Original Research Article

Response of Foliar Supplementation of N, P and K Fertilizers on Yield and Economics of Pearl Millet

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A B S T R A C T

An experiment was conducted during rainy season of 2016 at Agronomy Farm of College of Agriculture, Bikaner (Rajasthan) to study the Response of foliar supplementation of N, P and K fertilizers on yield and economics of pearl millet [Pennisetum glaucum (L.)] hybrid RHB-177. The study comprised of 14 treatments of different N, P and K fertilizers applied as basal, top dressing and foliar application in randomized block design replicated thrice. Urea, DAP and KCl were used for basal application and urea as top dressing. Foliar spray of NPK (18:18:18) was done at 25 DAS and 35 DAS and urea (0.5, 1.0 and 1.5%) at 35 DAS. The results revealed that 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 (T11) recorded significantly higher total number of tillers/plant at 60 DAS (5.05), number of effective tillers/plant (2.91), ear head weight (32.39 g), grain weight/ear head (4744 kg ha⁻¹), of pearl millet. The highest harvest index (31.94%) was recorded with 50% as basal (NPK)+1.5% spray of NPK (18:18:18) at 35 DAS (T8) which was significantly higher over T1, T3, T4 and T6. The significantly highest gross return (₹42798 ha⁻¹), net return (₹23026 ha⁻¹) and benefit: cost ratio (2.16) were also obtained with 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 (T11).

Keywords
N, P and K fertilizers, Pearl millet

Introduction

Pearl millet [Pennisetum glaucum (L.)] is an important cereal crop of arid and semi-arid regions of India. It is popularly known as Bajra and being drought tolerant generally grown as rainfed crop on marginal lands under low input management conditions. However, it responds well to good management practices and higher soil fertility levels. Rajasthan is one of the leading states in area (4.0 mha) and production of pearl millet (4.4 MT) however; the average productivity is only 10.93 q ha⁻¹ (Anonymous, 2015-16). The main causes of low productivity are prevailing abiotic stresses like drought, poor soil fertility, high soil pH and high temperature. These factors limit the uptake of applied nutrients by roots and also do not able to turn over the nutrients commensurate with crop nutritional requirement at different growth stages.

Balanced nutrition played an imported role in boosting the productivity of pearl millet (Narolia and Poonia, 2011). Integrated use of chemical fertilizers (N, P and K) through
foliar feeding has been accepted an effective way to compensate soil deficiency and inability of soil to transfer nutrients to the plants to maintain high productivity of undernourished crop (Pareek and Chandra, 2007). Therefore, the present experiment was undertaken in order to increase the productivity of pearl millet by efficient use of inorganic fertilizers applied through foliar feeding of N, P and K nutrients alone and/or in combination with soil application.

Materials and Methods

The field experiment was conducted during rainy season of 2016 at Agronomy Farm of College of Agriculture, Bikaner (28°01'N and 73°22'E at 234.7 m above mean sea level). Soil of the experimental plot was loamy sand in texture, alkaline in reaction (pH 8.5) with low organic carbon (0.11%). The available soil N, P and K were 120.30, 20.12 and 223.70 kg ha\(^{-1}\), respectively. The experiment was laid out in Randomized Block Design (RBD) with 3 replications. The treatments comprised 14 combinations viz., control, recommended dose of NPK (60:40:20 kg ha\(^{-1}\)), 0.5% spray of NPK (18:18:18) at 25 and 35 DAS, 1.0% 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):P\(_2\)O\(_5\):K\(_2\)O 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\(^{-1}\), 40 kg P\(_2\)O\(_5\) ha\(^{-1}\) and 20 kg K\(_2\)O ha\(^{-1}\)) through urea, DAP and KCl. The remaining 30 kg N ha\(^{-1}\) was top dressed at 25 DAS through urea. Urea, DAP and KCl were used for basal application and urea as top dressing. 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 early morning hours with knapsack sprayer.

Sowing of pearl millet hybrid RHB-177 was done on 2\(^{nd}\) July 2016 using seed rate of 4 kg ha\(^{-1}\) and maintained crop geometry of 45 x 12 cm. The size of individual plot was kept 4.5 x 4.0 m. The rainfall received during growing period (July to September) 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\(^{0}\)C with average relative humidity from 29.3 to 88.1%. Experimental crop was raised as per recommended package of practices. Two irrigations with sprinkler were applied during the dry spell observed at milking stage and pre-maturing stage.

