Yield and Nutrient Uptake of Pigeonpea [*Cajanus cajan* (L.)] as Influenced by Sowing Window, Nutrient Dose and Foliar Sprays

C. Nagamani, V. Sumathi, G. Prabhakara Reddy

**ABSTRACT**

A field experiment was conducted during the rabi seasons of 2012-13 and 2013-14 to study the influence of sowing window, nutrient dose and foliar spray on yield and nutrient uptake of pigeonpea on sandy loam soil which was low in available nitrogen, medium in available phosphorus and available potassium. The experiment was conducted in a split-split plot design, consisting of three sowing windows in main plots, three nutrient doses in sub-plots and two foliar sprays in sub-sub plots. Crop sown during II FN of September produced significantly higher seed and stalk yield, nutrient content and uptake. Application of 30-60-20 kg N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O ha<sup>-1</sup> improved seed yield, stalk yield, nutrient content and uptake of redgram. Higher seed yield, stalk yield and nutrient uptake by the crop was recorded with foliar application of NAA (25 ppm) and DAP (2 per cent) applied at 60 and 80 DAS. Interaction between sowing window and nutrient doses, sowing window and foliar sprays were significant in influencing yield of pigeonpea.

**Key words:** Foliar sprays, Nutrient dose, Nutrient uptake, Sowing window, Yield.

**INTRODUCTION**

Pulses form an important group of food crops for nutritional security, sustainable crop production and soil health. Pigeonpea has the special morphological characters with respect to deep rooting and drought tolerance that have made this crop adaptable for growing in wide range of unfavourable conditions with uncertain rainfall and varied soil depth. One of the significant achievements in the field of grain legume cultivation in India is that pigeonpea can be grown as *rabi* crop (Sengupta and Roy, 1982) particularly in the areas where winter is mild and short like Andhra Pradesh, West Bengal and Bihar. Thus, among the various agronomic practices, sowing date has more influence on yield than any other production factor. Appropriate sowing window causes optimal utilization of climatic factors such as temperature, humidity and day length. Early sowing in the season may encourage higher vegetative growth which may initiate various diseases and insect pests, whereas delayed sowing may shrink the vegetative phase, which in turn reduces dry matter accumulation leading to poor partitioning to reproductive parts and ultimately poor realization of the potential yield. The low yield of pigeonpea is mainly attributed to inadequate and imbalance application of nutrients. The prominent effect of foliar application of nutrients and growth regulator at pre flowering and flowering stage was on reduction in flower shed and flower drop percentage.

Hence, the present study was carried out to study the influence of sowing window, nutrient doses and foliar application on yield and nutrient uptake by the crop.

**MATERIALS AND METHODS**

A field experiment was conducted at S. V. Agricultural College, Tirupati campus of ANGRAU (A.P) during *rabi* seasons of 2012-13 and 2013-14 to study the influence of sowing window, nutrient dose and foliar sprays on yield and nutrient uptake of pigeonpea. The soil of the experimental field was sandy clay loam in texture, low in available N, medium in available P and available K. Pigeonpea variety LRG-41 was used for experimentation. The experiment was laid in split-split design with three sowing times (II FN of September (T<sub>1</sub>), I FN of October (T<sub>2</sub>) and II FN of October (T<sub>3</sub>)) in main plots, three nutrient doses [10-40-0 kg N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O ha<sup>-1</sup> (N<sub>1</sub>), 20-50-10 kg N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O ha<sup>-1</sup> (N<sub>2</sub>) and 30-60-20 kg N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O ha<sup>-1</sup> (N<sub>3</sub>)] in subplots and two foliar sprays [NAA (25 ppm) and DAP (2 per cent) applied at 60 DAS (F<sub>1</sub>) and NAA (25 ppm) and DAP (2 per cent) applied at 60 and 80 DAS (F<sub>2</sub>) in sub-sub plots. Healthy and well matured seeds were sown in furrows opened by hand hoes at a spacing of 45 cm x 15 cm. The herbicide imazethapyr was sprayed as pre emergence application @ 1.5 ml l<sup>-1</sup> of water to all the plots on the second day after sowing, using a sprayer with flat fan nozzle with a spray...
solution of 500 l ha\(^{-1}\). Hand weeding was done twice at 35 and 70 days after sowing. Three nutrient levels were applied to sub plots as per the prescribed treatments assigned. Entire quantities of N, P\(_{2}O_{5}\) and K\(_{2}O\) were applied by placement method at the time of sowing. At harvest, seed and stalk yields were recorded on a whole-plot basis after discarding border plants and were expressed as seed and stalk yield in kg ha\(^{-1}\). Nitrogen, phosphorus and potassium contents in plants were analyzed by the standard procedure outlined by Jackson (1973). The uptake of nitrogen, phosphorus and potassium at harvest were calculated and expressed in kg ha\(^{-1}\) by multiplying the nutrient content with

