Forage Res., **47** (1) : pp. 84-88 (2021) **http://forageresearch.in**

EFFECT OF CUSTOMIZED FERTILIZER AND HYBRIDS ON GROWTH ATTRIBUTES AND YIELD OF PEARL MILLET UNDER DRYLAND CONDITIONS

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(Received : 8 June 2021; Accepted : 28 June 2021)

SUMMARY

Efficient sources of nutrients supplying the nutrients with greater efficacy and high yielding pearl millet hybrid with nutrient responsiveness plays an important role in yield enhancement and quality improvement on pearl millet in the arid region under sandy loam soil. To find out the influence of customized fertilizers and hybrids on growth and yield of pearl millet, field experiments were carried out during *kharif* seasons of 2019 and 2020 at ICAR-All India Coordinated Research Project on Pearl Millet, Research Farm, Agricultural Research Station, Mandor, Jodhpur (Agriculture University, Jodhpur). Customized fertilizer substantially enhanced growth attributes viz., plant height (200.8 and 183.5 cm), days to panicle initiation (23.0 and 22.7 days), days to 50% flowering (46.8 and 44.7 days), days to maturity (86.7 and 83.8 days) during 2019 and 2020, respectively over control. Application of customized fertilizer recorded markedly higher grain yield (2124 and 1896 kg/ha) and straw yield (3611 and 3223 kg/ha) during 2019 and 2020 over control and straight fertilizer. Among hybrids, substantially taller plants were observed by the pearl millet hybrid 'MPMH 17' (192.6 cm) during 2019 and 'RHB 173' (171.6 cm) during 2020. The hybrid 'RHB 173' took a greater number of days to panicle initiation (23.8 and 23.7 days), days to 50% flowering (49.1 and 48.0 days) and days to maturity (84.3 and 82.2 days) during 2019 and 2020. Economic analysis envisages, application of customized fertilizer fetched significantly higher gross return (₹60,528 and 56,872/ha), net return (₹34,072 and 36,307/ha) and B: C ratio (2.75 and 2.49) during 2019 and 2020 over control. Likewise, markedly higher gross return (₹60,109 and 55,638/ha), net return (₹40,361 and 35,061/ha) and B: C ratio (3.02 and 2.68) was obtained by hybrid, 'MPMH 17' during 2019 and 2020.

Key words : Customized fertilizer, hybrids, MPMH 17, pearl millet, yield

In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize During 2019-20, pearl millet was grown in 7.41 million ha with an average production of 10.3 million tonnes and 1391 kg/ha productivity (DMD, 2021). The major pearl millet growing states are Rajasthan, Maharashtra, Uttar Pradesh, Gujarat and Haryana contributing to 90% of total production in the country. Among these states, Rajasthan contributes nearly 4.28 million tonnes, followed by Uttar Pradesh (1.30), Haryana (1.08), Gujarat (0.96), Maharashtra (0.66) and Tamil Nadu (0.08). Most of pearl millet in India is grown in rainy (*kharif*) season (June/July–September/October). It is also cultivated during 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 (PCR, 2021). Most of the pearl millet growing areas are confined to light textured soils suffering with twin problem of poor moisture retentivity and soil fertility. The major cause for its low productivity is crop raised under rainfed conditions on low fertile soils. Further, growing of composite or poor yielding pearl millet varieties hampers the productivity. The average harvested yield of pearl millet in India as well as Rajasthan is very low as compared to the yield potential of hybrids or improved varieties developed. Inappropriate selection of the pearl millet improved varieties or hybrids by the farmers' is also one of the major constraints for higher yield gap between potential

and actual yield at farmers field. Improved hybrids play key role in bridging the yield gap and profitability disparities among the farmers.

The development of area specific and crop specific customized fertilizers should be scientifically proved as more efficient and fulfill the demand of crop and also increase fertilizer use efficiency. This approach could enhance crop yields and control degradation of soil fertility for a longer period. The customized fertilizers are a carrier of various nutrients combination provides the application of desired plant nutrients in adequate amount to meet the demand of a crop for growth and development.