Observations on total number of tillers/plant at 60 DAS (days after sowing), number of effective tillers/plant, ear head weight (g), grain weight/ear head (g), test weight (g), grain yield (kg ha\(^{-1}\)), stover yield (kg ha\(^{-1}\)), biological yield (kg ha\(^{-1}\)) and harvest index (%) were recorded. Stover yield (kg plot\(^{-1}\)) was obtained by subtracting the seed yield from biological yield plot\(^{-1}\) recorded earlier and then converted in terms of kg ha\(^{-1}\). The harvested material from each plot was thoroughly sun dried and weighed to record biological yield. Harvest index (HI) was calculated as per the procedure prescribed by Singh and Stoskopf (1971). Economics of each treatment was worked out on prevailing market price of input and output in terms of net returns (\(\text{₹ ha}^{-1}\)) and B: C ratio to compare the profitability of different treatments. The
recorded data were subjected to statistical analysis following standard procedure as suggested by Fisher (1950).

**Results and Discussion**

**Effect on yield parameters and yield**

The data presented in Table 1 revealed that application of N, P and K significantly influences the yield parameters of pearl millet. 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 (T_{11}) resulted in significantly higher total number of tillers/plant at 60 DAS (5.05) which was 51.70% high as compared to T_1 (3.33 tillers/plant), T_3, T_4, T_5, T_6, T_7, T_8, T_{12}, T_{13} and T_{14}. However, it was found statistically at par with T_3, T_9 and T_{10} treatments. T_{11} treatment gave the maximum number of effective tillers/plant (2.91) which indicated an increase of 34.67% over T_1 and at par with T_2, T_9 and T_{10} but significantly higher over T_1 and rest of the treatments. Significantly higher ear head weight was recorded with T_{11} (32.39 g) over T_1, T_3, T_4, T_5, T_6, T_{12} and T_{13} which was 12.97, 15.21, 21.71, 33.02, 25.64, 27.10 and 32.73% higher, respectively and at par rest with T_2, T_7, T_8 T_9 and T_{10} treatments. There was significant difference among fertilizer application with respect to grain weight/ear head and T_{11} produced maximum grain weight/ear head (23.32 g), which was significantly higher over T_1, T_3, T_4, T_5, T_6, T_7, T_8, T_{12}, T_{13}, T_{14} and at par with rest of the treatments (T_2, T_9 and T_{10}). Likewise T_{11} resulted in maximum test weight (10.31 g) of pearl millet, which significantly higher over T_1 (86.43% higher) and other treatments except T_2, T_9 and T_{10}.

A glimpse of data (Table 2) indicated that the highest grain yield (2134 kg ha\(^{-1}\)) and stover yield (4744 kg ha\(^{-1}\)) was recorded with 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 (T_{11}) which was significantly higher over T_1, T_3, T_4, T_5, T_6, T_7, T_8, T_{12}, T_{13} and T_{14}, but at par with T_2, T_9 and T_{10}. 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 (T_{11}) increased yield by 72.32% over T_1. 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 (T_{11}) was found to be at par with 75% N (50% basal+25% top dressing at 25 DAS):P:K+0.5% spray of NPK (18:18:18) at 35 DAS (T_9) and 75% N (50% basal+25% top dressing at 25 DAS):P:K+1.0% spray of NPK (18:18:18) at 35 DAS (T_{10}), but significantly higher over remaining treatments. T_{11} treatment also increased biological yield 72.32% over T_1 which was at par with T_9 and T_{10}, but significantly higher over remaining treatments. The highest harvest index (31.94%) was recorded with 50% as basal (NPK)+1.5% spray of NPK (18:18:18) at 35 DAS (T_8) which was significantly higher over T_1, T_3, T_4 and T_5 however; it was statistically at par with other remaining treatments.

