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Effect of Nitrogen, Phosphorus and Biofertilizer Management on Growth and Yield of Pearl Millet [*Pennisetum Glaucum* (L.) R. Br.] *

Neeraj Yadav , Ch Pulla Rao, M Martin Luther and Y Ashoka Rani
Department of Agronomy, Agricultural College, Bapatla 522 101, Andhra Pradesh

ABSTRACT

A field experiment was conducted at the Agricultural College Farm, Bapatla, to study the effect of N, P and biofertilizer management practices on growth, and yield 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 plant height (201.1 cm) but recorded the lowest days to attain 50% flowering.All the yield attributes viz., number of earheads m^{-2}, length of earhead (cm), number of grain rows $earhead^{-1}$, number of filled grains row^{-1} and test weight (g/1000 grains) were significantly influenced by different treatments under test. Highest number of earheads m^{-2} (33.6), length of earhead (25.0 cm), grain rows $earhead^{-1}$ (32.0) and number of filled grains row^{-1} (87.4) were recorded with T_8 treatment (60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer) which was at a par with T_7 treatment (40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizer). Highest value of test weight (9.3 g/1000 grains) and harvest index (31.8%) was recorded with T_7 treatment being at par with T_8 treatment and proved significantly superior to control. Significantly highest grain (29.7 q ha^{-1}) and stover (67.5 q ha^{-1}) yield recorded with T_8 treatment.

Key words : *Azospirillum*, Nitrogen, Pearl millet, Phosphorus, PSB, Yield.

Pearl millet is the most widely cultivated millet crop, occupying a prominent position in global agriculture. Among the coarse cereals grown, pearl millet occupies pivotal position in arid and semi-arid regions of India. Pearl millet is grown mostly on marginal and sub-marginal lands, poor in organic matter, low in available nitrogen and phosphorus. The chemical fertilizers are quite expensive and the small and marginal farmers are unable to use these fertilizers in required quantities in moisture deficit areas. It is reported that pearl millet has a variety of nitrogen fixing bacteria in its rhizosphere which may release growth promoting substances. Through the use of biofertilizers, healthy plants can be grown, besides enhancing the sustainability and the health of the soil.

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 phosphorus (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 45cm X 15 cm. *Azospirillum* and PSB @ 3kg ha^{-1} were mixed separately with vermicompost 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 ha^{-1} 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. The data was analysed statistically by adopting the standard procedures as suggested by Rangaswamy (1995).

RESULTS AND DISCUSSION

The plant height was significantly influenced by different treatments. Significantly highest plant height (201.1 cm) was recorded with 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer (T_8 treatment) over control but it was at par with T_7 (199.5 cm) and T_5 treatment (190.2 cm). Biofertilizer application alone did not observe any significant increase in plant height over control. The results are in agreement with Guggari and Kalaghatagi (2005).

Highest number of effective tillers per plant was recorded with the application of 60 kg N + 45 kg P_2O_5 ha^{-1} (2.3) which was significantly superior to the control (1.8) and T_2 (2.0) but at par with the remaining treatments. The results were in conformity with those of Neelam *et al.* (2009).

Maximum number of ear heads m^{-2} was recorded with 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer (33.6) followed by 60 kg N + 45 kg P_2O_5 ha^{-1} (33.1) and lowest by control (26.4). Application of 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer and biofertilizer alone resulted in 27.3 and 13.3 per cent higher number of ear heads m^{-2} over control, respectively. T_8 was significantly superior to T_1, T_2 and T_3 treatments. While the rests of the treatments were at par among themselves. This increase in number of ear heads m^{-2} may be ascribed to better nutrition as a result of application of fertilizers and biofertilizers which might have aided in higher root growth and development and enhanced the uptake and translocation of nutrients. The result corroborate with the finding of Bar and Gautam (1991)

Increase in the levels of nitrogen and phosphorus in combination with biofertilizers significantly reduced the days to 50 per cent flowering in pearl millet. Treatment with control recorded highest days to 50 per cent flowering (52.7) among all the treatments. Lowest number of days to 50 per cent flowering was recorded with T_8 treatment (47.7) followed by T_7 (48.3) and T_5 treatment (48.7). There is a difference of 5 days between the highest and lowest number of days to 50 per cent flowering within the treatments. This might be due to better nutrient uptake and enhanced photosynthetic rate, drymatter accumulation and rapid growth rate because of increased nutrient availability with the increasing fertility level in combination with biofertilizer application. These results are in agreement with the findings of Kumar and Gautam (2004).

Each successive increase in fertilizer level from the control to the highest dose tested in this trial, recorded significant improvement in earhead length of pearl millet. Among the treatments, application of 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer recorded significantly highest length of earhead (25.0 cm) which was at par with T_7 (24.6 cm) and T_5 (24.1 cm) treatments but significantly superior to other treatments. Better nutrition due to application of fertilizers and biofertilizers might have resulted into better root growth and development and enhanced nutrient availability, uptake & translocation and thus increasing the earhead length. Such observations were also reported by Meena *et al*. (2008).

