PROCEEDINGS OF THE IN-HOUSE REVIEW

M I L L E T S

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Volume I

P R E F A C E

In-House Review is an important event for the Research programs, as it enables them to benefit from interdiscipline and intradiscipline interactions and to make a critical assessment of the accomplishments and short comings of the research program. It is a joint effort by the scientific community of the Institute to improve the quality of research, establish priorities and relevance,sharply focus the goals and fix the time schedule for their achievements.

The 1983/84 In-house Review was even more important in the sense that all the projects were reviewed. Secondly, the projects of ICRISAT cooperative research programs in West Africa; Mexico (CIMMYT) and Syria (ICARDA),were also reviewed along with Center's core program. Thirdly, besides Prof.Carl C.Thomsen, Chairman External Program Review (EPR) panel, Dr.A.B.Joshi and Dr.K.J.Frey, two members of the EPR and Dr.E.Steigmeir representing INTSORMIL also participated in the reviews on Sorghum and Millets.

The review was conducted in two periods - November,1983 and February,1984. The projects relating to Pulses, Groundnut,and related GRU research, Farming Systems,and Economics were reviewed in the first period and Sorghum and Millets program including cooperative programs in West Africa and Mexico and related GRU activities were reviewed in February, 1984.

The proceedings briefly summarise the objective, achievements, future plans, highlights of discussions and recommendations. The projects which have been concluded satisfactorily are recommended for termination. After discussing the proposed new projects are recommended for developing detailed outline. In case of terminated projects the scientists are requested to ensure that the important findings are published.

The detailed discussion reports prepared by the Rapporteurs, were reviewed by the concerned Program Leader, Mr.Bruce Gilliver and myself. Volume I is the consolidated Proceedings and Volume II Discussion Reports (Rapporteurs reports). They are being circulated to the scientists concerned.

I wish to thank the project scientists for preparing the project reports, the participants for contributing to discussion, the rapporteurs for the preparation of discussion reports, Mr.Bruce Gilliver for editing and Mr. K. Sampath Kumar for coordinating and typing the final report making it suitable for computerization with the help of Mr.P.Venkateswarlu of Statistics Unit.

J.S. Kanwar
Director of Research

March 14, 1984

MILLET IMPROVEMENT PROGRAM

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IN-HOUSE REVIEWS - 1984

MILLET IMPROVEMENT PROGRAM

R E C O M M E N D A T I O N S

Sl. No.	Project No.	Project title	Recommendations
1.	M-Brd-1(73)	Advanced composites-I - Intrapopulation improvement (KNR)	Continued
2.	M-Brd-2(74)	Advanced composites-II - Interpopulation improvement (KNR)	Terminated
3.	M-Brd-3(73)	Source material(KNR)	Continued
4.	M-Brd-4(73)	Variety crosses and synthetics (SBC)	Continued
5.	M-Brd-5(73)	Hybrids (BST)	Continued
6.	M-Brd-8(74)	International cooperation (KNR)	Continued
7.	M-Brd-9(76)	Comparison of population breeding methods (KNR)	Terminated
8.	M-Brd-10(80)	Dev. and improvement of seed parents (KNR)	Continued
9.	M-Brd-Agro-1(75)	Optimum cultivation practices and intercropping behaviour of new genotypes (DJA)	Continued
10.	M-Brd-Path-1(75)	Breeding for disease resistance (to become Breeding for downy mildew resistance) (BST/KNR/SBC/PS)	Continued
		(Subprojects 1.1, 1.2, 1.3 and 1.4)	
11.	M-Brd-Q&N-2(79)	Grain quality	Continued

Sl. No.	Project No.	Project title	Recommendations
12.	M-Brd-Phy--1(75)	Screening for drought resistance and maintenance of a nursery of contrasting morphological variability (BST)	Continued
13.	M-Brd-Micr-1 New (84)	Breeding for increased N2 fixation in millet(SPW/ SBC)	Recommended
14.	M-Path-N1.1(78)	Studies on the biology and Epidemiology of PM downy mildew(SDS)	Continued
15.	M-Path-N1.2(78)	Identification and utilization of stable resistance to pearl millet downy mildew (SDS)	Continued
16.	M-Path-N2.1(76)	Studies on the biology and epidemiology of ergot(RPT)	Continued
17.	M-Path-N2.2(78)	Identification and utilization of stable resistance to ergot (RPT)	Continued
18.	M-Path-N2.3(78)	Evaluation of alterntive Ergot Control Measures(RPT)	Terminated
19.	M-Path-N3.1(81)	Studies on biology and epiemiology of smut(RPT)	Continued
20.	M-Path-N3.2(78)	Identification and utilization of stable resistance to smut (RPT)	Continued
21.	M-Path-N4.1(78)	Studies on the biology and epidemiology of rust(SDS)	Continued
22.	M-Path-N4.2(78)	Identification and utilization of stable rust resistance (SDS)	Continued
23.	M-Phy-1(78)	Crop growth and yield under optimum management conditions (GA)	Terminated

Sl. No.	Project No.	Project title	Recommendations
24.	M-Phy-2(78)	Crop growth and yield under low intensity Management conditions(GA)	Terminated
25.	M-Phy-3(75)	Improvement in drought resistance (VM)	Continued
26.	M-Phy-5(78)	Improvement in crop establishment (PS)	Continued
27.	M-Phy-6(84) (new)	Control of flowering by photoperiod and its influence on crop adaptation (GA)	Recommended
28.	M-Phy-7(84) (New)	Evaluation of specific physiological hypothesis relating to yield improvement (GA)	Recommended
29.	M-Ent-2(80)	Studies on pearl millet insects of potential economic importance(HCS)	Continued
30.	M-Micro-1(81)	Host genetic differences in promoting N2 fixation associated with millet (SPW)	Revised
	Micro-1(81/84)	Revised title: Measurement of nitrogen fixation and host genetic differences in stimulating nitrogen fixation associated with millet and sorghum (SPW)	Continuing
31.	M-Micro-2(81)	Measurement of N2 fixation associated with millet, sorghum and related species and transferred to crop (largely completed, merge rest with M-Micro-1)(SPW)	Terminated
32.	M-Micro-3(81)	Bacteria associated with N2 fixation in millet, sorghum and related species and the response to inoculation (SPW)	Continued

Sl. No.	Project No.	Project title	Recommendations
33.	M-Micro-4(81)	Mycorrhiza development on millet, sorghum and groundnut in the SAT and the response to inoculation (KRK)	Continued
34.		Developing technology for bacterial inoculation(SPW/SBC)	Not recommended
35.	M-GQ&B-3(80)	Evaluation of protein and lysine contents in pearl millet (US)	Continued
36.	M-GQ&B-4(80)	Physicochemical properties and cooking characteristics of pearl millet (US)	Continued

PROJECT NUMBER: M-Brd-1(73)

PROJECT TITLE : Advanced Composites 1 - Intrapopulation Improvement

PROJECT SCIENTISTS : P. Singh

DURATION : a. Date of start : 1973
b. Date of completion: continuing

OBJECTIVES

1. To develop and improve the composite populations for grain yield, resistance to diseases and other important agronomic characters.

2. To breed widely adapted high yielding varieties with good seed quality from the composites.

ACHIEVEMENTS

Objective 1 - Development and Improvement of Composites

a) Development: A gene pool of early to medium maturity (80-90 days) is being developed and will be used to supplement the maturity range of our composites in future with new desirable variability. D1 and Serere 1 Composites have been merged with New Early and Medium Composites respectively to develop new versions of these Composites with a wider genetic base. Serere 2, ICRISAT Late and World composites having low mean yield and less variability have been dropped. Currently 7 composites belonging to diverse genetic background and phenotypic groups are under improvement.

b) Improvement: By 1983 kharif 2 to 7 cycles of selection in different composites have been completed. The results of the comparision of performance of the Co (base) and advanced cycle bulks indicate that recurrent selection has been effective in bringing the positive changes in gene frequencies for different characters in all populations. Genetic gains for grain yield from 2.3% (Super Serere) to 7.3% (D2) per cycle resulting in the overall net gains of 2 to 4 q/ha in different composites have been obtained. Levels of resistance to downy mildew of all the composites, though good initially (and to smut of one composite - SRC) have also been improved over cycles. At the same time maturity and plant height have been held constant or improved.

Objective 2 - Varieties and their Performance

a) Varieties from early cycles: WC-C75 an experimental variety giving 98% grain yield and 20% more fodder with better resistance to diseases in comparision to BJ-104 (a common hybrid) has been released in 1982 and IVC-5454 a progeny variety from Inter Varietal Composite under test in the AICMIP Trials since last three years has given yields similar to BJ-104. Experimental varieties IVC-P78, NELC-P79 and

DIC-P7904 which has performed exceedingly well in all the initial and advance test at ICRISAT were on 1st, 4th and 6th ranks respectively in AICMIP trials of 1982.

b) Varieties from recent cycles: IVC-80135, and IVC-P8004 developed in 1981 and tested from 1981 to 1983 have shown superiority (104-113%) over the mean of WC-C75 and ICMS-7703 and are followed by MC-81121 and IVC-P8001. Among the Experimental Varieties developed in 1982 and tested over 1982, and 1983, ICMV-82116, 82117, 82111 and 82113 out yielded ICMS-7703 the best check and 8 were better than WC-C75. Also, over both the years, ICMV-82131 and 82132 showed high resistance to smut in addition to DM. Four progeny varieties also gave yields better than the mean of WC-C75 and ICMS-7703 checks Superiority of still higher order of up to 125% of WC-C75 and ICMS-7703 has been observed in experimental and progeny varieties from latest cycles of selection. Dwarf Experimental Varieties selections developed from the latest cycle of D2 composite have also shown better performance over the best dwarf check in D2DVT-83. This demonstrates that recurrent selection has been successful in producing successively improved varieties.

Through our efforts on utilizing population progenies in hybrid development, ICH 415 a high yielding downy mildew resistant hybrid (5141A x a World Composite Progeny) has been developed and is in AICMIP test.

FUTURE PLANS

Continue as per current objectives. Some emphasis will be given to incorporating selection for good seedling emergence and to studying the most effective way to make varieties from composites.

DISCUSSION HIGHLIGHTS

Population breeding is an effective method for improving pearl millet for yield and other traits.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M-Brd-2(74)

PROJECT TITLE : Advanced Composites II - Interpopulation Improvement.

PROJECT SCIENTIST : K.N. Rai

DURATION : a. Date of start: 1974
b. Date of completion: 1984

OBJECTIVES

To select for increased heterosis between pairs of complementary populations for (a) developing hybrids through testcross evaluation on male sterile lines or through reciprocal full-sib evaluation and (b) developing experimental varities/progeny varieties from elite entries identified in each cycle.

ACHIEVEMENTS

1. Population bulk trial results available from two cycles of selection on 1R/1B composites and one cycle of selection on G75/3/4 ExBornu Composites showed that though per se performance of the populations registered improvement in grain yield, interpopulation-heterosis did not improve in any population pair. The rate of improvement in 1R/1B Composites was very low and statistically non-significant, although the marginal gains in grain yield were achieved with concomittant marginal gains in earliness and shorter height in 1R composite. The gains in grain yield were statistically significant for G75 and 3/4 ExBornu populations and population crosses with concomittant marginal increases of upto 2% per year for plant height (not a negative aspect in d2 height material) and days to 50% bloom.

2. Except one experimental variety (1R/1B-P7901) from 1R/1B Composites which did well for two consecutive years and contributed to ICRISAT millet program in Sudan, reciprocal recurrent selection was not effective in producing particularly promising experimental/progeny varieties.

3. The testcross evaluation of hybrids from 1R composite led to the identification of several promising restorers and two particularly promising hybrids which have done consistently well in yield trials over a period of 3-4 years. For instance, hybrid ICH-418 has consistently yielded about 15% or more than BJ-104 in multilocational yield trials over last 4 years. Another promising hybrid ICH-446 yielded 10% or more than MBH-110 (a hybrid still better than BJ-104) in yield tests over last three years and is now under seed multiplication to enter AICMIP testing.

Thus, the spin off of the project from 1R composite has been encouraging. It should be emphasized, however, that equally encouraging results on the production of actual hybrids have been

obtained by spending less resources in other projects. For instance, very small amount of time and land resources spent on D1 composite also resulted in a spin off leading to the development of hybrid ICH-423 which was equally high yielding and was entered to AICMIP trial last year.

FUTURE PLANS

Considering the resources demands and pay-offs, this project it will be frozen after conducting one more repeat bulk trial of G75, 3/4 ExBornu cycle bulks and another trial of NC and SC2 bulks in the rainy season of 1984.

DISCUSSION HIGHLIGHTS

In view of the poor payoff from these studies, it was agreed to terminate the project. If and when further useful B material can be accumulated work in this area might be reconsidered.

RECOMMENDATION

The project may be terminated.

PROJECT NUMBER: M-Brd-3(73)

PROJECT TITLE : Source Material

PROJECT SCIENTISTS : K.N. Rai
(Anand Kumar till March 82)

DURATION : a. Date of start: 1973
b. Date of completion: continuing

OBJECTIVES

1. Mobilize new variability present in unadapted germplasm accessions into adapted backgrounds for use by ICRISAT and cooperating scientists.