### Table 1: Seed and stalk yield (kg ha\(^{-1}\)) of rabi pigeonpea as influenced by varied sowing window, nutrient doses and foliar sprays (pooled data over two years).

| Treatment                                      | Seed yield (kg ha\(^{-1}\)) | Stalk yield (kg ha\(^{-1}\)) |
|------------------------------------------------|-----------------------------|------------------------------|
| T\(_{1}\) II Fortnight of September            | 1700                        | 7226                         |
| T\(_{2}\) I Fortnight of October               | 1329                        | 4102                         |
| T\(_{3}\) II Fortnight of October              | 1067                        | 3253                         |
| SEM ±                                          | 36.8                        | 52.3                         |
| CD (5%)                                        | 144                         | 204                          |
| N\(_{1}\): 10-40-0 kg N, P\(_{2}O_{5}\) and K\(_{2}O\) ha\(^{-1}\) | 1127                        | 4611                         |
| N\(_{2}\): 20-50-10 kg N, P\(_{2}O_{5}\) and K\(_{2}O\) ha\(^{-1}\) | 1379                        | 4867                         |
| N\(_{3}\): 30-60-20 kg N, P\(_{2}O_{5}\) and K\(_{2}O\) ha\(^{-1}\) | 1589                        | 5102                         |
| SEM ±                                          | 10.3                        | 6.7                          |
| CD (5%)                                        | 32                          | 21                           |
| F\(_{1}\): Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS | 1297                        | 4806                         |
| F\(_{2}\): Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS | 1434                        | 4914                         |
| SEM ±                                          | 3.6                         | 5.3                          |
| CD (5%)                                        | 11                          | 16                           |
| T\(_{1}\)N\(_{1}\)F\(_{1}\)                   | 1371                        | 6951                         |
| T\(_{1}\)N\(_{1}\)F\(_{2}\)                   | 1505                        | 7054                         |
| T\(_{1}\)N\(_{2}\)F\(_{1}\)                   | 1650                        | 7198                         |
| T\(_{1}\)N\(_{2}\)F\(_{2}\)                   | 1809                        | 7297                         |
| T\(_{1}\)N\(_{3}\)F\(_{1}\)                   | 1863                        | 7372                         |
| T\(_{1}\)N\(_{3}\)F\(_{2}\)                   | 2000                        | 7485                         |
| T\(_{1}\)N\(_{2}\)F\(_{1}\)                   | 976                         | 3769                         |
| T\(_{1}\)N\(_{2}\)F\(_{2}\)                   | 1145                        | 3881                         |
| T\(_{1}\)N\(_{3}\)F\(_{1}\)                   | 1245                        | 4035                         |
| T\(_{1}\)N\(_{3}\)F\(_{2}\)                   | 1407                        | 4144                         |
| T\(_{1}\)N\(_{3}\)F\(_{3}\)                   | 1521                        | 4308                         |
| T\(_{1}\)N\(_{1}\)F\(_{2}\)                   | 1680                        | 4476                         |
| T\(_{1}\)N\(_{1}\)F\(_{3}\)                   | 794                         | 2963                         |
| T\(_{1}\)N\(_{2}\)F\(_{3}\)                   | 794                         | 3052                         |
| T\(_{1}\)N\(_{3}\)F\(_{2}\)                   | 1066                        | 3218                         |
| T\(_{1}\)N\(_{2}\)F\(_{2}\)                   | 1097                        | 3313                         |
| T\(_{1}\)N\(_{3}\)F\(_{3}\)                   | 1187                        | 3445                         |
| T\(_{1}\)N\(_{3}\)F\(_{2}\)                   | 1285                        | 3528                         |
| TxN                                            | 17.8                        | 11.6                         |
| SEM ±                                          | 55                          | 36                           |
| TxF                                            | 6.2                         | 9.2                          |
| SEM ±                                          | 19                          | NS                           |
| NxF                                            | 6.2                         | 9.2                          |
| SEM ±                                          | 19                          | NS                           |
| TxFNxF                                         | 10.8                        | 15.9                         |
| SEM ±                                          | 32                          | NS                           |
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RESULTS AND DISCUSSION

