

Yield and Nutrient Uptake of pearl millet (*Pennisetum glaucum*) as affected by Integrated Nutrient Management Strategies

Abstract

The present study was carried out at Research Farm, Department of Soil Science, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, during the Kharif season 2022 and 2023 to study the effect of integrated nutrient management on yield and nutrient uptake by pearl millet and impact on soil properties in grid region of Madhya Pradesh. The twelve treatment combinations with three replications of integrated nutrient management were used for the existing study. The data revealed that the test weight and harvest index were found to be non-significant with various treatments of integrated nutrient management. The significantly higher biological yield (8026 kg/ha) and total nitrogen uptake (89.84 kg/ha), total phosphorus uptake (17.90 kg/ha), and total potassium uptake (111.50 kg/ha) were registered under T₁₂-100% NPK + FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} than rest of the treatments. The pH and electrical conductivity were found to be non-significant. However, organic carbon was found to be significant, while significantly higher organic carbon was obtained under T₁₂-100% NPK + FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} among all the treatments. Therefore, it was concluded that treatment 100% NPK + FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)} was found superior among all the treatments as well as maintaining the soil health and productivity.

Key words: Azotobacter, FYM, Long-term, Physico-chemical properties

Introduction

Pearl millet (*Pennisetum glaucum*) is commonly known as Bajra, Bajri, Sajje, Kambu, Kamban, Sajjalu, etc., in various Indian local languages and is commonly used for food, feed, and forage. It is the most widely grown millet, and it is one of the important millet crops in hot and dry areas with arid and semi-arid climatic conditions, particularly in Rajasthan. Pearl millet belongs to the family Gramineae or Poaceae. The inflorescence of pearl millet is known as spike. It is a highly cross-pollinated crop due to protogynous habit and C₄ plant, and it has very high photosynthetic efficiency and dry matter production capacity. Pearl millet originated in tropical Western Africa about 4000 years ago. India is the largest producer of

pearl millet among all the states and UTs: Rajasthan (46%), Maharashtra (19%), Gujarat (11%), Uttar Pradesh (8%) and Haryana (6%) (Amarghade and 2021) were among top pearl millet producing states.

In India, pearl millet is a primary source of dietary energy (360 kcal/kg) for rural populations and the fourth most important cereal after rice, wheat, and sorghum (Tomar *et al.* 2013). It is a rich source of protein, calcium, phosphorous, and iron. Pearl millet grain contains fairly high amounts of thiamine, riboflavin, and niacin. Pearl millet grain is also used for non-food purposes such as poultry feed, cattle feed, and alcohol extraction (Mohan and Singh 2022). The productivity of pearl millet is very low as compared to important pearl millet-growing countries in the world. It is, therefore, necessary to increase the production and productivity of pearl millet by adopting scientific innovations (Thumare *et al.* 2016).

An integrated nutrient supply system comprising biofertilizers, organic manures and FYM in conjunction with chemical fertilizers is necessary to meet the crop nutrient demand. In the research problem, various organic like FYM and seed treatment with PSB and Rhizobium and inorganic nutrient sources like nitrogen, phosphorus, potassium, sulphur, zinc, and ferrous-containing fertilizer were used. Long-term application of inorganic fertilizers depletes the physical, chemical, and biological qualities of soil and pollutes the environment when combined with organic additions (Singh *et al.* 2013). In addition to providing the soil with nutrients and organic matter, organic manures also influence the soil's structure, turnover of nutrients, biodiversity, and activity of the microbial population, among many other changes pertaining to the physical, chemical, and biological characteristics of the soil. The physicochemical qualities of soils can be enhanced by the use of organic manures alone or in conjunction with chemical fertilizers (Parsad 2010). A judicious combination of chemical fertilizers, organic manures, and bio-fertilizers should be formulated for crops and cropping systems within the ecological, social, and economic possibilities (Arya *et al.* 2022).

Since information pertaining to the above aspects is meager, the present investigation was carried out to study the effect of integrated nutrient management (INM) on nutrient uptake, productivity, and soil sustainability to enhance the fertility and productivity of the soil.

