



Project Coordinator Review

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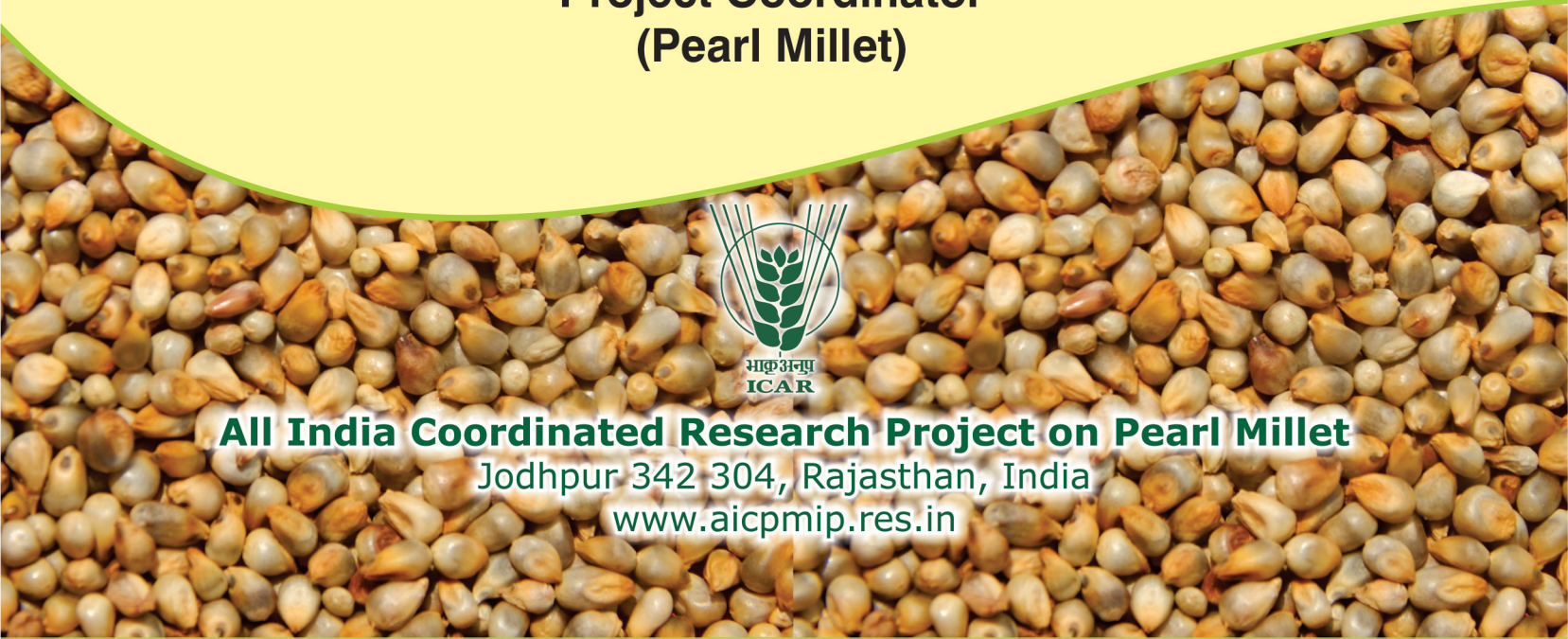
**Project Coordinator
(Pearl Millet)**



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REVIEW OF PEARL MILLET RESEARCH

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the staple food of majority of the poor and small land holders, as well as feed and fodder for livestock in the rainfed regions of the country. Pearl millet excels all other cereals because it is a C₄ plant with high photosynthetic efficiency and dry matter production capacity, requires less inputs, matures in short duration and is considered as nutritious food, feed and fodder. It is usually grown under the most adverse agro-climatic conditions where other crops like sorghum and maize fail to produce economic yields. It is a rich source of fibers and minerals especially iron, calcium, zinc and high in fats among cereals and hence can provide all the nutrients at very low cost compared to wheat and rice. Despite all these advantages, it is perceived inferior due to lack of awareness about its nutritional richness, lack of right processing technologies and lack of economic incentives to farmers. Its per capita consumption is declining and production's increasing leading to high volatility in prices and farmer's income. In order to sustain the production, demand should be enhanced through various alternative uses of pearl millet.

