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Effect of Different Sources of Nitrogen and Phosphorus and Application Methods on Yield and Quality of Hybrid Pearl Millet

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Due to high yielding and short duration hybrid pearl millet got populized in last few years under pearlmillet-mustard/wheat cropping system but its required higher nutrient as compared to composite varieties but farmers apply only N and little amount of P which is responsile for low yield therefore, the present study was carried out during kharif 2021 and 2022 with 12 treatments of different sources which are chemical fertilizers, vermicompost (VC) and bio-fertilizers(Azotobacter and PSB) and application methods (seed treatment, soil and foliar application) of nitrogen and phosphorus in RBD with 3 replications. The resulted indicated that the application of 100% Nitrogen and Phosphorus by chemical fertilizers produced significantly higher yield attributes (length and girth of cobs) and yield parameter (grain and stover yield and harvest index) of pearlmilletas compared to 50 and 75% NP treatments. Maximum grain yield 29.87 q ha^{-1}) was noted with

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integration of chemical, organic and bio fertilizers (75% NP + Seed treatment by *Azoto* + PSB + 5 t VCha^{-1}) which was significantly higher over rest of all other treatments. Minimum yield parameters were noted with control (0 % NP). Application of vermicompost @ 5 t ha^{-1} with 75 per cent of NP and inoculation of *Azotobacter and PSB* improved test weight and protein content.

Keywords: Bio-fertilizers; pearl millet; foliar application; nitrogen; phosphorus vermicompost.

1. INTRODUCTION

High yielding and short duration varieties of hybrid Pearl millet are available in the market as well as MSP of pearl Millet was increased so that hybrid Pearl millet got popularized during last several years among the farmers Soils of Gwalior-Chambal region is low to nitrogen and low to medium in available P. In this area farmers applied only nitrogen fertilizer without or very little amount of P fertilizer in Pearl millet crop due to recent hike in prices of phosphorus fertilizers which create the problem of imbalance use of the nutrient and responsible for low productivity of Pearl millet as well as mustard which grown after Pearl millet [1]. Looking to the rising price of chemical fertilizers, alternate sources like microbial cultures (*Azotobacter* and PSB), organic manure (vermi-compost) and foliar spray of nutrients improve its use efficiently and provide viable support to small and marginal farmers by partly replacing inorganic fertilizers use in crop production. Keeping in view the present investigation was carried out with different nitrogen and phosphorus applying sources (organic, bio and inorganic) and methods (soil, foliar and seed treatment) to increase the yield and quality of hybrid pearlmillet grown in Inceptosols.

2. METHODS AND MATERIALS

The present experiments were carried out at experimental research farm of the Department of Soil Science & Agricultural Chemistry, College of Agriculture, R.V.S.K.V.V., Gwalior during kharif 2021 and 2022. In this study 12 treatments namely T_1 : 0% NP, T_2 : 50% NP, T_3 : 75% NP, T_4 : 100% NP, T_5 : T_2 + 1% Foliar spray of 17 :44:0 at 30-35 DAS, T_6 : 75% NP+ 1% Foliar spray of 17 :44:0 at 30-35 DAS, T_7 : T_2 + 5t VC/ha, T_8 : T_3 + 5t VC/ha, T_9 : T_2 + Seed treatment by *Azoto* + PSB, T_{10} : T_3 + Seed treatment by *Azoto* + PSB, T_{11} : T_2 + Seed treatment by *Azoto* + PSB+ 5t VC/ha and T_{12} : T_3 + Seed treatment by *Azoto* + PSB+ 5t VC/ha and were conducted with 3 replications under Randomized Block Design. The experimental soil was alluvial and sandy clay loam in nature having pH 7.76, organic carbon 0.406% and available N, P, & K were 187.5, 13.84 & 202.4 kg ha^{-1}, respectively. The hybrid pearlmillet were sown on the first fortnight of July in both years. Vermicompost (1.28% N, 0.85% P, 0.83% K and 12.4:1 C: N ration) was mixed at 5 tonnes ha^{-1} in the soil at the time of field preparation as per treatment. *Azotobacter* and PSB were added by seed treatment at the time of sowing.The optimum dose of fertilizer (100% NPK) for Pearl millet was applied at 80:40:20 N: P_2O_5: K_2O kg ha^{-1}. In all treatments recommended dose of potassium was applied as basal through muriate of potash and half (50%) of nitrogen and the entire dose of P_2O_5 through urea and di-ammonium phosphate was also applied at the time of sowing as per treatments and the remaining 50 percent of nitrogen was top dressed through urea at 30 -35 days after sowing. Weed removal by hand weeding and the required plant population was maintained. Harvesting of crops was done at maturity and proper drying of grain; this was followed by recording ofgrain and stover yield. Growth and yield attribute parameters were also recorded during the time being of investigation. The ground grain and stover samples were digested with a di-acid mixture of nitric-perchloric (9:4) for the analysis of phosphorus. Nitrogen was determined by the KEL PLUS nitrogen estimation system and phosphorus by the vanadomolybdate yellow colour method [2]. The uptake of nutrients was calculated with their content and yields of respective parts of Pearl millet.

