UNDP - ICRISAT - INRAN COOPERATIVE PROJECT FOR THE IMPROVEMENT OF PEARL MILLET

Progress report 1983*

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The objectives of the U.N.D.P. funded ICRISAT cooperative project to improve pearl millet in Niger are complementary to the Niger national program research objectives. The important objectives are summarised below :

1. Assembling and evaluating varieties and breeding materials received from various sources, against major diseases, insects, striga and other stresses and to select promising material for strengthening the Nigerien millet improvement program.

2. Maintaining the desirable variability of pearl millet for the current and the future use.

3. Developing synthetics, experimental varieties and composites to meet the varietal requirements of various agroclimatic zones of Niger and similar zones in other countries in the region.

4. Mobilising the best of the new varieties and breeding materials across countries in Africa and testing them in coordinated multilocational trials and nurseries(zonal adaptation trial(IMZAT) and PEXN).

5. Conducting international and regional trials to asses the adaptation and reaction of new genotypes againsts diseases, insects striga and drought.

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The necessary efforts to achieve these objectives have been made and the encouraging results have been obtained. The major achievements are summarised below :

A. New germplasm

During the last 5-6 years, thousands of new genotypes were obtained from all possible sources, in to Niger, for their evaluation and use in the local pearl millet breeding program. During these years, the improved and unimproved genotypes were introduced from various countries of Africa and Asia. Besides evaluating the uniform progenies, synthetics and experimental varieties received from ICRISAT center in India and other millet improvement programs in Africa, representatives of African and Indian collections of local cultivars were also evaluated and the promising ones are being utilised and maintained. At present, we are maintaining a wide array of pearl millet breeding materials representing genotypes from Indian sub-continent and from Senegal, Mali, Upper Volta, Togo, Ghana, Niger, Nigeria, Cameroun, Central African republic, Uganda and Botswana. These materials were not available in Niger earlier. The breeding lines and populations represent following categories of materials :

Working collections	307
Inbreds and segregating progenies:	
F 3'S from diallel	76
Source material F_3	66
F_4 lines	133
F_5 lines	23
F_6 lines	28
F_7-S_7 lines	59
Gene-pools	5
Expérimental varieties and composites	12

B. Gene-pools and Composites

To maintain the desirable variability in pearl millet and to overcome the problems associated with inbreeding, development of four gene-pools was initiated in 1979. Five recombinations have been completed in each of these four gene-pools. Each of these gene-pools was developed by pooling together the genotype with similar height, maturity and head size. The four gene-pools developed in our program are :

1. Gene-pool 1 (INPG-1) - Head length more than 40cm, maturity 90 - 110 days, mostly African genotypes
2. Gene-pool 2 (INPG-2) - Head length less than 40cm, maturity 75 - 90 days, high tillering genotypes both African and Indian.
3. Gene-pool 3 (INPG-3) - A collection of dwarf derivatives of both African and Indian origin.
4. Gene-pool 4 (INPG-4) - Bristled genotypes.

Since 1981, a fifth gene-pool(INPG-5) is being developed by pooling together short and thick headed genotypes from Mali, Togo, Ankutess(Niger) and their crosses.

The gene-pools not only provide an easy system of maintaining desirable variability in pearl millet but they also provide an increased opportunity of recombination among component genotypes. While the component lines for each gene-pool are subjected to recombination, all shibras and off type plants are removed before flowering. The flowering ear heads of the plants showing downy mildew and high striga attack are removed before they shed pollen. At the time of harvesting, grided mass selection is practiced to develop composites and experimental varieties.

During 1983 rainy season, two trials one at Maradi and other at Sadore in Niger, were conducted to evaluate the performance of

composites derived from above mentioned gene-pools along with other populations, The results are presented in table 1. Several composites yielded equal or superior to the recommended variety CIVT.

Large plot yield assesment was done for the 5 gene-pools described earier and the ten experimental varieties derived from them(two from each). The average plant height, head length and grain yield has been presented in table 2. As expected, the experimental varieties have given better grain yield than the parental gene-pools.