In India, pearl millet is the third most widely cultivated food crop after rice and wheat. It is grown on 7.128 million ha with an average productivity of 1132 kg/ha during 2015-16 (Directorate of Millet Development, 2017). 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 the country. Most of pearl millet in India is grown in rainy (*kharif*) season (June–September). It is also cultivated during the summer season (February–May) in parts of Gujarat, Rajasthan and Uttar Pradesh; and during the post-rainy (*rabi*) season (November–February) at a small scale in Maharashtra and Gujarat. At present the total area under pearl millet is 7.128 million hectares in 2015-16 and advanced estimates for 2016-17 showed slight increase up to 7.48 m.ha. In spite of area shrinkage, the production of pearl millet increased constantly to 8.06 m.t. in 2015-16 and estimated to reach 9.41m.t. (advance estimates for 2016-17). As an average of latest data of four years (2012-13 to 2015-16) Rajasthan, Uttar Pradesh, Maharashtra, Haryana and Gujarat accounted for 94.82% of total area under Pearl millet and contributed to 87.70% of total production.

Pearl millet improvement research in India is carried out through the All India Coordinated Pearl Millet Improvement Project (AICPMIP) under the leadership of Indian Council of Agricultural Research (ICAR). In the cultivar development, greater emphasis has been given on genetic diversification of both seed and pollinator parents with the result that more than 113 hybrids were released for various niche ecologies during 1991-2016. As a result, improvement in grain productivity has further increased to 27 kg/ha/year (1991-2015). Breeding programme has been

fully backed-up by strong seed production and marketing of pearl millet cultivars by both public and private sectors. As a result, pearl millet has recorded 124% increase in its productivity since 1986-90 which is highest among all food crops during last 30 years.

Pearl millet improvement research in India is carried out through the All India Coordinated Research Project on Pearl Millet (AICRP-PM) administered by Indian Council of Agricultural Research (ICAR). The AICRP-PM has a network of 14 AICRP centers in Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Karnataka, Andhra Pradesh, Madhya Pradesh, Panjab, Haryana and Tamil Nadu. The AICRP-PM centers located in 12 State Agricultural Universities (SAU's) and University of Mysore pursue mandated activities and strategic research on pearl millet in the area of germplasm utilization, improvement, production, protection, value addition etc. The growing conditions for pearl millet vary from near-optimum with high external inputs to highly drought-prone environments. This led to the prioritization of research in cognizance of production constraints and differential requirement of various crop growing regions. Hence, the whole pearl millet area has been divided into three zones viz., A₁, A and B. Zone A₁ is comprised of parts of Rajasthan, Gujarat and Haryana receiving less than 400 mm annual rainfall.

Therefore, keeping in view the achievements and future requirements, the major emphasis for pearl millet improvement, production and protection should be on development of Pearl millet hybrids/varieties, production technology to produce more yield per drop of water, high per day productivity, with high degree of resistance to downy mildew and blast and increased concentrations of Fe & Zn. Along with the yield improvement traits, focus should also be on breeding for low anti nutritional factors like phytate and polyphenols in grain and oxalic acid in fodder. Hence, the twin goals of pearl millet improvement should be increasing the production and productivity in A₁ zone and enhancing the demand of pearl millet through increased consumption and alternative food uses.

Refinement of technologies for processing for grain and development of value added products along with development of sound extension support for popularization of these technologies and products, spread of pearl millet cultivation in nontraditional areas and pearl millet hybrid seed production in North - Western part of the country is the need of the hour.

