

Effect of different sources and application methods of Nitrogen and Phosphorus on yield and quality of hybrid pearl **M**millet

Comment [NP1]: Add its scientific name.

ABSTRACT

Formatted: Left

Present study was carried out during kharif 2021 and 2022 with 12 treatments of different sources i.e. chemical fertilizers, vermicompost (VC) and bio-fertilizers (Azotobacter and PSB) and application methods (i.e. seed treatment, soil and foliar application) of nitrogen and phosphorus in RBD with 3 replications. Resulted indicates that the application of 100% NP by chemical fertilizers produced significantly higher yield attributes (length and girth of cobs) and yield parameter (grain and stover yield and harvest index) of pearl millet as compared to 50 and 75% NP treatments. Maximum grain yield 29.87 q ha^{-1} was noted with integration of chemical, organic and bio fertilizers (i.e. 75% NP + Seed treatment by *Azoto* + PSB + 5t VC/ha) which was significantly higher over rest of all other treatments. Minimum yield parameters were noted with control (0 % NP). Maximum test weight and protein content was also found with integration of chemical, organic and bio fertilizers treatment (i.e. 75% NP + Seed treatment by *Azoto* + PSB + 5t VC/ha) which was at par with 75% NP + 5t VC/ha treatment.

Keywords: Bio-fertilizers, Pearl millet, Foliar application, Nitrogen, Phosphorus Vermicompost

Formatted: Font: Bold

INTRODUCTION :

Comment [NP2]: Why is the investigation of the effect of vermicompost and other treatments not used in the findings of other researchers in the introduction? Should be added the newest some study.

High yielding and short duration varieties of hybrid Pearl millet are available in the market as well as MSP of pearl millet was increase 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 these areas 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. 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 efficiency 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) on yield and quality of hybrid pearl millet grown in Inceptosols.

Comment [NP3]: Please correct in all manuscript.

METHOD AND MATERIALS:

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. Under study 12 treatments namely T₁: 0% NP, T₂: 50% NP, T₃: 75% NP, T₄: 100% NP, T₅: T₂+ 1% Foliar spray of 17 :44:0 at 30-35 DAS, T₆: 75% NP+ 1% Foliar spray of 17 :44:0 at 30-35 DAS, T₇: T₂+ 5t VC/ha, T₈: T₃+ 5t VC/ha, T₉: T₂+ Seed treatment by *Azoto* + PSB, T₁₀: T₃+ Seed treatment by *Azoto* + PSB, T₁₁: T₂+ Seed treatment by *Azoto* + PSB+ 5t VC/ha and T₁₂: T₃+ Seed treatment by *Azoto* + PSB+ 5t VC/ha were replicated thrice under Randomized Block Design. The experimental soil was alluvial and Vermicompost is obtained from what source? sandy clay loam in nature having pH 7.76, organic carbon 0.406% and available N,P, & and K were 177.5, 11.84 & and 202.4 kg ha⁻¹, respectively. The hybrid pearl millet were sown on the first fortnight of July in both the years. Vermicompost (1.68 % N, 0.85 % P, 0.83 % K and 12.4:1 C: N ration) was mixed @5 tonnes ha⁻¹ in soil at the time of field preparation as per treatment. and *Azotobacter* and PSB were added by seed treatment at the time of sowing. The optimum dose of fertilizer (100% NPK) for pearl millet were applied 80:40:20 N: P₂O₅: K₂O kg ha⁻¹. In all treatments recommended dose of potassium were applied as basal through muriate of potash and half(50 %) of nitrogen and entire dose of

Comment [NP4]: Since the activity of microorganisms in the soil is affected by temperature, it is suggested to add a month temperature chart in the of planting times.

Comment [NP5]: what is the source of vermicompost?

Comment [NP6]: It is suggested that the physicochemical characteristics of soil and vermicompost are listed in Table.