2. Maintain composites of exotic origin, under mild selection with recombination opportunities.

3. Generate segregating populations for the ICRISAT cooperative programs in West Africa for local selection.

4. Form populations containing sources of valuable characteristics.

ACHIEVEMENTS

1.At present we have available ~ 1700 F4-F8 selected progenies for utilization as parents of hybrids, synthetics or to feed in composite program. Of a large number of crosses made and tested in West Africa, Souna x Togo crosses appeared the most promising ones. We have available with us 118 F4 progenies selected from such combinations. LCSN, F4FC, S10B, 3/4HK, 3/4ExB and Togo selections in crosses with promising restorers/elite inbreds have proved particularly useful in widening the genetic base of existing hybrid parents. This project has also identified 211 non-restorers from a testcross nursery of 2719 hybrids in K1983 which will be further tested to confirm their maintenance ability and then utilize in seed parents project. Direct use of a source material restorer line (LCSN72-1-2-1-1) on 81A has produced a promising hybrid which after 3 years of yield test in ICRISAT trials will be entered in AICMIP in Kharif 1984.

2.Of the 10 exotic composites maintained under this project, two (3/4 ExBornu and 3/4HK) have proved particularly useful in crosses. Because of their lateness and hence limited direct use under Indian environments (also see item 4), the improvement of these composites has not been continued. Togo population, however, on account of its earliness, large seed size and yielding ability has proved more useful in crosses as well as for its direct use. Five experimental varieties made from a S2 progeny trial of this population, two (Togo-P8202 and Togo-P8203) yielded 125% and 118%, respectively, of a released population variety WC-C75 (22.2 q/ha). They were also 2-3 days earlier and about 15 cm shorter than WC-C75. Our initial evaluations indicate that several Ghana accessions (phenotypically similar to Togo

and probably of the same landrace type) will make useful additions to broaden Togo base to make a good exotic composite.

3. Crosses between Indian x African and African x African lines have been made and supplied to ICRISAT cooperative programs in West Africa. The usefulness of such materials will be highlighted by ICRISAT breeders in cooperating programs. Besides, crosses are also made on request for those not working in ICRISAT programs. For instance, we made 8 crosses between smut resistant lines x Cameroun accessions and supplied the F1's to the sorghum/millet breeder working in Cameroun in IITA program.

4.In a dwarf side cars program, d2 dwarf versions derived from the third backcross of seven tall(normal)composites were compared with their recurrent tall composites for two years at two locations. The dwarf version of Nigerian Composite (NC) yielded consistently more than the tall one Ex Bornu(ExB)and Medium Composite(MC)dwarf versions were also slightly superior to their tall recurrent composites. This was achieved with drastic reduction in plant height and with 1-2 days delay in bloom. D2 versions have slightly longer head length than tall versions and all have much better exsertion than any d2 population available at the time when this program was carried out.

Based on four tests over two years, we have identified several dwarf synthetic vaieties which have yielded upto 14% more than the best trial check variety (3/4HK-B78).

From this program, we are also developing isogenic lines at d2 (height) locus under divese genetic background of three composite (EC, MC, ExB) and are now at F8 generation.

FUTURE PLAN

Continued emphasis will be given to this project under the objectives listed as it is a major source of new variability for cooperators and ICRISAT projects both in the cooperative program and at the Center.

DISCUSSION HIGHLIGHTS

A plea was made for using new sources of dwarfing genes identified by GRU and also including more material from West Africa.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M-Brd-4(73)

PROJECT TITLE : Variety Crosses and Synthetics

PROJECT SCIENTIST : S.B. Chavan

DURATION : a. Date of start: 1973
b. Date of completion: continuing

OBJECTIVES

1) To develop an array of high yielding synthetics

2) To generate and make available to cooperators new variability.

3) To utilize identified downy mildew, ergot and smut resistance in making stable better yielding synthetics.

ACHIEVEMENTS

1.Synthetics developed in this project and contributed to AICMIP continued to be high yielding; and those results are given under project "International Cooperation (M-brd-8)". However results for ICMS 7703 which is in the pre-release stage and show that this synthetic has been stable in yield with little downy mildew and ergot and is slightly better than BJ 104. This synthetic showed good tolerance in drought experiments and was reported to be salt tolerant in All India Salinity tests. ICMS 7704 has been identified for minikit testing during 1984 and 1985, ICMS 7818 and ICMS 8021 have also performed well in (3-10% better than standard checks) in AICMIP trials. shows the performance of elite synthetics for various years in different trials. These are new batch of synthetics and some of which would be proposed to AICMIP testing.

It may be seen that under days to 50% bloom we have many synthetics which flower as early as BJ 104, have equal yield potential with better downy mildew resistance. Synthetics ICMS 8141, 8283 and 8120 were better than WC-C75 and ICMS 7703 in yield during 1983 , and synthetics ICMS 8150, 8147, 8133, 8008 and 8134 were superior to basket of checks in 1982. Performance of top few entries from the Advanced synthetics trial in 1981 shows that synthetics are equal to or just below the BJ104 during that year.

2.In the last 3 years a large number of specific seed requests have been met through this project. Total of 6000 samples covering 600 F3-F5 individual progenies were supplied to 20 locations in India and few to West Africa. It is encouraging to note that breeders now request specific lines during field visits on field days organized at three primary locations of the project. Uniform Progeny Nursery (UPN) was coordinated and movement of the contributions from other projects was streamlined (see M-brd-8. "International Cooperation").

3.Utilization and monitoring of downy mildew resistant lines is a

continuous process while ergot and smut resistant lines were utilized specifically to develop ergot and smut resistant synthetics. We have now evidence that smut resistant synthetics (ICMS 8282 and ICMS 8283) developed from smut resistant lines have good yield levels (25 quintals/ha grain yield over 4 locations) and hold smut resistance in Patancheru smut nursery as well as under field conditions of Niamey and Senegal. However, the utilization of ergot resistance in synthetics will require further reselection and testing.

FUTURE PLAN

To continue as indicated but more material will be drawn from M-brd-1 and parents of proven synthetics will be intercrossed to generate new variability.

DISCUSSION HIGHLIGHTS

(i) Some method of assessing the variation of entries across tests as well should be used. This will give a crude measure of adaptability of each entry.

(ii) There should be means of funneling in newer germplasm in the varieties and synthetics to bring about progressional improvement.

(iii) It should be determined whether experimental varieties are more plastic and widely adapted than synthetics.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: H-Brd-5 (73)

PROJECT TITLE : Hybrids

PROJECT SCIENTIST : B.S. Talukdar

DURATION : a. Date of start : 1973
b. Date of completion : continuing

OBJECTIVES

1. To identify and develop new pollen parents capable of producing superior hybrids with high and stable grain yield and acceptable grain quality.

2. To disseminate inbred lines and a range of advanced pollen parents to co-operating scientists in national programs.

ACHIEVEMENTS

1. During 1981, two hybrids ICH-433 and ICH-431 were found 13% and 14% superior in yield over mean of checks (BJ-104, WC-C75, and ICMS-7703) in PMHT and six hybrids EICH-8103, EICH-8111, EICH-8113, EICH-8102, EICH-8101 and EICH-8104 were found from 1 to 15% superior in yield over the mean of checks in PMEHT . During 1982 two hybrids ICH-466 and ICH-451 were 29% and 25% superior in yield over the mean of checks in PMHT, and four hybrids EICH-8215, EICH-8214, EICH-8203, and EICH-8204 were from 16 to 23% superior in yield over the mean of checks in PMEHT. During 1983 two hybrids ICMH-82601 and EICH-8215 were 26% and 22% superior in yield over the mean of checks in PMHT and six hybrids EICH-8306, EICH-8315, EICH-8317, EICH-8301, EICH-8309, and EICH-8316 were 25 to 30% superior in yield over the mean of checks in PMEHT. One of the three checks viz., BJ-104 showed high level of downy mildew and consequently low yield during 1983.

2. During the period 1981-83, two hundred and twenty four inbred lines and sixteen pollinators were disseminated to cooperating scientists

FUTURE PLANS

Continue as per objectives with emphasis on the use of new male sterile lines and intercrossing among existing good pollen parents.

DISCUSSION HIGHLIGHTS AND RECOMMENDATION

A number of questions were raised but no change in program was suggested. The project may be continued.

PROJECT NUMBER: M-Brd-8 (74)

PROJECT TITLE : International Cooperation

PROJECT SCIENTISTS : S.B. Chavan
K. Anand Kumar (till March 82)
Pheru Singh and
K.N. Rai

DURATION : a. Date of start : 1974
b. Date of completion : continuing

OBJECTIVES

1) To conduct and coordinate the International Pearl Millet Adaptation Trial (IPMAT) with entries both from ICRISAT and cooperators.

2) To participate and conduct yield trials of All India Coordinated Millet Improvement Project (AICMIP) and finally collate information on performance of ICRISAT entries.

3) Exchange of seed material between ICRISAT and breeders in the SAT.

4) To advise and assist in coordination of ICRISAT Millet Zonal Trials (African Regional Trial) being conducted by West African Programs. This would be done until ISC Niamey is in a position to take it over.

ACHIEVEMENTS

1. IPMAT-6 (1980): Contained 20 genotypes in four distinct groups: 9 hybrids, 4 synthetics, 5 experimental varieties and 2 population progenies was sent to 45 locations in 19 countries ranging in latitude from 24 degree S to 30 degree N .Data were received from 33 locations in 12 countries. 31 locations reported data on grain yield. The across location mean grain yield of test entries was 18.0 Q/ha. Entries with high grain yielding averages over all locations were ICH-220 (20.2 Q/ha), ICH-211 (19.6 Q/ha), and MBH-127 (19.2 Q/ha) and the average of the local checks was 17.5 q/ha. Good performances were also shown by ICH-162, IVS P77, UCH-4 and ICMS-7818. At 16 locations the mean yield of the test entries was more than the yield of the local check. In the Indian sub-continent hybrid ICH-220 was the highest yielding entry closely followed by the hybrid UCH-4. Five hybrids, three synthetics and one experimental variety also performed well. In Africa, entries ICH-211, ICH-220, IVS P77, MBH-127 and ICH-162 performed well . The downy mildew reactions in general were higher at African locations than in Indian locations. Some countries gave distinct differential reactions. As many as 10 entries showed an overall downy mildew incidence of 5 percent or less .

IPMAT-7 (1981): Consisting of 20 genotypes in the following groupings. 8 hybrids, 6 experimental varieties, 4 synthetics, 1 population bulk and 1 population progeny was sent to 47 locations in 14 countries. Data were received from 26 locations in 8 countries. 24 locations reported data on grain yield. The mean grain yield across locations of test entries was 19.8 Q/ha. The top five high yielding entries across locations were all hybrids: BD763 (22.2 Q/ha), MBH-131 (22.2 Q/ha) ICH-220 (21.7 Q/ha), ICH-418 (21.6 Q/ha) and ICH-226 (21.3 Q/ha) the average yield of the local checks being 19.9 Q/ha. Two other hybrids ICH-165 (21.0 Q/ha) and ICH-415 (20.2 Q/ha), one experimental variety IVS P78 (20.3 Q/ha) and one population bulk IVC(C3) bulk (20.8 Q/ha) also showed good performances. At 11 locations the mean yield of the test entries was higher than the local check yield. Over locations in the Indian sub-continent hybrid MBH-131 stood superior over other test entries. Five other hybrids, one experimental variety and one population bulk showed better performance. Among African locations hybrid BD 763 was significantly better than local check . Both extremeties of downy mildew incidence were observed in African locations with Samaru and Zambia showing the highest and the least occurance. Except for Samaru there was not a marked difference amongst Indian and African locations on downy mildew incidence. As many as 13 test entries showed an over all downy mildew incidence of less than 5 percent.

IPMAT-8 (1983):Containing 21 entries consisting of 7 hybrids 2 population composite varieties 7 synthetics and 5 experimental varieties were despatched to 21 locations in 3 countries. This reflects our reduction in the scale of activity on this trial. Further as IMZAT is being coordinated from West African programs the only country covered in Africa for IPMAT-8 was Niger. At the time of preparing this report, data had been received from 9 locations. Based on the performance at 5 locations (4 locations with more than 20% C.V. not considered). The highest yielding entries were three hybrids (ICH-446 from ICRISAT, UCH-10 from TNAU and MBH-137 from MAHYCO), yielding 30.0, 27.8 and 27.6 q/ha, respectively. ICMS-8008 from ICRISAT ranked 4th (27.4 q/ha), being the best among open-pollinated varieties (experimental varieties and synthetics). The two lowest yielding entries were also hybrids (UCH-1 and UCH-12) both from TNAU.

IPON International Pearl Millet Observation Nursery. This nursery was initiated during the period under report to provide an opportunity to those outside the principal millet growing regions who wish to evaluate pearl millet for the first time. time. During 1981 a large number of IPON-81 sets were despatched , however over all response to this nursery has not been encouraging. We received feed back from very few locations who requested further seed. In 1983 we have revised the list of entries and total supply so far has been low.

SADCC: Six sets of this (seventeen entry) nursery along with few more elite hybrids, synthetics and experimental varieties were supplied to cooperators in Botswana, Zambia and Zimbabwe. A similar nursery (PMVO) from West African cooperating programs was also arranged and despatched to SADCC program.

2. AICMIP Trials: We contribute entries to the hybrid, population and varietal trials organized by AICMIP and grow 7 trials, normally under low fertility conditions. ICRISAT has contributed total 6 hybrids and 4 varieties (synthetics and experimental varieties) together during 981 to 1983 for testing under All India coordinated testing system . C-C75 which has been released during the period under report is being used as trial check in population trials of AICMIP. WC-C75 which is now under commercial cultivation in Maharashtra and other states in India has proved our earlier feeling that varieties with good yield and disease resistance etc., would be acceptable to farmers in spite of their nonuniformity compared to hybrids. ICMS-7703 which is now in the final stage and would be considered for its possible release this year, yielded slightly higher than BJ 104. Another synthetic CMS-7704 has been identified for minikit testing during K-84 and K-85.