Materials and methods

The present investigation is a part of an on-going long-term field experiment of integrated nutrient management on pearl millet. The experiment was initiated in 2002 on

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permanent plots with latitude of 26° 13'N and longitude 76° 10'E with an altitude 197 meters. The climate of experimental site is semi-arid and subtropical with extreme weather conditions having hot and dry summer and cold winter, where maximum temperature goes up to 45 °C during summer and minimum as low as 2.80 °C. The mean annual rainfall of area is 700-800 mm. The soil of the experimental field is alluvial, sandy clay loam in texture and classified as Typic Ustochreptsat great group level as comes under Inceptisols. The experiment was laid out with randomized block design having three replications comprising of 12 treatments, viz T₁-Absolute Control, T₂-100% N, T₃-100% NP, T₄-100% NPK, T₅-100% NPK + 25 kg ZnSO₄/ha/yr, T₆-100% NPK + 50 Kg FeSO₄/ha/yr, T₇-100% NPK + FeSO₄ + ZnSO₄, T₈-100% NPK + 1% (FeSO₄ + ZnSO₄ Spray), T₉-50% NPK + FYM @ 10t/ha/yr, T₁₀-75% NPK + FYM @ 10t/ha/yr, T₁₁-100% NPK+ FYM @ 10t/ha/yr and T₁₂-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}, respectively.

The recommended dose of fertilizer for pearl millet was 80 N + 40 P₂ O₅ + 20 K₂O kg/ha. Half of the nitrogen was applied in the form of urea as a basal dose and remaining was top dressed after 1st irrigation at 30 DAS. Full dose of phosphorus and potash applied as basal through single super phosphate and muriate of potash. The treatments applied as per treatment details and FYM was applied 1 month before sowing. The azotobacter was applied as seed treatment at the rate of 10g/ kg seed. The JBV-3, cultivar was sown 5 kg/ha seed rate during July month and harvested in second week of October. The pH, EC and OC content in soil before sowing were 7.72, 0.23 dSm⁻¹, and 0.39 % respectively.

Results and Discussion

The data furnished (Table 1) that the test weight and harvest index found non-significantly effect of treatment in both years. The data showed that the pooled mean found significantly higher biological yield (Table 1) (8026 kg/ha) was recorded with treatment T₁₂-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment)}, closely followed by T₁₁-100% NPK+ FYM @ 10t/ha/yr and T₁₀-75% NPK + FYM @ 10t/ha/yr (7380 and 6702 kg/ha). The minimum biological yield was recorded with control treatment (2987 kg/ha). The application of the organic and inorganic nutrient sources including 100% NPK + FYM + PSB+ Azotobacter (Seed treatment) provided balanced nutrients to the pearl millet which resulted into significantly enhance in biological yield. Similar result also reported by Abraham *et al.*, (2007), Devi *et al.*, (2011), Ram and Dhaliwal (2012), Kumar *et al.*, (2014) and Susmitha *et al.* 2022.

The data obtained that total nitrogen uptake (Table 2) significantly higher the pooled mean was recorded with T₁₂-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment) (89.84 kg/ha), closely followed by T₁₁-100% NPK+ FYM @ 10t/ha/yr and T₁₀-75% NPK + FYM @ 10t/ha/yr (78.39 and 67.41 kg/ha). The minimum total nitrogen uptake was recorded with control treatment (20.87 kg/ha).This might due to addition of FYM enhanced significantly total nitrogen uptake by the crop. More uptake of N under the treatment with FYM resulted in mineralized N from FYM could meet the need of nutrient of crop. The outcome is turned with findings by Dahiya *et al.* (1987) and Singh *et al.* (1994).The data obtained that pooled mean of total phosphorus uptake (Table 2) maximum recorded with T₁₂-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment) (17.90 kg/ha), closely followed by T₁₁-100% NPK+ FYM @ 10t/ha/yr and T₁₀-75% NPK + FYM @ 10t/ha/yr (15.97 and 13.25 kg/ha). The minimum total phosphorus uptake was recorded with control treatment (4.05 kg/ha).This might due to higher availability of P from applied FYM resulting the decomposing the organic materials which produced from the solubilizing action of organic acid. The data obtained that pooled mean of total potassium uptake (Table 2) maximum recorded with T₁₂-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment) (111.50 kg/ha), closely followed by T₁₁-100% NPK+ FYM @ 10t/ha/yr and T₁₀-75% NPK + FYM @ 10t/ha/yr (100.07 and 87.40 kg/ha). The minimum total potassium uptake was recorded with control treatment (30.27 kg/ha). These results also confirmed by Ramdas *et al.*, (2016), Choudhary *et al.*, (2017), Yadavetal.,(2018) and Sunaget *et al.*, (2021).