Seed and stalk yield

There was a progressive decrease in seed and stalk yield of pigeonpea with successive delay in sowing time from II FN of September to II FN of October (Table 1). The crop sown during II FN of September (T₁) resulted in significantly higher seed and stalk yield of pigeonpea. Higher seed and stalk yield with early sowing can be attributed to longer vegetative phase leading to improvement in growth, yield attributes and yield. These results are in conformity with that of Padhi (1995) and Laxminarayana (2003). Among the fertilizer doses, the higher seed and stalk yield were recorded with application of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (N₃) which was significantly superior to that of 20-50-10 kg N, P₂O₅ and K₂O ha⁻¹ (N₂) and 10-40-0 kg N, P₂O₅ and K₂O ha⁻¹ (N₁). The differences in seed and stalk yield might be attributed to difference in doses of N, P and K. Improvement in growth parameters might have lead to improvement in the corresponding dry matter production. The data was analysed statistically and presented.

Table 2: Nutrient content of pigeonpea at harvest as influenced by varied sowing window, nutrient doses and foliar sprays.

| Times of sowing                  | Nitrogen content (%) | Phosphorus content (%) | Potassium content (%) |
|----------------------------------|----------------------|------------------------|-----------------------|
|                                  | 2012-13              | 2013-14                | 2012-13               | 2013-14                | 2012-13 | 2013-14 |
| T₁-II Fortnight of September     | 1.33                 | 1.32                   | 0.212                 | 0.195                 | 0.755   | 0.729   |
| T₂-I Fortnight of October        | 1.28                 | 1.24                   | 0.182                 | 0.160                 | 0.683   | 0.662   |
| T₃-II Fortnight of October       | 1.16                 | 1.11                   | 0.165                 | 0.145                 | 0.616   | 0.640   |
| SEM±                             | 0.013                | 0.011                  | 0.005                 | 0.003                 | 0.011   | 0.005   |
| CD (P=0.05)                      | 0.05                 | 0.04                   | 0.020                 | 0.013                 | 0.043   | 0.018   |

Nutrient levels

N₁-10-40-0 kg N, P₂O₅ and K₂O ha⁻¹

N₂-20-50-10 kg N, P₂O₅ and K₂O ha⁻¹

N₃-30-60-20 kg N, P₂O₅ and K₂O ha⁻¹

SEM±

CD (P=0.05)

Foliar applications

F₁-Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS

F₂-Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS

SEM±

CD (P=0.05)

Table 3: Nitrogen uptake at harvest (kg ha⁻¹) of pigeonpea as influenced by varied sowing window, nutrient doses and foliar sprays.

| Times of sowing                  | 2012-13 | 2013-14 |
|----------------------------------|---------|---------|
| T₁-II Fortnight of September     | 191.6   | 190.8   |
| T₂-I Fortnight of October        | 116.3   | 111.8   |
| T₃-II Fortnight of October       | 66.2    | 63.8    |
| SEM±                             | 1.27    | 2.23    |
| CD (P=0.05)                      | 5.0     | 8.7     |

