

Project Coordinator Review

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Review of Pearl Millet Research

Pearl millet is the staple cereal in arid and drier semi-arid regions of country. It is the only cereal crop that is capable of producing a reliable yield under the marginal environments and simultaneously responds to high management conditions. Its nutritious grain forms the important component of human diet and stover forms the principal maintenance ration for ruminant livestock during the dry season. In addition, pearl millet grain is increasingly being used as feed for livestock and poultry.

Pearl millet is the most widely cultivated cereal in India after rice and wheat. It is grown on more than 9.3 m ha with current grain production of 9.5 m tonnes and productivity of 1044 kg/ha. The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana which account for more than 90% of pearl millet acreage in country. Pearl millet can easily provide economical grain yield (600 – 700 kg ha⁻¹) under marginal and low management conditions with the additional ability to produce a grain yield of 4-5 t/ha when hybrids of 80-85 days maturity are grown in summer season crop under irrigated and high fertility conditions.

Pearl millet research is conducted through the All India Coordinated Research Project of the Indian Council of Agricultural Research. The 13 AICPMIP project centres are located in Rajasthan, Maharashtra, Gujarat, Haryana, Punjab, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu with Central Coordinating Unit located at Jodhpur, Rajasthan. In addition, there are 18 cooperating centres and more than 30 partners from private sector.

The brief review of the progress of research and salient achievements during 2010-11 are presented here.

1. Trends in pearl millet cultivation

The trends in area, production and productivity of pearl millet suggest that area has increased marginally (2%) during last two years and productivity has gone up by 19% (Table 1). Rajasthan,

Maharashtra, Gujarat, Uttar Pradesh and Haryana continue to be the major pearl millet growing states.

Table 1: Area, production and yield estimates of pearl millet during 2007-08 to 2010-11

Area in Lakh ha, production in Lakh tonnes, yield in Kg/ha

State	Season	2007-08			2008-09			2009-10			2010-11 (Advance)		
		Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Rajasthan	Kharif	50.774	42.233	832	51.746	42.834	828	51.685	20.349	394	54.961	49.750	905
Maharashtra	Kharif	12.830	11.270	878	8.650	6.620	765	10.430	8.470	812	10.080	9.390	932
Gujarat	Kharif	7.280	8.520	1170	5.290	5.350	1011	4.988	4.324	867	4.810	4.800	998
	Summer	1.930	4.550	2358	1.750	4.260	2434	1.742	3.964	2276			
	Total	9.210	13.070	1419	7.040	9.610	1365	6.730	8.288	1232	4.810	4.800	998
Uttar Pradesh	Kharif	8.790	13.364	1520	8.090	13.020	1609	8.480	13.890	1638	8.910	13.810	1550
Haryana	Kharif	6.300	11.610	1843	6.100	10.790	1769	5.850	9.320	1593	6.410	11.120	1735
Karnataka	Kharif	4.300	3.540	823	2.650	1.850	698	3.040	1.500	493	3.110	2.400	772
	Summer	0.020	0.020	1000	0.010	0.020	2000	0.010	0.020	2000			
	Total	4.320	3.560	824	2.660	1.870	703	3.050	1.520	498	3.110	2.400	772
Andhra Pradesh	Kharif	0.600	0.810	1350	0.500	0.510	1020	0.450	0.520	1156	0.570	0.600	1053
	Total	0.740	0.920	1243	0.590	0.600	1017	0.520	0.590	1135	0.570	0.600	1053
Bihar	Kharif	0.090	0.100	1111	0.030	0.036	1200	0.042	0.050	1190	0.040	0.045	1125
Himachal Pradesh	Kharif	0.004	0.002	500	0.002	0.001	500	0.003	0.001	333	0.002	0.001	500
J & K	Kharif	0.168	0.100	595	0.179	0.106	592	0.167	0.099	593	0.086	0.050	581
M.P.	Kharif	1.798	2.521	1402	1.753	2.406	1373	1.655	2.475	1495	1.720	2.500	1453
Orissa	Kharif	0.027	0.016	593	0.030	0.018	600	0.028	0.017	607	0.030	0.018	600
Punjab	Kharif	0.040	0.040	1000	0.050	0.050	1000	0.030	0.040	1333	0.030	0.030	1000
Tamil Nadu	Kharif	0.598	0.858	1435	0.567	0.841	1483	0.538	0.950	1766	0.534	0.800	1498
Others	Kharif	0.021	0.037	1762	0.036	0.068	1889	0.035	0.049	1400	0.007	0.011	1571
India	Kharif	93.623	95.021	1015	85.675	84.501	986	87.423	62.054	710	91.300	95.325	1044
	Rabi	0.140	0.110	786	0.090	0.090	1000	0.070	0.070	1000			
	Summer	1.950	4.570	2344	1.760	4.280	2432	1.752	3.984	2274			
	Total	95.713	99.701	1042	87.525	88.871	1015	89.245	66.108	741	91.300	95.325	1044