It may be noted that these new products eg., ICMS-7835 are yielding better than earlier varieties and some times exceed the yields of hybrid BJ104.

Uniform Progeny Nursery: This nursery (a major responsibility/contribution of M-brd-4) is an important channel of making available to Indian cooperators elite variability generated at ICRISAT. Since 1982 January Pre-Uniform Nursery of 300 entries pooled from different projects is planted at ICRISAT Center, Bhavanisagar and Hissar; and in subsequent season (90-entries + D2 Dwarf check repeated every 10th entry) nursery is formed considering across location selections involving the contributing breeder.

3. Seed Distribution: The range of material we distribute includes international trials, international breeding nurseries, breeding lines (specific requests) and lines selected by cooperators during field days. In 1983 we have supplied total of 420 seed samples to Zambia where work on millet has started with SADCC collaboration.

. The assistance given in conducting of ICRISAT Pearl Millet Zone A Trial (IMZAT) were by trial randomisation, preparation and despatch of field books, and data analysis. Compilation of data and bringing out report was also mainly done at ICRISAT Center.

FUTURE PLANS

Continue with existing objectives. Strengthen relationship with SADCC project.

DISCUSSION HIGHLIGHTS AND RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M-Brd-9(76)

PROJECT TITLE : Comparison of Population Breeding Methods

PROJECT SCIENTIST : K.N. Rai

DURATION : a. Date of start: 1976
b. Date of completion: 1984

OBJECTIVES

To compare the efficiency of four different methods of population improvement, viz., Gridded Mass Selection (GMS) Recurrent Restricted Phenotypic Selection (RRPS), Full-sib selection (FS) and S2 progeny selection (S2).

ACHIEVEMENTS

1. During six years of the study, 3 cycles of S2 selection (2 years/cycle) and 6 cycles of other methods (1 year/cycle) were completed with the bulk trial conducted at ICRISAT Center in the rainy season of 1982.

2. Results showed that there were no significant differences among bulks for any of the characters. However, selection methods based on progeny tests (S2 and FS) appeared to be more effective in grain yield improvement than those based on visual phenotypic assessment of individual plants. RRPS(M) was clearly and expectedly more efficient than Burton's original RRPS. This would possibly result from two-stage selection in RRPS(M) as compared to one-stage selection in RRPS.

3. There were no changes in plant height and days to bloom under either method except FS selection which was effective in selecting for earliness in cycles 5 and 6 whereas GMS led to delay in flowering.

4. Considering the changes in grain yield and days to bloom (and accounting for resources allocation) FS method was more efficient than S2 method. On the cost consideration and grain yield improvement, RRPS(M) can be considered probably the best method, although, at least, 3-4 more cycles of it would be required to substantiate this view.

5. When compared with 2.4-7.4% per cycle genetic advance in Composites under M-brd-1, 1.8% per year genetic advance recorded in this project is low but not unexpected. This may be, in part, due to multilocational tests in M-brd-1 in contrast to single location test used in M-brd-9. This may also be due to measurement data plus breeder's judgement on visual selection involved in M-brd-1 in contrast to purely measurement data making the selection criteria in M-brd-9.

'UTURE PLANS

With one more bulk trial to be repeated in the rainy season of 1984, :he project will stand as concluded.

)ISCUSSION HIGHLIGHTS AND RECOMMENDATION

The project may be terminated and results written up.

PROJECT NUMBER: M-Brd-10(80)

PROJECT TITLE : Development and Improvement of seed parents

PROJECT SCIENTIST : K.N. Rai
(Anand Kumar till March 1982)

DURATION : a. Date of start: 1980
b. Date of completion: continuing

OBJECTIVES

1. To develop new male-sterile lines incorporating (mainly A1) cytoplasm.

2. To eliminate "defects" of the existing, but as yet commercially unutilized male-sterile lines.

3. To identify, to a limited extent, restorers for the newly developed seed parents.

4. To attempt to breed male-sterile lines with ergot/smut resistance

5. Gather basic information on breeding of male-sterile lines.

ACHIEVEMENTS

1.We have now 228 pairs of A/B-lines at various stages of backcrossing (all in A1 system) which have been derived from 12 initial crosses and vary considerably for maturity, plant height, ear length and tillering. From cross (J1623x3/4ExBornu-96-1-10) we entered three A lines into AICMIP A-lines nursery in kharif 1983. One of these (named ICM 833A) which is an early flowering progeny of the group (52 days to 50% flower) was consistently selected at several locations. There is a great seed demand from Indian breeders and we have supplied small quantities to several breeders to enable immediate exploitation.

2.Male-sterile line 23D2(A), developed by Dr. Burton in Georgia, has been found to be a very high general combiner but highly susceptible to downy mildew in India. After irradiating 23D2(B) seeds with gamma rays and carrying out massive plant(A) x plant (B) crossing for six generations in downy mildew disease nursery, at least five A/B sister lines have been identified which are highly resistant to downy mildew. One of the A/B pairs (named ms 81A/B) has already been released to the AICMIP program. In two experiments conducted both at Bhavanisagar and ICRISAT Center, 81A hybrids yielded more than 5141A hybrids, the yield margin of 81A hybrids being more at Bhavanisagar than at ICRISAT Center . Three A/B pairs (21A/B, 26A/B and 68A/B) which we received from KSU are short (d2 dwarf), have larger seeds (10-11 g/1000 seeds) and are very early (40-43 days to 50% flower). However, all three pairs were susceptible to downy mildew. We have been successful, to some extent (in 21A/B and 68A/B pairs) in selecting from the residual variability, downy mildew resistant A/B pairs which have shown

substantial hybrid yield potential in our preliminary trials . During kharif 1983 field day there was considerable pressure from Indian breeders for release and we propose a joint ICRISAT-KSU-INTSORMIL release of these lines. From Serere 10L bulk (having poor but variable seed set) we have been able to develop an A/B pair (called ICM 834 A) which has much improved seed set. Our preliminary yield trials indicate that this male-sterile line has probably the best hybrid yield potential among the existing A-lines. Last year it was entered in AICMIP A-lines nursery and was selected at most locations. Many seed requests have also been received for this and small quantities supplied to several breeders.

3.From new seed parents hybrid trials, we have indications that several progeny derivatives each from (J104x3/4HK), (B282xS10B), (B282x3/4ExB), (B282x3/4HK), (B282xLCSN), and (LCSNxS10B), and Togo lines, have produced high yielding hybrids on a number of male-sterile lines (21A, 68A, S10A, MC103A, J1623A etc.). These pollen parents will be now transferred to hybrid project for further exploitation.

4.Substantial progress has been shown in breeding for downy mildew resistant A/B-lines. All the male sterile entered into AICMIP and almost all of those under development have very high level of downy mildew resistance under Indian conditions. Considering the complexity of genetic control of ergot resistance (and to some extent the same is true of smut resistance) and lower priority given to these two diseases, not much progress has been made on this front. (Details of this work will be presented by Dr. Thakur in pathology section). However, our knowledge of the gentics of these two diseases, is now sufficient to step up the resistance breeding work for these two diseases in the future.

FUTURE PLANS

In addition to current objectives we will: 1) Generate new variability from BxB crosses in A1 cytoplasm, since we now have several contrasting B lines of different origins. 2) Incorporate disease resistance into leading male steriles. 3) Search for male steriles in new cytoplasms.

DISCUSSION HIGHLIGHTS

No change in the program was suggested but a plea was made to breed, to a limited extent, male sterile lines of longer heads and later maturity to suit the hybrid programs in West Africa.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: N-Brd-Agron-1(75)

PROJECT TITLE : Optimum cultivation practices and intercropping behaviour of new genotypes

PROJECT SCIENTIST : D.J. Andrews

DURATION : a. Date of start: 1975
b. Date of completion: continuing

OBJECTIVES

1. To determine the intercropping characteristics of a range of different millet phenotypes, including leading sole crop genotypes.

2. To supply varieties/hybrids to FSRP for general evaluation and cultivation.

ACHIEVEMENTS

Objective 1

No intercrop experiments could be planted since the last review as FSRP scientists were on sabbatical.

Objective 2

Non-randomised strips of 2 new hybrids and 2 dwarf varieties were planted in a field of BJ-104 in RW3.

BJ-104 lodged badly and gave poor quality grain. Hybrid 972 was equally as early but did not lodge and gave 26% more grain of good visual appearence.

FUTURE PLANS

New dwarf early contrasting hybrid phenotypes have been identified for intercropping trials.

DISCUSSION HIGHLIGHTS

In answer to a query on whether it was necessary to breed for intercropping, it was stated that the range of plant types normally produced in a breeding program gave ample choice of the phenotype suited to the intercrop in question.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: **M-Brd-Path-1.1 (84) New number**

M-Brd-Path-1(75) (Old number)

PROJECT TITLE : Breeding for disease resistance (Revised title) Breeding for Downy Mildew Resistance

PROJECT SCIENTISTS : B.S. Talukdar
K.N. Rai
S.B. Chavan
Pheru Singh

DURATION : a. Date of start : 1975
b. Date of completion : continuing

OBJECTIVES

1. Evaluation of finished products and breeding materials for downy mildew, ergot, and smut reaction.

2. Improvement in downy mildew resistance in composite bulks, experimental and progeny varieties, synthetics and parents of elite hybrids.

ACHIEVEMENTS

1. Experimental and progeny varieties are generally found to have a high level of resistance to downy mildew. Adequate resistance was also noted in a large number of synthetics and hybrids . A high proportion of breeding materials previously selected in the DM nursery are found resistant to downy mildew. Experimental varieties and synthetics escape ergot and smut but hybrids and their parents are often seriously affected by these two diseases.

2. Through selection of residual variability downy mildew resistant versions of 68A and 21A have been obtained.

FUTURE PLAN

It is proposed that more specific attention should be given to the incorporation of resistance to all four diseases into material in various breeding projects. While it is desirable to breed for all diseases together, apart from DM, ergot, smut and rust are of primary importance only in some products. A seperate collaborative project is therefore proposed for each disease to bring more focus on these activities. Mbrd-path-1 will be reorganised to deal with DM primarily, and M-brd-Path-2, -3 and -4, are proposed for breeding for ergot, smut, and rust respectively.

DISCUSSION HIGHLIGHTS

M-Brd-Path-1(75) is revised as 'Breeding for downy mildew resistance'. Three other new disease resistance breeding projects - one each for ergot, smut and rust be initiated. Interdisciplinary efforts of breeders and plant pathologists are needed to breed for resistance to specific diseases. It may be better to have these three subprojects under one umbrella project of breeding for disease resistance.

RECOMMENDATION

A new project is approved in principle which will clearly set out four subprojects - objectives of breeding and inheritance studies on each disease. While resistance for ergot smut and rust may be individually emphasised for particular materials but they all must be in downy mildew resistant backgrounds.

Sub-projects

M-Brd-Path-1.1 (84)	Breeding for DM (KNR BST PS SBC SDS)
M-Brd-Path-1.2 (84)	Breeding for Ergot (BST RPT)
M-Brd-Path-1.3 (84)	Breeding for Smut (SBC PS KNR RPT)
M-Brd-Path-1.4 (84)	Breeding for Rust (KNR BST SDS)

PROJECT NUMBER: M-Brd-Q&N-2(79)

PROJECT TITLE : Grain Quality

PROJECT SCIENTIST : Pheru Singh

DURATION : a. Date of start: 1979
b. Date of completion: continuing

OBJECTIVES

1. Development of stable sources (lines) of high protein.

2. Utilization of these sources in developing hybrids and varieties having high protein and grain yield.

3. Identification of new sources of high protein with better agronomic traits.

4. Monitoring the protein content of elite products tested in advanced trials.

5. Study the inheritance of protein.

6. Evaluating the quality of protein and nutrition value of the high protein lines.

ACHIEVEMENTS

1 - Development of high protein lines: About 440 progenies showing 14.0-23.3% protein have been selected from 15 genotypes at sixth generation of selfing during 1983 summer. 700112 WC 190, IP 2701 and B 816 showing 18.5, 16.1, 17.5 and 15.6% mean protein values respectively compared to 11% in check WC-C75 have attained stability while others are still segregating .

2 - Utilization of high protein lines: i) Varietal crosses: Results of tests of 100 F1's between lines selected for high protein in 1982 and 32 selected F1's along with their parents in 1983 have shown that combinations of high protein and high yields are possible. All the crosses between high protein lines do not always produce high protein F1's and the protein content of F1's depends on specific combinations. 18 crosses showed 14.1-15.9% protein in 1982 and five of them also gave better yield than BJ104 (11.7% protein) .Crosses of 700112 with B816 gave highest yield and with IP2702 highest protein in both the years .

ii) Hybrids: In a trial of 252 hybrids made between three ms lines and the derivatives of high protein lines, conducted in 1982, 32 hybrids showed 14.0-15.8% protein . 700112 followed by B816 and IP2702 appeared the bcs+ pollinator and ms 81 the best male sterile

line in producing high yield and high protein . For protein in hybrids differential response of the pollinators related to same source has been observed and high protein lines did not always produce high protein hybrid.

3 - Identification of new sources: Of the 38 lines selected initially in 1981 and tested in 1982 Kharif, 25 lines showed 13.5 to 17.3% protein. In 1982, nintynine S2 progenies of Togo population and in 1983 ninty entries from Uniform Progeny Nursery were analysed. Seventeen S2 Progenies of Togo and 10 entries from UPN showed 14.8 to 17.3% and 15.1 to 20.2% protein respectively .

4 - Monitoring the protein content: All the entries of four advance trials of 1982 kharif were tested for protein and the mean protein value of these trials ranged from 7.3 (ELVT zero fertility) to 12.2 (ELVT high fertility) with out any distinct variation between types of material tested. Fertility levels has general increasing effects on protein levels .

