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Effect of Integrated Nutrient Management on Yield, Uptake and Soil Properties of Pearl Millet (*Pennisetum glaucum* L.) in Alluvial Soil of Gird Region of Madhya Pradesh

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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

Aims: Effect of Integrated nutrient management onyield, uptake and soil properties of pearl millet (*Pennisetum glaucum* L.) in alluvial soil of Gird region of Madhya Pradesh.
Study Design: Randomized block design.
Place and Duration of Study: Department of Soil Science and Agricultural Chemistry, R.V.S.K.V.V., CoA, Gwalior, Districts of Madhya Pradesh during *kharif,* 2022.
Methodology: There were 12 treatments T_1 – Control, T_2 -50% NPK, T_3-75% NPK, T_4-100% NPK, T_5- 150% NPK, T_6-100% NPK-S, T_7-100% NPK $ZnSO_4$, T_8 -100% NPK + $FeSO_4$, T_9-50% NPK + FYM, T_{10} -75% NPK + FYM, T_{11} -100% NPK + FYM and T_{12}-100% NPK + FYM + {PSB+

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Azotobacter (Seed treatment)} and were replicated thrice under RBD and were statistically analyzed by the Fishher the analysis of variance technique was adopted as suggested by Panse and Sukhatme (1984) for Randomized Block Design. The pH , EC, OC, N, P, K and S content before creation of treatments were 7.72, 0.23 dSm^{-1}, 0.39 %, 170 $kgha^{-1}$, 12.04 kg ha^{-1} and 180 kg ha^{-1} respectively.

Results: The results indicated that yield, uptake of nutrients and soil properties pH, EC, OC, Available Nitrogen, Phosphorus, Potassium and Sulphur were found highest in the treatment T_{12}- 100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)} and was found lowest in the treatment T_1 – Control.

Conclusion: Based on experimental findings it can be concluded that application of100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)} is beneficial in terms of yield, uptake of nutrients and Soil chemical properties pearl millet.

Keywords: Integrated nutrient; yield; uptake; soil properties and alluvial soil.

1. INTRODUCTION

"The dramatic increase in worldwide agricultural production per unit area significantly reduced starvation rates in the developing world and enhanced the global food supply" [1]. "During recent intensive farming systems, chemical fertilizers (consisting of N, P and K) are applied excessively to provide the nutrients for plants for increasing agricultural productivity. However, injudicious use of these fertilizers has caused pollution problems leading to public health hazards. Moreover, use of chemical fertilizers alone was not efficient in improving the nutrient status of soil" [2] and integrated nutrient management system was found more appropriate to enhance soil fertility and plant growth. During last decades in India, it has been widely acknowledged that system oriented production research is needed to be strengthened as it is essential for maximizing land production per unit area, by harnessing synergies generated through microbial interactions in soil-crop-weather systems.

"Pearl millet [*Pennisetum glaucum* (L.)] is one of the vital cropping systems of our country, which is spread over arid and semi-arid regions. During the last five decades, consumption of chemical fertilizers (NPK) has increased phenomenally from 0.07 mt in 1950-51 to 25.95 mt in 2021-22" (Anonymous, 2021). With the application of recommended doses of fertilizers, the yield potential of cereal-cereal cropping system has reached to a plateau. Moreover, application of excessive fertilizers has deteriorated soil health and especially organic matter has depleted.

"For obtaining optimum crop production fertility of soil is very important but the absence of organic matter from soil results in unproductive soil. To supply essential plant nutrients in adequate amounts, huge quantity of organic material is needed. Slow release of plant nutrients after decomposition from organic material has been reported to promote crop growth" [3]. Organic sources when applied to preceding crop, leaves the residual effect and this benefit is harvested by the succeeding crop and system becomes sustainable through integrated use of crop residues, chemical fertilizers, green manure and FYM (farm yard manure) as a source of nutrients.

2. MATERIALS AND METHODS

The field experiment was conducted during *kharif*, 2022-23 at the research farm of the Department of Soil Science and Agricultural Chemistry, College of Agriculture, R.V.S. K.V.V., Gwalior. There were 12 treatmentsT_1 – Control, T_2 -50% NPK, T_3-75% NPK, T_4 -100% NPK, T_5 - 150% NPK, T_6 -100% NPK-S, T_7 -100% NPK $ZnSO_4$, T_8 -100% NPK + $FeSO_4$, T_9 -50% NPK + Farm Yard Manure, T_{10} -75% NPK + FYM, T_{11} - 100% NPK + FYM and T_{12}-100% NPK + FYM + {PSB+ *Azotobacter* were applied through Seed treatment)} and were replicated thrice under Randomized Block Design. There recommended fertilizer dose for pearl millet as per the treatments were applied (80:40:20 N, P_2O_5 and K_2Okgha^{-1},respectively) through urea, di-ammonium phosphate, SSP and muriate of potash. In all, 50 per cent of nitrogen andentire dose of P_2O_5 and K_2O was applied at the time of sowing and remaining 50 percent of nitrogen was top dressed in the form of urea for pearl millet at 30 days aftersowing. In treatment 100 % NPK, phosphorus was addedthrough SSP. Only T6-100% NPK-S phosphorus source was DAP to make it sulphur free treatment. As per treatment FYM was added @10 tonnes ha^{-1} yr^{-1} before

