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Effect of Nitrogen and Potassium on Yield and Quality of Pearl Millet (*Pennisetum glaucum* L.)

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Abstract **– A field experiment was carried out during to study the effect of nitrogen and potassium on yield and quality of pearl millet during *kharif* 2013. Eight nutrient management practices were imposed with three replications using RBD. All the yield, yield attributing parameters and grain quality parameters were recorded accordingly. The significantly highest grain yield was recorded with T_7 followed by T_4. Similar trend was seen with grain quality parameters *viz.*, total protein, total amino acid and total carbohydrate content. Based on the results, it may be concluded that for higher production with good quality grain, pearl millet crop has to be supplied with 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} (T_7). However, for optimum and economic production, pearl millet has to be supplied with 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1} (T_4).**

Keywords **– Dry matter production, Grain yield, Pearl millet, Quality parameters, Straw yield.**

I. INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.)] is the fifth most important cereal crop in the world after rice, wheat, maize, and sorghum. It is a widely grown rainfed cereal crop in the arid and semi-arid regions of Africa and Southern Asia, and can be grown in areas where rainfall is not sufficient (200 to 600 mm yr^{-1}) for the cultivation of maize and sorghum. Its grain is more nutritious and the protein content is not only high but it is also of good quality. The grain contains 11-19 % protein, 60-78 % carbohydrates and 3.0 - 4.6 % fat and also has good amount of phosphorus and iron. It has the maximum potential of all the millets and is mainly grown in drought prone areas and marginal soils.

India is the largest producer of pearl millet, both in terms of area (9.3 m ha) and production (9.3 mt) , with an average productivity of 1044 kg ha^{-1} during the last five years. The trends in area, production and productivity of pearl millet suggest that area has increased marginally (2 %) during last two years and productivity has gone up by 19% as in [1]. Pearl millet occupies fourth place in cereals and second place in coarse cereals and is the most widely cultivated millet next only to Jowar in India. In Andhra Pradesh it is grown in an area of 67000 ha with a production of 102000 tonnes and productivity of 1349 kg ha^{-1}. The productivity of pearl millet in Andhra Pradesh is low compared to other states like Haryana (2040 kg ha^{-1}), Madhya Pradesh (1924 kg ha^{-1}) and Uttar Pradesh (1839 kg ha^{-1}). The potential of pearl millet as rainfed crop has not been fully exploited. Nitrogen and Potassium are two key inputs for realizing higher grain yield and quality in pearl millet.

Information on optimum and economic dose of nitrogen and potassium requirement for higher grain yield and quality is lacking in rain fed Pearl millet in Andhra Pradesh. Keeping the above points in view the present investigation was conducted to study the effect of N and K on grain yield and quality and to fix the optimum and economic dose of N and K for pearl millet crop.

II. MATERIAL AND METHODS

A field experiment was conducted at S.V. Agricultural Farm, Tirupati, during *kharif* 2013. The experiment was laid out in randomized block design with three replications and eight treatments *viz.*, T_1: control (no fertilizers); T_2: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1} (RDF); T_3: 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}; T_4: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}; T_5: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} (T_5), 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}; T_7: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} and T_8: Application of N, P_2O_5 and K_2O based on Soil Test Values (78 kg N ha^{-1} + 21 kg P_2O_5 ha^{-1} + 14 kg K_2O ha^{-1}). The crop was transplanted at a spacing of 45 cm x 15 cm. The pearl millet hybrid of PHB-3 was used for the experiment with 4 kg ha^{-1} seed rate. The soil of the experimental field was neutral in pH (7.35), normal in EC (0.068 dsm^{-1}), sandy loam in texture, low in OC (0.63 %), low in available nitrogen (150.52 kg ha^{-1}), high in available P_2O_5 (159.97 kg ha^{-1}) and low in available K_2O (422.01 kg ha^{-1} The nitrogen application was done in two splits, 50 % of N, full dose of P_2O_5 and K_2O were applied as a basal and remaining 50 % N, at 30 days after transplanting of pearl millet. Data on plant height and dry matter production at different growth stages, grain and straw yield at harvest were recorded. Grain quality parameters *viz.*, total protein, total amino acid content estimated as in [2] and total carbohydrate content estimated as in [3] as per standard procedures. The B : C ratio of different treatments were calculated. Data obtained was statistically analyzed as [4].

III. RESULTS AND DISCUSSION

The data pertaining to effect of nitrogen and potassium on different growth parameters, yield and quality parameters are presented and discussed here under

A. Plant Height

The pearl millet crop attained the maximum plant height at all the stages of crop growth at 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1} (T_4) followed by 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} (T_7) while significantly inferior and least plant height was obtained with control (T_1) (**Table 1.**). At harvest the maximum plant height was recorded with T_4 (179.60 cm) followed by T_7 (172.60 cm). Nitrogen promotes the vegetative growth thus, leading to significant increase in plant height. These results were similar with [5]-[6].