2.1 Data Analysis

The data processing for various parameters was analyzed using proper statistical methods using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at a 5 percent level of significance.

3. RESULTS AND DISCUSSION

3.1 Growth and Yield Attribute Parameters

Among the different sources and methods application for nitrogen and phosphorus,

applying75% NP+ *Azotobacter* + PSB + vermicompost 5 t / ha resulted in maximum plant height and yield attributes parameters. The length and girth of cob (cm) and test weight of Pearlmillet which was significantly higher over 100% NP treatments. Thus, there was a saving of 25% of the recommended dose of nitrogen and phosphorus with the application of organic and bio fertilizers. This is evident from the result (Table 1) application of 5 t / ha vermicompost with 50 and 75 % of NP recorded significantly higher growth and yield attributes parameters as compared to the same level of chemical fertilizer applied treatments. Further seed treatment with biofertilizers (*Azotobacter* and PSB) along with vermicompost applied treatment recorded the maximum value of these parameters. The basic fact is that the application of vermicompost increases CEC, water holding capacity, and phosphate availability in the soil and also provides secondary elements like Ca, Mg, and S and fairly high amounts of micronutrients to the plants. This accelerated the growth of new tissues and the development of new shoots that have ultimately increased the plant height and dry matter accumulation. The results of the present investigation are in agreement with those of Narolia et al., [3] and Chaudhary et al. [4] in Pearl millet. Minimum values of growth and yield attributes parameters were noted with control treatment for nitrogen and phosphorus nutrients (0% NP).

3.2 Yield Parameters

The results on yield parameters (grain, stover yields, and harvest index) of Pearl millet (Table 1) indicated that the difference due to various sources and methods application for nitrogen and phosphorus were found significant. An appraisal of data in Table 1 revealed that the grain and stover yields of Pearl millet displayed on significantly increasing trend with an increase in NP levels from 50 to 100 percent. The higher grain (25.95 q ha^{-1}) and stover (57.47 q ha^{-1}) yields were registered under 100% NP treatment. Additional application of organic manure (5 t vermicompost/ha) with 50 and 75 % of NP recorded significantly higher yield parameters as compared to same level of chemical fertilizer applied treatments. Further seed treatment with bio-fertilizers (*Azotobacter* and PSB) along with vermicompost and chemical NP applied treatment recorded significantly higher values of these yield parameters. This may be attributed to the higher availability of nutrients in vermicompost and bio-fertilizer treatments that increased the availability of both the native and applied nutrients and better source and sink relationship that contributed to better dry-matter production of crops, leading to the production of favourable yield components (Verma et al., 2016). Maximum grain (29.87 q ha^{-1}) and stover yield (64.69 q ha^{-1}) were recorded with integration of nutrients (75% NP + *Azotobacter* + PSB + vermicompost 5 t / ha treatment) which was significantly higher over 100% NP as well asall other treatments. Maximum harvest index (31.63 %) was also found with 75% NP + *Azotobacter* + PSB + vermicompost 5 t / ha treatment which was at par with 100% NP and 50% NP + *Azotobacter* + PSB + vermicompost 5 t / ha treatments. It might be due to the fact that the integration of nutrients gave an adequate supply of nutrients throughout the entire growth period which resulted in better growth and yield attributing characteristics. The better growth of crops ultimately diverted more energy under sink source relationship which helped in producing more yields. The present findings are in close agreement with the results obtained by Rinku et al*.,* [5] and Divya et al*.,* [6] in Pearl millet.