Nutrient levels

N₁-10-40-0 kg N, P₂O₅ and K₂O ha⁻¹

N₂-20-50-10 kg N, P₂O₅ and K₂O ha⁻¹

N₃-30-60-20 kg N, P₂O₅ and K₂O ha⁻¹

SEM±

CD (P=0.05)

Foliar applications

F₁-Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS

F₂-Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS

SEM±

CD (P=0.05)
Table 4: Phosphorus and potassium uptake at harvest (kg ha⁻¹) of pigeonpea as influenced by varied sowing window, nutrient doses and foliar sprays.

|                | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
|----------------|---------|---------|---------|---------|
|                | F₁      | F₂      | Mean for T | Mean for N | F₁      | F₂      | Mean for T | Mean for N | F₁      | F₂      | Mean for T | Mean for N |
| **T₁**         |         |         |           |           |         |         |           |           |         |         |           |           |
| N₁             | 23.0    | 24.7    | 30.7      | 14.4      | 21.5    | 21.3    | 28.3      | 12.9      | 87.5    | 92.0    | 109.2      | 55.6      | 87.2    | 92.3    | 105.5      | 56.9      |
| N₂             | 28.6    | 31.5    | 33.0      | 35.7      | 105.3   | 111.1   | 92.0      | 111.1     | 103.5   | 108.2   | 103.5      | 108.2     |         |         |             |           |
| N₃             | 37.1    | 39.3    | 33.0      | 35.7      | 127.5   | 131.6   | 117.7     | 123.9     | 103.5   | 108.2   | 103.5      | 108.2     |         |         |             |           |
| **T₂**         |         |         |           |           |         |         |           |           |         |         |           |           |         |         |             |           |
| N₁             | 12.0    | 13.8    | 16.5      | 18.6      | 10.6    | 12.1    | 14.5      | 17.0      | 49.2    | 52.5    | 61.9       | 68.3      | 51.8    | 53.2    | 59.6       | 66.9      |
| N₂             | 16.1    | 16.7    | 13.0      | 14.8      | 61.1    | 62.7    | 58.0      | 59.3      | 34.9    | 37.5    | 34.9       | 37.5      |         |         |             |           |
| N₃             | 19.5    | 21.1    | 17.7      | 18.9      | 71.4    | 74.7    | 66.0      | 69.3      |         |         |             |           |         |         |             |           |
| **T₃**         |         |         |           |           |         |         |           |           |         |         |           |           |         |         |             |           |
| N₁             | 6.3     | 6.8     | 9.5       | 23.7      | 5.5     | 6.5     | 8.4       | 21.3      | 24.7    | 27.8    | 35.3       | 82.4      | 26.6    | 30.3    | 36.9       | 78.2      |
| N₂             | 8.7     | 10.2    | 7.6       | 8.8       | 33.7    | 36.1    | 34.9      | 37.5      | 44.5    | 47.5    |             |            |         |         |             |           |
| N₃             | 11.8    | 13.3    | 10.5      | 11.8      | 42.6    | 46.5    | 44.5      | 47.5      |         |         |             |            |         |         |             |           |
| Mean for F     | 18.1    | 19.7    | -         | -         | 67.0    | 70.5    | -         | -         | 65.6    | 69.1    | -          | -          |         |         |             |           |