The increased supply of NPK and their higher uptake by plants might have stimulated the rate of various physiological processes in plant and 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 and furthermore higher efficiency of foliar supply of N, P and K can further boost photosynthetic efficiency by delaying the onset of leaf senescence which improved the yield and yield parameters of pearl millet. The results of present investigation are in close agreements with the findings of Chaudhari *et al.*, (2002), Bhowmick (2006), Rathore *et al.*, (2006), Sritharan *et al.*, (2006), Choudhary and Gautam (2007), Kanzaria *et al.*, (2010), Ansari *et al.*, (2011), Narolia and Poonia (2011) and Zaki *et al.*, (2016).
Table 1. Effect of N, P and K fertilizers on yield parameters of pearl millet

| Treatment                                                                 | Total no. of tillers plant<sup>-1</sup> at 60 DAS | No. of effective tillers plant<sup>-1</sup> | Ear head weight (g) | Grain weight per ear head (g) | Test weight (g) |
|---------------------------------------------------------------------------|-----------------------------------------------|---------------------------------|-------------------|-------------------------------|-----------------|
| T<sub>1</sub> (Control)                                                  | 3.33                                          | 1.83                             | 21.39             | 14.18                         | 6.85            |
| T<sub>2</sub> (Recommended dose of NPK (60:40:20 kg ha<sup>-1</sup>)       | 4.70                                          | 2.84                             | 30.59             | 21.34                         | 9.71            |
| T<sub>3</sub> (0.5% spray of NPK (18:18:18) at 25 and 35 DAS)             | 3.64                                          | 2.17                             | 24.16             | 16.70                         | 8.54            |
| T<sub>4</sub> (1.0% spray of NPK (18:18:18) at 25 and 35 DAS)             | 3.69                                          | 2.22                             | 24.64             | 17.13                         | 8.57            |
| T<sub>5</sub> (1.5% spray of NPK (18:18:18) at 25 and 35 DAS)             | 3.72                                          | 2.24                             | 26.03             | 17.50                         | 8.65            |
| T<sub>6</sub> (50% as basal (NPK)+0.5% spray of NPK (18:18:18) at 35 DAS) | 4.11                                          | 2.63                             | 28.45             | 18.89                         | 8.83            |
| T<sub>7</sub> (50% as basal (NPK)+1.0% spray of NPK (18:18:18) at 35 DAS) | 4.25                                          | 2.65                             | 30.84             | 20.19                         | 8.91            |
| T<sub>8</sub> (50% as basal (NPK)+1.5% spray of NPK (18:18:18) at 35 DAS) | 4.30                                          | 2.66                             | 30.94             | 20.55                         | 8.96            |
| T<sub>9</sub> (75% N (50% basal+25% top dressing at 25 DAS):P:K+0.5% spray of NPK (18:18:18) at 35 DAS) | 4.75                                          | 2.86                             | 31.50             | 22.08                         | 9.96            |
| T<sub>10</sub> (75% N (50% basal+25% top dressing at 25 DAS):P:K+1.0% spray of NPK (18:18:18) at 35 DAS) | 4.83                                          | 2.88                             | 31.79             | 22.41                         | 10.12           |
| T<sub>11</sub> (75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS) | 5.05                                          | 2.91                             | 32.39             | 23.32                         | 10.31           |
| T<sub>12</sub> (50% N+100% (P and K) as basal+0.5% urea at 35 DAS)         | 4.23                                          | 2.67                             | 26.87             | 19.25                         | 9.15            |
| T<sub>13</sub> (50% N+100% (P and K) as basal+1.0% urea at 35 DAS)         | 4.29                                          | 2.69                             | 27.19             | 19.30                         | 9.31            |
| T<sub>14</sub> (50% N+100% (P and K) as basal+1.5% urea at 35 DAS)         | 4.33                                          | 2.72                             | 28.39             | 19.65                         | 9.37            |
| SEM±                                                                     | 0.15                                          | 0.06                             | 1.03              | 0.88                          | 0.25            |
| CD (0.05)                                                                | 0.42                                          | 0.17                             | 2.98              | 2.57                          | 0.73            |
Table 2 Effect of N, P and K fertilizers on yield and harvest index of pearl millet