FUTURE PLANS

Objectives will continue as stated. Work will commence on inheritance studies and overall chemical composition and nutritive value of the high protein lines.

DISCUSSION HIGHLIGHTS

It is a good collaborative effort between the breeders and biochemists.

RECOMMENDATION

The project may be continued

PROJECT NUMBER: M-Brd-Phy-1(75)

PROJECT TITLE : Breeding for drought resistance

PROJECT SCIENTIST : B.S.Talukdar

DURATION : a. Date of start: 1975
b. Date of completion: continuing

OBJECTIVES

1. Identification of materials performing well under limited moisture (drought) conditions.

2. Examine the possibilities of breeding for superior performance under limited moisture conditions.

ACHIEVEMENTS

1. Genotypes superior under GS2 and/or GS3 were hybrids ICH 211, ICH 426, and ICH 226; experimental and progeny varieties SSC-K78, NELC B8102, NELC B8103, IVCP 8101 and SC1P 8101 and synthetics ICMS 7703, ICMS 7818, ICMS 7845, and ICMS 7857. These materials will be more widely reevaluated.

2. In each case, selection in summer stress produced synthetics which were superior under summer stress. However in three cases selection under kharif conditions also produced synthetics which performed equally as well under stress. In two cases selection in summer control also gave good synthetics under summer sress. However, under kharif conditions all selected synthetics were invariably signficantly inferior to the original population. Evaluation tests will be repeated.

FUTURE PLANS

Continue with objectives as stated. Retest the selected products reported under achievement 2 to verify the differences. Continue with the comparison of effects of selecting in stress and non-stress environments.

DISCUSSION HIGHLIGHTS

Collaboration work should be through the mechanisms of ICAR Coordinated program on Pearl Millet

RECOMMENDATION

The project may be continued.

PROJECT NUMBER:M.Micro-Brd-1(84) [New Project]

PROJECT TITLE : Selection for nitrogenase activity trait in pearl millet.

PROJECT SCIENTISTS : S.P. Wani and S.B. Chavan

DURATION : a. Date of start: 1984
b. Date of completion : continuing

OBJECTIVES

i) To select for high and low rhizosphere nitrogenase stimulating ability from a population of millet.

ii) To study the mechanism of inheritance of nitrogenase stimulating ability in pearl millet.

ACHIEVEMENTS

Pearl millet landrace population Ex-Bornu has been identified in M-Micro-1(76) as a high mean level nitrogenase stimulating ability. Plant to plant variability was observed using the intact plant assay technique and to verify this 150 individual seeds of Ex-Bornu obtained from GRU were grown in glasshouse and nitrogenase activity was estimated. A large variation existed ranging from 0-1900 nmoles C H plant hour . The individual plants were selfed and seeds were collected. Preliminary test crosses between ms 81 x individual Ex-Bornu plants have been prepared.

FUTURE PLANS

This project should provide information on how nitrogenase stimulating activity can be manipulated genetically. This could mean that high stimulating lines identified in this project, or by M-Micro-1 (84), could be used as donors in breeding projects.

DISCUSSION HIGHLIGHTS

It was felt that there are still unanswered questions and the results need to be reconfirmed before taking up a project on breeding for higher nitrogenese activity.

RECOMMENDATION

The project will be considered after one more year's data have been critically analysed and results confirmed. However, Drs.Chavan and Wani can initiate some preliminary studies in the glasshouse.

PROJECT NUMBER: M. Path.N.1.1(78)

PROJECT TITLE : Studies on the epidemiology and biology of pearl millet downy mildew

PROJECT SCIENTIST : S.D. Singh

DURATION : a. Date of start : 1978
b. Date of completion : continuing

OBJECTIVES

1) Determine optimum conditions for the production, germination and infectivity of sporangia.

2) Determine pathogenic variability among pathogen populations.

3) Develop a laboratory/glasshouse screening technique.

4) Investigate germination of oospores.

ACHIEVEMENTS

Asexual sporulation is apparently not affected by the presence or absence of light. Zoospores retain normal infectivity for 12 hrs when kept at 10-15 C, but infectivity decreases as temperature increases. Infectivity is not affected by the presence or absence of light.

The downy mildew pathogen population in India differs in virulence from that found in Nigeria and Niger. Relatively less difference was found among populations within India. The serial passage of the pathogen through a specific host has little effect on virulence. There appears to be some specificity for oospore infection. An oospore population may die out in a few years in the absence of the specific host, and oospores produced on different cultivars may not necessarily infect all genotypes equally.

Shoots of 48-60 hr old seedlings were more susceptible to sporangial infection than roots, and combined inoculation of both resulted in even higher infection frequency. A laboratory inoculation technique, which helps minimise the escapes that may occur in field screening has been developed.

Attempts to germinate oospores in vitro were unsuccessful.

FUTURE PLANS

1) Further study pathogen variability among oospore populations in India and West Africa.

2) Test longevity of oospores produced on specific host genotypes.

3) Continue to study factors influencing oospore germination.

4) Determine optimum sporangial threshold for infection.

5) Investigate long-term storage of sporangia.

DISCUSSION HIGHLIGHTS

(i) The observations of ICRISAT pathologists differ from those published by Neergard about the role of seed-borne inocolum. In view of the importance of this subject it is necessary to publish that ICRISAT has been unable to reproduce Neergards results, despite several attempts. It is possible his infection was due to surface burn inoculum. In either case metalaxyl treatment would present infection.

(ii) Breeders should be involved in the study of inheritance of downy mildew.

RECOMMENDATION

This project may be continued since several questions on the biology and epidemiology need to be answered.

PROJECT NUMBER: M.Path.N.1.2 (78)

PROJECT TITLE	:	Identification, development and utilization of stable host plant resistance to pearl millet downy mildew
PROJECT SCIENTIST	:	S.D. Singh
DURATION	:	a. Date of start : 1978 b. Date of completion : continuing

OBJECTIVES

1) To identify sources of stable resistance and assist in incorporating such resistances into elite, high yielding material in the breeding program.

2) To develop resistance in downy mildew susceptible, but agronomically superior, genotypes.

3) To complete experimentation on control of downy mildew with metalaxyl

ACHIEVEMENTS

One hundred and twenty nine of 3163 germplasm accessions were resistant to downy mildew and rest were found agronomically acceptable. Thirty four entries with a high degree of stable downy mildew resistance (<10% across location mean) were identified in 2-8 years of international testing. Approximately 400 entries from the AICMIP trials (237 with combined resistance to ergot, smut and rust, 66 resistant to rust and 64 resistant to smut) were evaluated for downy mildew resistance. Many entries in these groups showed high levels of downy mildew resistance.

Several downy mildew resistant lines from a highly susceptible cultivar 7042 were isolated. Several of these lines are being used for transferring earliness (35-40 days flowering), dwarfness (100-120 cm tall) and the bold seeded character. Valuable sources of rust resistance and photoperiod insensitivity were also detected in these lines. Utilizing this information, and by selecting within the parent 'lines', we have reconstituted a resistant form of BJ-104, the most popular hybrid in India. Seed of resistant A&B lines have been supplied to Indian program.

Downy mildew symptoms were suppressed by metalaxyl spray. If the sprays are given prior to panicle initiation, yield losses can substantially be reduced.

FUTURE PLANS

1) Continue identification of downy mildew resistance and multilocational testing.

2) Continue to develop downy mildew resistance in agronomically elite genotypes by selecting for residual resistance.

3) Continue to assist national program scientists in evaluation of their material for disease resistance.

4) Evaluate selected genotypes for their sporulation ability, both oospores and sporangia.

5) Initiate studies on genetics of downy mildew resistance.

DISCUSSION HIGHLIGHTS

In study of inheritance of downy mildew breeders should be involved.

RECOMMENDATION

This proejct may be continued.

PROJECT NUMBER: M.Path.N2.1(76)

PROJECT TITLE : Studies on the biology and epidemiology of ergot

PROJECT SCIENTIST : R.P. Thakur

DURATION : a. Date of start : 1976
b. Date of completion : continuing

OBJECTIVES

1. To investigate the role of sclerotia in ergot epidemiology.
2. To study morphological and pathogenic variations in the ergot pathogen.
3. To investigate the potential alternative hosts of the ergot pathogen.
4. To study the infection process and understand the mechanism of resistance.

ACHIEVEMENTS

The positive role of sclerotia as the primary source of inoculum was confirmed. Ascospores released from germinating sclerotia in field soil become air-borne and infect the flowering pearl millet earheads. Isolates of C. fusiformis from different Indian locations varied in cultural and morphological traits and showed differential virulence on susceptible/resistant genotypes. The differential reactions to the isolates, however, need confirmation. It is too early to comment on studies of pathogenic variability at Imperial College. Of the eight grass species tested, only Cenchrus ciliaris was confirmed as an alternative host of C. fusiformis. Pearl millet florets from Patancheru and London are now being examined at Imperial College to determine path of infection and interaction between infection and fertilization.

FUTURE PLANS

1. Determine factors influencing sclerotial germination.

2. Continue work on differences between Indian isolates.

3. Continue collaboration with Imperial College, UK.

4. Initiate studies on mechanism of resistance.

DISCUSSION HIGHLIGHTS

More fundamental work on mechanism of ergot infection is needed.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M.Path.N2.2 (78)

PROJECT TITLE	:	Identification, development and utilization of stable resistance to ergot.
PROJECT SCIENTIST	:	R.P. Thakur
DURATION	:	a. Date of start : 1978 b. Date of completion: continuing

OBJECTIVES

1) To identify and develop sources of ergot resistance at ICRISAT Center.

2) To test the stability of resistance by multilocational testing through the International Pearl Millet Ergot Nursery (IPMEN).

3) To utilize resistance sources to develop, in collaboration with the breeders, ergot resistant hybrids and varieties.

ACHIEVEMENTS

More than 700 (S1-S3) lines from Tanzania, Togo, Nigeria (ExBornu) and Ghana were screened during 1981-83. At S1 screening many low susceptible plants were selected but by S2 or S3 screening progeny showed high susceptibility and none were selected. However, many ergot resistant lines have been developed among other selections by intermating ergot low-susceptible plants and selecting resistant progenies at each generation under high disease pressure. Ergot resistant sister lines were sib-mated to produce 37 sib-bulks, designated as ICMPES Nos. Most of these have high levels of ergot resistance and good phenotypic uniformity, and some yield at par with the standard check varieties. All the disease nursery entries (IPMDMN, IPMEN, IPMSN, IPMRN) were evaluated for downy mildew ergot and smut. Many ergot resistant lines also showed resistance to downy mildew smut and to some degree rust .

During 3 years of multilocational testing several lines have shown high levels of resistance across locations over years in India .

Several ergot resistant lines, which have been identified as maintainers on established 'A' lines, are being converted into ms lines through back-crossing. Back-crossing is being used to transfer resistance into established 'B' and 'R' lines. Five synthetics have been constituted using ergot resistant lines, but, though resistant, these have shown poor yield potential; Ergot resistance is governed by 5-10 effective factors with large recessive effects. Seed of ergot resistant lines have been supplied to several breeders in India for their utilization.

FUTURE PLANS

Continue stated objectives and collaborate with breeders in a new project to utilise resistance and further study the genetics of resistance.

DISCUSSION HIGHLIGHTS

More fundamental work on mechanism of ergot infection is needed.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M.Path.N2.3 (78)

PROJECT TITLE : Evaluation of alternative ergot control measures

PROJECT SCIENTIST : R.P. Thakur

DURATION : a. Date of start: 1978
b. Date of completion: 1984

OBJECTIVES

To evaluate possible effective control of ergot by methods other than host plant resistance:

1) Timely provision of pollen to the flowering hybrid.

2) Other cultural control measures based on role of sclerotia and alternative hosts in ergot epidemiology.

ACHIEVEMENTS

The four hybrids grown with the pollen-donor line developed significantly less ergot than when grown without the pollen donor A considerable increase in 1000-grain weight occurred when the hybrids were grown with the pollen-donor line than when they were grown without the pollen-donor line.

Information obtained from investigations on biology and epidemiology, did not suggest additional methods of alternative control worth investigating.

FUTURE PLANS

A control method has been described and the project will be terminated.

DISCUSSION HIGHLIGHTS

Identification and development of pollen donor lines to match with the flowering of F1 hybrids and testing their flowering behaviour in different environments will be needed.

RECOMMENDATION

The project may be terminated.

PROJECT NUMBER: M.Path.N3.1 (78)

PROJECT TITLE : Studies on biology and epidemiology of smut

PROJECT SCIENTIST : R.P. Thakur

DURATION : a. Date of start: 1978
b. Date of completion: continuing

OBJECTIVES

1.To determine the primary sources of inoculum and its role in epidemiology.
2.To determine mode of infection.
3.To determine variability in the pathogen.
84.To improve the field screening technique.

ACHIEVEMENTS

Smut spore-balls (teliospores) which remain in the soil from infected plants in the previous season serve as the main source of primary inoculum. Following rain showers or irrigation, teliospores germinate to produce air-borne sporidia which infect the flowering plants. Sporidial trappings during three seasons at Hissar and ICRISAT Center support this hypothesis. Similar results have been obtained in the screenhouse experiment. Pollination of smut-inoculated inflorescences reduced smut development significantly, compared with inoculated, but non-pollinated inflorescences . This suggests that smut infection occurs through the stigma. Histopathological studies are needed to confirm this. The smut screening technique developed, based on the results of several basic studies, has been effective for large-scale field screening. We have now shifted our major smut screening work from Hissar to ICRISAT Center since the 1982 rainy season.