MATERIALS AND METHODS

The field experiments were carried out at ICAR-All India Coordinated Research Project on Pearl Millet, Research Farm, Agricultural Research Station, Mandor, Jodhpur (Agriculture University, Jodhpur). The soil of the experimental field was sandy loam having pH 8.2, organic carbon (1.13 g/kg), available nitrogen (158.2 and 159.3 kg N/ha), phosphorus (15.8 and 16.00 kg P_2O_5/ha) and potash (284.7 and 283.4 kg K_2O/ha). Geographically experimental site was located between 26º15' N to 26º45' North latitude and 73º00' E to 73º29' East longitude at an altitude of 231 meters above mean sea level. This region falls under agro-climatic zone Ia (Arid Western Plains Zone) of Rajasthan. The climate of Jodhpur is typically arid with hot dry and sunny summers. The average annual rainfall is about 367 mm and major part of it (85 to 90%) is received from June to September (*Kharif* season) through South West monsoon. The normal time of onset of monsoon in the region is last week of June to first week of July but weather aberrations are quite common. The mean weekly maximum and minimum temperature fluctuated between 25.6ºC to 35.2ºC and 28.1ºC to 35.4ºC, respectively during the crop growing season. The experimental crop received 537.7 and 223.3 mm of rainfall with 24 and 15 rainy days during 2019 and 2020, respectively. The average weekly relative humidity fluctuated between 48.5 to 76.1% and 46.2 to 71.0% during 2019 and 2020, respectively. Detailed weather variable recorded during the cropping period are present in Figure 1 and 2.

The treatments comprising of three fertility levels (Control, Nutrient supply through straight fertilizers and Nutrient supply through customized fertilizer) and seven different pearl millet hybrids ('MPMH 21', 'MPMH 17', 'RHB 177', 'RHB 173',

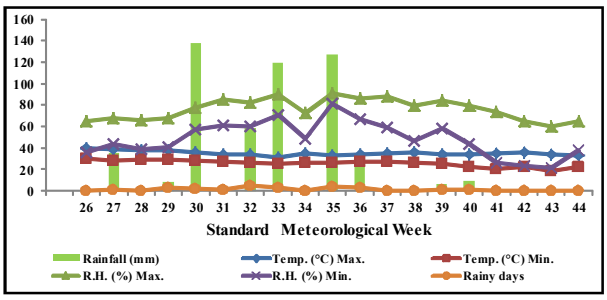

Fig. 1. Meteorological data recorded at ARS Mandor, Jodhpur during crop season (*Kharif*, 2019).

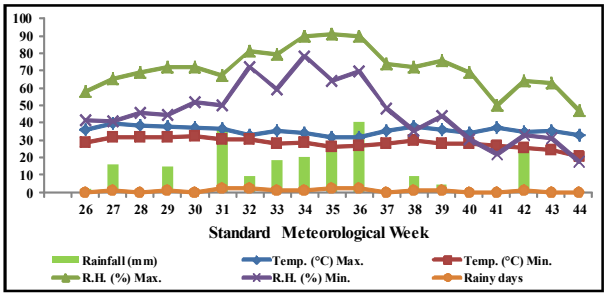

Fig. 2. Meteorological data recorded at ARS Mandor, Jodhpur during crop season (*Kharif*, 2020).

'HHB 67 (Improved)', 'HHB 197' and 'HHB 272') was laid out in Factorial Rendomised Block Design and replicated thrice. Pearl millet was sown at a row to row spacing of 45 cm and 15 cm plant to plant using 4 kg seeds/ha. The sowing was done on July 21, 2019 and July 7, 2020. Height of each tagged plant was measured at panicle initiation, 50% flowering and at harvest. Number of days taken from date of sowing to the appearance of flower in 50% of plants in a plot was recorded. Net area from each plot was harvested and threshed separately. Grain yield from each net plot was recorded and computed as grain yield kg/ha. The stover yield for each plot was worked out by subtracting grain yield from total biomass of each net plot and stover yield was expressed in kg/ha. The cost of cultivation was taken into account for calculating economics of different treatments and expressed as gross return, net return (₹/ha) and B: C ratio.

RESULTS AND DISCUSSION

Growth attributes

Marked variations in plant height (Table 1) of pearl millet were recorded due to application of customized fertilizer formulation (6:6:2:1). Taller plants (200.8 cm and 183.0 cm) over control and straight fertilizer (60:30:10:5) application at harvest stages were

TABLE 1
Effect of fertility levels and hybrids on plant height and phenological events of pearl millet