2. Release of new hybrids

Six hybrids were released and notified in 2010. The domain area of these hybrids includes states of Rajasthan, Gujarat, Uttar Pradesh, Haryana, Punjab, Madhya Pradesh, Maharashtra, Tamil Nadu, Karnataka and Andhra Pradesh. Given that pearl millet is grown over a wide range of climatic conditions, HHB 216 (MH 1421) was released for A₁ zone (low rainfall areas of north-western India), Nandi 65 (MH 1549), Nandi 61 (MH 1548) and HHB 223 (MH 1468)

for A zone (high rainfall area of north and north-western India) and Nandi 64 (MSH 199) for summer growing areas of Gujarat, Tamil Nadu, Rajasthan and Maharashtra. Hybrid RHRBH 9808 was released for Maharashtra.

3. Genetic enhancement

A significant progress was made during the year 2010-11 in genetic enhancement of crop. The 159 experimental new cultivars were evaluated in 15 trials during kharif and summer of 2010 at combination of 64 locations in four agro-climatic zones of pearl millet (Table 2). A wide range in their grain and stover productivity was observed among test cultivars.

Table 2: Details of pearl millet experimental cultivar evaluated in 2010 and range in their grain and stover yields

Zone	Trials	No. of entries	Grain yield (kg/ha)	Stover yield (q/ha)
A ₁	IHT Early	15	1143-2225	26-53
	AHPT Early	8	1500-1762	36-46
A	IHT Medium	30	1664-2682	49-86
	IHT Late	28	2032-3537	77-143
	AHT Medium	9	1972-2534	54-70
	AHT Late	18	2480-3278	80-106
	IPT	9	1480-2081	52-76
	APT	3	1847-2057	55-65
B	IHT Medium	30	2113-3439	49-86
	IHT Late	28	2127-3366	45-86
	AHT Medium	12	2164-3250	53-74
	AHT Late	9	1899-3367	59-82
	IPT	9	1536-2600	46-75
	APT	1	2500	64
Summer	SHT	17	3812-5124	63-91

4. Utilization of male-sterile (A) and restorers (R) lines

A wide range of A and R lines were used in order to develop new experimental hybrids for evaluation over time and space. The hybrids evaluated during 2010 were based on 95 A-lines (by name) and 119 R lines (by name). This is contributing significantly towards

genetic diversification of parental lines and ultimately of hybrids in the country.

5. Assessment of grain quality

A total of 76 genotypes were assessed for quality parameters like protein and fat. A wide range in protein (7.4 - 13.2%) and fat (4.0 - 7.1%) contents was observed in the test material demonstrating that there exists enough opportunity to select for quality parameters in addition to high grain and stover yields.

6. Breeder seed Production

During the current year the breeder seed production of 22 parental lines (A, B & R) of hybrids and of 9 OPVs was organized. A total of 22.66 q of breeder seed was produced which is 121% higher over indented quantity of 10.22 q from Department of Agriculture & Cooperation, Ministry of Agriculture.

