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First Semi-annual report for the period October 1977 through March 1978 submitted to the Agency for International Development by Kansas State University, Manhattan, Kansas.

Richard L. Vanderlip
Principal Investigator
Professor Agronomy
Kansas State University

Semi Annual Report

Outline

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I. Progress Toward Research Objectives.

> "Objective 1. Accelerate improvement in pearl millet yield by creating widely adapted high yielding populations and synthetic varieties and investigate possibilities of creating inbred lines and hybrids for use in developing countries."

Population Improvement Improvement of HMP 550, a dwarf, early-maturing, large-seeded population, continued with the Cycle 1 of 182 lines S_1 progeny testing phase being conducted during 1977. The recombination population to begin Cycle 2 is presently being grown at the Corozal Substation, Corozal, Puerto Rico. S_1 progenies produced grain yields ranging from less than 11 to over 37 quintals per hectare and crude protein contents of 13.4 to 17.6 percent.

HMP 1700 Cycle 1 S_0 was self-pollinated to generate S_1 lines for testing in summer, 1978.

Desirable genetic characteristics including dwarf plant stature, increased seed size, earlier maturity, and the B_1 cytoplasmic male-sterility maintainer reaction were introduced into the World Pearl Millet Collection bulk population. The resulting tall F_1 bulk will be grown as a random-mating population in 1978.

Greenbug Aphid Studies Population screening and genetic studies of pearl millet tolerance to the greenbug (aphid), *Schizaphis graminum*, are being conducted. HMP 550 Cycle 1 S_1 lines placed in the Cycle 2 recombination population indicated a good level of tolerance as 14 of the 20 lines had seedling survival rates of 60 to 100 percent.

Preliminary genetic studies indicate tolerance to the greenbug is conditioned by a single incompletely dominant gene. Also, there are indications that a second gene giving partial tolerance may be present in one of the parent lines.

Hybrid Possibilities Development of lines to be used as parents of grain type F_1 hybrids continued to show promise. Superior A_1 and A_2 cytoplasmic male-sterile lines are presently receiving another backcross to their respective B_1 and B_2 fertility maintainer lines following backcrossing in the summer of 1977.

Fertility restorer lines derived mainly from Plant Introduction Station materials were crossed to A_1 lines in the summer of 1977 in the field and in the present greenhouse crop to provide F_1 hybrid seed for 1978 testing.

A total of 278 F_1 dwarf, grain type hybrids were evaluated in performance trials and observation nurseries in the summer of 1977. Grain yields of the pearl millet F_1 hybrids ranged from 12.3 to 51.7 quintals per hectare compared to hybrid grain sorghum yields of 30.2 to 39.7 quintals. Several millet hybrids with maturity requirements similar to the sorghum check produced yields comparable to sorghum. Late maturing millet hybrids benefited from near record

rainfall in August and produced up to 11.2 quintals per hectare more than the early maturing sorghum checks.

Selection for crude protein content among the parent lines of these hybrids may prove possible. Two replications of 200 genetic lines of pearl millet grain were tested for protein by the Kjeldahl process. A wide range in protein content was found with many of the millets producing higher per hectare yields of protein than the sorghums.

Heterosis Dr. A. J. Casady has provided the genetic material of three female parents and six male parents with the resultant eighteen hybrids. This material has been organized into a research project to study the effects of heterosis on growth and development of pearl millet. In addition to the effect of heterosis, it is anticipated this research will provide information on the growth and development of pearl millet complimenting the work of Dr. Bidinger, Crop Physiologist, ICRISAT.

Yield Testing The grain yield testing project is organized into two separate programs. One program will be a test of the populations and hybrids of pearl millet at the Fort Hays Branch Experiment Station, Hays, Kansas on silt loam soil and at the Sandyland Experiment Field, St. John, Kansas on a fine sandy loam both under dry-land conditions. An early maturing and a mid season maturing grain sorghum hybrid will be included for comparative grain yields. These trials will be similar in organization and size with the same entries to evaluate the effect of different soil and climatic conditions at two different locations. In addition, a yield trial including pearl millet hybrids developed by Dr. Burton, Tifton, Georgia and Dr. Casady, Manhattan, Kansas will be on the Ashland Experiment Field, Manhattan, Kansas on sandy land under dry land conditions.

> "Objective 2. Determine factors related to and genetic variability in seed and seedling vigor, water use, drought resistance, and herbicide susceptibility of pearl millet."

Seedling Vigor A study of the seed vigor measurements that could be used to predict field establishment of pearl millet was initiated during 1977. Laboratory tests included standard germination test, aqueous NH_4Cl treatment, accelerated aging treatment, NaOH treatment and cold treatment. Twenty seed lots were utilized. There were three plantings during the 1977 growing season. Field establishment was correlated with the standard germination, NaOH and NH_4Cl laboratory treatments. This research is continuing with laboratory tests and field plantings during 1978 growing season to confirm the results from last cropping year.