P₂O₅ through urea and di-ammonium phosphate were also applied at the time of sowing as per treatments and remaining 50 per cent of nitrogen was top dressed through urea at 30 -35 days after sowing. Weed removal by hands weeding and the required plant population was maintained. Harvesting of crop was done at maturity and proper drying of grain; this was followed by recording of grain and stover yield. Growth and yield attributes parameters were also recorded during the time being of investigation. The ground grain and stover samples were digested with di-acid mixture of nitric-perchloric (9:4) for the analysis of phosphorus. Nitrogen was determined by KEL PLUS nitrogen estimation system and phosphorus by vanadomolybdate yellow colour method (Jackson, 1973). The uptake of nutrients was calculated with their content and yields of respective parts of pearl millet. The data processing for various parameters was analyzed using proper statistically methods using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at 5 per cent level of significance.

RESULT AND DISCUSSION:

Growth and yield attributes parameters

Among the different sources and methods application for nitrogen and phosphorus, applying of 75% NP+Azotobacter+PSB +vermicompost 5 t/ha resulted in significantly maximum plant height and yield attributes parameters i.e. length and girth of cob (cm) and test weight of pearl millet which was significantly higher over 100% NP treatments. Thus there was saving of 25% of recommended dose of nitrogen and phosphorus with the application of organic and bio fertilizers. This is evident from 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 same level of chemical fertilizer applied treatments. Further seed treatment with bio fertilizers (*Azotobacter* and PSB) along with vermicompost applied treatment recorded maximum value of these parameters. The basic fact is that 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 development of new shoots that have ultimately increased the plant height and dry matter accumulation. The results of present investigation are in conformity with those of Narolia *et al.*, (2009) and Chaudhary *et al.* (2015) in pearl millet. Minimum values of

Comment [NP7]: It should be written officially and internationally in all manuscript: ton ha⁻¹

Comment [NP8]: Its true but need to references!

Comment [NP9]: Replaces by newest References.

growth and yield attributes parameters were noted with control treatment for nitrogen and phosphorus nutrients (0% NP).

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 increase in NP levels from 50 to 100 percent significantly 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 vermicompost) 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 value of these yield parameters. This may be attributed to 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 (i.e. 75% NP + *Azotobacter* + PSB + vermicompost 5 t / ha treatment) which was significantly higher over 100% NP as well as all 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 fact that integration of nutrients gave adequate supply of nutrients throughout the entire growth period which resulted into better growth and yield attributing characters. The better growth of crop 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.*, (2014) and Divya *et al.*, (2017) in pearl millet.

Quality parameters:

Nutrient uptake by pearl millet

Comment [NP10]: : ton ha⁻¹vermicompost.
Kindly replaces in all manuscript

Comment [NP11]: Surly but need to references!

Among the different sources and methods application for nitrogen and phosphorus, applying of 75% NP + *Azotobacter* + PSB + vermicompost 5 t/ha observed significantly increased the grain, stover and total nitrogen and phosphorus uptake by pearl millet (Table 2). Application of 75% NP + 5 ton ha^{-1} 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 cereal crop, pearl millet required nutrients throughout the growing season. The results obtained in the present investigation are in close conformity with the finding of Rathore *et al.*, (2006), Narolia and Poonia (2011).

Formatted: Superscript

Protein content and protein yield

It is revealed from result (Table-2) that under different sources and methods application for nitrogen and phosphorus protein content was recorded in the range of 7.92 to 10.34 % whereas protein yield were 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.* (2020) also confirmed that, balanced use of organic and inorganic fertilizers provides 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 rest of all other treatments due to significantly highest grain yield in this treatment. This might be the integrated nutrient applied treatments have resulted in 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 cumulative effect of organic sources combined with inorganic source of nutrients, which enhanced the yield attributes

Comment [NP12]: What does it mean?

Comment [NP13]: standard model

Comment [NP14]: The standard model should be observed in all manuscript.

and yield. The results of present investigation are in conformity with those of Patidar and Mali (2004) and Hashim *et al.* (2015).

Comment [NP15]: Any references?