| Treatment | Yield (kg ha⁻¹) | Harvest index (%) |
|-----------|----------------|------------------|
|           | Grain | Stover | Biological |           |
| T₁        | 1067  | 2924   | 3991       | 26.82     |
| T₂        | 2010  | 4506   | 6516       | 30.88     |
| T₃        | 1257  | 3401   | 4657       | 26.99     |
| T₄        | 1270  | 3509   | 4779       | 26.58     |
| T₅        | 1288  | 3510   | 4798       | 26.93     |
| T₆        | 1753  | 3856   | 5608       | 31.22     |
| T₇        | 1847  | 4024   | 5871       | 31.44     |
| T₈        | 1892  | 4025   | 5917       | 31.94     |
| T₉        | 2029  | 4524   | 6553       | 30.96     |
| T₁₀       | 2115  | 4674   | 6789       | 31.19     |
| T₁₁       | 2134  | 4744   | 6878       | 31.07     |
| T₁₂       | 1748  | 3894   | 5642       | 31.13     |
| T₁₃       | 1807  | 4193   | 6001       | 30.19     |
| T₁₄       | 1889  | 4139   | 6028       | 31.31     |
| 50% N+100% (P and K) as basal+0.5% urea at 35 DAS | 1748 | 3894 | 5642 | 31.13 |
| 50% N+100% (P and K) as basal+1.0% urea at 35 DAS | 1807 | 4193 | 6001 | 30.19 |
| 50% N+100% (P and K) as basal+1.5% urea at 35 DAS | 1889 | 4139 | 6028 | 31.31 |
| SEm±      | 46    | 105    | 124        | 0.68      |
| CD (0.05) | 133   | 306    | 359        | 1.98      |
| CV (%)    | 7.98  | 7.92   | 6.49       | 6.83      |
Table 3. Effect of N, P and K fertilizers on economics of pearl millet

| Treatment                                                                 | Cost of cultivation (₹ ha⁻¹) | Gross returns (₹ ha⁻¹) | Net returns (₹ ha⁻¹) | B:C ratio |
|---------------------------------------------------------------------------|------------------------------|------------------------|----------------------|-----------|
| T₁   Control                                                              | 16080                        | 22787                  | 6707                 | 1.31      |
| T₂   Recommended dose of NPK (60:40:20 kg ha⁻¹)                            | 19323                        | 40412                  | 21089                | 2.09      |
| T₃   0.5% spray of NPK (18:18:18) at 25 and 35 DAS                         | 17420                        | 26725                  | 9305                 | 1.53      |
| T₄   1.0% spray of NPK (18:18:18) at 25 and 35 DAS                         | 17960                        | 27187                  | 9227                 | 1.51      |
| T₅   1.5% spray of NPK (18:18:18) at 25 and 35 DAS                         | 18500                        | 27453                  | 8953                 | 1.48      |
| T₆   50% as basal (NPK)+0.5% spray of NPK (18:18:18) at 35 DAS             | 18471                        | 35056                  | 16584                | 1.90      |
| T₇   50% as basal (NPK)+1.0% spray of NPK (18:18:18) at 35 DAS             | 18741                        | 36837                  | 18095                | 1.97      |
| T₈   50% as basal (NPK)+1.5% spray of NPK (18:18:18) at 35 DAS             | 19011                        | 37492                  | 18480                | 1.97      |
| T₉   75% N (50% basal+25% top dressing at 25 DAS):P:K+0.5% spray of NPK (18:18:18) at 35 DAS | 19232                        | 40728                  | 21496                | 2.12      |
| T₁₀  75% N (50% basal+25% top dressing at 25 DAS):P:K+1.0% spray of NPK (18:18:18) at 35 DAS | 19502                        | 42353                  | 22851                | 2.17      |
| T₁₁  75% N (50% basal+25% top dressing at 25 DAS):P:K+1.5% spray of NPK (18:18:18) at 35 DAS | 19772                        | 42798                  | 23026                | 2.16      |
| T₁₂  50% N+100% (P and K) as basal+0.5% urea at 35 DAS                     | 19350                        | 35076                  | 15726                | 1.81      |
| T₁₃  50% N+100% (P and K) as basal+1.0% urea at 35 DAS                     | 19368                        | 36691                  | 17323                | 1.89      |
| T₁₄  50% N+100% (P and K) as basal+1.5% urea at 35 DAS                     | 19386                        | 37741                  | 18355                | 1.95      |
| SEm±                                       | -                            | 765                    | 765                  | 0.04      |
| CD (0.05)                                  | -                            | 2225                   | 2225                 | 0.12      |
Effect on economics

Economics of the treatments presented in Table 3 revealed that the gross return (₹42798 ha⁻¹), net return (₹23026 ha⁻¹) and benefit: cost ratio (2.16) were higher with 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 (T₁₁).

It was found to be at par with T₂, T₉ and T₁₀ and significantly higher over control and other remaining treatments. The lowest gross return (₹22787), net return (₹6707) and B: C ratio (1.31) were recorded in the control.

These findings are in vicinity with those reported by Parihar et al., (2009) and Narolia and Poonia (2011).

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