FUTURE PLANS

1. Histopathological interactions will be studied between infection and fertilization in resistant and susceptible genotypes.

2. Continue studies on pathogen variability.

3. Study survival of inoculum under natural conditions.

DISCUSSION HIGHLIGHTS

Basic studies related to biology and epidermiology should be continued.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M.Path.M3.2(78)

PROJECT TITLE : Identification and utilization of stable resistance to smut

PROJECT SCIENTIST : R.P. Thakur

DURATION : a. Date of start: 1978
b. Date of completion: continuing

OBJECTIVES

1) To identify sources of smut resistance by screening germplasm and breeding lines.

2) To test the stability of resistance by multilocational-testing in India and West Africa through the International Pearl Millet Smut Nursery (IPMSN).

3) To utilize resistance in development of smut resistant hybrids and varieties through breeding.

ACHIEVEMENTS

About 3300 selections (S4/F4 to S6/F6 generations) from germplasm lines and crosses involving smut resistant lines were screened. In the 1983 rainy season, 1772 selections from these were screened and about 96% showed high levels of smut resistance with mean severity <5% compared with >60% severity on the susceptible checks . These lines have been categorised into tall, medium-tall and dwarf groups. Several smut resistant lines were intermated to produce smut resistant agronomic elite segregants. Many such lines at F4 or F5 were sib-bulked and designated as ICMPS Nos. Multilocational testing through IPMSN has identified several lines with stable resistance across locations over years in India and Africa. Smut resistant lines are being utilized by ICRISAT breeders to develop smut resistant hybrids, synthetics and composites. A backcross method is being used to transfer smut resistance into ICM ms81. One synthetic ICMS 8282, besides showing high levels of smut resistance, yielded 96% of ICMS 7703 and looked promising at Sadore in West Africa. Two experimental varieties, ICMV 82131 and ICMV 82132 from a smut resistant composite constituted in 1978, have performed well in the 1983 rainy season.

FUTURE PLANS

1. To identify sources of smut resistance by screening germplasm and breeding lines.

2. To test the stability of resistance by multilocational testing in India and West Africa the International Pearl Millet Smut Nursery (IPMSN).

3. To utilise resistance in development of smut resistance hybrids and varieties through breeding.

DISCUSSION HIGHLIGHTS

The multiple disease screening effort for downy mildew smut and ergot should be continued.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M.Path.M4.1 (78)

PROJECT TITLE : Studies on the epidemiology and biology of pearl millet rust.

PROJECT SCIENTIST : S.D.Singh

DURATION : a. Date of start: 1978
b. Date of completion: continuing

OBJECTIVES

1.To clarify the identity of the casual organism of pearl millet rust.

2.To determine the effects of temperature, light, and relative humidity on uredospore production, viability over time and germination.

3.To study the relationship between plant age and susceptibility to rust.

4.To develop an effective field screening technique.

5.To obtain quantitative data on the relationship between rust severity and yield.

ACHIEVEMENTS

This project was initially written in 1978 but was not reviewed in 1981. However, because of the apparent importance of rust in several states of India and parts of Africa, it seems appropriate that ICRISAT undertake studies to answer some basic questions about this disease.

FUTURE PLANS

1.To clarify the identity of the casual organism of pearl millet rust.

2.To determine the effects of temperature, light, and relative humidity on ureadospore production, variability over time and germination.

3.To develop an effective field screning technique.

4.To develop an effective field screening technique.

5.To obtain quantitative data on the relationship between rust severity and yield.

DISCUSSION HIGHLIGHTS AND RECOMMENDATIONS

The project may be continued. Multiple disease screening effort should be continued.

PROJECT NUMBER: M.Path.N.4.2(78)

PROJECT TITLE : Identification and utilization of stable rust resistance.

PROJECT SCIENTIST : S.D. Singh

DURATION : a. Date of start: 1978
b. Date of completion: continuing

OBJECTIVES

1) To identify new sources of rust resistance with agronomic eliteness from germplasm accessions, to evaluate breeding material, and incorporate resistance into improved cultivars.

2) To test ICRISAT identified sources multilocationally for stability of resistance.

3) To improve the visual rating system used for rust severity evaluation.

ACHIEVEMENTS

About 400 of over 2500 germplasm accessions evaluated were found to have high levels of resistance to rust. High levels of resistance to both rust and downy mildew have been identified in 47 lines.

Eighteen lines have shown high levels of stable resistance in 2 to 6 years of multilocational testing in India.

Work on development of a new rating system is being initiated.

FUTURE PLANS

Continue stated objectives and collaborate in breeding for rust resistance.

DISCUSSION HIGHLIGHTS

Multiple disease screening effort should be continued.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M-Phy-1(78)

PROJECT TITLE : Crop growth and yield under optimum management conditions.

PROJECT SCIENTIST : G. Alagarswamy

DURATION : a. Date of start: 1978
b. Date of completion: 1984

OBJECTIVES

i. To understand the phenology of the crop and its influence on grain yield.

ii. To better understand the growth and development of millet in response to the physical environment of the crop.

iii. To develop and test hypotheses on the determinants of grain yield in different millet genotypes and on ways in which yield potential in the crop might be improved.

ACHIEVEMENTS

The research in this project had been carried out under three broad areas (i) Crop phenology, (ii) Biomass production (growth) and (iii) Yield components. Under each area of studies three types of investigations were carried out. They were (i) Assesment of naturally existing variation, (ii) Experimental manipulation and (iii) Development of genetic variation. Each type of investigations will be used to determine the effects of variation in each of the areas of study on grain yield. Information thus generated will be used to develop hypotheses for the improvement of grain yield.

I: Crop Phenology

i. Assessment of natural variation: Variations in phenology in 50 millet genotypes over two seasons under high fertility indicated that days to panicle initiation (PI) varied from 15 to 24 days. Days to flowering varied from 40 to 58 days. Days to flowering were related to days to PI ($r=0.75$, $P<0.01$, $df=48$). There was not large variation in expanded leaf number at PI and the total leaf number was related to days to PI ($r=0.70$, $P<0.01$ $df=48$).

ii. Experimental variation: Millet being a quantitatively short day plant, extended day length delayed PI by 13 days and flowering by 15-21 days. Delay in PI increased dry weight of heads at flowering, indicating a potential for increased grain yield. Despite a 70 per cent increase in production of individual panicles, the grain yield increased by 10% only due reduction in productive tillering. The productive tiller number was related to the days to flowering. In high tillering millets,lengthening of preflowering period reduced

productive tillers. Similarly in Sanio millets reduction in preflowering period increased productive tillers. The optimum days to flowering ranged between 55-65 days for maximum yield at Patancheru.

iii. Genetic variation: In fifteen S2 progenies whose flowering period varied from 57-81 days, the maximum yield was obtained when the flowering occurred between 50-55 days.

II: Growth and biomass production

i. Basic assessment of variation: In several crops of BJ-104 grain yield was related to preflowering growth ($r=0.79$, $P<0.01$, $df=18$). Such an association was due to the direct relation of grain number/m2 to crop dry matter at flowering ($r=0.76$, $P<0.01$, $df=18$).

ii. Experimental variation: Changes in plant population caused changes in leaf area index and dry weight. At low plant population millet plant was multitillered, exhibiting low interplant but high intraplant competition. However, at high population it became an uniculm plant exhibiting high interplant and low intraplant competition. At low plant density BJ-104, SPTC 972 and ICH 412 yielded similarly. At higher populations SPTC 972 yielded better than other hybrids. At high population grain yield was reduced in ICH 412.

iii. Genetic manipulation: Growth rate evaluation in weedy, wild and cultivated pearl millet indicated that one harvest of vegetative dry matter at either ten days after flowering or at the final harvest was as good an estimate of growthrate as using more harvests. When wild and weedy types were involved, one harvest at 10 days after flowering and one at final harvest were needed for growth rate estimation. Growth rate related positively to biomass production.

III: Yield component:

i. Basic assessment of variation: In low tillering West African millet, panicle/plant was the predominant variable, while in high tillering millet grain number/panicle was the major yield determinant. Variation in grain yield strongly related to variation in grain number/m2.

ii. Experimental variation: Plant population in general had no effect on grain yield (in the range of 30,000 to 250,000 plants/ha). Variation in head/m2 caused by plant population influenced the individual head productivity.

iii. Genetic variation: A selection study was used to test two ways (surface area of main panicle and number of productive tillers) of selecting for increased grain number from a variable dwarf population. From selected S1 progenies synthetics were formed representing each criterion of selection. In the resulting synthetics produced, only selection for head surface area increased grain number/head leading to a 15 per cent yield increase .

FUTURE PLANS

Conclusions have been reached on a number of the objectives and the project will be terminated. Some lines of research on photoperiod will be continued in a proposed new project.

DISCUSSION HIGHLIGHTS

The objectives of the project have been achieved and it may be terminated.

RECOMMENDATION

The project may be terminated and results published.

PROJECT NUMBER: M-Phy-2(78)

PROJECT TITLE : Crop growth and yield under low intensity management conditions.

PROJECT SCIENTIST : G.Alagarswamy

DURATION : a. Date of start: 1978
b. Date of completion: 1984

OBJECTIVES

1. To investigate the genotypic variation in nitrogen uptake and utilization and its relationship to growth and yield.

2. To investigate the determinants of yield under low fertility (LF) and to compare with the determinants of yield under high fertility (HF).

3. To test the effects of direct selection in the F2 and F3 generation under LF conditions in comparison to selection under HF conditions.s

ACHIEVEMENTS

I: Nitrogen (N) uptake and efficiency of utilization:

N uptake, utilization, growth and yield in a set of 20 genotypes were examined under LF and HF over two years. Differences between two fertility levels were substantial for all characters studied. Genotype X Fertility interactions were not significant for N uptake, biomass or biomass produced per unit of nitrogen uptake. However,such interactions were present for grain yield and grain yield per unit of nitrogen taken up. Variation in N utilization for grain yield was primarily responsible for variation in yield in LF and HF. For biomass, however, variation in both uptake and efficiency contributed equally. Considerable genotypic variability existed for efficiency of N utilization rather than N uptake. There was a high degree of correlation between N utilization fro grain yield and grain yield ($r=0.75$, $P<0.01$). Variation in rate of N uptake was the major determinant of growth. However, in case of grain yield variations in both rate of uptake and efficiency of N utilization contributed equally. In neither case did variation in season length contributed to variation in growth or grain yield .

II: Determinant of grain yield:

Variation in grain yield was related to variation in grain number in LF and HF. Grain number/m2 was strongly related to grain number/panicle. 1000 grain weight was a smaller determinant than the grain numbers. Grain number / panicle was the predominant yield component.

III: Genotype x Fertility interaction:

Thirty two genotypes were tested over three years under HF and LF. There were significant genotypic differences under LF conditions and significant genotype x fertility interactions for grain yield and yield components .

Comparison of selection efficiencies under LF:

Selections made from early generation (F3) evaluation under LF and HF were used to make LF and HF synthetics. These synthetics were tested over two years both in HF and LF conditions. Results under significantly different testing environments, indicated that synthetics made from early generation selections under LF conditions gave nearly equal yields as compared to selections from HF conditions. There is no difference in yield advantage for synthetics made from F3 derived lines selected under nutrient stress conditions. Hence selection under normal HF conditions will be effective for LF conditions also. There is no need to breed specifically under LF conditions.

FUTURE PLANS

Some conclusions have been reached in this project which will now be terminated. Some lines of work are followed up in proposed new projects.

DISCUSSION HIGHLIGHTS

The main objectives of the project have been achieved and it may be terminated.

RECOMMENDATION

The project may be terminated and results published.

PROJECT NUMBER: M-Phy-3(75)

PROJECT TITLE : Improvement in drought resistance

PROJECT SCIENTIST : V.Mahalakshmi

DURATION : a. Date of start: 1975
b. Date of completion: continuing

OBJECTIVES

1.To assess the possibility of direct field screening for drought resistance during summer season at ICRISAT centre, and to define the limitations and the applicability of the results.

2.Evaluation of the drought response of advanced breeding materials and possible sources of drought resistance.

3.To better understand the physiology of drought response in millet and , to look for simpler methods of identifing desirable genotypes.

4.Comparison of line source (LS) irrigation-system as an alternative to the empirical screen(ES) and analytical approaches in utilizing the data.

5.Screening of pointed germplasm collections for drought performance at various location.

6.Physiological studies on the management (plant density and fertility) under stress.

ACHIEVEMENTS

1: PMHT-80 grown at 10 locations with 21 hybrids was grouped using Byth's two-way pattern analysis. The location grouping of summer environment at ICRISAT center with Kharif environments here and at Anantapur suggests no obvious limitation to drought screening in summer at ICRISAT.

2. In the initial years (1977-1979) the experiments included breeding lines that differed considerably in yield potential. As a result a significant portion of the variation in yields under stress simply reflected the variation in yield potential. Since 1981, however, only advanced breeding lines that differ little in yield potential was screened. Drought escape and drought resistance/susceptability were the major factors influencing grain yields under drought. In the flowering stress escape was negatively related to grain number, individual grain weight and relative yields. Drought index, however, was positively related to grain number, individual grain weight and relative yields.

3. Genotypes of millet with high and low levels of abscisic acid have been identified. A cross between a high ABA accumulator and a low ABA accumulator was made. F7 lines and synthetics with high and low ABA are currently being tested for yield and resistance.