7. DUS test and registration of cultivars with PPV & FRA

The DUS testing was undertaken as per approved guidelines of PPV & FRA during kharif 2010. Three candidate varieties (VBBHH 3040, JKBH 778 and JKBH 768) along with six reference/example varieties were tested for second year at AICPMIP, Jodhpur and MPKV, Rahuri. Five candidate varieties (KBMS 329, KBR 621, BIO 448 H, KBH BOSS 65 and HT PM 4201 and seven reference varieties tested for second year. Observations on candidate and reference varieties on twenty six characters were recorded as per general and specific DUS. Thirteen extant varieties (PUSA 605, PHB 2168, GHB 744, Pusa Composite 443, GHB 577, HHB 146, PCB 164, HHB 94, RHB 90, PUSA 415, CZP IC 923, PUSA 444, RHB 58) of pearl millet were approved for registration by PPV & FRA.

The monitoring team chaired by Dr. S. Dass visited the DUS experiments at AICPMIP, Jodhpur on 15.09.10 and at Rahuri on 17.09.10. One day training on awareness on PPV & FRA was organized at AICPMIP, Jodhpur in which 21 researchers from public and private sectors participated.

8. ICAR-ICRISAT partnership research

A range of breeding material was evaluated at 13 AICPMIP centres in order to select adapted lines to various zones. A total of 248 R lines and 182 B lines were assessed by AICPMIP breeders and many of them were selected for utilization in their breeding programme. In addition, 2 populations were grown over 12 locations for selection and further inbreeding to derive new parental lines of hybrids. Selected genetic materials were also assessed for high iron and zinc contents and salinity tolerance. Phenotyping of selected material was accomplished for mapping QTLs for drought tolerance and other traits.

9. Diseases

A total of 247 entries were evaluated against downy mildew, smut, rust, ergot and blast at 14 locations to assess their disease reaction. The evaluations were carried out under epiphytotic conditions. The details of varieties tested for disease reactions provided in Table 3.

Table 3: Summary of pathology trials conducted in 2010

Trial	Zone	No. of entries/ treatments	Locations	Diseases
PMPT I	A & B	101	12	Downy mildew, Smut, Rust, Ergot & Blast
PMPT II	A & B	71	12	Downy mildew, Smut, Rust, Ergot & Blast
PMPT III	A & B	24	12	Downy mildew, Smut, Rust, Ergot & Blast
PMPT IVA	A & B	26	12	Downy mildew
PMPT IVC	A & B	25	4	Blast
PMPT V	A & B	6	11	Downy mildew
PMPT VI	A & B	Monitoring	Farmers field	Downy mildew, Smut, Rust, Ergot & Blast

Monitoring of pearl millet for diseases showed that downy mildew incidence was higher than the previous year presumably because of higher and well-distributed rainfall. There was also a wide range (0-80%) in the downy mildew incidence in the farmers' field. Severe downy mildew was observed on susceptible cultivars in Maharashtra. The popular hybrids grown by the farmers were Proagro 9444, PHI 7688, RHB 121, HHB 67, Nirmal 40, Pioneer

86M64, Pioneer 86M32, JKBH 778 and JK 26. In pearl millet downy mildew virulence nursery, *Sclerospora graminicola* exhibited high level of variation across the locations.

10. Entomology

Trials were conducted at Jaipur, Fatehpur Shekhawati and Jamnagar in which 71 genotypes were tested against key pests of pearl millet (Table 4). There was a wide range in insect infestation in various treatments.