The data furnished (Table 3) that the soil pH and electrical conductivity found non-significantly effect of treatment in both years. The data presented that the pooled mean found significantly higher (Table 3) organic carbonrecorded with T₁₂-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment) (0.408 %), it was at par with T₁₁-100% NPK+ FYM @ 10t/ha/yr (0.405 %). The minimum organic carbon recorded with control treatment with (0.373 %).The organic carbon content of the soil due to application of Farm Yard Manure might be due to the deposition of organic matter in the soil in the crop residues and directly addition of OM through FYM along with inorganic fertilizer. Similar concluded by Kumar *et al.* 2012,Rao *et al.*, (2021), Bairwa *et al.*, (2021) and Kalaliyaet *et al.*, (2022).

Table 1. Effect of integrated nutrient management on yield attributes and yield of pearl millet

Treatments	Test weight (g)			Harvest index (%)			Biological yield (kg/ha)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T ₁	7.46	7.45	7.46	30.69	29.78	30.24	2917	3056	2987
T ₂	7.52	7.50	7.51	31.22	30.71	30.96	3574	3623	3599
T ₃	7.54	7.53	7.54	31.27	30.58	30.92	4431	4575	4503
T ₄	7.58	7.62	7.60	28.65	28.45	28.55	5324	5486	5405
T ₅	7.62	7.61	7.62	28.11	28.54	28.32	5534	5496	5515
T ₆	7.60	7.60	7.60	28.58	28.27	28.43	5353	5466	5409
T ₇	7.63	7.62	7.63	28.78	28.76	28.77	5596	5637	5617
T ₈	7.61	7.60	7.61	28.42	28.40	28.41	5189	5478	5334
T ₉	7.65	7.66	7.66	27.78	27.53	27.65	6049	6093	6071
T ₁₀	7.69	7.72	7.71	28.26	27.57	27.91	6549	6856	6702
T ₁₁	7.50	7.52	7.51	29.14	29.64	29.39	7362	7398	7380
T ₁₂	7.50	7.50	7.50	29.45	29.27	29.36	7988	8064	8026
S. Em. (±)	0.319	0.343	0.234	1.275	1.192	0.873	213.86	245.46	162.78
CD (0.05%)	NS	NS	NS	NS	NS	NS	627.24	719.93	463.95

Table 2. Effect of integrated nutrient management on total uptake by pearl millet

Treatments	Total nitrogen uptake (kg/ha)			Total phosphorus uptake (kg/ha)			Total potassium uptake (kg/ha)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T ₁	20.47	21.26	20.87	3.34	4.77	4.05	30.52	30.02	30.27
T ₂	30.92	31.34	31.13	4.74	6.40	5.57	39.15	39.74	39.45
T ₃	38.83	39.97	39.40	7.60	9.98	8.79	48.96	50.71	49.84
T ₄	47.99	48.86	48.43	8.74	12.13	10.44	66.06	67.56	66.81
T ₅	49.62	49.61	49.62	8.87	12.24	10.56	69.22	68.45	68.84
T ₆	49.74	50.21	49.98	9.00	12.30	10.65	66.50	68.24	67.37
T ₇	52.14	53.67	52.91	9.57	13.14	11.36	70.34	70.87	70.61
T ₈	49.58	49.95	49.77	8.99	12.35	10.67	68.47	76.47	72.47
T ₉	57.31	57.86	57.58	9.24	12.94	11.09	74.69	78.06	76.37
T ₁₀	66.13	68.69	67.41	11.12	15.38	13.25	85.02	89.77	87.40
T ₁₁	78.05	78.73	78.39	13.41	18.52	15.97	99.92	100.21	100.07
T ₁₂	89.53	90.14	89.84	15.13	20.66	17.90	110.68	112.31	111.50
S. Em. (\pm)	1.52	1.73	1.15	0.23	0.42	0.24	1.60	1.78	1.20
CD (0.05%)	4.46	5.09	3.29	0.69	1.23	0.68	4.69	5.21	3.41