C. National and Regional yield trials

A number of experimental varieties developed from our program have been evaluated in Niger and other similar locations in Africa. ITMV 8001 and ITMV 8003 identified in 1980-81, are under intensive trial coordinated by Institute of Sahel in CILSS countries. During 1982, in CILSS multilocation trials, ITMV 8001 and 8003 performed better than best improved and local checks at most of the locations. They are being reevaluated during 1983. Similarly ITMV 8002 and ITMV 8004 have also shown promise in various national and regional trials. These will be subjected to national demonstration and farmers field trials in 1984. These entries have also shown promise in Nigeria, Cameroun and Sudan and are under national trials in these countries.

During the rainy season 1983, seven experimental varieties were evaluated multilocationally alongwith the best varieties developed by INRAN. Two trials were designed for this purpose, one for drier areas with average annual rain fall of less than 400mm(National trial 2) and the second for zones receiving more than 400mm rain annually (National trial 1).

The national trial 1 was sent to five locations namely Kolo, Bengou, Kawara, Maradi and Magaria. However, data is available only from Maradi, Magaria and Kolo. The mean performances of entries over these three locations are presented in table 3. Highest grain yield was obtained for ITMV 8303 followed by ITMV 8002 and ITMV 8001, all yielding equal or better than CIVT. Entries no. 5 to 9 contributed by INRAN and developed by selection from local varieties performed inferior than CIVT.

The national trial 2 was grown at Diffa, Guraphane, Maradi and Guallam. Because of drought, the crop failed at all locations except Maradi(table4). At Maradi, the trial mean yield was 881 kg/ha. ITMV 8304 and ITMV 8004 gave 13 and 12% better yield than check HKP.

Regional Coordination

One of the important objectives of ICRISAT program is to mobilise improved genotypes and varieties and local cultivars across countries in the region for their evaluation and possible use outside the country of origin. A regional trial namely ICRISAT millet zonal adaptation trial(IMZAT) and an exchange nursery (PMXN) are organised to meet this objective. Advanced elite breeding materials and new synthetics and experimental varieties developed from various national and ICRISAT pearl millet breeding programs in the region are assembled and compared with the best improved varieties and local cultivars in the major millet producing countries.

The IMZAT 1983 has been despatched to 16 locations in 10 countries of west, east, central and south Africa. The data from various locations will be sent to ICRISAT center for analysis. The performance of the entries in this trial at Maradi is summarised in table-5.

The IMZAT 83 at Maradi suffered with drought during the growing period and flowening (Appendix 1). The crop received only 222mm rain as against 500-550mm normal rainfall at Maradi. This is reflected in the trial mean grain yield of 688kg/ha which is about 1/3 of normal grain yield at this location. In IMZAT 83, 14 test entries contributed by ICRISAT millet breeders in Senegal, Upper Volta, Niger, Nigeria and Sudan were evaluated alongwith CIVT and Zanfarwa. The highest grain yield of 890 kg/ha was obtained for ITMV 8002, gave 20% higher yield than CIVT followed by ITMV 8004 wich yielded 14% better than CIVT.

Breeding for Striga resistance

Striga hermontheca a semi plant parasite cause considerable yield loss to millet crop particularly in low soil fertility conditions. In the experimental plots where ICRISAT pearl millet improvement work is carriedout at Maradi, high natural pressure of Striga hermontheca is present. We have taken advantage of this natural striga pressure to evaluate large number of pearl millet genotypes, available from millet improvement programs in Africa and India. The genotypes, while evaluating for other agronomic characters and resistances to diseases and insects, are also evaluated for their reaction to striga on a 1-5 score. The score of 1 is given to genotypes which do not support any striga germination and 5 where very high incidence of striga plants near the host plants are observed. The genotypes initially identified with low striga scores are evaluated in striga sick plot where number of striga plants in per unit area are counted to give a quantitative evaluation of the resistance. Several genotypes with low incidence of striga have been isolated under natural striga pressure at Maradi. experience in such natural striga pressure have indicated that striga incidence is highly variable and influenced by soil type, soil fertility and other environmental factors. To overcome these problems,

a striga sick plot is being used to evaluate genotypes since 1983. During 1983 an advance striga trial, a F_5 progenies trial and evaluation of 7 millet populations to identify resistant segregants was carriedout in striga sick plot. These trials were coordinated by ICRISAT cereals breedár(striga) in Upper Volta.

