

Effect of foliar supplementation of N, P and K on nutrient dynamics and productivity of pearl millet (*Pennisetum glaucum*)

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ABSTRACT

A field experiment was conducted at Bikaner, Rajasthan during rainy (*khariif*) season of 2016 to study the effect of foliar supplementation of N, P and K on nutrient content, uptake and productivity of pearl millet [*Pennisetum glaucum* (L.) R. Br. emend Stuntz]. The experiment was laid out in randomized block design with 3 replications. The treatments comprised 14 combinations of N, P and K applied through basal application, foliar application and top-dressing. The results revealed that, application of N, P and K through foliar supplementation significantly influenced the nutrient content and uptake in pearl millet. Application of 75% RDF of N (50% basal + 25% top-dressing at 25 DAS) : P : K + 1.5% spray of NPK (18:18:18) at 35 DAS resulted in maximum crude protein content (11.58%), total N uptake (70.7 kg/ha), total P uptake (13.1 kg/ha), total K uptake (74.0 kg/ha), ear-head length (32.4 cm), grain weight per ear-head (23.3 g), grain yield (2.13 t/ha), biological yield (6.88 t/ha) and B:C ratio (2.16) under hot arid conditions of western Rajasthan.

Key words : Economics, Foliar supplementation, Nutrient uptake, Pearl millet, Phosphorus, Potassium, Yield

Pearl millet is a drought tolerant cereal crop commonly cultivated as rainfed crop on marginal lands under low input management conditions. However, it responds well to good management practices and higher fertility levels. Rajasthan is one of the leading states and ranks first in area (4.0 million ha) and production (4.4 million tonne), but the average productivity is low (1,093 kg/ha) (GoI, 2015–16). Water and nutritional stresses are the main reasons behind low productivity (Bana *et al.*, 2016). The uptake of applied nutrients by roots is adversely affected by prevalent high soil pH, temperature stress, too low or too high moisture, weed infestation, presence of pests, *etc.* and consequently the roots are unable to turn over the nutrients commensurate with crop nutritional requirement at different growth stages (Choudhary *et al.*, 2016). No single

source of nutrient is capable of supplying plant nutrients in adequate amount and balanced proportion. Therefore, to maintain soil fertility and to supply plant nutrients in balanced proportion for optimum growth, yield and quality of crop in an integrated manner in a specific agro-ecological situation is to practice integrated nutrient supply (Choudhary and Gautam, 2007 and Bana *et al.*, 2012). In arid regions, farmers use very less inorganic fertilizers due to uncertainty of rain resulting in severe mineral nutrient deficiencies which is one of the major factors responsible for low yield in pearl millet (Bamboriya *et al.*, 2017). Therefore, the balanced supply of fertilizers to the undernourished crop through foliar feeding is one of the easiest ways for boosting the productivity of pearl millet (Rana *et al.*, 2012). Foliar supplementation of N, P and K nutrients has, therefore, been accepted as an effective way to compensate for soil deficiencies and soil's inability to transfer nutrients to the plants (Pareek and Chandra, 2007). Considering the importance of foliar feeding, the present experiment was undertaken to investigate the nutrient content, uptake and post-harvest soil nutrient status through efficient use of inorganic fertilizers in pearl millet.

The experiment was conducted at Agronomy Farm, College of Agriculture, Bikaner, (28°01' N and 73°22' E at 234.7 m above mean-sea level) Rajasthan during rainy

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(*khariif*) season of 2016. The soil was loamy sand, alkaline in reaction (*pH* 8.5) with low organic carbon (0.11%). The available soil N, P and K were 120.3, 20.1 and 223.7 kg/ha respectively. The experiment was laid out in randomized block design with 3 replications. The treatments comprised 14 combinations, viz. control, recommended dose of NPK (60:40:20 kg/ha), 0.5% spray of NPK (18:18:18) at 25 and 35 days after sowing (DAS), 1.0% spray of NPK (18:18:18) at 25 and 35 DAS, 1.5% spray of NPK (18:18:18) at 25 and 35 DAS, 50% as basal (NPK) + 0.5% spray of NPK (18:18:18) at 35 DAS, 50% as basal (NPK) + 1.0% spray of NPK (18:18:18) at 35 DAS, 50% as basal (NPK) + 1.5% spray of NPK (18:18:18) at 35 DAS, 75% N (50% basal + 25% top-dressing at 25 DAS):P:K as basal + 0.5% spray of NPK (18:18:18) at 35 DAS, 75% N (50%