B. Dry Matter Production

Dry matter accumulation at 30 DAT, was highest (1488.46 kg ha^{-1}) with T_7 followed by T_4 (1360.62 kg ha^{-1}) and T_6 (1288.47 kg ha^{-1}) which were significantly superior to rest of the treatments (**Fig. 1.**). The lowest dry matter production (897.52 kg ha^{-1}) was obtained with control (T_1) followed by 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} (T_5). At 60 DAT, the maximum dry matter accumulation (5069.71 kg ha^{-1}) was obtained with 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} (T_7) which was, however, on par with 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1} (T_4) but significantly superior to rest of the treatments. The least dry matter production (3338.48 kg ha^{-1}) was recorded with control (T_1). Among all the treatments, the highest dry matter (7539.67 kg ha^{-1}) was recorded, at harvest, with 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} (T_7) which was followed by 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1} (T_4) and 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} (T_6) which was significantly superior to all other treatments. As at other stages of observations, control (T_1) accounted for significantly inferior dry matter production (4108.59 kg ha^{-1}) at harvest also. Similar result of increased dry matter production with increased levels of N at all the growth stages of pearl millet crop was reported in [7]-[8].

C. Grain And Straw Yield

The significantly highest grain yield (3839 kg ha^{-1}) and straw yield (5578 kg ha^{-1}) was obtained with T_7 followed by T_4 (3798 kg ha^{-1} and 5465 kg ha^{-1}, respectively), but superior to rest of the treatments (**Table 2.**). The lowest grain yield (1390 kg ha^{-1}) and straw yield (2815 kg ha^{-1}) was recorded from T_1 (control) which was followed by T_2 (2861 kg ha^{-1} and 4815 kg ha^{-1}, respectively). which were inferior to rest of the treatments. Low initial N status of soil limited the yield of pearl millet to lower level in control treatment. The increase in grain and straw yields with enhanced N application could be ascribed to increases the activity of cytokinin in plant which leads to the increased cell-division and elongation which leads to better plant growth, dry-matter production and higher photosynthesis. This was further supported by the fact that soil of the experimental field was low in nitrogen (150.52 kg ha^{-1}). Thus, an increase in nitrogen supply might have increased all the growth parameters, yield attributing characters which ultimately contributed to increase in yields. Increased grain yield due to varying levels of nutrients have also been reported in [9]-[10].

D. Harvest Index (%)

The different nutrient management practices showed significant influence on the harvest index of pearl millet (**Table 2.**). The maximum value of harvest index (41.00 %) was noticed with T_4 compared to all other treatments. This was followed by T_7 (40.77 %). The lowest harvest index (33.05 %) was noticed with control (T_1). The dry matter partitioning has been effective with increased level of nitrogen, thus, resulting in higher harvest index.

E. Total Protein Content In Grain

The protein content in grain was significantly influenced by different nutrient management practices (**Table 3.**). The highest protein content in grain was recorded with T_7 (14.47 %) which was on par with T_4 (13.95 %) and T_6 (13.83 %) and these treatments were significantly superior to other treatments. The least protein content in grain (9.74 %) was recorded with control (T_1) followed by T_2 (11.99 %) and T_5 (12.05 %). All these treatments were significantly inferior to rest of the treatments. In pearl millet, the protein content of grain increased with increasing levels of nitrogen and phosphorus as in [11]-[12].

F. Total Amino Acid Content In Grain

Significant effect of nutrient management practices was noticed on the total amino acid content of the grain in pearl millet (**Table 3.**). The highest total amino acid content in grain was recorded with T_7 (743.85 mg 100 g^{-1}) which was superior over all other treatments. T_4 (714.04 mg 100 g^{-1}) and T_6 (705.04 mg 100 g^{-1}) were on par with each other and superior over rest of the treatments. The least total amino acid content in grain was noticed with control (T_1). Similar results are reported in [13].

G. Total Carbohydrate Content

The nutrient management practices significantly influenced the carbohydrate content in the grain (**Table 3.**). The highest carbohydrate content in grain was recorded with T_7 (69.55 g 100 g^{-1}) which was on par with T_4 (67.85 g 100 g^{-1}). In turn T_4 was on par with T_8 (64.49 g 100 g^{-1}) but, all these treatments were significantly superior to rest of the treatments. The least carbohydrate content in grain (58.74 g 100 g^{-1}) was recorded with control (T_1) which was closely followed by T_2 (60.60 g 100 g^{-1}) and T_5 (61.14 g 100 g^{-1}) which were comparable to each other and inferior to rest of the treatments. A critical analysis of the data on quality parameters indicated a positive influence on increased nitrogen content in grain. Similar findings are reported in [13].