From 1982 striga trials at Maradi, 60 striga free plants from low striga supporting progenies were selected and evaluated in 1983. The progenies which showed high tolerance to striga from this trial and the trials received from Upper Volta, have been retained for reevaluation in 1984 and 1985 and for the development of a striga resistant millet population.

PLAN OF WORK FOR 1984

The work plan for 1984 will be similar to that of 1983 with the greater emphasis for improving the performance of composites and experimental varieties through appropriate recurrent selection procedures, and multilocation evaluation of the promising experimental varieties. The main aim of our efforts is to develop stable, moderately high yielding and disease and pest resistant experimental varieties and synthetics of following maturity cycles :

1. Less than 80 days - For north and eastern Niger
2. 90 - 100 days - For major millet growing areas with annual rainfall of 450-550mm, around 14° lattitude.
3. 100-120 days - For Southern Niger with rainfall more than 550mm- below 14° lattitude.
4. Varieties for the zone Ankutess. The work planned for 1984 has been summarised in table 6.

Appendix_I

Temperature and Rainfall at CNRA, Maradi, 1983

Total rain in crop season = 221.9mm

Month	Date	Temperature Maximum °C	Temperature Minimum °C	Rainfall mm	Cumulative rainfall mm
May, 83	24	41.0	28.4	5.0	5.0
	25	39.8	25.0	16.5	21.5
Total of May, 83	-	-	-	21.5	
June, 83	16	36.8	24.5	15.5	37.0
	22	34.5	26.5	24.0	61.0
	25	35.1	25.8	6.0	67.0
Total of June, 83	-	-	-	45.5	-
July, 83	12	34.4	26.2	4.0	71.0
	17	35.5	27.2	8.0	79.0
	19	32.0	22.8	3.0	82.0
	21	34.6	22.0	11.0	93.0
	23	32.5	25.4	5.0	98.0
	28	29.5	21.5	3.9	101.9
	29	32.5	23.6	2.0	103.9
Total of July, 83	-	-	-	36.9	-
August 83	1	30.5	22.0	23.0	126.9
	4	32.5	26.0	22.0	148.9
	7	33.2	23.8	10.0	158.9
	9	31.8	24.5	10.0	168.9
	11	33.0	25.4	8.0	176.9
	22	33.2	22.5	20.0	196.9
	29	32.9	23.5	1.0	197.9
Total of August, 83	-	-	-	94.0	-
September, 83	2	34.5	23.5	11.0	208.9
	7	31.4	19.8	16.0	224.9
	14	33.6	24.5	18.0	242.9
	20	36.1	23.8	0.5	243.4
Total of Sept, 83	-	-	-	45.5	-

Table 1

Evaluation of the composites derived from the gene-pools, 1985

(Mean over 2 locations)

S.No.	Name of comp.	Origin	Days to 50% flowering	Plant height (cm)	Head length (cm)	Grain yield kg/ha
1	African comp-1	INTG-1-1	65	249	54	1023
2	" -2	" -2-2	65	246	53	1017
3	Indian comp- 1	" -2-1	64	256	47	1109
4	" -2	" -2-2	62	214	40	900
5	Dwarf deriva.-1	" -3-1	65	222	55	809
6	" -2	" -3-2	63	241	47	1032
7	Bristled comp-1	" -4-1	62	230	54	915
8	" -2	" -4-2	63	220	49	1122
9	Comp.(SMXA) -1	" -5-1	65	214	40	884
10	" -2	" -5-2	63	220	37	932
11	Comp. Souna III x	CIVT -1	66	231	52	833
12	" "	" -2	64	223	47	984
13	Toriniou Mali		76	231	40	792
14	Souna Mali	Mali	66	197	30	622
15	Early comp.	INMG-2	55	195	39	1259
16	CIVT		60	233	53	1106
Mean			64.5	230	48	955
C.V.%			4.01	11.0	17.4	26.3
L.S.D.			3.20	31.6	10.4	311.5

