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Productivity, Nutrient Uptake and Economics of Pearl Millet [*Pennisetum Glaucum* (L.)] as Influenced by Nitrogen, Phosphorus and Biofertilizer Management

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ABSTRACT

A field experiment was conducted at the Agricultural College Farm, Bapatla, to study the effect of N, P and biofertilizer management practices on yield, nutrient uptake and economics of pearl millet. The treatments consisted of T_1 : Control, T_2 : Biofertilizer alone (Azospirillum and PSB), T_3 : 20 kg N + 15 kg P_2O_5 ha^{-1}, T_4 : 40 kg N + 30 kg P_2O_5 ha^{-1}, T_5 : 60 kg N + 45 kg P_2O_5 ha^{-1}, T_6 : T_2 + T_3, T_7 : T_2 + T_4 and T_8 : T_2 + T_5. Application of 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer recorded the highest grain yield (29.7 q ha^{-1}), stover yield (67.5 q ha^{-1}) and protein content (10.41%) but it was at par with T_7 and T_5 treatments. Significantly highest N (98.3 kg ha^{-1}) and P (25.8 kg ha^{-1}) uptake recorded with T_8 treatment. T_8 treatment recorded the highest net returns (₹ 27357 ha^{-1}) but T_7 was more economical with the highest B: C ratio (2.57).

Key words : Biofertilizer, Economics, Nitrogen, Nutrient uptake, Pearl millet, Phosphorus, Protein, Yield.

Pearl millet is indispensable rainfed cereal crop of arid and semi-arid regions. Pearl millet is endowed with greater ability to withstand harsh climatic conditions. In India pearl millet is grown in an area of 9.60 Mha with an annual production of 10.40 Mt and a productivity of 1079 kg ha^{-1}. With rapid increase in input costs especially inorganic fertilizers and low commodity prices, there is a need for low cost input alternatives. These alternatives management techniques minimize the use of purchased inputs and exploit biological system to improve the efficiency of applied fertilizers and thus enhance the crop yield. Due to escalation of fertilizers price, biofertilizers approach would be more remunerative and cost effective for getting higher returns with considerable fertilizer economy and better soil health.

MATERIAL AND METHODS

The field experiment was conducted during the *kharif* season of 2013 at the Agricultural College Farm, Bapatla. The soil was sandy in texture, slightly alkaline in reaction with p^H 7.8, low-in organic carbon (0.23 %) and available nitrogen (205 kg ha^{-1}), medium in available phosphous (24 kg ha^{-1}) and high in available potassium (334 kg ha^{-1}).

The treatments consisted of T_1 : Control, T_2 : Biofertilizer alone (Azospirillum and PSB), T_3 : 20 kg N + 15 kg P_2O_5 ha^{-1}, T_4 : 40 kg N + 30 kg P_2O_5 ha^{-1}, T_5 : 60 kg N + 45 kg P_2O_5 ha^{-1}, T_6 : T_2 + T_3, T_7 : T_2 + T_4 and T_8 : T_2 + T_5. The treatments were laid out in randomized block design (RBD) and replicated thrice. Pearl millet hybrid MLBH-308 was sown on 21 July, 2013 by adopting a spacing of 45 cm X 15 cm. *Azospirillum* and PSB @ 3kg ha^{-1} were mixed separately with vermincompost and were applied in respective treatments before sowing. Half dose of nitrogen and full dose of P_2O_5 was applied at the time of sowing through urea (46% N) and Single superphosphate (16% P_2O_5) respectively, as per the treatments. A uniform application of 30 kg K_2O was applied to all the treatments at the time of sowing through muriate of potash (60% K_2O). Remaining dose of nitrogen was applied at knee high stage (35 DAS) as per the treatments.

RESULTS AND DISCUSSION

The increasing levels of nitrogen and phosphorus up to 60 kg N + 45 kg P_2O_5 ha^{-1} significantly increased the grain yield over its preceding levels. The maximum grain yield was recorded with the combined application of inorganic and biofertilizers (60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer) but it remained at par with 40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizer. However, the

differences in grain yield between T_3 and T_4 and T_5 and T_6 treatments did not reach to the level of significance.

The lowest grain yield of 13.2 q ha^{-1} was recorded in control. The magnitude of increase in grain yield with T_8 (29.7 q ha^{-1}), T_7 (27.2 q ha^{-1}) and T_5 treatments (25.1 q ha^{-1}) over control (13.2 q ha^{-1}) was to the extent of 125.0, 106.1 and 90.1 per cent, respectively. Application of biofertilizer alone recorded 20.5 per cent higher grain yield over control. Adequate amounts of N and P fertilization facilitated better growth and development of pearl millet, which ultimately increased the yield. Integration of biofertilizers with inorganic source improved grain yield markedly over alone application of N and P to crop. The favourable effect of *Azotobacter* attributed to atmospheric N_2 fixation while that of PSB to its role in solubilisation of native phosphorus (Ansari *et al*., 2011).

Each successive increase in chemical fertilizer (N and P) level from the control to the highest dose tried, recorded significant increase in stover yield, while the maximum was recorded with application of 60 kg N + 45 kg P_2O_5 ha^{-1}. However, the differences in stover yield due to T_2 and T_3 remained statistically identical. Highest stover yield (67.5 q ha^{-1}) was recorded with combined application of higher dose of chemical fertilizer along with biofertilizer (60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer).

The magnitude of increase in stover yield with T_8 treatment (67.5 q ha^{-1}), T_5 treatment (60.5 q ha^{-1}) and T_7 treatment (58.3 q ha^{-1}) over control (36.9 q ha^{-1}) was to the extent of 82.9, 63.9 and 57.9 per cent, respectively. Application of biofertilizer alone recorded 13.5 per cent higher stover yield over control.This might be due to relative higher level of nitrogen and phosphorus, probably increased mobility, absorption and translocation of nutrient leading to increased production of photosynthates by the crop resulting in increased biomass accumulation.