The results of the research conducted during 2016-17 are summarized below:

CROP IMPROVEMENT

1. Release/identification of new hybrids

Thirteen pearl millet hybrids/varieties were notified and released for cultivation for various agro-ecologies of the country viz., three hybrids MPMH 21, HHB 272 and JKBH 1008 were released for cultivation in drier parts of the country (Rajasthan, Gujarat and Haryana), four hybrids KBH 3940, Bio 8145, 86M82 and 86M84 were released for cultivation in late maturity group for the state of Rajasthan, Gujarat, Haryana, Punjab, Delhi, Uttar Pradesh and Madhya Pradesh, two hybrids Nandi 75 (NMH 82) and 86M13 were released for cultivation in summer growing areas of Gujarat, Rajasthan, Uttar Pradesh, Maharashtra and Tamil Nadu, two hybrids JKBH 1100 and JKBH 1105 were released for the state of Uttar Pradesh. Hybrid Proagro Tejas was released for the drier part of state of Rajasthan, hybrid PHB 2884 was released for the state of Punjab.

Genetic enhancement

A significant progress was made during the year 2016-17 in genetic enhancement of crop. A total of 258 new experimental cultivars were evaluated in 14 trials during *kharif* and *summer* 2016 at 67 test locations in the four agro-climatic zones of the country. These genotypes expressed a wide range of grain and stover productivity (Table1).

Table 1: Details of trials conducted in 2016

| Zone | Trials | No. of test entries | Range | |
|--------------------------|--------------|---------------------|---------------------|---------------------|
| | | | Grain Yield (kg/ha) | Stover Yield (q/ha) |
| A ₁ | IHT Early | 24 | 2012-2996 | 41-60 |
| | AHPT Early | 11 | 2020-2682 | 38-53 |
| A | IHT Medium | 32 | 2046-3644 | 56-99 |
| | IHT Late | 31 | 2669-3959 | 85-35 |
| | AHT Medium | 7 | 2562-3463 | 59-81 |
| | AHT Late | 6 | 3277-4067 | 80-108 |
| | PT | 10 | 1755-2553 | 47-70 |
| | | | | |
| B | IHT Medium | 32 | 2436-4311 | 50-94 |
| | IHT Late | 31 | 2804-4629 | 65-103 |
| | AHT Medium | 6 | 3265-4016 | 52-70 |
| | AHT Late | 15 | 3472-4384 | 61-106 |
| | PT | 10 | 2248-3149 | 50-63 |
| A ₁ , A and B | HT (Fe & Zn) | 27 | 2393-3924 | 59-90 |
| Summer | SHT | 16 | 4075-5139 | 72-98 |

2. 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. The hybrids evaluated during 2016 were based on 110 A-lines (by name) and 151 R-lines (by name). This is contributing significantly towards genetic diversification of parental lines and ultimately of hybrids in the country.

3. Assessment of grain quality

- A total of 61 test entries were assessed for quality parameters like protein and fat. A wide range in protein content (7.70–14.80%) was observed in the test material demonstrating that there exists enough opportunity to select for protein content in addition to high grain and stover yields.
- A special trial for development of high iron and zinc hybrids was carried out in which hybrids MH 2072, MH 2173, MH 2278, MH 2179, MH 2282, MH 2185, MH 2077, MH 2174 and MH 2180 were identified having high iron (80-87 ppm) and zinc (36-46 ppm) content along with high grain yield.
- Iron and zinc content of hybrids tested in advance trials in zone A₁, A and B during *kharif* 2016 were also estimated. Range of iron and zinc along with superior hybrids are presented in table 2.