Increase in fertilizer level from the control to the highest dose recorded significant improvement in number of grain rows per earhead and number of filled grains per row of pearl millet. Among the different treatments, application of 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer recorded significantly higher number of grain rows per earhead (32.0) and number of filled grains per row (87.4) which was at par with T_7 and T_5 treatments but significantly superior to other treatments.

Increased nutrient availability with the application of fertilizers in combination with biofertilizers might have been enjoyed by the plant at the flower primordial initiation stage, which might have helped in increasing the girth of earhead thus increasing the number of grain rows per earhead and number of filled grains per row. These results are in agreement with the findings of Rathore *et al.* (2008).

Application of 60 kg N + 45 kg P_2O_5 ha^{-1} significantly increased the test weight over control but it remained at par with 40 kg N + 30 kg P_2O_5 ha^{-1}. Highest test weight was recorded with 40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizer (9.3g) but it remained at par with 60 kg N + 45 kg P_2O_5 ha^{-1} + biofertilizer (9.2 g). Though test weight is a genetic character, but due to its good management weight of pearl millet grain increased progressively with increased quantity of nitrogen and phosphorus fertilizer in combination with biofertilizers. Such observations were also reported by Neelam *et al.* (2009).

Table 1. Growth and yield parameters of pearl millet as influenced by N, P and biofertilizer management practices.

Treatment	Plant height (cm)	Effective tillers plant^{-1}	Days to 50% flowering	No. of earheads m^{-2}	Earhead length (cm)	Number of Grain rows per earhead	Number of filled grains per row
T_1 : Control	178.1	1.8	52.7	26.4	18.0	28.0	63.4
T_2 : Biofertilizer alone (Azospirillum and PSB)	182.5	2.0	52.0	29.9	20.2	30.1	74.4
T_3 : 20 kg N + 15 kg P_2O_5 ha^{-1}	188.9	2.1	51.3	30.8	20.5	29.0	70.2
T_4 : 40 kg N + 30 kg P_2O_5 ha^{-1}	190.6	2.1	49.0	31.5	22.6	29.8	73.8
T_5 : 60 kg N + 45 kg P_2O_5 ha^{-1}	195.7	2.1	48.7	33.1	24.1	31.1	82.6
T_6 : $T_2 + T_3$	191.3	2.1	51.0	31.5	22.6	30.1	81.1
T_7 : $T_2 + T_4$	199.5	2.2	48.3	32.8	24.6	31.9	86.4
T_8 : $T_2 + T_5$	201.1	2.3	47.7	33.6	25.0	32.0	87.4
SEm±	2.96	0.06	1.05	0.92	0.44	0.61	2.03
CD (P = 0.05)	8.8	0.2	3.2	2.8	1.3	1.8	6.1
CV (%)	5.7	6.8	7.6	6.9	7.4	10.3	8.9

Table 2. Test weight, grain yield, stover yield and harvest index of pearl millet as influenced by N, P and biofertilizer management practices.

Treatment	Test Weight (g / 1000-grains)	Grain Yield (q ha^{-1})	Stover Yield (q ha^{-1})	Harvest index (%)
T_1 : Control	6.5	13.2	36.9	26.3
T_2 : Biofertilizer alone (Azospirillum and PSB)	7.6	15.9	41.9	27.5
T_3 : 20 kg N + 15 kg P_2O_5 ha^{-1}	7.3	20.0	44.1	31.2
T_4 : 40 kg N + 30 kg P_2O_5 ha^{-1}	7.6	21.8	50.1	30.3
T_5 : 60 kg N + 45 kg P_2O_5 ha^{-1}	8.2	25.1	60.5	29.3
T_6 : $T_2 + T_3$	7.9	22.8	51.6	30.6
T_7 : $T_2 + T_4$	9.3	27.2	58.3	31.8
T_8 : $T_2 + T_5$	9.2	29.7	67.5	30.5
SEm±	0.27	1.07	3.13	1.13
CD (P = 0.05)	0.8	3.2	9.4	3.4
CV (%)	5.2	12.6	11.3	7.8

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 (29.7 q ha^{-1}) 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 & T_4 and T_5 & 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. Similar results have also been reported earlier by Kumar and Gautam (2004).

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, 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 was 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 in this trail might have recorded maximum stover yield of pearl millet. Such observations were also reported by Rathore *et al.* (2004).

The highest harvest index (31.8 %) was recorded with the application of 40 kg N + 30 kg P_2O_5 ha^{-1} + biofertilizer during the study followed by T_3 treatment (31.2 %) which were on a par with rest of the treatments except control. However, the treatment, T_1 (control) of pearl millet recorded the lowest harvest index (26.3 %). Partitioning of photosynthates improved favourably with increase in nitrogen and phosphorus leading to greater translocation of these towards sink that resulted in significant increase in harvest index. These results are in agreement with the findings of Parihar *et al.* (1998).

CONCLUSION

From the above study it can be concluded that there was a progressive and significant increase in growth parameters, yield attributes and yield with increasing N and P rates up to 60 kg N + 45 kg P_2O_5 ha^{-1}. 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.

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