Treatments	Plant height (cm)						Days to panicle initiation		Days to 50% flowering		Days to maturity	
	Panicle initiation		50% flowering		At harvest							
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Fertility levels												
Control	20.5	18.3	149.6	142.9	169.4	153.7	22.1	22.3	44.8	44.8	78.9	76.8
Straight fertilizer	24.5	22.2	162.6	155.0	185.9	173.9	23.0	22.5	45.7	45.4	83.0	81.9
Customized fertilizer	28.9	26.8	174.6	165.9	200.5	183.8	23.0	22.7	46.8	44.7	86.7	83.8
SEm±	0.08	0.10	1.41	1.30	1.33	1.88	0.12	0.02	0.14	0.11	0.14	0.14
CD (P=0.05)	0.24	0.28	4.03	3.71	3.81	5.38	0.34	0.07	0.39	0.30	0.41	0.40
Hybrids												
MPMH 21	24.5	22.4	156.7	149.6	178.5	170.7	22.1	22.0	46.3	45.9	81.9	80.0
MPMH 17	25.6	23.5	166.8	158.7	192.6	170.6	23.7	23.3	48.3	47.7	83.6	81.2
RHB 177	24.8	22.8	163.4	155.4	186.4	169.5	22.6	22.4	44.6	43.6	81.3	79.8
RHB 173	26.4	24.4	159.5	151.7	192.0	171.4	23.8	23.7	49.1	48.0	84.3	82.2
HHB 67 (Improved)	23.6	21.2	164.3	155.6	176.5	165.5	21.6	21.4	43.2	42.3	81.7	79.2
HHB 197	22.9	20.6	166.9	158.6	184.1	173.8	22.7	22.5	44.3	43.2	83.3	81.3
HHB 272	24.6	22.3	158.5	152.8	186.9	171.5	22.4	22.2	44.4	44.0	83.8	82.0
SEm±	0.13	0.15	2.15	1.98	2.04	2.88	0.18	0.04	0.21	0.16	0.22	0.22
CD (P=0.05)	0.37	0.42	6.15	5.67	5.82	NS	0.52	0.11	0.60	0.46	0.63	0.62
Interaction												
SEm±	0.22	0.26	3.73	3.44	3.53	4.98	0.31	0.06	0.36	0.28	0.38	0.37
CD (P=0.05)	0.64	0.73	NS	NS	NS	NS	NS	NS	NS	NS	1.09	1.07

observed during both the years of experimentation. Among hybrids, substantially taller plants were observed by the pearl millet hybrid 'MPMH 17' (192.6 cm) during 2019 and 'RHB 173' (171.6 cm) during 2020. Significant interaction effect of fertilizers and hybrids on plant height showed at panicle initiation. The interaction effect of fertilizers and hybrids at days to 50% flowering and at harvest stages found non-significant. The improvement in plant height ascribed to the proper nutrient availability to crop to attain optimum growth by application of customized fertilizer (Mudalagiriyappa *et al.,* 2015). These results are in close conformity with the findings of Rana *et al*., (2009), Yadav *et al.,* (2014), Meshram *et al*., (2015) and Jakhar *et al*., (2018).

Application of customized fertilizer formulation to pearl millet prolonged substantially days to panicle initiation, days to 50% flowering and days to maturity over control during both years of experimentation. Significant differences in the phenological events among pearl millet hybrids noticed. The hybrid 'RHB 173' took a greater number of days to panicle initiation (23.8 and 23.7 days), days to 50% flowering (49.1 and 48.0 days) and days to maturity (84.3 and 82.2 days) during 2019 and 2020. Significant interaction effect among fertilizers and

TABLE 2
Yield of pearl millet as influenced by fertility levels and hybrids

Treatments	Grain yield (kg/ha)		Straw yield (kg/ha)	
	2019	2020	2019	2020
Fertility levels				
Control	1,340	1186	2,558	2266
Straight fertilizer	1,925	1,697	3,391	3,026
Customized fertilizer	2,124	1,896	3,611	3,223
SEm±	47	39	81	72
CD (P=0.05)	135	111	232	207
Hybrids				
MPMH 21	1,536	1,469	2,728	2,594
MPMH 17	2,079	1,838	3,706	3,226
RHB 177	1,680	1,575	2,823	2,893
RHB 173	1,895	1,696	3,392	2,948
HHB 67 (Improved)	1,853	1,521	3,361	2,753
HHB 197	1,877	1,642	3,345	2,889
HHB 272	1,654	1,409	2,951	2,564
SEm±	72	59	124	111
CD (P=0.05)	206	169	354	316
Interaction				
SEm±	125	102	214	192
CD (P=0.05)	NS	NS	NS	NS

hybrids at days to maturity showed that maximum number of days to maturity in hybrid 'RHB 173' (87.3 days) was taken with the application of customized fertilizer. These results on phenology are agreed with those of Alatorre *et al.,* (2009), Yadav *et al.,* (2014) and Wamalwa, (2017).