sowing of crop. Azotobacter and PSB were added in soil by seed treatment at the time of sowing. The investigation entitled study the "Effect of Integrated nutrient management on yield, uptake and soil properties of pearlmillet (*Pennisetum glaucum* L.) in alluvial soil of Gird region of Madhya Pradesh. The pH , EC, OC, N, P, and K content in soil before creation of treatments were 7.72, 0.23 dSm^{-1}, 0.39 %, 170 kg ha^{-1}, 12.04 kg ha^{-1} and 180 kg ha^{-1} respectively. The observations were recorded during course of study including the yield at harvesting, uptake of nutrients after harvest of sample, pH, EC, OC, available N, P, K and S after harvesting of crop samples were collected from soil. The collected data for various parameters were statistically analyzed using Fisher's analysis of variance (ANOVA) technique and the treatments were compared at 5 per cent level of significance.

3. RESULTS AND DISCUSSION

The data presented investigation revealed that the highest grain yield 2353.33 $kgha^{-1}$was obtained under the application of T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) which was found highly significant over other treatment. The treatment recorded 37.08 and 37.96 % increased in the grain yield over control. The significantly higher grain yield of 2349.0 $kgha^{-1}$ was recorded with application of (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) which was 37.52 % and 65.34 % higher than T_1 (Control) and T_4 (100% NPK) respectively. Application of various combination of treatment significantly increased straw yield over T_1 (Control). The maximum straw yield 5724.67 $kgha^{-1}$ was obtained with treatment T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) which was found to be significantly higher over rest of the other treatment. The treatment recorded 35.89 % increased in the straw yield over control. The application of the organic and inorganic nutrient sources including 100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) provided balanced nutrients to the pearlmillet which resulted into significantly enhance in grain and straw yield. The outcomes showed conformity with Karforma et al. [4], Husain et al. [5], Jat et al. [6] and Verma [7].

It is evident from the Table 2 that the application of T_{12} (100% NPK + FYM + {PSB+ Azotobacter (Seed treatment)}) obtained highest uptake of Nutrients by pearlmillet grain and straw which was significant than the remaining treatments. However, addition of FYM enhanced significantly the Nutrients uptake by the crop. More uptake of Nutrients with FYM addition are more likely the outcomes of favourable effect of FYM on Nutrients by pearlmillet crop might be due to attribution of more availability of Nutrients from addition of FYM. More uptake of Nutrient under the treatments with FYM resultant in mineralized Nutrients from FYM could meet the need of nutrients of crop. The outcomes are tuned with findings by Dahiya et al. [8] and Singh et al. [9]. Mishustin and Petrova [10] recorded that the raised uptake of Nutrients with Azotobacter inoculation.

From the data presented in the Table 3 it can be revealed that the maximum in organic carbon content of soil was indicated in the treatment T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) 0.407 % which was found non significant than T_{11} (100% NPK+ FYM) 0.405%. It might be due to consistent increase in yields leads by the application of this treatment. The application of FYM and seed inoculation with *Azotobacter* and PSB were the reason of increasing the organic carbon content in comparision with the application of NPK alone. Similar results were reported by kumar [11], Prakash et al. [12], Bhattacharya et al. [13].

The available N values of different soil layers as impacted by continuous application of various treatmentsare represented in Table 3. On further study of data, the maximum value of available N was recorded in the treatment T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) 184.11 $kgha^{-1}$ which was found significant over other treatment although found at par with the treatment T_{11} (100% NPK + FYM), 179.93. The results showed with the findings of Singh et al. [14]. Application of the treatment T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) in comparison with the treatment NPK applied alone.

Maximum available P was noticed in T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) 15.19 $kgha^{-1}$ which was found significant than other treatments. It was also recorded that significant increases had occurred with the increases in level of fertilizer application in soil. Results are lined with the finding of Shinde and Solanki [15], Swarup and Yaduvanshi [16].