Further, the biofertilizers in the treatments with inorganic sources, which are nitrogen fixing, plant growth promoting and phosphate solubilizing bacteria has synergistic effect on plant growth as they increase the fertilizer efficiency as well soil fertility by enhancing soil microbial activities. Hence, T_8 treatment might have recorded maximum stover yield of pearl millet. Such trends were also reported by Rathore *et al.* (2004).

Maximum protein content in grain was recorded in the T_8 treatment (10.41%) which was at par with T_7 (10.24%) and T_5 treatment (9.85%). The treatments T_4, T_6 and T_3 also recorded significantly higher protein content which were 6.5, 5.1 and 4.1 per cent respectively higher than the control and also found identical among themselves. This is due to nitrogen which is the most important element in protein synthesis as nitrogen is the base of nucleic acid and protein building. Hence an increase in optimum conditions with the increased availability of nitrogen through chemical and biofertilizers application increased the protein content in grain.These present findings are in close conformity with the observations made Rathore *et al.* (2004).

Significantly highest nitrogen uptake (98.3 kg ha^{-1}) was recorded with the application of 60 kg N + 45 kg P_2O_5 ha^{-1} + bifertilizers followd by 40 kg N + 30 kg P_2O_5 ha^{-1} + bifertilizers and 60 kg N + 45 kg P_2O_5 ha^{-1}. Lowest total nitrogen uptake was recorded with control (35.7 kg ha^{-1}). The treatments T_3 and T_4 remained at par with each other.The higher yields (grain and stover) of pearl millet coupled with higher nitrogen content resulted in higher uptake of nitrogen due to application of fertilizers and biofertilizers. These findings corroborate with the results obtained by Ansari *et al*. (2011).

Significantly highest phosphorus uptake (25.8 kg ha^{-1}) was recorded with the application of of 60 kg N + 45 kg P_2O_5 ha^{-1} + bifertilizers followd by 40 kg N + 30 kg P_2O_5 ha^{-1} + bifertilizers and 60 kg N + 45 kg P_2O_5 ha^{-1}. The treatments T_3 and T_4 were at par with each other. Lowest total phosphorus uptake was recorded with control (9.4 kg ha^{-1}). Application of T_8, T_7 and T_5 treatments recorded 174.5, 148.9 and 122.1 per cent higher total phosphorus uptake over control, respectively.

. The increase in P uptake may be attributed to higher P content as well as grain and straw yields with higher dose of P. This might be due to increased concentration of phosphorus in soil solution with increasing phosphorus application. Further, PSB application resulted in greater mobilisation of insoluble inorganic phosphate and mineralization of organic phosphorus and thus biofertilizers that could have stimulated greater root growth and might have favoured better absorption of phosphorus. These findings are in close conformity with the observations made by Meena and Gautam (2005).

Table 1. Yield, protein content, nutrient uptake and economics of pearl millet as influenced by N, P and biofertilizer management practices.

Treatment	Yield (q ha^{-1})		Protein content (%)	Nutrient uptake (kg ha^{-1})		Net return (₹ ha^{-1})	B : C ratio
	Grain	Stover		N	P		
T_1 : Control	13.2	36.9	9.15	35.7	9.4	11151	1.50
T_2 : Biofertilizer alone (Azospirillum and PSB)	15.9	41.9	9.22	48.0	13.4	15609	2.07
T_3 : 20 kg N + 15 kg P_2O_5 ha^{-1}	20.0	44.1	9.53	56.9	15.9	17216	2.02
T_4 : 40 kg N + 30 kg P_2O_5 ha^{-1}	21.8	50.1	9.75	64.0	17.5	18526	1.92
T_5 : 60 kg N + 45 kg P_2O_5 ha^{-1}	25.1	60.5	9.85	81.8	20.9	21721	2.02
T_6 : T_2 + T_3	22.8	51.6	9.62	64.2	16.6	20763	2.40
T_7 : T_2 + T_4	27.2	58.3	10.24	82.8	23.4	25057	2.57
T_8: T_2 + T_5	29.7	67.5	10.41	98.3	25.8	27357	2.51
SEm±	1.0	3.1	0.21	2.8	0.9		
CD (P = 0.05)	3.2	9.4	0.63	8.5	1.9		
CV (%)	12.6	11.3	10.43	7.4	8.3		

Net returns increased with the increase in levels of nitrogen and phosphorus applied along with biofertilizers. The highest value of net returns (₹ 27357 ha^{-1}) was obtained by the application of 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizers (T_8) followed by 40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizers (T_7) and T_5 treatment. Lowest net returns (11151) was recorded with control. Net returns differed by 16206 between the highest and lowest fertility treatments. Similarly application of biofertilizer alone gave a monetory benefit of 4458 over the control.

Highest benefit cost ratio (2.57) was obtained with the application of 40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizers (T_7 treatment) followed by T_8 treatment (2.51) and T_6 treatment (2.40). Lowest benefit cost ratio (1.50) was recorded with control.These results are in accordance with Guggari and Kalaghatagi (2005).

CONCLUSION

It can be concluded that application of 40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizers produced at a par grain yield as compared to that produced through application of 60 kg N + 45 kg P_2O_5 ha^{-1} and there by a saving of 20 kg N + 15 kg P_2O_5 ha^{-1} could be possible by the use of biofertilizers. Significantly highest nutrient uptake (N & P) recorded with the application of 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizers. Though the highest net returns (27357 ha^{-1}) was obtained by the application of 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizers but application of 40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizers was more economical with the highest B: C ratio (2.57).

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