A study has been developed for 1978 and 1979 to determine correlation between seed size and density and field performance of pearl millet. This research is part of a master's degree program and will be published as a thesis. The laboratory portion of this research has been initiated.

Water Use and Drought Resistance We hypothesize that under conditions of high soil moisture, leaf or canopy temperatures can be used to distinguish levels of drought resistance. Leaf temperatures were measured in the field on 20 millet lines with an infrared thermometer (PRT-5 Barnes). Preliminary results indicate that the millet lines do possess a range in leaf temperatures under the same environmental conditions. Portable instrumentation has been purchased to permit the measurement of environmental and plant variables in the field.

Field work for the coming summer includes (1) phenological studies on serial plantings of millet lines, (2) leaf temperature, stomatal resistance and leaf water potential measurements on millet lines, and (3) water use of millet lines. Some of the work on leaf temperatures will be performed at the Fort Hays Branch Experiment Station while the majority of the study will be conducted on the Ashland Experiment Field south of Manhattan. We are anticipating a graduate student from ICRISAT joining our program in June, 1978.

Herbicide Susceptibility Tests were conducted at Ashland Experiment Field, Manhattan, Kansas on sandy soil and at the Southwest Kansas Experiment Field at Minneola, Kansas on heavier soil of the effects of various herbicide treatments on pearl millet during the 1977 growing season. Generally, the herbicides recommended for grain sorghum had no effect on pearl millet when applied at the recommended rate. These tests are to be continued during the 1978 growing season.

> "Objective 3. Determine the nutritional quality and digestibility of pearl millet grain by analyzing protein in germplasm introductions and breeding materials and determining magnitudes of variation in lysine content among and within populations and varieties. Determine the characteristics and digestibility of pearl millet protein and carbohydrates."

Nutritional Quality Over 150 S_1 lines from HMP 550 were received from the Fort Hays Branch Experiment Station. Eighteen of those lines are currently being screened for minerals (Fe, Zn, Ca, Mg, Na, K) and vitamins (niacin, riboflavin). Preliminary results indicate that pearl millet contains higher amounts of Fe, Na, K, and niacin but lower amounts of Ca compared to values reported for HRW wheat. Millet also appears to be a good source of Zn.

Studies to characterize the carbohydrates (pentosans and starch) of millet are under way. In addition, faculty memebers in the Department of Foods and Nutrition are making plans for digestibility studies on millet.

> "Objective 4. Determine the storage stability of pearl millet grain and millet meal by determining the factors contributing to grain losses during storage and determining the factors contributing to the development of rancidity in millet meal."

Storage Stability Quantitative and qualitative analyses of the lipids in millet are being conducted as the first step in determining susceptibility to rancidity during storage. The free lipid content appears to vary considerably among lines; the HMP 550 S_1 lines had values ranging from 4.7% to 6.9% with an average of 5.8%. Thin-layer and gas chromatography are being used to characterize the free and bound lipids.

Work on the susceptability of pearl millet to certain stored grain insects is in the planning stage.

II. Contacts Established

T. C. Jain, Documentation Services in Agricultural Research, Sorghums and Millets Information Center, ICRISAT

Dr. Frank R. Bidinger, Crop Physiologist, ICRISAT

Dr. Glenn W. Burton, Research Geneticist, ARS-USDA, Tifton, Georgia

Dr. Raul Abrams, Director Puerto Rico Agricultural Experiment Station, Mayaguez, Puerto Rico

Lidy Lopez-Matos, Assistant Director, Puerto Rico Agricultural Experiment Station, Mayaguez, Puerto Rico

Shadrach O. Okiror, Plant Breeding Section, IAR/ICRISAT, Samaru, Zaria, Nigeria

Paul Menge, Plant Breeder, Northrup King, Minneapolis, Minnesota

Ray Smith, Plant Breeder, Northrup King, Bolivar, Tennessee

Bobby Jones, Plant Breeder, PAG, Lubbock, Texas

Roy Conlee, Owner, Conlee Seed Co., Waco, Texas

Paul Revier, FUNK Seed Co., Lubbock, Texas

Dr. John M. Peacock, Crop Physiologist, Dryland Farming Research Scheme, Gaborone, Botswana

Jimmy L. Barber, Plant Breeder, North American Plant Breeders, West Memphis, Arkansas

Dr. M. B. Russell, Soil Physicist, ICRISAT

Dr. R. Jambunathan, Biochemistry and Nutrition, _____

C. D. Handa, Documentalist, Library, ICRISAT

Justo Lopez-Garcia, Superintendent, Corozal Substation, Corozal, Puerto Rico

III. Presentations, Seminars, Publicity

Dr. Vanderlip presented a Seminar to the faculty and graduate students of Agronomy, KSU, 28 February 1978, concerning the pearl millet project.