Table 4. Summary of entomology trials conducted in 2010

Trial	No. of entries/ treatments	Major insect-pests
PMET I	71	Shoot fly, stem borer, grey weevil, chaffer beetle
PMET II	Monitoring (Research Station)	Shoot fly, stem borer, leaf binder, grass hopper, jassid, thrips
PMET III	Monitoring (Farmers field)	Key pest of pearl millet during the season
PMET IV	7	Shoot fly and stem borer
PMET V	5	Shoot fly, stem borer, termite, white grub
PMET VI	11	Storage grain pest of pearl millet

Integrated pest management module i.e. seed treatment with Imidacloprid 70 WS @ 7.5 g/kg seed, spray of endosulfan 0.07% 30 days after germination and dusting of malathion 5% @ 20 kg/ha at milky grain stage was most effective and economical.

Shoot fly and stem borer were predominant while Jassid, thrips, leaf roller, grass hopper, flea beetle, earhead beetle and earhead worm were found in low intensity in Gujarat. While in Rajasthan, grey weevil, chaffer beetle, termite, grass hopper, shoot fly, stem border and leaf roller were found in low to moderate intensity.

11. Crop Production

During the season, eight agronomic trials were conducted in A₁, A, B and summer zones. Thirty entries were evaluated at three doses of nitrogen in order to generate their response data for varietal

release. Various production technologies were fine tuned which included:

- Response of advance hybrids and OPVs to nitrogen levels
- Organic cultivation in pearl millet-gram cropping sequence
- *In situ* moisture conservation techniques
- Comparative performance of hybrids and OPVs under different management conditions for sustainable production
- Effect of planting time on productivity of different hybrids and varieties
- Performance of recently developed drought resistant hybrids under different row spacing
- Integrated nutrient management in summer pearl millet

12. Plant Physiology

Five physiological trials were conducted at Jaipur and Jamnagar during summer and kharif 2010 (Table 5). The hybrids ICMH 356, RHB 121 and population ICTP 8203 in summer; and MH 1609, RHB 121 and MH 1617 in kharif season were found drought tolerant. Lines 97111B, 97444B, J 2450, HBL 11, 21A/S 10, MS 93333B and 85A/S-10 were also found drought tolerant.

Table 5. Summary of physiology trials conducted in 2010

Trial	No. of entries/ treatments	Remarks
PMPHY I	28	Agronomic performance under drought and normal conditions
PMPHY II	15 (Jaipur) 36 (Jamnagar)	Agronomic performance under drought and normal conditions
PMPHY III	9	Effect of foliar spray on agronomic parameters
PMPHY IV	15 (Jaipur) 16 (Jamnagar)	Establishment of pearl millet under stress conditions
PMPHY V	12 (Jaipur) 19 (Jamnagar)	Assessment of salinity tolerance

13. Frontline demonstrations (FLDs)

As against the target of 500 ha, FLDs were organized over an area of 342 ha during Kharif-2010 in Rajasthan, Gujarat, Maharashtra, Haryana, Tamil Nadu, Madhya Pradesh and Andhra Pradesh in kharif and 10 ha in summer in Maharashtra. The yield results indicate a wider yield gap over control plots. The overall yield advantage of 30% was observed in FLDs with improved practices over farmers' practice during kharif season. The average yield improvement in summer season was 18%.

13. Points to ponder

- The adoption of public-released hybrids is to be pushed with more vigour and force through sensitization of State Seed Corporations and Public-Private-Partnership mode
- Genetic and cytoplasmic diversification of seed parents should be addressed on priority
- Dual-purpose cultivars to meet the need of crop-livestock production systems
- More emphasis on genetic improvement targeting A₁ zone.
- More pro-active action to register both breeding material and commercial cultivars
- In view of climate change and temperature-rise prediction, heat tolerance needs to be addressed in breeding programmes
- Pearl millet is more nutritious than other cereals but general public is not aware of this. Publicity is needed to highlight pearl millet as nutritious food rather than branding it as poor man's crop
- With increase in production of pearl millet, larger proportion of pearl millet grain is being diverted to feed for cattle and poultry and for beverage industry as well. However, there are no base-line surveys available on this aspect