Table 2: Zone-wise details of superior pearl millet test hybrids and varieties containing high iron and zinc

| Trial | Hybrid | Iron (ppm) | Zinc (ppm) |
|-----------|---------|------------|------------|
| AHT (M)-A | MH 2114 | 61 | 36 |
| AHT (M)-B | MH 2010 | 59 | 38 |
| | MH 2024 | 59 | 35 |
| AHT (L)-A | MH 2155 | 57 | 42 |
| AHT (L)-B | MH 2035 | 53 | 41 |

4. Breeder seed Production

During the current year breeder seed production of 29 parental lines (A, B & R) of hybrids and 9 OPVs was organized. A total of 31.81 q of breeder seed was produced which was much higher than the indented quantity of breeder seed (8.45 q) from Department of Agriculture and Cooperation, Ministry of Agriculture.

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

- The DUS testing was undertaken as per approved guidelines of PPV & FRA during *kharif* 2016. A total of 44 candidate varieties including 31 for second year and 13 for first year along with 20 reference/example varieties were tested at AICRP on Pearl Millet, Jodhpur and MPKV, Rahuri. Observations on candidate and reference varieties for twenty six characters were recorded as per general and specific DUS guidelines.
- During the year under report four cultivars and parental lines namely 86M40, 86M76, 86M11 and PM80105R were registered with PPV and FRA and several are in the process of registration. So far 105 cultivars and parental lines (34 Public and 71 Private) have been registered with PPV and FRA.
- The monitoring team led by Dr. O.P. Yadav at AICRP on Pearl Millet, Mandor on 10th October, 2016 visited the DUS experiments.

6. ICAR-ICRISAT partnership research

A total of 104 R lines and 90 B lines were evaluated at 17 locations of AICRP centers and cooperating centers and superior lines selected by breeders will be utilized by different centre's in their breeding programme. In high iron and zinc trials, parental lines viz., ICHFPT 16-4, ICHFPT 16-11, ICHFPT 16-8 and ICHFPT 16-3 were identified as superior to the best check ICMB 98222 and recorded 100-106 ppm iron and 69-80 ppm zinc. High forage hybrid trial was conducted across 2 locations - Jamnagar (Dhari) and Ludhiana and twelve entries out-yielded in green fodder yield (9.6-35.8%) to the best check PAC 981. In high forage population trial 4 entries out-yielded in green fodder yield (11.5-15.5%) to the best check PAC 981 at two locations (Vijayapur & Ludhiana).

Resource management:

Seven agronomy trials on aspects of nitrogen management in Fe and Zn rich hybrids; among advance hybrid and population entries (early, medium and late); Integrated nutrient management in pearl millet under irrigated situations, Response of pearl millet to foliar application of FeSO₄, Irrigation scheduling during summer season, Maximization in the pearl millet productivity under late sown situations and to evaluate the comparative performance of advance hybrid and population entries under different sowing dates during *kharif* & summer seasons of 2016 were conducted in different agro climatic zones (Zone A₁, Zone A and Zone B) (Table 3).

Table 3: The list of the experiments along with treatments are as under:

| S. No. | Title | Treatment |
|--------|--|---|
| 1 | PMAT 1: Response of advance hybrid & population entries to nitrogen levels Zone A ₁ Zone A Zone B | 12 (Entries 4, N level 3) 18 (Entries 6, N level 3) 30 (Entries 10, N level 3) |
| 2 | PMAT 2: Integrated nutrient management (INM) for pearl millet hybrids under optimum management | 12 (Hybrids 3 & INM Levels 4 <i>i.e.</i> RDF of each location, RDF + PSB + <i>Azospirillum</i> , 75% of RDF + PSB + <i>Azospirillum</i> + 5.0 t FYM/ha and 50% of RDF + PSB + <i>Azospirillum</i> + 7.5 t FYM/ha.) |
| 3 | PMAT 3: Response of pearl millet hybrids to foliar application of FeSO ₄ | 12 (Hybrids 3 & 4 FeSO ₄ foliar spray <i>i.e.</i> Control, 0.25%, 0.50% & 0.75% at tillering stage (25-30 DAS) |
| 4 | PMAT 4: Irrigation scheduling for summer pearl millet hybrids | 12 (3 Hybrids <i>i.e.</i> 86M64, Pro Agro 9444 and Nandi 72 & 4 irrigation levels (At 50 mm, 75 mm, 100 mm CPE and Critical Growth Stages) |
| 5 | PMAT 5: Maximization in the pearl millet productivity under late sown situations | 10 (Two Sowing Dates: July 25-30 & August 10-15; 5 nutrient management practices T ₁ : RDF* of respective Zones, T ₂ : RDF + FYM @ 5.0 t/ha, T ₃ : 125% of RDF (N:P:K), T ₄ : T ₂ + NPK foliar spray (19:19:19 grade) @ 0.50% at 20-25 DAS and T ₅ : 75% RDF + FYM @ 5.0 t/ha.) |
| 6 | PMAT 6: Response of Fe and Zn rich hybrids to nitrogen application Zone A ₁ Zone A Zone B | 15 (Entries 5, N level 3) 18 (Entries 6, N level 3) 30 (Entries 6, N level 3) |
| 7 | PMAT 11: Performance of advance hybrids under different dates of sowing Zone A ₁ Zone A Zone B | 12 (Entries 4, Dates of Sowing 3*) 18 (Entries 6, Dates of Sowing 3*) 30 (Entries 10, Dates of Sowing 3*) *July 10-15, July 25-30 & August 10-15 |

The salient achievements are as below:

- Response of advance hybrid entries to different nitrogen levels revealed that in Zone A₁, the performance of only one advance hybrid entry MH 1998 in terms of grain and stover yield was found significantly better than the tested check RHB 177. Application of 60 & 40 kg N/ha increased the grain yield to the tune of 23.40 & 13.80%, respectively over 20 kg/ha.
- In Zone A, the entry MH 2008 (30.48 q/ha) was found highest grain yielder and it produced 6.40% more grain yield than the higher yielder check 86M86 (28.64 q/ha). Maximum grain (31.95 q/ha) and stover (80.60 q/ha) yields were recorded with the application of 90 kg N/ha and it produced 6.98 and 2.99 q/ha more grain yield, whereas, stover yield was 8.95 and 3.24 q/ha higher over application of 30 kg and 60 kg N/ha, respectively.
- In Zone B, maximum grain (31.10 q/ha) and dry stover yield (56.20 q/ha) recorded with application of 90 kg N/ha was found to be higher by 29.20 and 10.30% in grain and 25.00 and 8.20% in dry stover yield with the application of 30 kg & 60 kg N/ha, respectively. The advance entries MH 2053 (32.03 q/ha) and MH 2047 (31.92 q/ha) produced higher grain yield over the hybrid checks 86M86 (24.68 q/ha) and NBH 5767 (24.15 q/ha).
- INM studies carried out among three different hybrids in each zone showed the superiority of treatment 75% of RDF + PSB + *Azospirillum* + 5.0 t FYM/ha (16.85 q/ha) over RDF alone (14.79 q/ha) in Zone A₁. In Zone A & Zone B, seed treatment with bio inoculants *Azospirillum* and *PSB* in addition to RDF was the best one and in Zone A & Zone B, it improved the grain yield to the tune of 7.60 and 7.30%, respectively over the RDF alone. Among the hybrids, HHB 234 Improved in Zone A₁, RHB 173 in Zone A & 86M86 in Zone B were the best performer.
- The chemical soil property pH and EC of the soil was decreased as compared to initial soil status prior to the experiment. Both available N and P status in the soil were maintained and improved as compared to initial soil status. The improvement in the soil properties were maximum in the treatments 75% of RDF + PSB + *Azospirillum* + 5.0 t FYM/ha.
- Response of pearl millet hybrids to foliar application of FeSO₄ studies revealed that the grain yield was improved to the tune of 30.70, 16.00 and 31.40%, respectively by the best treatment of 0.50% FeSO₄ foliar spray at tillering stage (25-30 DAS) over the control in Zone A₁, Zone A and Zone B.
- Irrigation scheduling for summer pearl millet hybrids study revealed that the application of irrigation at 50 mm CPE recorded maximum grain (41.48 q/ha) and stover yield (68.04 q/ha). However, the water use efficiency was recorded maximum in 100 mm CPE treatment (133.41 kg/ha-cm). The mean