Table 3. Effect of integrated nutrient management on pH, Electrical conductivity and Organic carbon in soil after harvest of pearl millet

Treatments	Soil pH			Electrical conductivity (dSm ⁻¹)			Organic carbon (%)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T ₁	7.70	7.70	7.70	0.119	0.117	0.118	0.372	0.373	0.373
T ₂	7.60	7.60	7.60	0.119	0.118	0.119	0.375	0.378	0.376
T ₃	7.60	7.60	7.60	0.121	0.120	0.121	0.378	0.376	0.377
T ₄	7.60	7.60	7.60	0.123	0.123	0.123	0.389	0.390	0.390
T ₅	7.60	7.60	7.60	0.125	0.125	0.125	0.390	0.391	0.390
T ₆	7.60	7.60	7.60	0.125	0.126	0.126	0.389	0.390	0.390
T ₇	7.60	7.60	7.60	0.126	0.126	0.126	0.391	0.392	0.392
T ₈	7.60	7.60	7.60	0.123	0.123	0.123	0.388	0.389	0.389
T ₉	7.60	7.50	7.55	0.126	0.125	0.126	0.392	0.394	0.393
T ₁₀	7.50	7.50	7.50	0.125	0.125	0.125	0.395	0.397	0.396
T ₁₁	7.50	7.50	7.50	0.124	0.124	0.124	0.405	0.404	0.405
T ₁₂	7.50	7.50	7.50	0.124	0.123	0.124	0.407	0.409	0.408
S. Em. (±)	0.212	0.204	0.147	0.003	0.003	0.002	0.005	0.005	0.003
CD (0.05%)	NS	NS	NS	NS	NS	NS	0.014	0.014	0.009

Conclusion

On the basis of these findings, it was concluded that treatment T₁₂-100% NPK +FYM @ 10 t/ha/yr + {PSB+ Azotobacter (Seed treatment) found best among remaining treatment. This research showed the highest yield was obtained and a significantly impact on soil properties as prospective to soil fertility.

Reference

- Abraham, T., Thenua, O.V.S., Singh, S.P. and Jacob, P. (2008). Performance of groundnut as influenced by organic and inorganic sources of nutrients and their method of application. *Legume Research*. 31: 224-226.
- Amarghade and Singh R. (2021) Effect of inorganic and organic nutrient sources on growth and yield of pearl millet (*Pennisetum glaucum* L.). *The Pharma Innovation Journal*. **10**(10):507-509.
- Arya, V., Trivedi, S. K., Tomar, P. S., Singh, M., & Dhakad, H. (2022). Effect of Integrated Nutrient Management (INM) on physico-chemical Properties of Soils under Pearl Millet-mustard Cropping Sequence in Typic Ustochrepts. *International Journal of Plant & Soil Science*, **34**(19), 183-193.
- Bairwa, J., Dwivedi, B.S., Rawat, A., Thakur, R.K. and Mahawar, Neeta (2021). Long-Term Effect of Nutrient Management on Soil Microbial Properties and Nitrogen Fixation in a Vertisol under Soybean- Wheat Cropping Sequence. *Journal of the Indian Society of Soil Science*. Vol. 69, No. 2, pp 171-178.
- Choudhary, K., Sharma, S. R., Jat, R. and Didal, V. K. (2017). Effect of organic manures and mineral nutrients on quality parameters and economics of sesame (*Sesamum indicum* L.). *Journal of Pharmacognosy and Phytochemistry*. **6**(3): 263-265.
- Dahiya, S. S., Goyal, S., Antil, R. S. and Karwasra, S. P. S. (1987). Effect of farm yard manure and cadmium on dry matter yield and nutrient uptake by maize. *J. Ind. Soc. Soil. Sci.*, 35:460-464
- Devi, K. N., Singh, M. S., Singh, N. G. and Athokpam, S. (2011). Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.). *Journal of Crop and Weed*, **7**(2): 23-27.
- Kalaliya, A., Sharma, S. K. and Kamboj, B.R. (2022). Effect of nutrient management on growth, yield attributing characters, yield and economics of rainfed pearl millet [*Pennisetum glaucum* (L) R.Br.]. *The Pharma Innovation Journal*. **11**(7): 290-294.
- Kumar, Pradeep., Singh, Rakesh., Singh, Archana., Paliwal, Dinesh and Kumar, Sushil (2014). Integrated nutrient management in pearl millet (*Pennisetum glaucum*) – wheat

(*Triticum aestivum*) cropping sequence in semi arid condition of India. *Internat. J. agric. Sci.* **10** (1): 96-101.

