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# Utilization of Nutrients by Short-Duration Pigeonpea (*Cajanus cajan* L.) Genotypes Applied with Phosphorus and Sulphur

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**ABSTRACT**

A field experiment was conducted during cropping seasons 2021-22 and 2022-23 at the Private Agricultural-cum-Research Farm, Beenda-Semaria Road, Rewa (M.P.) to study the utilization of nutrients by short-duration pigeonpea genotypes applied with phosphorus and sulphur. The N, P, K, S nutrient contents in grain and straw deviated significantly due to different genotypes and fertility levels as well as their interactions. The genotype TJT-501 as well as highest fertility level ($P_{60}$ $S_{45}$) recorded significantly higher N, P, K and S nutrient contents in grain and straw over the respective treatments. Consequently the uptake of these nutrients was found significantly higher in grain and straw of TJT-501 over other genotypes. Thus highest nutrients uptake by TJT-501, genotype producing a total biomass up to 54.64 q/ha, was 79.32 kg N, 12.84 kg P, 55.98 kg K and 11.93 kg S/ha. The uptake nutrients was found significantly higher in grain and straw due to increasing fertility levels up to $P_{60}$ $S_{45.}$ Similarly the maximum N, P, K and S uptake was recorded under highest $P_{60}$ $S_{45}$ fertility level producing total biomass upto 70.64 q/ha. The findings suggest that due to heavy withdrawal of nutrients by pigeonpea genotypes, the succeeding crop must be nourished properly based on soil test values.

## Introduction

The deficiency of multi-nutrients in soil is posing a great threat towards sustainable productivity of pigeonpea. The heavy withdrawal of nutrients by high-yielding varieties, intensive cropping systems, imbalanced and insufficient use of manures and fertilizers, and use of sulphur-free fertilizers aggravated the multi-nutrient deficiencies in the soil. The general tendency is that the total crop removal of nutrients is never replenished. That is why soil health and sustainable productivity of pigeonpea are becoming the burning problems. It is well known fact that pigeonpea, a nutritious crop, is heavy feeder of nutrients and highly responsive to the applied nutrients including sulphur. Due to fertility variations in different soil types, the response of a certain pigeonpea genotype to direct fertilizers application is highly inconsistent, location and even site specific (Saket *et al.,* 2014).

Limited work has been done in Rewa region on the response of newly developed pigeonpea genotypes towards the applied P and S fertilizers. In view of this fact, the present research was taken up.

## Materials and Methods

A field experiment was conducted during cropping seasons 2021-22 and 2022-23 at the Private Agriculture-cum-Research Fram, Beenda-Semaria Road, Rewa (M.P.). The soil of the experimental field was silty clay-loam having ph *7.1-7.3,* electrical conductivity 0.26-0.33 dS/m, organic carbon 6.35-6.53 g/kg, available N 230-238 kg/ha, $P_2O_5$ 22.4-25.3 kg/ha, $K_2O$ 330-349 kg/ha and available 13.0-13.8 kg/ha. The rainfall received during cropping period was 760 mm. The treatments comprised pigeon pea genotypes in the main/plots and five fertility levels in the sub-plots (Table 1). The experiment was laid out in split-plot design with three replications. The pigeonpea genotypes inoculated with *Rhizobium* and PSB were sown during on $3^{rd}$ week of July and both the years @ 20 kg seed/ha at 30 cm row spacing. The P and S levels were applied through diammonium phosphate, urea and single superphosphate. An uniform dose of 20 kg $K_2O$/ha was applied as basal through muriate of potash in all the treatments. The crop was grown as per recommended package of practices. The crop was harvested during last week of December to $1^{st}$ week of January in both the years. The per cent N, P, K and S concentrations in seed and straw of pigeonpea were determined by following the standard analytical procedures (A.O.A.C., 1997). The nutrients uptake per hectare was calculated by multiplying the seed or straw yield with the per cent N, P, K and S nutrient contents in seed or straw.

## Results and Discussion

### Nutrient Contents

The data (Table 1) reveal that the N, P, K and S contents in pigeonpea genotypes were, in general, higher in grain than in straw. In fact, the grain acted as a sink for photosynthates and nitrogen. Among the pigeonpea genotypes, these nutrient contents in grain and straw were found to deviate almost significantly TJT-501 and then UPAS-120 showed higher nutrient contents over ICPL-157 and ICPL-87.