|                | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
|----------------|---------|---------|---------|---------|
|                | SEm ±   | CD (P = 0.05) | SEm ±   | CD (P = 0.05) | SEm ±   | CD (P = 0.05) | SEm ±   | CD (P = 0.05) |
| T               | 0.48    | 1.9     | 0.32    | 1.2     | 1.10    | 4.3     | 1.21    | 4.7     |
| N               | 0.55    | 1.7     | 0.32    | 1.0     | 2.56    | 7.9     | 1.30    | 4.0     |
| F               | 0.37    | 1.1     | 0.41    | 1.7     | 1.91    | NS      | 1.14    | NS      |
| TN              | 0.95    | 2.9     | 0.56    | 1.2     | 4.43    | NS      | 2.25    | 6.9     |
| TF              | 0.65    | NS      | 0.72    | NS      | 3.31    | NS      | 1.98    | NS      |
| NF              | 0.65    | NS      | 0.72    | NS      | 3.31    | NS      | 1.98    | NS      |
| TNF             | 1.12    | NS      | 1.24    | NS      | 5.73    | NS      | 3.42    | NS      |
Yield attributes and hence the higher yield at higher nutrient level (Meena et al., 2013 and Umesh et al., 2013). Foliar spray of NAA (25 ppm) and DAP (2%) twice at 60 and 80 DAS (F₂) resulted in significantly higher seed and stalk yield (Table 2) relative to that due to the same foliar spray once at 60 DAS (F₁). It was probable that application of NAA might have induced large number of new sinks leading to greater activity of carboxylating enzymes and rate of protein synthesis. This resulted in higher photosynthetic rate, translocation and accumulation of metabolites in the sink and eventually greater seed production (Kalpana and Krishnarajan, 2003). Interaction of sowing times and nutrient levels significantly increased the seed and stalk yield of pigeonpea. It appears that, early sowing with higher nutrient dose (T₃) had improved growth parameters (plant height, leaf area, dry matter production and crop growth rate) and yield attributes (number of pod bearing branches plant⁻¹, number of pods branch⁻¹, number of seeds pod⁻¹ and test weight) leading to higher seed and stalk yield. Significantly, higher seed yield was with crop sown during II FN of September receiving two foliar sprays at 60 and 80 DAS (T₃F₃) due to N and P₂O₅ availability from flower primordia initiation to seed maturity as DAP was applied through foliar application. Highest nutrient level along with foliar application twice (N₂F₂) resulted in higher seed yield. Earliest sown crop receiving higher nutrient dose and two foliar applications (T₁N₂F₂) resulted in the highest seed yield of rabi pigeonpea due to efficient use of natural resources and applied nutrients.

Nutrient content and uptake

The higher nitrogen, phosphorus and potassium content of plant (Table 2) were recorded when the crop was sown during II FN of September (T₃) followed by that with that of I FN of October sown crop during both the years. Longer duration of the crop due to early sowing allowed the crop to absorb nutrients for a longer period of time leading to higher concentration of nutrients in the plant. These results are in accordance with those of Gill (2013). Application of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (T₃) resulted in significantly higher nutrient content relative to the lower doses of nutrients applied. The results are in line with those of Singh and Singh (2011). Foliar application did not significantly influence the nutrient content of plant during both the years of investigation.

The higher nutrient (nitrogen, phosphorus and potassium) uptake was with the earliest sown crop during II FN of September (T₃) during both the years (Table 3 and 4). Higher nutrient uptake with early sown crop was due to the longer vegetative lag phase of the crop that has lead to efficient use of growth resources and hence higher dry matter production. Application of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (T₃) resulted in the highest nutrient uptake, which was significantly higher than with 20-50-10 kg N, P₂O₅ and K₂O ha⁻¹ (T₁) in both the years. Increase in nutrient uptake by redgram at higher nutrient doses can be attributed to higher yield coupled with slight improvement in nutrient concentration in seed and non-seed parts. These results are in accordance with Umesh and Shankar (2013). With regard to foliar sprays, nitrogen uptake during first year and phosphorus uptake during both the years, were the highest with NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS (F₂). With regard to interaction, the highest phosphorus uptake during both the years of study and potassium uptake during second year of study were with crop sown during II FN of September along with the nutrient dose of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ (T₃N₃), which was significantly higher than that due to rest of the combinations.

CONCLUSION

From the present investigation it can be concluded that crop sown during II FN of September with nutrient dose of 30-60-20 kg N, P₂O₅ and K₂O ha⁻¹ and foliar application of NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS resulted in better seed and stalk yield, nutrient content and uptake under the prevailing condition.

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