grain yield was 11.90 and 6.70% higher in the hybrid 86M64 (40.99 q/ha) compared to Nandi 72 (36.62 q/ha) and ProAgro 9444 (38.40 q/ha). The water use efficiency was highest in 86M64 (123.81 kg/ha-cm) and it was followed by ProAgro 9444 (115.71 kg/ha-cm) and Nandi 72 (114.48 kg/ha-cm).

- Maximization in the pearl millet productivity under late sown situations (July 25-30 & August 10-15) study showed the superiority of the treatment RDF + FYM @ 5.0t/ha + NPK foliar spray @ 0.50% at 20-25 DAS in terms of grain (14.75 q/ha) and fodder yield (31.22 q/ha) over RDF alone (10.88 q/ha grain; 24.69 q/ha fodder) in Zone A₁. Also in Zone A, this treatment with grain (25.77 q/ha) and fodder yield (62.37 q/ha) was best and superior than RDF alone (20.79 q/ha grain and 55.41 q/ha stover). In Zone B, RDF + FYM @ 5.0 t/ha (23.55 q/ha), 125% of RDF (24.13 q/ha) and RDF + FYM @ 5.0t/ha + NPK foliar spray @ 0.50% at 20-25 DAS (25.10 q/ha) treatments recorded 11.70, 14.40 and 19.00% higher grain yield than the RDF alone (21.09 q/ha).
- Response of Fe and Zn rich advance hybrid entries to N levels study revealed that the performance of advance test hybrid entries MH 2072 (20.32 q/ha) and MH 2077 (19.49 q/ha) in terms of grain yield was found superior than the check Dhanshakti (16.11 q/ha) and application of 60 and 40 kg N/ha increased the grain yield to the tune of 15.80 and 18.90% over 20 kg/ha in Zone A₁. In Zone A & Zone B, in comparison to the checks MPMH 17 (28.42 q/ha) and KBH 108 (30.81 q/ha) neither of the entry could supersede their grain yield. The application of 90 kg N/ha produced 6.56 and 2.68 q/ha more grain yield in Zone A and 20.90 & 6.20% higher over 30 kg and 60 kg N/ha, respectively.
- There was a decrease of 12.20 and 36.00%, 12.70 and 40.50%, 17.60 and 35.40% in grain yield of in Zone A₁, Zone A and Zone B, respectively in D₂ (July 25-30) and the D₃ (August 10-15) sowings compared to the D₁ (July 10-15) planting. The interaction effect between dates of sowing and advance entries was found significant at some locations in Zone A & B, thereby, indicating differential behavior of the pearl millet entries with delayed sowing.

Technology demonstrated:

- During *kharif* & Summer 2016 crop seasons, various Front Line Demonstrations (FLD's) on different production aspects [Improved hybrid/variety, weed management, use of micro nutrient ZnSO₄ and biofertilizer (*Azospirillum* + PSB), moisture conservation practices (opening furrows in between two rows at 30-35 DAS), sowing of pearl millet at wider row spacing of 90-120 cm, pearl millet + pigeon pea intercropping system

(2:1), use of recommended dose of NPJ were conducted on 220 ha area against the target plan of 250 ha on pearl millet crop in the states of Rajasthan, Gujarat, Haryana, Tamil Nadu, Karnataka, Maharashtra and Andhra Pradesh, Adoption of improved production technologies recorded 57.40% higher grain yield compared to the yield recorded with the farmer's practice in Zone A₁, 24.4% in Zone A and the increase was 29.50% in Zone B. During summer season in Gujarat state, the grain yield of 4138 kg/ha was obtained with improved cultivation practices as against 3858 kg/ha recorded with farmer's practices thereby improving the grain yield by 7.3% whereas in Kalai (UP), the improvement was 44.20% with IP's (4131 kg/ha) than FP's (2863 kg/ha) during the summer season.