IV. ECONOMICS

Benefit : cost ratio was calculated by considering the cost of cultivation, gross and net returns for each treatment (**Table 2.**). The highest benefit : cost ratio (3.16) was recorded with T_4 which was on par with T_7 (3.11). The least benefit : cost ratio (0.97) was recorded with control (T_1).

V. CONCLUSIONS

For high production with good quality grain, pearl millet crop has to be supplied with 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1} in sandy loam soils. However for realizing optimum and economic production with good quality grain, the pearl millet crop has to be supplied with 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1} (T_4) in sandy loam soils of Southern agro-climatic zone of A.P. Application of soil test based fertilizers also resulted good yields with compared economics but lower than T_4. This shows that present RDF (60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}) has to be changed for optimizing the yield.

REFERENCES

[1] O. P. Yadav. (2011). Project Coordinator's Review (2010 -11) on Pearl Millet Research. Available: http://www.aicpmip.res.in/pcr2011.pdf

[2] S. Moore and W. H. Stein. (1948). *Methods in Enzymol (Eds. Colowick, S.P and Kalpan, N.D)* Academic Press New York 3. pp. 468.

[3] J. F. Hedge and B. T. Hofreiter. (1962). *In: Carbohydrate chemistry 17 (Eds Whistler R L and Be MardaJ N)*Acdemic Press New York.

[4] V. G. Panse and P. V. Sukhatmae. (1978). Statistical methods for agricultural workers. New Delhi. ICAR *Publications*.

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

[6] E. Obeng, E. Cebert, B. P. Singh, R. Ward, L. M. Nyochembeng and D. A. Mays. (2012). Growth and grain yield of pearl millet (*Pennisetum glaucum*) genotypes at different levels of nitrogen fertilization in the southern United States. *Journal of Agricultural Science*. 4(12). pp. 155-163.

[7] S. Kumar,V. S. Kadian and R. C. Singh. (2004). Response of pearl millet (*pennisetum glacum* L.) hybrids to row spacing and nitrogen application. *Annals of Agricultural Research*. 25(1). pp. 68-70.

[8] M. Yakadri and A. P. K. Reddy. (2009). Productivity of pearl millet (*Pennisetum glaucum* L.) as influenced by planting pattern and nitrogen levels during *summer*. Journal of Research ANGRAU. 37(1&2). pp. 34-37.

[9] P. Munirathnam and R. C. Gautam. (2002). Response of promising pearl millet (*Pennisetum glaucum*) cultivars to levels and time of nitrogen application under rainfed conditions. *Indian Journal of Agronomy*. 47(1). pp. 77-80.

[10] R. K. Singh, D. Chakraborty, R. N. Garg, P. K. Sharma and U. C. Sharma. (2010). Effect of different water regimes and nitrogen application on growth, yield, water use and nitrogen uptake by pearl millet (*Pennisetum glaucum*). *Indian Journal of Agricultural Sciences*. 80(3). pp. 213-216.

[11] C. M. Parihar, K. S. Rana and M. D. Parihar. (2009). Crop productivity, quality and nutrient uptake of pearl millet (*pennisetum glaucum*) Indian mustard (*Brassica juncea*) cropping system as influenced by land configuration and direct and residual effect of nutrient management. *Indian Journal of Agricultural Sciences*. 79(1). pp. 927-930

[12] R. P. Jadhav, H. R. Khafi and A. D. Raj. (2011). Effect of qnitrogen and vermicompost on protein content and nutrient uptake in pearl millet. *Agricultural Science Digest*. 31(4). pp. 319-321.

[13] S. Kathju, U. Burman and B. K. Garg. (2001). Influence of nitrogen fertilizationon water relations, photosynthesis, carbohydrates and nitrogen metabolism of diverse pearl millet genotypes under arid conditions. The journal of Agricultural Science. 137(3). pp. 307-318.