Table 2

Plant height, head length and grain yield of gene-pools and experimental varieties derived from them

(Maradi - 1983)

Rainfall: 222mm

S.No.	Pedigree	Plant height (cm)	Head length (cm)	Grain yield kg/ha
1.	INMG-1	193	56	660
	ITMV 8001	202	51	595
	ITMV 8002	194	43	890
2.	INMG-2	178	39	633
	ITMV 8003	166	32	1220
	ITMV 8302	172	32	920
3.	INMG-3	123	40	1105
	ITMV 8303	210	50	1340
	ITMV 8004	211	46	1320
4.	INMG-4	196	42	1267
	ITMV 8301	196	42	1290
	ITMV 8306	201	41	1275
5.	INMG-5	186	32	1120
	ITMV 8304	204	35	1340
	ITMV 8305	197	32	1290

Table 3

ICRISAT-INRAN Cooperative Multilocation Trial
(National Trial - 1) 1983
(Mean over 3 locations)

S.N.o.	Entry	Days to 50% flowering	Head length	Grain yield	% of check CIVT
1	ITMV 8001	63	56	1102	101
2	" 8002	62	57	1103	101
3	" 8003	60	48	1045	96
4	" 8303	62	52	1188	109
5	DG - P_1	63	61	1049	96
6	GR - P_1	65	57	977	90
7	T - 18 - L	67	63	1037	95
8	ZA - P_1	67	62	837	77
9	TB - P_1	68	66	1002	92
10	CIVT(check)	60	55	1089	100
Mean		64	58	1049	-
C.V.%		2.86	12.18	24.1	-
L.S.D.		2.22	8.71	291	-

Table 4

ICRISAT-INRAN Cooperative trial

(National trial-2)

North zone Maradi, 1983

S.No.	Entry	Source	Days to 50% flowering	Plant height (cm)	Head length (cm)	Grain yield kg/ha	% check
1	HKB	INRAN	62	229	67	862	104
2	HKP-Tif		54	185	43	844	101
3	Comp. Tarna-2		62	229	46	865	104
4	ITMV 8004		67	231	47	933	112
5	ITMV 8302		62	216	38	898	108
6	ITMV 8304		65	207	39	940	113
7	HKP-3		54	210	50	895	108
8	HKP(Check)		64	226	55	832	100
Mean			61	217	48	881	-
C.V. %			3.86	9.06	10.9	27.3	-
L.S.D.			2.92	24.4	6.51	297	-

Table 5

ICRISAT pearl millet african zone A trial 1983
(INZAT 83, Maradi)

S.No.	Variety	Source	Days to 50% flowering	Plant height (cm)	Head length (cm)	Grain yield kg/ha	% of CIV
1	IKMV 8101	ICRISAT Upper Volta	62	207	40	693	93.5
2	IKMV 8201	"	61	212	31	686	92.6
3	IBMV 8301	ICRISAT Sénegal	61	194	39	561	75.7
4	IBMV 8302	"	72	174	47	439	59.2
5	ITMV 8001	ICRISAT Niger	67	220	47	770	103.9
6	ITMV 8002	"	63	236	47	890	120.1
7	ITMV 8003	"	63	199	40	744	100.4
8	ITMV 8004	"	62	216	43	847	114.3
9	INMV 8210	ICRISAT Nigeria	61	205	38	780	105.3
10	INMV 8212	"	61	212	37	588	79.3
11	INMV 8220	"	61	221	37	788	106.3
12	IBMV 8301	ICRISAT Sudan	61	180	27	608	82.1
13	IBMV 8302	"	54	185	30	580	78.3
14	IBMV 8303	"	61	189	34	621	83.8
15	CIVT	INRAN	62	222	49	741	100.0
16	Zanfarwa	Local	69	221	59	672	90.7
Trial mean			63	207	40	688	-
C.V. %			1.55	8.30	17.58	29.93	-
L.S.D.			0.75	21.10	3.29	255	-