Table 1. Effect of integrated nutrient management on grain and straw yield

S.No.	Treatment	Grain yield (Kgha^{-1})	Straw yield (kgha^{-1})
1	Control	893.33	2054.67
2	50% NPK	1116.67	2568.33
3	75% NPK	1326.67	3051.33
4	100% NPK	1520.00	3496.00
5	150% NPK	1640.00	4100.00
6	100% NPK –S	1523.33	3604.00
7	100% NPK + $ZnSO_4$	1546.67	3662.00
8	100% NPK + $FeSO_4$	1521.00	3702.40
9	50% NPK + FYM	1632.67	3918.40
10	75% NPK + FYM	1853.33	4633.33
11	100% NPK+ FYM	2196.67	5272.00
12	100% NPK + FYM + {PSB+ Azotobacter (Seed treatment)}	2353.33	5724.67
S.Em.(±)		30.84	88.11
CD(0.05%)		90.44	258.41

Table 2. Effect of integrated nutrient management on nutrient uptake N, P, K and S

S. no.	Treatment	N uptake		P uptake		K uptake		S uptake	
		Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
1	Control	44.61	8.66	2.17	2.30	5.22	25.19	2.48	1.83
2	50% NPK	50.04	12.59	3.59	3.31	6.97	34.02	3.73	2.79
3	75% NPK	52.17	15.59	4.99	4.21	9.67	43.49	4.94	3.66
4	100% NPK	55.47	23.53	6.50	4.54	11.42	50.54	6.58	4.28
5	150% NPK	56.50	23.36	7.27	5.81	12.70	59.49	7.47	5.33
6	100% NPK –S	55.64	20.98	6.48	4.64	11.86	52.13	4.32	4.04
7	100% NPK + $ZnSO_4$	56.46	24.14	6.66	5.02	11.23	53.34	7.46	4.66
8	100% NPK + $FeSO_4$	55.48	25.36	6.35	4.91	11.23	53.90	7.39	4.76
9	50% NPK + FYM	55.00	28.12	6.95	5.39	11.99	57.72	7.22	4.89
10	75% NPK + FYM	63.24	36.65	8.05	6.49	13.64	70.49	8.62	5.96
11	100% NPK+ FYM	65.48	43.35	10.10	8.52	16.51	85.72	11.11	7.11
12	100% NPK + FYM + {PSB+ Azotobacter (Seed treatment)}	75.27	50.11	11.30	9.69	20.10	94.11	12.21	8.30
S.Em.(±)		1.380	0.611	0.179	0.140	0.31	1.33	0.16	0.11
CD(0.05%)		4.047	1.791	0.525	0.411	0.91	3.89	0.46	0.33

Table 3. Effect of integrated nutrient management on pH, EC, OC(%) Available N, P, K and S

S. no.	Treatment	pH	EC	OC (%)	N (Kgha^{-1})	P (Kgha^{-1})	K (Kgha^{-1})	S (Kgha^{-1})
1	Control	7.516	0.119	0.363	158.77	9.61	160.27	6.41
2	50% NPK	7.480	0.119	0.376	162.36	9.83	164.20	7.67
3	75% NPK	7.633	0.130	0.379	165.58	10.97	163.40	10.53
4	100% NPK	7.680	0.116	0.391	171.32	11.07	176.47	12.04
5	150% NPK	7.780	0.125	0.392	177.30	12.07	177.17	12.78
6	100% NPK –S	7.660	0.132	0.391	171.71	11.29	174.40	9.13
7	100% NPK + $ZnSO_4$	7.633	0.125	0.390	172.91	11.28	173.53	12.81
8	100% NPK + $FeSO_4$	7.630	0.126	0.391	171.57	11.38	173.90	12.66
9	50% NPK + FYM	7.643	0.125	0.383	172.23	11.98	172.87	14.48
10	75% NPK + FYM	7.553	0.127	0.393	177.27	13.57	177.57	17.67
11	100% NPK+ FYM	7.650	0.126	0.405	178.93	14.21	186.53	17.87
12	100% NPK + FYM + {PSB+ Azotobacter (Seed treatment)}	7.540	0.125	0.407	183.11	15.19	196.57	18.63
S.Em.(±)		0.054	0.004	0.009	3.574	0.691	2.205	0.127
CD(0.05%)		NS	NS	0.027	10.483	2.027	6.468	0.372

The available K content of soil as influenced by application of various treatments. In general the available K was found maximum in the treatment T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) 196.57 kgha^{-1} which was followed by the treatment T_{11} (100% NPK + FYM) 186.53 kgha^{-1}. Kauraw, [17] and Sahu [18] summarized that the typical behavior of K distribution within the soil profile from the applied pool, Luxury consumption of K by the growing crops as per its availability and prevailing moisture situations of the profiles.

The available S content of soil as influenced by application of various treatments. In general the available S was found maximum in the treatment T_{12} (100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)}) 18.63 kgha^{-1} which was followed by the treatment T_{11} (100% NPK + FYM) 17.87 kgha^{-1}. Similar findings have been reported by Singh et al. [19] and Rsikesh thakur [20].

4. CONCLUSION

Based on experimental findings it can be concluded that application of100% NPK + FYM + {PSB+ *Azotobacter* (Seed treatment)} is beneficial in terms of yield, uptake of nutrients and Soil chemical properties pearl millet.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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