3.3 Quality Parameter

3.3.1 Nutrient uptake by pearl millet

Among the different sources and methods application for nitrogen and phosphorus, applying 75% NP + *Azotobacter* + PSB + vermicompost 5 t / ha was observed to significantly increase the grain, stover and total nitrogen and phosphorus uptake by Pearl millet (Table 2). Application of 75% NP + 5 t vermicompost+ *Azotobacter* + PSB increased the total nitrogen and phosphorus uptake by 16.09 and 17.04 % as compared to 100% NP and 177.82 and 190.49% as compared to control (0% NP) treatments. This might be because of improved nutritional environment in the rhizosphere as well as in the plant system by adding N and P with different sources (organic, bio and chemical fertilizers) which leading to enhanced translocation of N and P in plant parts. It also balanced nutrition due to release of macro and micro nutrients due to application of vermicompost under favorable environment might have helped in higher uptake of nutrients. The reason for more uptake in integrated treatment might be the increased availability of nutrients to plant initially through inorganic fertilizers and then by organic manures like vermicompost as well as biofertilizers (*Azotobacter* and PSB) matching to the need of crop throughout the growing season. Being a

Table 1. Yield attributes and yield parameters of pearlmillet as influenced by different sources and method of nutrient application (Mean data of two years)

Tr. No.	Treatments	Growth and yield attributes parameters				Yield parameters	
		Plant height (cm)	Ear headlength (cm)	Girth of ear head(cm)	Test weight (g)	Grain yield (q ha^{-1})	Harvest index (%)
T_1	0% NP	170.04	19.80	4.01	8.09	12.22	26.81
T_2	50% NP	178.53	22.48	4.47	8.60	18.45	27.35
T_3	75% NP	188.77	23.84	4.75	9.24	21.38	28.30
T_4	100% NP	207.15	24.38	5.11	9.96	25.95	31.10
T_5	T_2 + 1% Foliar spray of 17 :44:0 at 30-35 DAS	185.37	23.84	4.79	9.36	21.41	26.62
T_6	T_3 + 1% Foliar spray of 17:44:0 at 30-35 DAS	192.69	24.53	4.97	9.71	24.97	28.91
T_7	T_2 + 5t VC/ha	199.37	23.50	5.10	10.15	25.24	29.82
T_8	T_3 + 5t VC/ha	204.78	24.74	5.23	10.40	27.50	30.89
T_9	T_2 + Seed treatment by *Azoto* + PSB	191.84	24.22	4.87	9.69	22.02	27.70
T_{10}	T_3 + Seed treatment by *Azoto*+ PSB	201.94	24.94	5.03	9.82	24.35	29.26
T_{11}	T_2 + Seed treatment by *Azoto*+ PSB + 5t VC/ha	213.63	26.57	5.18	10.23	27.78	30.91
T_{12}	T_3 + Seed treatment by *Azoto*+ PSB + 5t VC/ha	217.96	28.94	5.42	10.64	29.87	31.63
	S.Em.(±)	**2.64**	**0.63**	**0.08**	**0.13**	**0.53**	**0.63**
	CD(0.05)	**7.61**	**1.82**	**0.23**	**0.36**	**1.52**	**1.82**

Table 2. Uptake and quality parameters of pearlmillet as influenced by different sources and method of nutrient application (Mean data of two years)

