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Influence of nipping and growth regulators on nutrient uptake of redgram [*Cajanus cajan* (L.) Millsp] under HDPS

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Abstract

The present field experiment entitled “Influence of nipping and growth regulators on nutrient uptake of redgram [*Cajanus cajan* (L.) Millsp] under HDPS” was conducted during *khari* 2025 at the Regional Agricultural Research Station (RARS), Palem, Professor Jayashankar Telangana Agricultural University, Telangana. The experiment was laid out in a strip plot design comprising three spacing levels viz., 90 × 20 cm (M₁), 75 × 20 cm (M₂) and 60 × 20 cm (M₃) as main plot treatments and sub plot treatments include growth regulators and nipping practice viz., Mepiquat chloride (MC) @ 500 ppm (S₁), Paclobutrazole (PBZ) @ 100 ppm (S₂), nipping at 60 DAS (S₃) and Control (S₄) and this were replicated thrice. The nitrogen, phosphorus and potassium uptake by seed and stover were registered significantly higher under in 75 × 20 cm (M₂). Among the growth regulators and nipping practice, the application of Mepiquat Chloride @ 500 ppm at 60 DAS (S₁) resulted significantly higher in nitrogen, phosphorus and potassium uptake by seed and stover were significantly higher under MC @ 500 ppm. The interaction effect of spacing, growth regulators and nipping practice on yield, quality parameters did not differ significantly. From this investigating it can be concluded that, among spacing treatments, 75 × 20 cm (M₂) spacing found best and Mepiquat chloride @ 500 ppm (S₁) was superior over Paclobutrazole @ 100 ppm (S₂), nipping practice.

Keywords: Redgram, *Cajanus cajan*, High Density Planting System (HDPS)

1. Introduction

Redgram (*Cajanus cajan* L.) is a prominent pulse crop belonging to the family Leguminosae, commonly referred to as pigeonpea, tur or arhar and occupies a significant position in Indian agriculture. In India, pigeonpea ranks second among pulse crops after chickpea and stands sixth among grain legumes at the global level (Kumar *et al.*, 2022) ^[6]. Redgram contains around 22.3 per cent protein, 1.7 per cent fat, 3.5 per cent minerals, 1.5 per cent fibre and 57.5 per cent carbohydrates per 100 g. Pulses are an important source of protein for vegetarians in India, supplementing staple grains with necessary amino acids, vitamins and minerals (Raju, 2019) ^[9]. India has the highest redgram area of 4.33 Mha with production of 3.62 Mt and productivity of 836 kg ha⁻¹, whereas in Telangana it occupies 2.15 lakh ha and contributes 2.01 lakh tonnes with productivity of 934 kg ha⁻¹ (INDIASTAT, 2024-25) ^[5].

In Telangana, pigeonpea is predominantly cultivated under rainfed conditions, where productivity largely depends on efficient crop management. Among the agronomic practices, optimum plant population and regulation of vegetative growth are key factors influencing yield. Under conventional cultivation, excessive vegetative growth often results in taller plants with dense canopies, reducing light penetration and aeration, increasing flower abscission and limiting pod set, thereby lowering productivity (Veeranna *et al.*, 2020) ^[12]. With limited scope for area expansion and a continuously increasing demand for pigeonpea in India, improving crop productivity has become imperative. Excessive vegetative growth not only lowers the harvest index but also reduces the translocation of photoassimilates to developing seeds during the reproductive stage, leading to poor yield realization. Appropriate spacing, tailored to the genotype, ensures efficient utilization of light, water, nutrients and growing space, thereby improving resource use efficiency, yield stability and overall productivity (Sivakumar *et al.*, 2021) ^[10].

Appropriate spacing, depending on soil type, fertility and variety, minimizes interplant competition

and maximizes resource utilization, while HDPS accommodates a greater number of plants per unit area, resulting in higher productivity and profitability (Ammaiyappan *et al.*, 2023; Abhishek *et al.*, 2023) ^[2, 1]. Nipping is an important agronomic approach to arrest the apical bud dominance and to enhance the lateral growth (Bahekar *et al.*, 2024) ^[3]. Nipping was increased the number of productive branches and ultimately the economic yield in pigeonpea (Ammaiyappan *et al.*, 2023) ^[2]. (Dhaka *et al.*, 2020) ^[4] also stated that the nipping of the apical bud at the start of branching is an economically viable agronomical practice to enhance seed yield of pigeonpea due to significant improvement in primary and secondary branches.