4. Comparison of line source(LS) and empirical screen(ES) was made with 32 genotypes under flowering stress. Since the response is linear a comparison between the two techniques is possible assuming that the ES represents the two extreme ends of the LS. Slopes were similar in all cases except MBH-110, ICH-226, ICMS-7918, and ICMS-8010. In MBH-110 and ICH-226 both r2 and the slopes were low. In ICMS-7918 and ICMS-8010, however, the fits were good and slopes were high. In most cases the intercepts were different eg.,ICH-438, MBH-131. There were also cases where the response was similar eg., PSB-8, ICMS-7914. In the case of mid season stress such type of analysis is not possible because the response is non-linear.

5. In 1982, 100 accessions of early, bold grain types from different rainfall regions were tested. Lines from Ghana and Togo appeared promising and a replicated test of the selected lines was conducted at Anantapur in 1983. There were lines which yielded as well as BJ 104(August planting) and had better tolerance to mid season stress(June Planting).

Except for 1980 which was an extremely low rainfall year this location has proved quite useful. The potential yields can be obtained if the rainfall is uniform and well distributed ICH 446 and ICH 448 yielded better than BJ 104 in both June and August plantings at Anantapur during 1983 rainy season .

6. There was no effect of plant population (50,000 and 200,000) on the grain yields in both moisture stress and fertility treatments. Grain yields under moisture stress in the two fertilities were similar. Irrigated controls in the high fertility, however, yielded significantly higher than the low fertility controls. The percentage reduction in grain yields under moisture stress was higher in high fertility than in low fertility. Water potential and stomatal conductance for fertility x stress treatments suggest that high fertility plants suffered more than the low fertility plants under stress(lower water potential).

Additonally, grains from the three treatments (control, mid-season, & flowering stress) were analysed for grain protein. There was an increase in the %protein in the flowering stress treatment but total protein harvested(area basis), however, was reduced. Due to the low grain yields in the flowering stress treatment.

FUTURE PLANS

1) Screening of emerging breeding products with existing techniques to identify susceptible material.

2) Classification of millet growing enviornments for probable patterns of drought.

3) Summarising the comparison of LS technique with ES at flowering stress treatment. Development of analytical methods for mid season stress in LS where the response is non-linear.

4) Physiological studies on the parameters (eg., grain number and individual grain weight in flowering stress) which are correlated with drought index.

DISCUSSION HIGHLIGHTS AND RECOMMENDATIONS

The project may be continued.

PROJECT NUMBER : M-Phy-5(78)

PROJECT TITLE : Improvement in Crop Establishment

PROJECT SCIENTIST : P. Soman

DURATION : a. Date of start: 1978
b. Date of completion: continuing

OBJECTIVES

Millet in farmer's field conditions is subjected to constant selection pressure for establishment ability and for seedling competitiveness. Under experimental station conditions (good seedbed preparation, sowing, irrigation, etc.) this selection pressure may be considerably relaxed and breeding program products may not be equal to farmer's varieties in establishment ability. This project is therefore designed to:

i) Develop and test methodologies for screening for seedling emergence and establishment under conditions of crusted soils, seedling drought, high soil surface temperature.

ii) Identify the variablity existing in millet populations with improved stand establishment ability and early vigour for incorporation into the breeding program.

iii) To study the transferability of the emergence trait across generations.

ACHIEVEMENTS

i. A field technique for screening materials for their ability to emerge through crusted soil was developed. Crusting was created on Alfisol broad beds by applying sprinkler irrigation to smoothed broad beds. The control treatment was made by breaking the crust with a mechanical crust breaker just prior to emergence. Number of seedlings emerged through the crust was compared with that emerged through the control crust. Strength was measured for each trial.

ii. 285 germplasm lines were screened for emergence through crust.Only 3 entries emerged more than 80% through the crust Selected lines of millet populations were screened for their ability to emerge through high surface soil temperature . The field technique on screening under moisture stress needs further refining. However the trend showed by a few entries provides confidence in the technique . Plumule length of large number of germplasm lines was studied and classified according to the final plumule lengths . Plumule length ranged from 16 mm to 40 mm.

iii. Experiments are under way to test the transferability of emergence traits across generations.

FUTURE PLANS

Continue with stated objectives.

DISCUSSION HIGHLIGHTS AND RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M-Phy-6 (84)NEW PROJECT

PROJECT TITLE : Control of flowering by photoperiod and its influence on crop adaptation

PROJECT SCIENTIST : G. Alagarswamy

DURATION : a. Date of start: June 1984
b. Date of completion : continuing

OBJECTIVES

1.To understand the nature and effects of photoperiod in controlling flowering.

2.To evaluate the role of daylength response in adaptation and crop management such as adaptation to variations in planting date and latitude of planting.

3.To identify parent material which are less sensitive to photoperiod or with a range of photoperiod sensitivity.

4.In collaboration with breeder to determine whether it is possible to select for photoperiod insensitivity in existing composites. If successful, a less photoperiod sensitive composite will be formed.

5.To build an effective collaborative research net work on control of flowering in millet.

ACHIEVEMENTS

a) Review of past background: The photoperiod sensitivity restricts the use of same varieties across the locations. However, there are only limited a priori grounds for believing that photoperiod sensitivity mechanism is necessary for varieties grown in India (L.A. Hunt, Pearl millet breeding at ICRISAT, present status and projected changes, June 1983). The possibility to select for insensitivity or less sensitivity in the existing composites was suggested.

b) Present status: This is a product of the previous project M-Phy-1. Preliminary data on the effects of extended daylength on the phenology of selected genotypes are available. Twenty entries from Germplasm Resource Unit and 64 genotypes from millet breeding were screened under 19 h and 15.5 h daylength respectively. From this certain entries with less photoperiod sensitivity were identified.

FUTURE PLANS

New project - no change from stated objectives.

DISCUSSION HIGHLIGHTS

The new project may be postponed for a year and in the meantime results of the completed project should be published.

RECOMMENDATIONS

The project is recommended. Details may be worked out and submitted on the prescribed proforma.

PROJECT NUMBER: M-Phy-7 (84)NEW PROJECT

PROJECT TITLE : Evaluation of specific physiological hypotheses relating to yield improvement

PROJECT SCIENTIST : G. Alagarswamy

DURATION : a. Date of start: June 1984
b. Date of completion : continuing

OBJECTIVES

i. To develop lines with varying levels of characters associated with grain numbers such as effective tillers, head surface area and grain size from the same source population.

ii. To evaluate material developed in objective (i) for raising the potential grain yield by increasing grain numbers.

iii. To test the lines developed with specific characters in a variety of environments such as drought, N fertility, N fertility x water interaction and varying levels of plant competition.

ACHIEVEMENTS

a) Review of past background: Grain number/m2 was the major determinant of grain yield (ICRISAT Annual Report 1978-79) accounting for 50 to 75 per cent of yield variation. A selection study to test two ways (head surface area and productive tillers) of selecting for increased grain numbers, indicated selection for productive tillering increased the head number in the synthetics made from selected S progenies. However, due to decreased head and grain size, there was no yield gain. On the other hand, selecting for head surface area, increased grain number/head by 25 per cent with no change in seed size. Head numbers declined slightly, but the net result was a 15 per cent yield increase (ICRISAT Annual Report 1982).

b) Present status: This is a continuation/revision of the project M-Phy-1. Preliminary data on yield determinants in a wide range of material is available. Initial evaluation for certain characters have been taken up.

FUTURE PLANS

New project - no change from stated objectives.

DISCUSSION HIGHLIGHTS AND RECOMMENDATIONS

New project may be proposed after the results of the previous project have been written up.

PROJECT NUMBER: M-ENT-2(80)

PROJECT TITLE : Studies on pearl millet insects of potential economic importance.

PROJECT SCIENTIST : H.C. Sharma

DURATION : a. Date of start: 1979
b. Date of completion : continuing

OBJECTIVES

a) Status of insects feeding on pearl millet, extent of losses and ecology of important pests such as shootfly, stemborer, white grubs and head caterpillars.

b) Data collection from pearl millet growing areas in India for important pests.

c) Assessment of susceptibility of millet germplasm to important pests.

ACHIEVEMENTS

(a) The published information on insect pests of millets has been collected and a monograph on "Insects Pests of millets" has been written up, which will be published soon.

(b) The insect-pest complex associated with pearl millet has been studied on 4 cultivars over 8 crop seasons. At ICRISAT Center eighty five insects and mite species have been found to be associated with the crop, of which 23 are new records. Among these, shootfly (Atherigona approximata), aphid (Rhopalosiphum maidis), headcaterpillars (Heliothis armigera and Eublema silicula), headbugs (various species), blister beetles (Cylindrothorax tenuicollis), and thrips (Thrips) sp.) tend to gain importance. In a survey conducted in South India, shootfly, headbugs, leaf folder, grey weevil and midge have been observed to be serious on farmers' fields.

(c) Whitegrub and shootfly attack is higher on late sown crop, while Mythimna and Heliothis tend to be more damaging on early sown crop.

(d) Wireworms grubs are attracted to the farm yard manure. Aldrin or BHC in combination with FYM can be used for wireworm control.

(e) Mythimna causes extensive defoliation in pearl millet because of lower larval parasitism. Its damage is also higher in weedy fields as compared to weeded ones.

(f) Pearl millet cultivars differ in their susceptibility to important insect pests.Cultivars less damaged by shootfly, spider mites, grey weevil, leaf folder, armyworm, aphids, shootbugs,Heliothis and thrips have been identified under natural free choice conditions. A technique to screen for resistance to armyworm under screen house conditions has been developed. Using this technique 6 cultivars, less susceptible to the armyworm have been identified. The combining ability and other genetic interactions of 5 resistant and one susceptibility cultivar on 4 male sterile d lines have been studied. A few combinations with good combining ability for resistance could be identified. 81A shows better combining ability than other male sterile lines.

FUTURE PLANS

Pest surveys shall be conducted in other important millet growing areas. Studies on the millet earhead pests such as Heliothis, thrips, stink bugs, blister beetles and possibly midge will be intiated. Particular emphasis shall be placed upon insect-host plant interaction with the aim of identifying resistant genotypes and plant characters (such as anther covering, presence of awns, earhead compactness, plant height etc.) which make the host-plant less hospitable to the insects. Our efforts will largely be guided by the current breeding objectives in Pearl Millet.

The project shall be revised with the following objectives:

1. Pest surveys in pearl millet growing areas.

2. Studies on insect-host plant interactions of earhead pests (Heliothis, thrips,stinkbugs, blister beetles, and possibly midge).

DISCUSSION HIGHLIGHTS

The research on pearl millet entomology was in its infancy and required more attention. Attention should be given to development of screening techniques in West African situation where the problem was most serious.

RECOMMENDATION

The project may be continued laying greater emphasis on perfecting the methodology for screening and identification of resistant/tolerant lines.

PROJECT NUMBER: M.Micro-1(81)

PROJECT TITLE	: Host-genetic differences in promoting N2 fixation associated with millet and sorghum.
PROJECT SCIENTIST	: S.P.Wani
DURATION	: a. Date of start: 1981 b. Date of completion: continuing

OBJECTIVES

i) To evaluate millet and sorghum germplasm, varieties and hybrids for potential to stimulate nitrogen fixation.

ii) To select and cross promising genotypes to see if N2 ase activity associated with millet and sorghum roots can be enhanced and incorporated into material having other desirable characteristics.

ACHIEVEMENTS

The activities in this project were frozen due to budget cut in 1981.

FUTURE PLANS

Revise this project according to the objectives listed in the attached proforma numbered M-Micro-1(81/84).

PROJECT NUMBER: M-Micro-1(81/84)

PROJECT TITLE : Measurement of nitrogen fixation and host genetic differences in stimulating nitrogen fixation associated with millet and sorghum.

PROJECT SCIENTIST : S.P.Wani

DURATION : a. Date of start: 1981
b. Date of completion: continuing

OBJECTIVES

i) To evaluate millet and sorghum germplasm and elite breeding material for their potential to stimulate rhizosphere N2-fixation.

ii) To quantify the amounts of nitrogen fixed by organisms associated with millet and sorghum roots and transferred to the plant.

iii)To study the effects of soil fertility, geographical location and agronomic practices on nitrogen fixation.

iv) Continue development and use of 15 N2 methods of estimating N2 fixation.

FUTURE PLANS

As per revised objectives above.

DISCUSSION HIGHLIGHTS

It is an important project and considerably more work needs to be done. The work in this area should be persued vigorously.

RECOMMENDATION

Recommended in principle - the revised project should be presented in the proper proforma.

PROJECT NUMBER: M.Micro-2(81)

PROJECT TITLE : Measurement of N2-fixation associated with millet, sorghum and related species,and transferred to the crop.

PROJECT SCIENTIST : S.P. Wani

DURATION : a. Date of start: 1981
b. Date of completion: 1984

OBJECTIVES

i) Develop a reliable assay technique for measuring nitrogen fixation by sorghum, millet and related species grown in the field, based on the acetylene reduction assay for nitrogenase activity.

ii) Develop a pot culture assay for measuring N2-fixation by acetylene reduction or by plant N uptake.

iii) Develop assay for determining differences between plants in N2-ase activity based on enrichment of soil organic matter by N15.

iv) To determine the amounts of nitrogen fixed by organisms associated with millet and sorghum roots and transferred to the plant.

v) To determine the effects on this N2-fixation of soil fertility particularly N levels, and environmental factors such as soil moisture and temperature, geographical location, seasonal effects and agronomic practices.

ACHIEVEMENTS

i. Comparison between an improved and regular soil core assay techniques used for estimating C H reduction associated with field grown millet plants indicated positive relationship ($r = 0.70$, $p < 0.05$, $n = 7$).