Table 1. Plant height (cm) of pearl millet at different stages of crop growth as influenced by nutrient management practices

Treatment	30 DAT	60 DAT	At harvest
T_1: Control (no fertilizers).	43.63	146.63	158.28
T_2: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}(**RDF**)	44.62	148.46	161.00
T_3: 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}	54.01	156.93	172.60
T_4: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}	54.24	160.73	179.60
T_5: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	46.66	149.20	169.80
T_6: 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	52.70	156.81	165.92
T_7: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	57.73	160.40	172.60
T_8: Application of N, P_2O_5 and K_2O based on Soil Test Values.	55.13	156.63	170.00
SEm±	**0.198**	**0.371**	**0.793**
CD (P = 0.05)	**0.606**	**1.138**	**2.429**

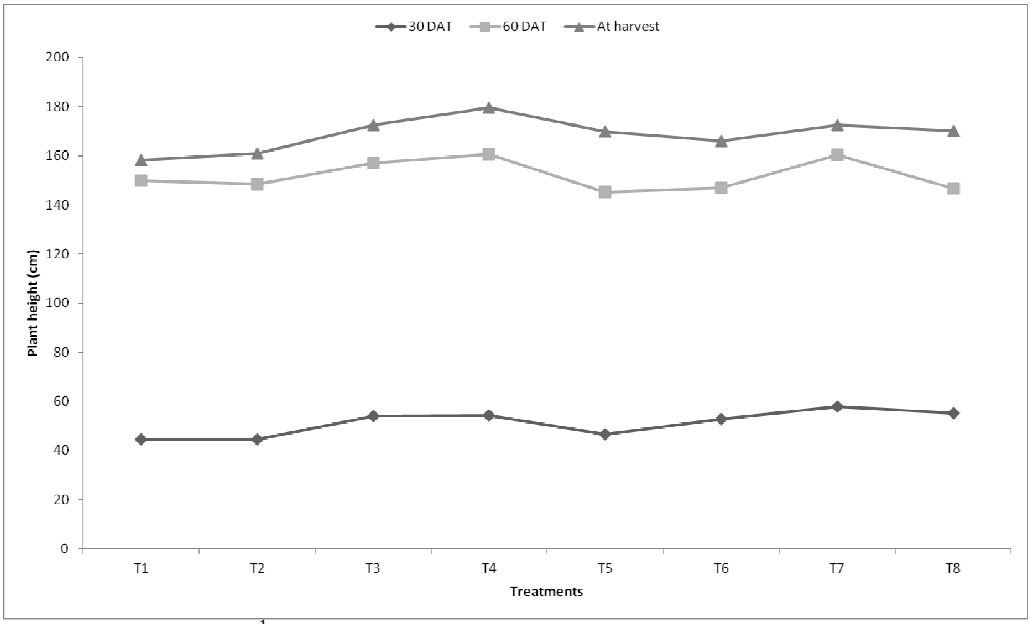

Fig. 1. Dry matter production (kg ha^{-1}) at different stages of crop growth as influenced by nutrient management practices

Table 2. Grain yield, Straw yield, Harvest Index (HI) and B : C ratio of pearl millet as influenced by nutrient management practices

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)	B : C ratio
T_1: Control (no fertilizers).	1390	2815	33.05	0.97
T_2: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}(**RDF**)	2861	4815	37.27	2.29
T_3: 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}	3501	5275	39.89	2.92
T_4: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}	3798	5465	41.00	3.16
T_5: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	2965	4785	38.26	2.31
T_6: 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	3379	5185	39.45	2.69
T_7: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	3839	5578	40.77	3.11
T_8: Application of N, P_2O_5 and K_2O based on Soil Test Values.	3360	5145	39.51	2.91
SEm±	**44.596**	**50.325**	**0.147**	**0.041**
CD (P = 0.05)	**136.578**	**154.124**	**0.449**	**0.125**

Table 3. Grain quality parameters total protein, total amino acid and total carbohydrates content of pearl millet as influenced by nutrient management practices

Treatment	Total Protein (%)	Total Amino Acid (mg $100g^{-1}$)	Total Carbohydrates (g $100g^{-1}$)
T_1: Control (no fertilizers).	9.74	573.57	58.47
T_2: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}(**RDF**)	11.99	595.16	60.60
T_3: 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}	12.95	654.03	63.01
T_4: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 20 kg K_2O ha^{-1}	13.95	714.04	67.85
T_5: 60 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	12.05	605.07	61.14
T_6: 80 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	13.83	705.04	62.90
T_7: 100 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 40 kg K_2O ha^{-1}	14.47	743.85	69.55
T_8: Application of N, P_2O_5 and K_2O based on Soil Test Values.	13.04	652.94	64.49
SEm±	**0.263**	**3.559**	**0.901**
CD (P = 0.05)	**0.807**	**10.898**	**2.759**

AUTHOR'S PROFILE

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S. Bhanu Prasad Reddy was born in Rajampet on 25 May 1990 and completed M.Sc. in Agriculture from S. V. Agricultural College, Tirupati, Andhra Pradesh in the year 2014 in the division of Soil Science and Agricultural Chemistry.