Yield

Grain yield is an important parameter which decides the overall efficiency and superiority of a particular treatment over other treatments. Grain yield (Table 2) of pearl millet was improved significantly with the application of customized fertilizer. It attained the grain yield to the extent of 2124 and 1896 kg/ha during 2019 and 2020. The order of increase in grain yield under varying treatment was in the order: F_3 (Nutrient supply through customized fertilizer)> F_2 (Nutrient supply through straight fertilizers)> F_1 (control). Markedly higher grain yield (2,079 and 1,838 kg/ha) was produced under 'MPMH 17' hybrid and proved significant superiority over rest of the hybrids during both the year of investigation. Application of customized fertilizer recorded markedly higher straw yield (3611 and 3223 kg/ha) during 2019 and 2020 over control and straight fertilizer. Maximum stover yield (3,706 and 3,221 kg/ha) was observed under hybrid 'MPMH 17' showed significant superiority over all other hybrids. The higher grain yield may be due to the application of sufficient nutrients in combination which resulted to greater availability of essential nutrients to plants, improvement of soil environment which facilitate in better root proliferation leading to higher absorption of water and nutrients and ultimately resulted into higher yield. Higher yield is closely correlated with high values for growth attributes and yield attributes. The differences in growth attribute and yield parameters between the hybrids of pearl millet might be attributed to the effect of the genetic makeup of the hybrids. Similar findings were also reported by Rana *et al*., (2009), Dwivedi *et al*., (2014), Yadav *et al.,* (2014), Meshram *et al*., (2015), Mudalagiriyappa *et al.,* (2015), Kailaselvi *et al*., (2016) and Bisht *et al.,* (2019).

Economics

Economic analysis (Table 3) envisages, application of customized fertilizer fetched significantly higher gross return (₹60,528 and 56,872/ha), net return (₹ 34,072 and 36,307/ha) and B: C ratio (2.75 and 2.49) during 2019 and 2020 over control. Likewise, markedly higher gross return (₹ 60,109 and 55,638/ ha), net return (₹40,361 and 35,061/ha) and B: C ratio (3.02 and 2.68) was obtained by hybrid, 'MPMH 17' during 2019 and 2020. Similar findings of economics were also reported by Dwivedi *et al*., (2014), Yadav *et al.,* (2014). Mudalagiriyappa *et al.,* (2015) and Jakhar *et al*., (2018).

CONCLUSION

Application of customized fertilizer (6:6:2:1) to pearl millet gave substantially higher grain yield, straw yield, net return and B: C ratio to the tune of 2,124 and 1,896 kg/ha; 3,611 and 3,223 kg/ha;₹38,543 and₹34,072/ha and 2.75 & 2.49, respectively during 2019 and 2020. Moreover, pearl millet hybrid 'MPMH

TABLE 3
Influence of fertility levels and hybrids on economics of pearl millet

Treatments	Gross return (₹/ha)		Net return (₹/ha)		B:C ratio	
	2019	2020	2019	2020	2019	2020
Fertility levels						
Control	39,588	36,832	22,773	19,177	2.35	2.09
Straight fertilizer	55,457	51,608	35,011	30,332	2.71	2.43
Customized fertilizer	60,528	56,872	38,543	34,072	2.75	2.49
Hybrids						
MPMH 21	44,358	44,557	24,609	23,980	2.24	2.15
MPMH 17	60,109	55,638	40,361	35,061	3.02	2.68
RHB 177	47,713	48,332	27,965	27,755	2.42	2.34
RHB 173	54,855	51,200	35,106	30,623	2.74	2.46
HHB 67 (Improved)	53,863	46,474	34,114	25,897	2.70	2.24
HHB 197	54,271	49,744	34,522	29,167	2.72	2.40
HHB 272	47,832	43,116	28,083	22,539	2.40	2.08

17' recorded significantly higher grain yield, straw yield, net return and B: C ratio to the tune of ₹2,079 and 1,838 kg/ha; 3,706 and 3,226 kg/ha; ₹40,361 and 35,061/ha and 3.02 & 2.68, respectively during 2019 and 2020.

ACKNOWLEDGEMENT

The authors duly acknowledge sincere thanks to College of Agriculture, Jodhpur and ICAR-All India Coordinated Research Project on Pearl Millet, Agricultural Research Station, Mandor, Jodhpur (Agriculture University, Jodhpur) for financial support and facilities provided to accomplish the research experiments.

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