basal + 25% top dressing at 25 DAS:P:K as basal + 1.0% spray of NPK (18:18:18) at 35 DAS, 75% N (50% basal + 25% top dressing at 25 DAS):P₂O₅:K₂O as basal + 1.5% spray of NPK (18:18:18) at 35 DAS, 50% N + 100% (P and K) as basal + 0.5% of urea at 35 DAS, 50% N + 100% (P and K) as basal + 1.0% of urea at 35 DAS and 50% N + 100% (P and K) as basal + 1.5% of urea at 35 DAS. The recommended dose was applied as basal (30 kg N/ha, 40 kg P₂O₅/ha and 20 kg K₂O/ha) through urea, diammonium phosphate (DAP) and potassium chloride (KCl). The remaining 30 kg N/ha was top-dressed at 25 DAS through urea. Foliar spray of NPK (18:18:18 @ 0.5, 1.0 and 1.5%) was done at 25 DAS and 35 DAS, and urea (0.5, 1.0 and 1.5%) at 35 DAS in morning hours with knapsack sprayer. Pearl millet hybrid 'RHB 177' sown on 2 July 2016 using

Table 1. Effect of foliar supplementation of N, P and K on nutrients uptake, yield and economics of pearl millet

Treatment	Crude protein content in grain (%)	Total N uptake (kg/ha)	Total P uptake (kg/ha)	Total K uptake (kg/ha)	Ear-head length (cm)	Grain weight per ear-head (g)	Yield (t/ha)		Benefit: cost ratio
							Grain	Biological	
Control	10.15	32.6	6.4	40.2	21.4	14.2	1.07	3.99	1.31
Recommended dose of NPK (60:40:20 kg/ha)	11.46	65.1	12.1	68.3	30.6	21.3	2.01	6.52	2.09
0.5% spray of NPK (18:18:18) at 25 and 35 DAS	11.00	40.7	7.8	48.2	24.2	16.7	1.26	4.66	1.53
1.0% spray of NPK (18:18:18) at 25 and 35 DAS	11.04	41.9	8.1	49.8	24.7	17.1	1.27	4.78	1.51
1.5% spray of NPK (18:18:18) at 25 and 35 DAS	11.10	42.5	8.3	50.0	26.0	17.5	1.29	4.80	1.48
50% as basal (NPK) + 0.5% spray of NPK (18:18:18) at 35 DAS	11.19	54.9	10.2	57.6	28.5	18.9	1.75	5.61	1.90
50% as basal (NPK) + 1.0% spray of NPK (18:18:18) at 35 DAS	11.33	58.2	10.9	60.6	30.8	20.2	1.85	5.87	1.97
50% as basal (NPK) + 1.5% spray of NPK (18:18:18) at 35 DAS	11.35	59.3	11.1	61.1	30.9	20.6	1.89	5.92	1.97
75% N (50% basal + 25% top-dressing at 25 DAS): P:K + 0.5% spray of NPK (18:18:18) at 35 DAS	11.44	66.2	12.3	68.7	31.5	22.1	2.03	6.55	2.12
75% N (50% basal + 25% top-dressing at 25 DAS): P:K + 1.0% spray of NPK (18:18:18) at 35 DAS	11.54	69.5	12.8	71.7	31.8	22.4	2.12	6.79	2.16
75% N (50% basal + 25% top-dressing at 25 DAS): P:K + 1.5% spray of NPK (18:18:18) at 35 DAS	11.58	70.7	13.1	74.0	32.4	23.3	2.13	6.88	2.16
50% N + 100% (P&K) as basal + 0.5% urea at 35 DAS	11.27	56.1	10.6	60.2	26.9	19.3	1.75	5.64	1.81
50% N + 100% (P&K) as basal + 1.0% urea at 35 DAS	11.35	58.4	11.0	62.8	27.2	19.3	1.81	6.00	1.89
50% N + 100% (P&K) as basal + 1.5% urea at 35 DAS	11.44	60.3	11.2	62.8	28.4	19.7	1.89	6.03	1.95
SEm±	0.13	1.34	0.24	1.34	1.03	0.88	0.05	0.12	0.04
CD (P=0.05)	0.39	3.89	0.69	3.91	2.98	2.57	0.13	0.36	0.12