PLANT PATHOLOGY

Screening for diseases: During *kharif and summer* 2016 seven trials were conducted on various aspects in pathology. The trials were conducted at Mandor, Jaipur, Hisar, Gwalior, Jamnagar, New Delhi and Anand in zone A₁ and A and at Mysore, Aurangabad, Dhule, Coimbatore and Patancheru in zone B. Total of 394 entries were screened against downy mildew, smut, rust, blast and ergot diseases. Out of these, 258 entries were highly resistant showing $\leq 5\%$ downy mildew incidence at 60 days after sowing at all India level. In addition, surveys were conducted at farmer's field to assess overall disease scenario during the crop season. The diversity in downy mildew and blast pathogen was also characterized. The mean downy mildew incidence at 60 days after sowing in Zone A₁ was 1.89%, and in Zone A it was 2.04% where as in Zone B it was 5.81%, indicating good resistance to downy mildew in test entries evaluated in Initial Trial. Similarly, mean downy mildew incidence in genotypes evaluated in Advance Trial in Zone A₁ was 1.50%, and in A Zone it was 1.50% whereas, in Zone B it was 6.31% at 60 days after sowing. During field surveys, it was observed that downy mildew and blast continued to be the main diseases of pearl millet. The range of downy mildew in the farmer's field varied (0-20%) according to the cultivar. It was observed that blast and rust were becoming more severe in the states like Maharashtra and New Delhi as high as 90% blast incidence was recorded. Blast was not recorded in the fields of Tamil Nadu, it was recorded in traces in Madhya Pradesh and Gujarat. High rust incidence (20%) was observed in Maharashtra during the field surveys. Smut incidence was very low in the most of the surveyed states. Ergot was observed in fields of Karnataka, whereas, other states were free from ergot incidence.

Table 4: Details of highly resistant ($\leq 5\%$) entries at all India level at 60 DAS

| Trial | Total number of entries | Highly resistant entries (No.) | Range (%) |
|----------|-------------------------|--------------------------------|----------------------------------|
| PMPT I | 130 | 104 | 0.81 (MH 2273) – 10.49 (MH 2233) |
| PMPT II | 76 | 61 | 1.40 (MH 2154) – 12.20 (MH 2129) |
| PMPT III | 33 | 26 | 1.08 (KBH 108) – 8.22 (PAC 909) |
| PMPT IVa | 70 | 49 | 1.10 (863 B-P2) – 88.50 (7042 S) |
| PMPT VII | 20 | 18 | 0.00-5.76 (86M64) |

ENTOMOLOGY

Five trials were conducted at Jaipur and Jamnagar. For screening insect-pests, in which 76 genotypes were tested against key pests of pearl millet. For management of foliar insect-pests IPM module IV consisting of application of clothianidin 50 WDG @ 7.5 g/kg as seed treatment followed by spray of fipronil 40% + imidacloprid 40% WG @ 0.04% (5 g/10 lit.) at 35 DAG found effective. Among the different IPM modules tested for their effectiveness against shoot fly and stem borer, IPM module IV (Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of dimethoate 30 EC 0.03% at 35 DAG) was found effective and highest gross income, net return and ICBR was found in IPM module IV.