This indicated that the absorption capacity of the applied nutrients to these four genotypes was different. The increasing fertility levels up to $P_{60}$ $S_{45}$ increased the N, P, K and S nutrient contents in grain and straw almost significantly. The increase in these nutrient contents might be with the fact that plants absorbed proportionately higher amount of applied nutrients as the pool of available nutrients increased in the soil by adding higher dose of P and S fertilizers. The increasing NPKS contents in plant parts has a close relationship with the symbiotic efficiency, specific rhizobial activity, increased N availability in soil and other favourable edaphic conditions. The present results agree with those of many workers (Singh *et al.*, 2013; Shukla *et al.*, 2013; Raj *et al.*, 2014; Saket *et al.*, 2014; Saket *et al.*, 2017).

### Uptake of Nutrients

The data in Table 2 reveal that uptake of N, P, K and S per hectare was, in general, higher in grain than in straw. There were wide variations in the quantum of N, P, K and S uptake by grain and straw.

Due to applied treatments. As regards with the pigeonpea genotypes, TJT -501 resulted in significantly higher uptake of N,P,K and S nutrients over other three genotypes. Thus, the highest total nutrients uptake by TJT-501 producing total biomass up to 57.64 q/ha, was 79.32 kg N, 12.84 kg P, 55.98 kg K and 11.93 kg S/ha. This was, however, followed by UPAS-120, ICPL-157 and then ICPL-87. The ICPL-87 genotype producing 57.08 q/ha biomass brought about the lowest total nutrients uptake (68.51 kg N, 10.91 kg P, 54.59 kg K and 10.73 kg S/ha.). The uptake of N, P, K and S nutrients was found to enhance almost significantly with the increasing fertility levels up to $P_{60}$ $S_{45.}$

**Table.1** Nutrient contents in (%) pigeonpea grain and straw as influenced by genotypes and fertility levels (Pooled for 2 seasons)

| Treatments | N-content (%) | | P-content (%) | | K-content (%) | | S-content (%) | |
|---|---|---|---|---|---|---|---|---|
| **Genotypes** | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| **ICPL-87** | 3.35 | 0.76 | 0.52 | 0.124 | 0.219 | 1.10 | 0.415 | 0.141 |
| **ICPL-157** | 3.38 | 0.78 | 0.54 | 0.127 | 0.222 | 1.13 | 0.419 | 0.144 |
| **UPAS-120** | 3.41 | 0.80 | 0.56 | 0.130 | 0.225 | 1.16 | 0.422 | 0.146 |
| **TJT-501** | 3.44 | 0.83 | 0.57 | 0.132 | 0.228 | 1.17 | 0.424 | 0.149 |
| **CD(P=0.05)** | 0.140 | 0.03 | 0.036 | 0.021 | 0.017 | 0.08 | 0.002 | 0.002 |
| **Fertility levels(kg/ha)** | | | | | | | | |
| **$P_0$ $S_0$** | 3.25 | 0.67 | 0.45 | 0.105 | 0.195 | 0.97 | 0.393 | 0.123 |
| **$P_{30}$ $S_0$** | 3.31 | 0.74 | 0.51 | 0.117 | 0.209 | 1.07 | 0.409 | 0.135 |
| **$P_{60}$ $S_0$** | 3.35 | 0.78 | 0.53 | 0.125 | 0.218 | 1.13 | 0.419 | 0.144 |
| **$P_{60}$ $S_{15}$** | 3.44 | 0.81 | 0.56 | 0.133 | 0.228 | 1.18 | 0.426 | 0.149 |
| **$P_{60}$ $S_{30}$** | 3.48 | 0.86 | 0.59 | 0.142 | 0.240 | 1.24 | 0.435 | 0.157 |
| **$P_{60}$ $S_{45}$** | 3.54 | 0.90 | 0.63 | 0.148 | 0.251 | 1.28 | 0.438 | 0.163 |
| **CD (P=0.05)** | 0.09 | 0.02 | 0.025 | 0.012 | 0.012 | 0.06 | 0.003 | 0.001 |
| **Interaction** | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |

Sig.=Significant

**Table.2** Uptake of nutrients (kg/ha) of pigeonpea as influenced by genotypes and P x S fertility levels (Pooled for 2 Seasons)