Tr. No.	Treatments	Uptake (kg ha^{-1})						Quality parameters	
		N-Uptake			P-Uptake			Protein content (%)	Protein yield (kg ha^{-1})
		Grain	Stover	Total	Grain	Stover	Total		
T_1	0% NP	16.82	19.79	36.61	4.02	3.97	7.99	7.92	96.7
T_2	50% NP	28.36	31.12	59.48	6.73	6.58	13.31	8.84	163.1
T_3	75% NP	34.73	36.66	71.39	8.26	7.73	16.00	9.33	199.7
T_4	100% NP	45.59	42.01	87.61	10.87	8.95	19.83	10.10	262.2
T_5	T_2 + 1% Foliar spray of 17 :44:0 at 30-35 DAS	35.21	40.63	75.84	8.53	8.51	17.05	9.45	202.5
T_6	T_3 + 1% Foliar spray of 17:44:0 at 30-35 DAS	42.66	42.79	85.45	10.28	9.29	19.56	9.81	245.3
T_7	T_2 + 5t VC/ha	44.20	43.11	87.31	10.57	9.40	19.97	10.08	254.2
T_8	T_3 + 5t VC/ha	49.36	45.40	94.76	11.92	9.96	21.87	10.30	283.8
T_9	T_2 + Seed treatment by *Azoto* + PSB	36.84	40.58	77.42	8.80	8.69	17.49	9.63	211.8
T_{10}	T_3 + Seed treatment by *Azoto*+ PSB	41.68	41.62	83.29	9.98	9.03	19.01	9.83	239.6
T_{11}	T_2 + Seed treatment by *Azoto*+ PSB + 5t VC/ha	48.87	45.65	94.52	11.61	9.79	21.40	10.12	281.0
T_{12}	T_3 + Seed treatment by *Azoto*+ PSB + 5t VC/ha	53.68	48.03	101.71	12.75	10.46	23.21	10.34	308.7
	S.Em.(±)	**1.08**	**0.68**	**1.33**	**0.24**	**0.17**	**0.33**	**0.15**	**6.2**
	CD(0.05)	**3.10**	**1.95**	**3.84**	**0.70**	**0.50**	**0.96**	**0.43**	**17.8**

cereal crop, Pearl millet requires nutrients throughout the growing season. The results obtained in the present investigation were in close conformity with the findings of Narolia and Poonia [7] and Tomar et al. [1].

3.3.2 Protein content and protein yield

It was revealed from the result (Table 2) that under different sources and methods application for nitrogen and phosphorus protein content was recorded to the tune of 7.92 to 10.34 % whereas protein yield was 96.7 to 308.7 kg ha^{-1}. Maximum protein content was recorded with 75% NP + 5 t vermicompost + *Azotobacter* + PSB treatment which was at par with 50% NP + 5 t vermicompost + *Azotobacter* + PSB, 75% NP + 5 t vermicompost, 50% NP + 5 t vermicompost and 100% NP treatments. Bangre et al*.* [8] also confirmed that the balanced use of organic and inorganic fertilizers provided higher nutrient content and quality of wheat. Maximum protein yield was also recorded with 75% NP + 5 t vermicompost + *Azotobacter* + PSB treatment which was significantly higher over the rest of all other treatments due to significantly highest grain yield in this treatment [9,10]. This might be because the integrated nutrient applied treatments resulted in a sufficient amount of released nutrients by mineralization at a constant level and increased the nutrient uptake because of the better soil environment created owing to the cumulative effect of organic sources combined with inorganic sources of nutrients, which enhanced the yield attributes and yield. The results of the present investigation are in conformity with those of Hashim et al*.* [11].

4. CONCLUSION

From the present study, it could be concluded that application of vermicompost at 5 tonnes ha^{-1} with 75 per cent of NP and inoculation of *Azotobacter* and PSB improved growth and yield attributes, yield and quality parameters in Pearl millet under the prevailing agro-climatic conditions of Gwalior region of Madhya Pradesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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