Conclusion

From present study, It could be concluded that application of vermicompost@ 5 tonnes/ha¹ 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.

Comment [NP16]: What is it?

Formatted: Superscript

References

Bangre, J., Dwivedi, A.K., Mohanty, M., Sinha, N.K., Dwivedi, B.S., Yadav, T.C. and Chaubey, D. (2020). Effect of long-term application of inorganic and organic sources of nutrients on productivity and quality of wheat in a Vertisol. *Journal of Soil and Water Conservation* **19**(3): 322–327.

Choudhary, R., Yadav, L. R. and Parihar, S. (2015). Effect of vermicompost and fertility levels on growth and yield of pearl millet (*Pennisetum glaucum* L.). *Annals of Arid Zone*, 54(1&2): 59-61.

Comment [NP17]: This references is absent in the manuscript!!

Divya, G., Vani, K. P., Babu, P. S. and Suneetha Devi, K. B. (2017). Yield attributes and yield of summer pearl millet as influenced by cultivars and integrated nutrient management. *International Journal of Current Microbiology and Applied Sciences*, 6(10): 1491-1495.

Hashim, M., Dhar, S., Vyas, A.K., Pramesh, V. and Kumar, B. (2015). Integrated nutrient management in maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy* **60**(3): 352–359.

Jackson, M.L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd, New Delhi

Jadhav, R. P., Khafi, H. R. and Raj, A. D. (2011). Effect of nitrogen and vermicompost on protein content and nutrients uptake in pearl millet (*Pennisetum glaucum*(L.) R. Br. Emend stuntz.). *Agricultural Science Digest*, 31 (4): 319-321

Comment [NP18]: I couldn't find this reference in the manuscript!!

Narolia, R. S. and Poonia, B. L. (2011). Growth dynamics, yield and economics of pearl millet (*Pennisetum glaucum*) as influenced by vermicompost and fertilizers. *Annals of Arid Zone*, 50(2): 145-149.

Narolia, R. S., Poonia, B. L. and Yadav, R. S. (2009). Effect of vermicompost and inorganic fertilizers on productivity of pearl millet (*Pennisetum glaucum*). *Indian Journal of Agriculture Science*, 79: 506-509.

Patidar, M. and Mali, A. L. (2004). Effect of farmyard manure, fertility levels and bio-fertilizers on growth, yield and quality of sorghum (*Sorghum bicolor*). *Indian Journal of Agronomy*, 49(2): 117-120.

Rathore, V. S., Singh, P. and Gautam, R. C. (2006). Productivity and water-use efficiency of rainfed pearl millet (*Pennisetum glaucum*) as influenced by planting patterns and integrated nutrient management. *Indian Journal of Agronomy*, 51(1): 46-48.

Rinku, Shekhawat, P. S., Kumawat, N., Rathore, P. S., Yadav, P. K. and Om, H. (2014).Effect of nitrogen levels and biofertilizers on growth and yield of pearl millet (*Pennisetum glaucum* L.) under north western Rajasthan. *Ann. Agric. Res. New Series*, 35 (3): 311-314.

UNDER PEER REVIEW

Table 1: Yield attributes and yield parameters of pearl millet 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 <i>Azoto</i> + PSB	191.84	24.22	4.87	9.69	22.02	27.70
T ₁₀	T ₃ + Seed treatment by <i>Azoto</i> + PSB	201.94	24.94	5.03	9.82	24.35	29.26
T ₁₁	T ₂ + Seed treatment by <i>Azoto</i> + PSB + 5t VC/ha	213.63	26.57	5.18	10.23	27.78	30.91
T ₁₂	T ₃ + Seed treatment by <i>Azoto</i> + 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

Comment [NP19]: If present the biomass in table, its more comprehensive?

Table 2: Uptake and quality parameters of pearl Millet 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

Comment [NP20]: Nitrogen is a building block of proteins. Therefore, the amount of protein is more than nitrogen. How do you evaluate this finding from the point of view of plant physiology?