	21.4
5057	20.0	5129	20.6
5059	20.2	5131	20.3
5060	20.0	5132	20.3
5061	19.8	5133	20.7
5066	18.6	6135	20.1

Tryptophan in Chickpea Protein:

Composite samples of chickpeas from five locations were prepared for each of 18 varieties. Analysis of these samples for tryptophan content indicated that some samples were quite deficient. In other samples the tryptophan content of the protein was about equivalent to the FAO requirement of about 10 mgm/g of protein (1%)

Methods:

The samples were analyzed for protein content by the Udy-binding method.

Tryptophan was determined by a modification of the method of Spies & Chambers. (Anal. Chem. 20:35 (1948) as follows:

100 mg sample and 300 mg dimethyl amino benzaldehyde were mixed in a 250 ml erlenmeyer flask and 100 ml of 19N sulfuric acid was added. The mixture was allowed to stand for two hours with frequent stirring. The samples were then filtered through glass wool.

20 ml aliquots were then placed in 100 ml beakers. 5 drops of 0.045% $NaNO_2$ solution was added to each aliquot. After thorough mixing the samples were allowed to stand for 30 minutes in darkness. Percent transmittances were then read at 600 millimicrons with a spectrophotometer using distilled water as reference.

A standard curve was prepared using known amounts of de-tryptophan.

Results are shown in table 160.

The data gives the percent tryptophan in the protein. Results of the analysis of duplicate samples are given.

Table 160. Tryptophan content (%) of total protein in 18 varieties of chickpeas, composite of five crop locations, India, 1969.

	Variety	Sample 1 % Trypt.	Sample 2 % Trypt.	% Protein
1.	S.T.4	1.04	1.11	19.3
2.	G.24	.87	.87	18.4
3.	T-1	1.04	1.16	18.9
4.	B.G.482	1.21	1.16	19.3
5.	C.235	.85	.65	18.4
6.	T.2	.93	.93	19.5
7.	Chaffa	.85	1.00	17.6
8.	S.26	1.08	1.02	19.7
9.	RS.10	1.16	1.22	19.3
10.	G62-404	.96	.95	17.6
11.	Pb.7	.66	.68	19.5
12.	736-1	.77	1.10	16.8
13.	RS.11	.98	.85	19.2
14.	Gwl.2	1.05	1.05	18.9
15.	BR.77	.79	.82	18.9
16.	742.7	.83	.85	20.0
17.	B.98	1.07	.91	19.7
18.	NP.58	1.14	1.22	17.4

Methionine Determination:

It is well known that most of the pulse proteins tend to be deficient in the amino acid methionine. Some work was done toword the development of a suitable colorimetric method based on a modification of the McCarthy-Sullivan method.

Method: - 2 gram samples of finely ground chickpeas were hydrolized with papain enzyme according to the method of Horn, Jones, and Blum (J. Biol Chem. 166, 313-320, 1946) except that the hydrolyzate was acidified with 4 drops of sirupy phosphoric acid and placed on a magnetic stirrer-heater. It was boiled for 5 minutes with stirring to remove HCN. This operation was carried in a fume chamber.

The hydrolyzate was filtered through filter paper into a 100 ml volumetric flask and made up to volume with washings from the precipitate.

The samples were clarified by centrifuging at about 25,000 times gravity. Transmittance was read at 530 millimicrons on a spectrophotometer. A standard curve was prepared for the range 0.25 to 1.50 mg. methionine using semilog. graph paper.

The synthetic hydrolyzate used in making the standard curve was made up as follows:

Dissolve in 500 ml of solution;
300 mg. dl-arginine hydrochloride
100 mg. dl-histidine hydrochloride
200 mg. dl-isoleucine
250 mg. dl-leucine
250 mg. dl-lycine hydrochloride
200 mg. dl-threonine
50 mg. dl-tryptophan
225 mg. dl-phenylalanine
200 mg. dl-valine

The use of this synthetic hydrolyzate with the known amounts of methionine in establishing the standard curve helps to compensate for any effect of amino acids other than methionine on the color developed. The use of 2 ml of the above solution with each standard is intended to match the proportions of amino acids in a 10 ml aliquot of the hydrolyzate from a 2 gram sample of pulse material containing about 20% protein.

Results obtained in the analysis of chickpea samples appeared to be rather low. This may have been due to the interference of carbohydrates or lipids since they were not removed. Unfortunately time did not permit further work on this method. The extraction of the samples with petroleum ether before hydrolysis would remove the lipids. Soluble sugars could be removed by soxhlet extraction with 50% ethanol.

This method looks promising for the determination of methionine in pulse proteins but more work on adapting it to the analysis of pulse materials will be necessary.