Table 5: Summary of entomology trials conducted in 2016

| Trial | No. of entries/ treatments | Major insect-pests |
|-----------|-----------------------------|---|
| PMET- I | 76 | Shoot fly, stem borer <i>Helicoverpa armigera</i> , Grey weevil and leaf roller |
| PMET- II | Monitoring on Research Farm | Shoot fly, stem borer, leaf binder, grass hopper, jassid, thrips, Flea beetle, Chrysopa, Blister beetle, earhead beetle, Hairy cater pillar, <i>Eublema silicula</i> , lady bird beetle, <i>Helicoverpa armigera</i> , white grub and termite |
| PMET- IV | 9 | Shoot fly and stem borer |
| PMET- V | 6 | Shoot fly, stem borer, and <i>Helicoverpa armigera</i> , white grub and termite |
| PMET -VII | 11 | white grub and termite |

PLANT PHYSIOLOGY

Six physiological trials were conducted at Mandor, Jaipur and Jamnagar during summer and *kharif* 2016.

PMPHY-1: (Screening of advance summer hybrids against terminal stress)

Under terminal stress condition MSH 312 and MSH 314 were the high yielders among advance summer hybrids at Jamnagar and MSH 315 and MSH 314 were high yielding at Mandor.

PMPHY-2: (Characterization for drought tolerance in pearl millet genotype)

B-lines (JMSB-200102 and JMSB-200142) and inbred lines (J-2569 and J-2480) at Jamnagar and B-lines JMSB 20102, inbred line J-2480 and J-2500 at Mandor were high yielders under terminal stress condition.

PMPHY-3: (Effect of foliar spray on agronomic parameters)

Among seven treatments growth substances potassium chloride (1.50%) improved grain yield and fodder yield (1789 kg/ha and 3271 kg/ha). It was followed by the Benzyl adenine applied @ 50 ppm (1675 kg/ha and 3083 kg/ha) at Mandor and at Jamnagar grain and stover yield (2885 kg/ha and 3641 kg/ha), respectively. Whereas, at Jaipur, benzyl adenine applied @ 50 ppm gave highest grain and stover yield (1630 kg/ha and 4150 kg/ha).

PMPHY-4: (Varietal characterization in pearl millet on the basis of root and shoot traits)

Five genotypes namely, HHB 67 Improved, RHB 177, RHB 173, GHB 538 and GHB 558 were studied for drought tolerant parameters, viz; shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight and root dry weight and field observation also studied at three locations (Mandor, Jaipur and Jamnagar). The genotype RHB 173 exhibited maximum shoot length, root length, shoot fresh weight, shoot dry weight, root dry weight, root shoot ratio, whereas, GHB 558 exhibited maximum root fresh weight and under field condition also these two hybrids were also performed better.

PMPHY-5: (Physiological mechanism of drought tolerance in pearl millet at early seedling stage)

The drought tolerant parameters viz; shoot length, seedling dry weight, relative water content, membrane stability index, chlorophyll content were decreased significantly with application of 5% and 10% PEG by inducing water stress in all the hybrids while root length and catalase activity increased significantly under water stress. The hybrids MH 2008 and MH 2047 performed better both under non stress and water stress conditions owing to maintain higher RWC, MSI Chlorophyll content and catalase activity at 10 and 20 days after sowing at Jaipur as well as Jamnagar. Three hybrid MH 1998, MH 2008 and MH 204 performed better under PEG induced water stress condition in 10 and 20 days old seedling at Mandor.

PMPHY-6: (Manipulation of source sinks relationship in Pearl millet through growth retardants)

The experiment was comprised of application of three concentrations of cycocel (chloromequet) (250, 500 & 750 ppm) and mepiquet chloride (250, 500 & 750 ppm) along control. The results revealed that both cycocel and mepiquet chloride showed significant variations on physiological growth and yield attributing characters in pearl millet. Among different concentrations cycocel 500 ppm and mepiquet chloride 500 ppm exhibited maximum number of effective tiller, ear head weight, total dry matter, biological yield and grain yield. It might be on account of maintaining higher RWC and chlorophyll content by CCC and mepiquet chloride.



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