Good positive relationship ($r = 0.86$, $p < 0.01$, $n = 7$) was observed between tube culture and improved soil core assays for C2H2 reduction activity associated with millet cutivars. Similarly, positive relationship was observed for N2-ase activity of millet cultivars estimated by tube culture assay and maximum field activity observed

with the lines by using regular core assay method.

ii. A non-destructive intact plant assay for estimating C2H2 reduction activity associated with pot grown millet and sorghum plants was developed, standardised and used for differentiating millet and sorghum lines for their N2-ase stimulating potential. With this technique diurnal pattern for N2-ase activity associated with intact millet plants was observed.

Significant differences were observed in amounts and patterns of organic carbon exuded in culture media by six sorghum cultivars grown in axenic liquid culture. Qualitative differences were observed in soluble exudates based on variation in growth and N2-ase activity of N2-fixing bacteria in synthetic medium containing root exudates as the sole carbon source.

iii. Under ODA-ICRISAT collaborative project Dr. K.E. Giller works at ICRISAT and Rothamsted Experimental Station U.K. Under this project a device has been developed for exposing the seedlings to 15N and it has been shown that 3 week old sorghum hybrid CSH 5 plants fixed atmospheric nitrogen in the rhizosphere and part of the fixed nitrogen was taken up by the plant within 3 days of exposure.

15N isotope dilution technique was used to differentiate pot grown millet and sorghum lines for their potential to stimulate rhizosphere nitrogen fixation. Sorghum line IS 801 and millet line D 180 derived 27% and 17% of total plant nitrogen from biological nitrogen fixation in comparison with a low N2-ase stimulating line IS 3003 and ICH 107 respectively.

iv. Nitrogen balance studies with field grown sorghum, millet and forage grasses were continued.

During 1983 rainy season (sixth year of N balance trial) total dry matter yield of 43.1 q/ha was recorded with cv Dobbs grown without any added nitrogen. In a nitrogen balance trial with millet during 4th year (1983 rainy season) top dry matter yield of 4860 kg/ha was recorded in case of an entry 700256 grown without any added nitrogen. Total dry matter production and N uptake by selected entries of forage grasses from N balance trial over 5 years has been reported. Maximum top dry matter of 329 t/ha which included 2322 kg N was produced by Napier Bajra (NB 21), a cross between Pennisetum americanum and P. purpureum.

With sorghum cv CSH 5 and millet cv BJ 104 grown in unsterilised alfisol soil in pots, net nitrogen balance of 331 and 322 mg/pot was recorded in a treatment inoculated with Azospirillum lipoferum.

v. The effect of soil moisture and soil temperature on N2-ase activity associated with millet and sorghum plants was studied. A positive relationship was observed between soil moisture and N2-ase activity.

The temperature effect on N2-ase activity of intact plant was studied and it was observed that diurnal variation in N2-ase activity was directly temperature dependent. A maximum N2-ase activity was recorded at 32 degrees C growth medium temperature.

FUTURE PLANS

This project will be terminated since assay techniques have been developed and standardised. Residual objectives will be incorporated into the revisions proposed for M-micro-1(81/84).

DISCUSSION HIGHLIGHTS

Some more work on methods needs to be done and it will be covered under the revised project M-Micro-1(81/84).

RECOMMENDATION

The project may be terminated and results published.

PROJECT NUMBER: M-Micro-3(81)

PROJECT TITLE : Bacteria associated with N2-fixation in millet, sorghum and related species and the response to inoculation.

PROJECT SCIENTISTS : S.P. Wani and D.B.Godse (up to Aug. 1981)

DURATION : a. Date of start: 1981
b. Date of completion: continuing

OBJECTIVES

i) Identify the microorganisms involved in N2-fixation in association with sorghum, millet and related species.

ii) Determine the variation in the populations between genotypes, soil types and localities.

iii) Assess potential for inoculation of sorghum and millet with microorganisms for increasing N2-fixation by associated bacteria.

ACHIEVEMENTS

i. We compared different methods of estimating population and isolation of N2-fixing bacteria from root samples. Higher counts of presumptive N2-fixers were recorded by dilution and plating method than by the most probable number (MPN) in semi-solid media or with plant tubes. However, recovery of N2-ase positive isolates was very low in direct plating method as compared to enrichment methods (MPN). Plant enrichment culture technique for isolating N2-fixers from the sample was standardised and used. It was observed that with the increasing enrichment during each generation the number of colony types decreased and the proportion of N2-ase positive bacteria increased. Nitrogenase activity (C_2H_2 reduction) of pure bacterial cultures was estimated by two assay methods Viz., incubation of inoculated semi-solid culture medium under 1% C H and culture grown in semisolid and incubated under 20% C_2H_2 for 3h. Both methods showed similar activity for Azospirillum lipoferum, a microaerophillic bacterium whereas, slightly lower activity for Pseudomonas paucimobilis an aerobe was observed by continuous incubation under 1% C_2H_2.

ii. Napier bajra root extract (NBRE) - a mixed culture inoculum, consists of 33 different colony types based on visual observations as using different methods of estimating population. Nine of these were N2-ase positive in semi-solid medium and in association with plant. In field trials with millet increased grain and plant dry matter yields of cvs IP 2787 and BJ 104 due to inoculation with N2-fixing bacteria have been observed consistently.

In a field trial with 2 millet cultivars during summer, 1982, 12% increased grain and plant dry matter yield of cv IP 2787 inoculated with Azospirillum lipoferum was observed whereas, cv ICMS 7819 did not respond to any of the cultures used. In other field trial conducted during rainy season, 1982 with 3 millet cultivars, increased grain yields of cv IP 2787 and cv WC C75 inocuated with A. lipoferum (ICRISAT isolate) to an extent of 24% and 37% were observed respectively. Millet cv ICMS 7703 did not respond in terms of increased grain yield, to inoculation with any of the cultures used. Both the trials indicated host cultivar bacterial strain interaction for inoculation responses. In two other field trials conducted during rainy season, 1982 and summer, 1983 with 3 millet cultivars viz.; BJ 104, MBH 110 and MEBH 23/81, consistently increased grain yields of cv BJ 104 inoculated with NBRE a mixed culture to an extent of 26% and 19% during rainy season and summer season, 1983 were observed respectively. Increased nitrogen uptake by field grown millet cultivars inoculated with N fixing bacteria was observed. In a field trial conducted during the 1982 rainy season with 3 sorghum hybrid cultivars inoculation with A. lipoferum and NBRE a mixed culture resulted in increased dry matter production. For studying persistence of inoculated strains in field, antisera with good titre against 4 bacterial inoculant strains have been raised.

FUTURE PLANS

i) Characterise N2-fixing populations associated with millet and sorghum grown in traditional areas of cultivation.

ii) Evaluate N2-fixing bacteria for their ability to fix nitrogen in culture media and in association with plants.

iii) Study host cultivar x bacterial strain interactions.

iv) Maintain efficient N2-fixing bacteria.

v) Use selected isolates to inoculate millet and sorghum in pot and field trials at center and other SAT locations.

vi) Standardise inoculation techniques for use in fields.

DISCUSSION HIGHLIGHTS

Consistency for inoculation responses should be confirmed at other location in SAT.

RECOMMENDATION

With revised objectives the project may be continued.

PROJECT NUMBER: M-Micro-4(81)

PROJECT TITLE : Mycorrhiza development on millet, sorghum and Groundnut in the SAT and the response to inoculation

PROJECT SCIENTIST : K.R. Krishna

DURATION : a. Date of start: 1981
b. Date of completion: continuing

OBJECTIVES

1. To determine the extent of mycorrhizal infection of millet, sorghum, and groundnut crops growing in the SAT and to assess the distribution of the different fungal types involved.

2. To isolate, identify, and select fungal strains producing efficient mycorrhizal symbiosis with these crops.

3. To determine host genotype, fungal strain, soil type interactions in establishment of mycorrhizal infections and in the effectiveness of the symbioses in enhancing plant nutrient uptake and growth.

4. To determine the response of field grown millet, sorghum, groundnut, to inoculation with mycorrhizal fungi in terms of growth, N2 fixation and uptake of soil nutrients.

5. Develop feasible methods for inoculation of field grown crops with mycorrhiza.

ACHIEVEMENTS

5.1: Survey of pearl millet at ICRISAT center revealed the occurrence of VAM species belonging to all the four major genera. Spore populations in the rhizosphere ranged between 10-2 and 10-3 per 100 ml soil, considered dense when compared with other reports. At different field locations in the center, pearl millet genotypes recorded VAM root colonizations between 10 and 54%. Consistantly higher colonization was found with the crop grown in highly sandy soils and on sand dunes in semi-arid Rajasthan, indicating a possible higher dependence of pearl millet on VAM under such nutrient deficient conditions. In West Africa, pearl millet forms extensive mycorrhizal symbioses. A preliminary survey revealed a mean of 65% VAM colonization across locations.

Sorghum grown in vertisols and alfisols formed mycorrhizal symbioses. The mycorrhizal status of the traditional sorghum belts of SAT regions in India and Africa is yet to be assessed. The mean mycorrhizal

colonization of groundnut grown at the ICRISAT Center was higher than that for pearl millet and sorghum.

5.2: We have isolated VAM species belonging to all the four major genera, identified and successfully multiplied them on a perennial grass host-Cenchrus ciliaris. Plant responses to inoculation with some of the VAM isolates tested, showed a wide variation. Efficiencies of the recently isolated VAM fungi from pearl millet growing regions of Rajasthan are yet to be assessed.

5.3: Mycorrhizal colonization was shown for the first time to be a host genotype dependent trait. Thirty selected genotypes of pearl millet tested at three field locations differing in soil fertility and VAM flora varied for mean mycorrhizal colonization between 25 and 50%. The dependence of VAM symbiosis on the plant genotype was further confirmed using certain selected parents and their crosses. Some of the crosses resulted in significantly higher VAM colonization than either of the parents. Not only VAM colonization, but response to inoculation was also shown to be genotype dependent, perhaps indicating a plant genotype X VAM isolate interaction. One of the West African cultivars (Zanfarwa), when inoculated with a particular VAM isolate, absorbed two times as much phosphorus as the control, while another cultivar (IP 5921) absorbed 25% over the uninoculated control. This again indicates a plant genotype x VAM isolate interaction. In the case of sorghum, there were also indications that P efficient lines were endowed with a higher mycorrhizal compliment than less efficient lines.

5.4: Increased dry matter responses to inoculation with VAM fungi under sterilized pot culture conditions, varied between 14 to 45% in the case of pearl millet, and between 16 and 125% for sorghum. This reveals a variation in the efficiency of VAM and a need for screening. Initial experiments with a single genotyipe failed to a show response in natural soil. However, two of the three West African cultivars responded significantly to VAM inoculation in natural soil.

In case of sorghum, VAM inoculation (at 1.5 PPM Olsen's P) resulted in growth equivalent to addition of 20 kg P/ha under controlled pot culture and 5-8 kg P/ha in natural soil. A positive correlation ($r=0.64$; at $P< 0.05$) was recorded for P translocated in the bleeding sap in relation to VAM response. This could be a good test to screen the efficiency of VAM-plant combinations when standardized.

5.5: Not attempted.

FUTURE PLANS

1. Survey W.Africa for VAM.

2. Collect and screen isolates of VAM for efficiency

3. Study further genotype variation for VAM colonisation

4. Estimate VAM contribution to P. nutrition in soils of low P. availability and utility with non-processed P. oves.

5. Standardise technique to estimate P in sap.

6. Explore methods of developing VAM inoculum.

DISCUSSION HIGHLIGHTS

Inheritance studies should be taken up after gathering more information.

RECOMMENDATION

With the revised objectives as mentioned under future plans project may be continued.

PROJECT NUMBER:N.Micro- **[New project]**

PROJECT TITLE : Developing technology for producing associative N2-fixing bacterial inoculants.

PROJECT SCIENTIST : S.P. Wani

DURATION : a. Date of start:
b. Date of completion:

OBJECTIVES

i) To develop adaptable technology to produce quality inoculants.

ii) To select locally available material as carrier for inoculant preparation.

iii) To study the shelf life of inoculants in different carriers.

ACHIEVEMENTS

We have studied the survival of Azospirillum lipoferum in a peat, sterilized by gamma irradiation obtained from Australia and steam sterilized peat from the Nilgiri hills (India). At initial stage the population in Australian peat and peat from Nilgiri hills was 3.7 x 10-8 and 1.4 x 10-8 respectively. The population of the A. lipoferum inoculum in Indian peat was higher (1 x 10-8/g peat) than in an Australian peat (3.4 x 10-5) after storage at room temperature (±28 degrees C) for 16 weeks.

FUTURE PLANS

New project - no change from listed objectives.

DISCUSSION HIGHLIGHTS

Consistency of the strains at other locations need to be tested.

RECOMMENDATION

Not recommended for approval.

PROJECT NUMBER : M-GQ&B-3 (80)

PROJECT TITLE : Evaluation of protein quality

PROJECT SCIENTIST : V. Subramanian

DURATION : a. Date of start: 1980
b. Date of completion: continuing

OBJECTIVES

(i) Study the variability in protein and lysine contents of germplasm accessions and breeding materials, including hybrids.

(ii) Determine the proportion of different protein fractions in advanced high protein lines.

(iii) Study protein digestibility by conducting in-vitro assays and if possible by animal feeding trials, and study their amino acid composition.

ACHIEVEMENTS

Several lines having protein content upto about 15% have been identified. Since protein content showed very weak negative correlation with grain yield, there is a possibility of simultaneous selection for grain yield and protein content.

Rapid methods of protein and lysine estimations were standardized. About 32000 samples comprising of entries from multilocation trials, germplasm and breeding materials (hybrids, parents, varieties synthesis and composite progenies) etc. were analysed for protein content. The range in protein content was from 5.8 to 20.9% and lysine varied from 1.59 to 3.80 g/100g protein. Efforts are being made to incorporate high protein trait in hybrids, synthetics etc without detrimental effect on agronomic desirability. In general, pearl millet proteins were low in lysine, threonine and sulphur containing amino acids when compared with 1973 FAO/WHO standard pattern .