4.0 kg seed/ha and crop geometry of 45 cm × 12 cm was maintained. The size of individual plot was kept 4.5 m × 4.0 m. Total rainfall received during crop growing period (July to November) was 335.3 mm in 20 rainy days. The mean weekly minimum and maximum temperature during the crop season fluctuated from 23.5 to 40.8°C, while average relative humidity from 29.3 to 88.1%. The crop was raised as per the recommended package of practices. Two irrigations with sprinkler were applied at milking stage and pre maturity stage due to prolonged dry spell observed during the experimentation. Observations were recorded on yield traits and content and uptake of nutrients (N, P and K) in grain and stover. Nutrient content was determined by using the method suggested by Snell and Snell (1949), whereas P and K as per Jackson (1973). Protein content in grain was calculated by multiplying nitrogen content with a factor of 6.25 (AOAC, 1960). The total uptake of nitrogen and phosphorus and potash of harvested seed was estimated by using the standard formula. The harvested material from each plot was thoroughly sun-dried and weighed to record biological yield. Economics of each treatment was worked out on prevailing market price of input and output in terms of net returns (ha) to work out benefit: cost (B:C) ratio. The recorded data were subjected to statistical analysis following standard procedure as suggested by Fisher (1950).

The results showed application of N, P and K fertilizers had significant effect on crude protein content and total uptake of nutrients in grain, ear-head length, grain weight/ear-head, yield and economics of pearl millet (Table 1). Application of 75% N (50% basal + 25% top-dressing at 25 DAS):P:K + 1.0% spray of NPK (18:18:18) at 35 DAS resulted in maximum crude protein content in grain (11.58%) which was 14.08, 5.27, 4.89 and 4.32% higher over control, 0.5% 1.0% and 1.5% spray of NPK (18:18:18) at 35 DAS. The application of 75% N (50% basal + 25% top-dressing at 25 DAS):P:K + 1.5% spray of NPK (18:18:18) at 35 DAS gave maximum total P uptake (13.1 kg/ha) by pearl millet, which was at par with that obtained with 75% N (50% basal + 25% top-dressing at 25 DAS):P:K + 1.0% spray of NPK (18:18:18) at 35 DAS and significantly higher than that obtained with other treatments. A similar trend was observed with respect to total K uptake by the crop as the same treatment gave maximum total K uptake in grain (74.0 kg/ha). Uptake of N, P and K is the function of accumulated biomass of different crops and their content, therefore higher uptake of nutrients in 75% N (50% basal + 25% top-dressing at 25 DAS):P:K + 1.5% spray of NPK (18:18:18) at 35 DAS. Can be attributed to increase in seed yield. The results of the present investigation corroborate with the findings of Rathore *et al.* (2006) and Choudhary and Gautam (2007).

Significantly higher ear-head length (32.4 cm), grain weight/ear-head (23.3 g), grain yield (2.13 t/ha), biological yield (6.88 t/ha) and B:C ratio (2.16) were recorded with 75% N (50% basal + 25% top-dressing at 25 DAS):P:K + 1.5% spray of NPK (18:18:18) at 35 DAS. The increased supply of NPK and their higher uptake by plants might have stimulated the rate of various physiological processes in plant which ultimately led to increased yield. Foliar supplementation of N, P and K might compensate for soil deficiencies and soil's inability to transfer nutrients to the plants. Furthermore higher efficiency of foliar supply of N, P and K can further boost the photosynthetic efficiency by delaying the onset of leaf senescence which improved the yield and yield parameters of pearl millet. The results of the present investigation are in agreement with those reported by Rathore *et al.* (2006), Choudhary and Gautam (2007) and Ansari *et al.* (2011).

Results of this study demonstrates that application of 75% RDF of N (50% basal + 25% top-dressing at 25 DAS):P:K as basal + 1.5% spray of NPK (18:18:18) at 35 DAS resulted in higher yield, better grain quality and more uptake of nutrients in pearl millet. Therefore, application of 75% RDF of N (50% basal + 25% top-dressing at 25 DAS):P:K as basal + 1.5% spray of NPK (18:18:18) at 35 DAS can be advocated for efficient nutrient management in pearl millet under hot arid conditions of Rajasthan.

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