| Treatments | N-uptake (kg/ha) | | | P-uptake (kg/ha) | | | K-uptake (kg/ha) | | | S-uptake (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Genotypes** | Grain | Straw | Total | Grain | Straw | Total | **Grain** | Straw | Total | Grain | Straw | Total |
| **ICPL-87** | 32.25 | 36.26 | 68.51 | 5.01 | 5.90 | 10.91 | 2.11 | 52.48 | 54.59 | 4.00 | 6.73 | 10.73 |
| **ICPL-157** | 35.40 | 36.52 | 71.92 | 5.66 | 5.92 | 11.58 | 2.32 | 52.90 | 55.22 | 4.40 | 6.74 | 11.14 |
| **UPAS-120** | 39.35 | 36.30 | 75.65 | 6.40 | 5.92 | 12.32 | 2.59 | 52.73 | 55.32 | 4.87 | 6.67 | 11.54 |
| **TJT-501** | 41.79 | 37.53 | 79.32 | 6.86 | 5.98 | 12.84 | 2.77 | 53.21 | 55.98 | 5.15 | 6.78 | 11.93 |
| **CD(P=0.05)** | 0.363 | 0.367 | 0.730 | 0.29 | 0.19 | 0.48 | 0.15 | 0.31 | 0.46 | 0.18 | 0.07 | 0.25 |
| **Fertility levels(kg/ha)** | | | | | | | | | | | | |
| **$P_0$ $S_0$** | 29.89 | 25.08 | 54.97 | 4.14 | 3.91 | 8.05 | 1.79 | 36.11 | 37.90 | 3.62 | 4.58 | 8.20 |
| **$P_{30}$ $S_0$** | 32.32 | 28.70 | 61.02 | 4.94 | 4.57 | 9.51 | 2.04 | 41.78 | 43.82 | 4.00 | 5.27 | 9.27 |
| **$P_{60}$ $S_0$** | 36.06 | 34.28 | 70.34 | 5.44 | 5.47 | 10.91 | 2.35 | 49.44 | 51.79 | 4.51 | 6.31 | 10.82 |
| **$P_{60}$ $S_{15}$** | 38.32 | 38.91 | 77.23 | 6.25 | 6.37 | 12.62 | 2.54 | 56.44 | 58.98 | 4.75 | 7.14 | 11.89 |
| **$P_{60}$ $S_{30}$** | 41.36 | 44.77 | 86.13 | 7.01 | 7.44 | 14.45 | 2.85 | 64.66 | 67.51 | 5.16 | 8.22 | 13.38 |
| **$P_{60}$ $S_{45}$** | 45.74 | 51.64 | 97.38 | 8.08 | 8.51 | 16.59 | 3.25 | 73.56 | 76.81 | 5.67 | 9.38 | 15.05 |
| **CD (P=0.05)** | 0.24 | 0.33 | 0.57 | 0.19 | 0.13 | 0.32 | 0.09 | 0.53 | 0.62 | 0.18 | 0.07 | 0.25 |
| **Interaction** | Sig | Sig | Sig | Sig | Sig | Sig | Sig | Sig | Sig | Sig | Sig | Sig |

Sig.=Significant

Accordingly, $P_{60}S_{45}$ recorded the highest N-uptake by grain 45.74 kg/ha and by straw 51.64 kg/ha, P-uptake by grain 8.08 kg/ha and by straw 8.51 kg/ha, K-uptake by grain 3.25 kg/ha and by straw 73.56 kg/ha and S-uptake by grain 5.67 kg/ha and by straw 9.38 kg/ha. Thus, the highest total nutrients uptake by pigeonpea, producing a total biomass (grain + straw) up to 70.64 q/ha applied with $P_{60}S_{45}$, was 97.38 kg N, 16.59 kg P, 76.81 kg K and 15.05 kg S/ha.

This was followed by $P_{60}S_{30}$ and then $P_{60}S_0$. In contrast, the lowest total nutrients uptake at $P_0S_0$, producing total biomass up to 46.64 q/ha, was only 54.97 kg N, 8.06 kg P, 37.90 kg K and 8.20 kg S/ha.

The higher uptake of N,P,K and S nutrients under different P x S levels may be attributed to increased grain and straw yield as well as increased N,P,K and S contents in grain and straw.

The present results corroborate with the findings of several workers (Mishra *et al.*, 2015; Singh, Saket *et al.*, 2017; Singh and Singh 2017; Gadi *et al.*, 2018; Tyagi and Singh, 2019). The findings further indicated that the uptake of these nutrients, in general, was almost higher in grain than in straw. This may be due to the fact that the larger part of P absorbed by the plant would have migrated into seeds by the time of harvest.

The treatment interactions were found to be significant with respect to nutrient contents and their uptake. Thus, the highest fertility level ($P_{60}$ $S_{45}$) applied to TJT-501 further enhanced all the nutrient contents and their uptake as compared to the separately applied treatments. The yield of TJT-501 was eventually found highest under this treatment interaction. This was, however, followed by $P_{60}$ $S_{30}$ applied to TJT-501 and then $P_{60}S_{45}$ applied to UPAS-120. The findings concluded that the highest NPKS uptake was recorded when total biomass was produced under TJT-501 genotype applied with $P_{60}S_{45}$ fertility level. Hence the fertilizers recommendation to the succeeding crop must be made accordingly.

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