Fractionation of seed proteins revealed that albumin and globulin together accounts for 25% of protein; prolamine 31% and glutelin 24% of High protein lines (>15%) contained more prolamin and this resulted in lower albumin, globulin and glutelin fractions.

By using pepsin enzyme, no large variation in the protein digestibility was observed among the pearl millet cultivars. Cooking showed considerable effects on the in vitro protein digestibility of pearl millet .

FUTURE PLANS

Digestibility of proteins will be determinedby using in vitro methods. Also, the effect of processing methods on protein digestibility will be studied using low and high protein lines. Studies will be initiated to conduct rat feeding trials.

Based on our findings, biological evaluations using small animals will be carried out on a limited number of samples in cooperation with other Institutes.

DISCUSSION HIGHLIGHTS

More emphasis should be on products of millet and food technological research.

RECOMMENDATION

The project may be continued.

PROJECT NUMBER: M-GQ&B-4 (80)

PROJECT TITLE : Physicochemical properties and cooking characteristics of pearl millet.

PROJECT SCIENTIST : V. Subramanian

DURATION : a. Date of start: 1980
b. Date of completion: continuing

OBJECTIVES

(a) Standardize the method of cooking of major forms of millet consumption (roti and porridge) and to evaluate the cooking quality of cultivars.

(b) Determine the physicochemical properties of cultivars and correlate with their cooking quality.

ACHIEVEMENTS

Millet is one of the staple food grain in several regions of India and West African countries. Austin and his associates conducted chapathi studies with millet in 1970. Desikachar (1976) studied the chapati making and cooking characteristics of millet flour. Casier et al. (1976) reported the use of millet flour for bread making.

Badi and Hoseney (1976) studied the utilization of millet flour for cookes and also compared the millet and sorghum starch for amylose contents. Much information is available on physical and chemical characteristics of wheat flour and its bread making qualities. A knowledge of food-making quality including processing characteristics of millets will be very useful.

Extensive village surveys have been carried in seven States of India. Several food products have been identified that can be perpared from millet in India and African countries.

Physicochemical characters of flour and roti quality were studied using 23 millet cultivars. Besides flour qualities, dough quality was also assessed. Roties were made under identical conditions. Taste panel evaluation of roties was conducted for color, texture, flavor, taste and acceptability with a limited number of trained taste panel. Preliminary results indicate that flour swelling capacity, water soluble protein and amylose are related to taste panel evaluation. Flour particle size and starch damage in various flour fractions were also determined. The cultivars which yield more fine fractions of flour with less starch damage tends to yields good quality rotis.

In most of the African countries, millet grains are used after dehulling. Hence dehulling quality of 12 selected cultivars was

determined. Since the African foods are starch-based, starch properties like gelatiniztion temperature, solubility, swelling power, viscosity etc. were determined in seleted cultivars. The quality parameters of soru (boiled millet) and To (porridge) were assessed using standardized procedures. The relationship between starch properties and food quality attributes have been worked out. Swelling power (70 C) and damaged starch content showed negative association with swelling power (80 C) of starch. It is likely that gelatinization and viscosity properties are associated which can be tested with amylograph and other related instruments for starch characteristics.

FUTURE PLANS

Studies will be conducted with more number of cultivars and flour characteristics that are likely to be related to roti quality will be tested. Other paramters that influence the dough and roti qualities will be studied. Studies will be intensified on African food products. An International Pearl Millet Food Quality Trial (IPMFQT) has been organized with collaborators in African countries and other laboratories in USA, UK etc.

DISCUSSION HIGHLIGHTS

More emphasis should be on products of millet and food technological research.

RECOMMENDATION

The project may be continued.

COLLABORATIVE RESEARCH PROJECTS WITH OTHER INSTITUTIONS

D.J. Andrews

Mr. D.J. Andrews mentioned a number of collaborative activities (both formal and informal) with other research institutes. Three of these are in Microbiology (two with UK research organisations and one with a West German University), two in Pathology with UK research organisations and one in Physiology with PBI, Cambridge, UK. He also mentioned about informal contacts with Kansas State University, Arizona State University and in India with ICAR and State Agricultural Universities like HAU, APAU, TNAU etc.

Dr. William Stegmier from Kansas State University presented a brief outline of his millet program at Hays and acknowledged the contribution ICRISAT-bred material has made in broadening the genetic base of his breeding program.

Dr. M.H.Mengesha inquired about the possibility of sabbatical for ICRISAT scientists at KSU on a more regular and formal basis.

The following are the collaborative projects (formal):

Title	Institution	Duration
A. Microbiology		
Measurement of N2 fixation, with particular reference to associative symbioses.	Rothamsted Expt. Stn., UK	1981-1986
Investigation into the use of vesicular arbuscular mycorrhizas in tropical crops.	Univ. of Dundee UK	1983

Ecology and cultivation of nitrogen fixing bacteria from the root zones of millet and sorghum.	Univ. of Marburg West Germany	1981-1984
B. Pathology		
Study of pathogenic variation of downy mildew of pearl millet	Univ. of Reading UK	1979-1985
Histopathology and variability in ergot *claviceps fusiformis* of pearl millet	Imperial College, London, UK	1983-1986
C. Physiology		
Role of abscisic acid in mediating the responses of tropical grain crops to water deficits.	Plant Breeding Institute,Cambridge UK	1977-1985

DISCUSSION HIGHLIGHTS OF PEARL MILLET PROGRAM

Chairman: J.S. Kanwar

(i) For interpreting results properly the environments and their biotic and abiotic factors should be described.

(ii) Shuttle breeding philosophy starting by even selecting material at early stages say F2 at different locations will be helpful in eliminating nonadaptable components. Leave as much variability as possible to give population buffering effect.

(iii) Emphasis in breeding pearl millet should continue on population breeding.

(iv) Genetic Resources should be evaluated under a range of environments.

(v) Evaluation for disease and pest resistance should be done on a carefully selected few hot spots using right screening procedures.

(vi) For hybrid work in Africa, search for newer B lines suited to the environments should be made. An opinion was expressed that instead of looking for new or cytoplasm emphasis should be on line x line or line x variety hybrids as the cytoplasmic route seems to be rather slow.

(vii) Testing of final products under intercropping situations should be done.

(viii) Material with higher yield potential should also be developed so that it could compete with other cereals under high input situations.

RECOMMENDATIONS

Breeders should consider these aspects in developing breeding strategy.

GENERAL DISCUSSION ON PEARL MILLET

L.D. Swindale

1. All our millet breeders have made some good progress in their areas in West Africa inspite of great difficulties of variability and uncontrolled climate. Can we help them in a few locations may be 3 or 4 locations including ISC where their best materials can be tested under better conditions and where we can do more precise research and multilocational trials?

D.J. Andrews

We can do better testing/research at some locations as Bambey in Senegal, Maradi in Niger and Kano in Nigeria. CILSS trial results for 1983 will be known from the meeting which was scheduled to be held in February 1982 results have been reported.

S.C. Gupta

During 1983, ICRISAT contributed 4 entries in CILSS trial and all performed well in Senegal. Meeting of CILSS to discuss the results was scheduled in second week of February. Regarding disease screening, in Senegal, we have the pathologist and the material. But the pathologist needs guidance and training.

S.B. King

I would like to entertain some discussion and comments particularly from those scientists involved in millet research in West Africa on what they feel the center pathology subprogram can do to help the West African based breeding programs.

K. Anand Kumar

I would need pathological input from the center for putting in ergot resistances into our B-lines.

D.J. Andrews

Suggests that besides going for 1-2 weeks on short visits, ICRISAT Center scientists can be sent to West Africa on deputation for 1-2 months to set up the research capability there, for instance setting up downy mildew disease nursery in Mali.

L.K. Fussell

In support of Mr. Andrews' comments, I feel we should look seriously at creating the processes by which the expertise developed at ICRISAT center can be used to help in transfer screening techniques across the zones ICRISAT works, as well as working on specific problems that scientists at the Center have expertise in. We should see a degree of flexibility in

moving around the staff within the worldwide ICRISAT research area. The administrative capabilities need to be developed to facilitate the move of the staff.

S.O. Okiror

Although this has been discussed in detail in our meeting with Pathologists, I like to draw a general attention to the need for the ISC to consider. Samaru or Kano, as a location for disease screening. Could this be considered more seriously in terms of financing?

C.R. Jackson

We should emphasize pathology and entomology research at our breeding locations in Africa. We are examining the costs of sending people from the Center to West Africa to do specific temporary jobs.

S.N. Lohani

In Upper Volta program we had principal pathologist from 1977 to 1981. He screened International downy mildew nurseries, ergot nurseries and materials from local program. A downy mildew sick field was developed. The present program is continuing to screen important materials in the downy mildew sick field. Infector rows are sown in the breeding plots.

Dr. Kanwar made a suggestion to have some discussion on International Testing (M-Brd-8).

D.J. Andrews

There are many factors contributing to increased production of which varietal improvement is but one. Fertilizer use is also one of them and is a key factor.

B. Gilliver

I refer to Table in M-Brd-2 project and others where yield figures are mentioned in q/ha. In others like M-15 given in kg/ha. I suggest that only one unit that is kg/ha be followed uniformly.

D.J. Andrews

Our all yield data is reported in Q/ha, however kg/ha data is available.

R.K. Maiti

I have a general comment on population breeding methods. I feel this method of breeding has good potential to improve stand establishment under adverse climatic conditions of the SAT. I suggest breeders to score their material for seedling emergence and seedling vigour in the seedling stage which may help them in improving crop establishment.

J.S. Kanwar

I sometimes hear comments that ICRISAT Center material does not do well in

Africa but if you see yield data (Table M-Brd-8-2) figures over nine locations, I see clearly many ICRISAT entries gave higher yields than local varieties.

D.J. Andrews

Yes, but still mean yield for African locations is generally lower than Indian locations. Data on downy mildew clearly indicates higher downy mildew incidence on these entries.

S.C. Gupta

Apart from yield, there are other characters also, viz., head length, disease and insect resistance, etc. which make a variety acceptable to farmers. However, for yield per se Center-bred varieties have a higher potential.

J.S. Kanwar

I am glad that S.C. Gupta has accepted yield advantage of ICRISAT Center-bred materials.

A.B. Joshi

Head length measurement needs to be supplemented by head diameter, grains per head and weight of grain per head. Attempt should be made to get the best combination of head length with 1000-grain weight as good as possible. Three-way crosses may be a good approach. If head length is highly heritable and stable over environments, what is the position regarding 1000-grain weight (expect in years of drought during grain filling)?

D.J. Andrews

I agree with you but there are chain of physiological consequences linked with longer heads. For example, to have a longer head length, there is a need of a thicker peduncle, and a larger meristem to bear long head. Stem also has to be thicker to produce such a meristem. The consequence of thicker stem is more competition between stems, and hence less heads/plant and less heads/m2. Further to have bolder grain without loss of number head has to be larger in diameter. This may be more feasible than longer heads.

S.C. Gupta

There is one more advantage of head length. It is a highly heritable character. Even in the drought or low fertility conditons head length can be seen clearly in the farmers fields. Overall crop may be poor but even then head length would be quite well expressed and farmers get a good yield.

CHAIRMAN'S CONCLUDING REMARKS

Dr. J.S. Kanwar pointed out that out of 86 pearl millet projects reviewed in 4 days, 9 projects were concluded and one of the concluded projects belonged to African program. He also reminded the scientists that several new projects have been proposed but before they really start on these, the final reports on the concluded projects should be written up. Even though journal articles from some of the concluded projects might have already been written up, the final report on these projects will be useful for future use. New projects should be formulated in prescribed proforma for formaiization and recording. The program should ensure that all projects are computerized.

Dr. Kanwar informed the house that EPR members seemed to be happy with the clarity of the presentations following strict time schedule, free and frank discussions/criticism, and the global nature of the millet research program, with the scientists working as one family. He expressed his satisfaction over the impressive progress made since last review and noted a positive trend reflected in several interdisciplinary research for the future. He observed that this In-House Review has given insight into future programs, in terms of resources allocations and priority setting.

Dr. Kanwar also observed that (1) in entomology, more work is required in Africa then in India which naturally puts heavy responsibility on Dr. Nwanze, who represents as the only millet entomologist for West Africa. He would, therefore, need cooperation from all to standardize the screening technique and (2) to screen the material. In breeding for high and better quality and protein consistant with high yield, very impressive advances have been made. No doubt drought research is rather difficult and we are still at the stage of developing simple reliable and repeatable screening technique. Dr. Kanwar emphasized that statistician should be consulted at the program planning stage and not when the experiment is over. This would make experimentation more precise and resources use more efficient.

Dr. L.D. Swindale also emphasized that the statistician should be consulted before the experiments are taken up. Dr. Swindale pointed out that for next meeting, the date should be fixed now to avoid any confusion. Dr. Nwanze pointed out that IHR meeting in January/February allows very little time for data analysis and report preparation and recommended it should be in March. Mr. Andrews inquired if In-House Review is required every year (with a suggestion that it should, at earliest, be alternate year). However, Dr. Swindale clarified that whether In-House Review or something else, at least, one meeting of millet scientists every year is required which to review some of the projects.

Chairman concluding the In-House Review after thanking the speakers and participants and reminding the rapporteurs for completing their reports quickly. He mentioned that a copy of the report should be sent to Mr.B. Gilliver, one copy to Program Leader and one copy to him. He also requested the program leaders to quickly review these reports and forward them to him.

JSK:kak