The office of University News, KSU, prepared a news release and mailed to all newspapers of Kansas, 23 February 1978. It appeared in the Kansas City Star, 5 March 1978, Manhattan, Kansas, Mercury, 26 February 1978, Wichita, Kansas, Eagle, 25 February 1978.

Richard L. Vanderlip taped an interview for radio of the pearl millet project which was distributed to all radio stations in Kansas, 6 March 1978.

The Fall Field Day, Kansas Agricultural Experiment Station, Manhattan, Kansas is scheduled 29 August 1978. A demonstration plot of pearl millet for grain production has been organized and will be included as one of the stops on the tour.

A demonstration plot of pearl millet for grain production is included in the Fall Field Day, Fort Hays Branch Experiment Station, Hays, Kansas, 1 September 1978.

IV. Planning Meetings

Meetings attended by the principal researchers were held 23 January 1978 and 24 March 1978, Room 106 Waters Hall, Kansas State University, Manhattan, Kansas. The first meeting was devoted to organizational and administrative requirements to fulfill the objectives of this program. The second meeting addressed the progress of planned projects, unresolved problems to complete the summer research programs, financial status, international travel plans and input, organization and editing of the semi-annual report.

V. International Travel Plans

Drs. Hoseney and Varriano-Marston plan a trip to ICRISAT to meet with Dr. R. Jambunathan, program head of Biochemistry and Nutrition, ICRISAT. Following this meeting Dr. Jambunathan will accompany Drs. Hoseney and Varriano-Marston on visits to countries of North Africa.

Discussions between Dr. M. B. Russell, Soil Physicist, ICRISAT and Dr. E. T. Kanemasu has lead to a tentative plan to visit ICRISAT, Rothemstead, England, and IRRI Philippines in September 1978.

Drs. Vanderlip, Stegmeier and Praeger plan a visit during August and September to ICRISAT, India, Pakistan, Afganistan, Kenya, Sudan, Nigeria, Senegal, Niger and Upper Volta. Purpose of this trip is to observe the pearl millet breeding programs for improvement of grain production, the plant characteristics required to be compatible with

the cultural practices of the various areas and the sociological significance of pearl millet for each region.

VI. Project Personnel

A list of project staff members for the period covered by this report.

Richard L. Vanderlip - Principal Investigator, Agronomist, Manhattan, Ks., .20 FTE - R

R. C. Hoseney - Cereal Chemist, Grain Science, Manhattan, Ks., .25 FTE - R

Elizabeth Varriano-Marston - Cereal Chemist, Grain Science, Manhattan Ks., .25 FTE - R

Edward T. Kanemasu - Research Microclimatologist, Evapotranspiration Laboratory, Manhattan, Ks., .10 FTE - R

T. L. Harvey - Entomologist, Ft. Hays Branch Experiment Station, Hays, Ks., .05 FTE - R

W. D. Stegmeier - Plant Breeder, Ft. Hays Branch Experiment Station, Hays, Ks., .40 FTE - R

Herman A. Praeger, Jr. - Research Agronomist, Manhattan, Ks., 1.0 FTE - R

Gallus, J. P. Mwageni - Graduate Student, Agronomy Seedling Vigor, Manhattan, Ks., Tanzania Scholarship, Ford Foundation

William B. Ndahi - Graduate Student, Agronomy Weed Control, Manhattan, Ks., Nigeria Scholarship

Cielo R. Sumayao - Graduate Student, Evapotranspiration Laboratory, Manhattan, Ks., Philippine student, .5 FTE - R

Adelaide Beleia - Graduate Student, Grain Science, Manhattan, Ks., Brazil student, .5 FTE - R

Christopher Chung Lai - Graduate Student, Grain Science, Manhattan, Ks., Taiwan student, .5 FTE - R

Aarion Johnson - Research Associate, Grain Science, Manhattan, Ks., 1.0 FTE - R

Dennis Ernst - Agricultural Technician, Ft. Hays Branch Experiment Station, Hays, Ks., 1.0 FTE - R

Rebecca Caulkins - Secretary, Grain Science, .5 FTE - R

Janet Snapp - Secretary, Agronomy, .5 FTE - R

FTE = full time equivalent

R = research contract

There are six undergraduate students assisting in the development of this program. They are employed on a part-time basis.

VII. Financial

	FIRM BUDGET 77-79	EXPENDITURES OCT 77 - MAR 78	BALANCE
Salaries	$185,800	$12,576.50	$173,223.50
Fringe Benefits	26,007	983.03	25,023.97
Indirect Costs	119,247	7,634.01	111,612.99
Travel and Per Diem	44,000	180.20	43,819.80
Equipment	51,000	6,000.00	45,000.00
Materials and Supplies	60,246	2,055.89	58,190.11
Other Direct Costs	12,700	88.79	12,611.21
Publications	6,000	----	6,000.00
Total	$505,000	$29,518.42	$475,481.58