Kumar, S., Dahiya, R., Kumar, P., Jhorar, B. S. and Phogat, V.K. (2012). Long Term effect of organic materials and fertilizers on soil properties in pearl millet - wheat cropping system. *Ind. J. Agric. Sci.* **46**(2): 161-166.

Mohan N and Singh S. (2022) Effect of organic manures and sources of sulphur on growth and yield of kharif pearl millet (*Pennisetum glaucum* L.). *The Pharma Innovation Journal.* **11**(3):2257-61.

Prasad, J.; Karmakar, S.; Kumar, R. and Mishra, B. (2010). Influence of integrated nutrient management on yield and soil properties in maize-wheat cropping system in an Alfisol of Jharkhand. *Journal of the Indian Society of Soil Science* **58**(2): 200-204.

Ram, Hari and Dhaliwal, S.S. (2012). Effect of varieties and integrated nutrient management techniques on growth, productivity, quality and economics of barley (*Hordeum vulgare* L.) *International Journal of Agricultural Sciences.* **8**(1) 91-97.

Ramdas, M. G., Manjunath B. L., Singh, N. P., Ramesh, R., Verma, R. R., Latare, A. M., Ruenna, D'Souza; Barnes, N. and Kulkarni, R (2016) Effect of organic and inorganic sources of nutrients on soil microbial activity and soil organic carbon build-up under rice in west coast of India. *Archivers of Agronomy and Soil Science.*

Rao, P. M., Sagar, V., Suresh, K., Padmaja, G. and Reddy, S. N. (2021). Influence of organic and inorganic sources of nitrogen on nutrient uptake and yield of maize in maize-mustard cropping system in Northren Telangana zone. *The Pharma Innovation Journal* **10** (10): 1351-1357.

Singh, R., Gupta, A. K., Ram, T., Choudhary, G. L., & Sheoran, A. C. (2013). Effect of integrated nitrogen management on transplanted pearlmillet (*Pennisetum glaucum*) under rainfed condition. *Indian Journal of Agronomy*, **58**(1), 81-85.

Singh, Vinay, Kumar, R. and Ram Lakhan. (1994). Effect of applied farmyard manure and molybdenum on yield and nutrient uptake by Egyptian clover. *Ind. J. Agron.*, **39** (3): 307-309.

- Sunag, M.N., Singh, R. M., Singh, V. and Singh, K. (2021). Effect of integrated nutrient management on the performance of barley (*Hordeum vulgare* L.). *The Pharma Innovation Journal*. **10**(9): 1492-1496.
- Susmitha, Kali, C. Umesha, and Shahazad Ahmed Khan. 2022. "Effect of Biofertilizer and Organic Manure on Growth and Yield of Pearl Millet (*Pennisetum Glaucum* L.)". *International Journal of Environment and Climate Change*, **12**(10):425-31. <https://doi.org/10.9734/ijecc/2022/v12i1030815>.
- Thumar, C. M., Dhdhat, M. S., Chaudhari, N. N., Hadiya, N. J., & Ahir, N. B. (2016). Growth, yield attributes, yield and economics of summer pearl millet (*Pennisetum glaucum* L.) as influenced by integrated nutrient management. *International Journal of Agriculture Sciences*, ISSN, 0975-3710.
- Tomar, P. S., Verma, S. K., Gupta, N., & Bansal, K. N. (2018). Effect of long-term integrated nutrient management on productivity of pearl millet (*Pennisetum glaucum*)-mustard (*Brassica juncea*) cropping system and soil fertility in an Inceptisol. *Journal of the Indian Society of Soil Science*, **66**(3), 295-299.
- Yadav, L.C., Yadav L.R., Yadav Nagesh and Yadav Mamta. (2018). Effect of organic sources of nitrogen fertilization on yield and yield attributes pearl millet [*Pennisetum glaucum* (L.) R. BR. emend stuntz]. *International Journal of Chemical Studies*. **6**(3): 2329-2331.