Plant growth regulators (PGR) are known to improve physiological efficiency, including the photosynthetic ability of plants and also enhance the source sink relationship and stimulate the translocation of photo-assimilates, thereby increasing productivity (Pawar *et al.*, 2022) ^[8]. Mepiquat chloride greatly enhanced the interaction between the source and sink, which eventually assisted the crop in reaching its maximum potential output (Chandrashekharayya *et al.*, 2023) ^[13]. Treating seeds with paclobutrazol can result in a significant reduction in plant height and an increase in branch numbers, hence seed yield (Udansi *et al.*, 2013) ^[11].

Therefore, the present investigation entitled “Effect of nipping and growth regulators on nutrient uptake of redgram [*Cajanus cajan* (L.) Millsp] under HDPS” was undertaken to identify an efficient combination of planting geometry, nipping and growth regulator application for improving growth, yield and productivity of pigeonpea under rainfed conditions.

2. Materials and Methods

2.1 Experimental site and soil

A field experiment entitled “Influence of nipping and growth regulators on nutrient uptake of redgram [*Cajanus cajan* (L.) Millsp] under HDPS” was conducted during the *kharif* 2025 season at the Research Farm of the Regional Agricultural Research Station (RARS), Palem, Professor Jayashankar Telangana Agricultural University (PJTUAU), Nagarkurnool, Telangana, India (16°31' N latitude, 78°14' E longitude and 495 m above mean sea level).

Before sowing, composite soil samples were collected from the 0-30 cm depth and analysed for their physico-chemical properties using standard analytical procedures. The experimental soil was sandy loam in texture with 63% sand, 21% silt and 16% clay, having neutral reaction (pH 7.35), electrical conductivity (0.361 dS m⁻¹) and organic carbon (0.31%). The soil was low in available nitrogen (124.5 kg ha⁻¹) and high in available phosphorus (41.62 kg ha⁻¹) and potassium (209.6 kg ha⁻¹).

2.2 Experimental details and treatments

The experiment was laid out in a strip plot design with three replications. The main plot treatments consisted of three planting

geometries viz., 90 × 20 cm (M₁), 75 × 20 cm (M₂) and 60 × 20 cm (M₃). The subplot treatments include foliar application of Mepiquat Chloride @ 500 ppm at 60 DAS (S₁), Paclobutrazol @ 100 ppm at 60 DAS (S₂), nipping at 60 DAS (S₃) and control (S₄). Thus, the experiment comprised 12 treatment combinations. The gross plot size was 9 × 3 m (27 m²). The pigeonpea variety PRG-176 (Ujwala), developed at RARS, Palem, was used for the study. The variety is a medium-duration genotype (130-145 days) and is tolerant to terminal drought.

2.3 Crop management

The experimental field was prepared to a fine tilth through repeated ploughing and harrowing, followed by layout of the experimental plots. Sowing was carried out according to the treatment-wise spacing during the *kharif* season 2025. The recommended package of agronomic practices for pigeonpea, except the treatment variables, was uniformly followed throughout the experiment. Foliar application of Mepiquat Chloride, Paclobutrazol and nipping practice were imposed at 60 days after sowing (DAS) according to the treatment schedule.

2.4 Observations recorded

2.4.1 Plant analysis

Collection and preparation of plant samples

Plant samples (seed and stover) were collected at harvest from each treatment. The collected samples were first washed with 0.1 N HCl, followed by thorough washing with tap water and finally rinsed with double distilled water to remove any surface impurities. The samples were then air dried under shade and subsequently dried in a hot air oven at 60 °C for 48 hours until a constant weight was obtained. The dried samples were ground using a willey mill and passed through a 0.5 mm sieve to obtain a fine powder for nutrient analysis.

Digestion of plant samples

The powdered plant samples (seed and stover) were digested separately for nutrient analysis. For nitrogen estimation, the samples were pre-digested overnight with concentrated sulphuric acid, followed by digestion using a di-acid mixture (H₂SO₄:H₂O₂ in a 3:1 ratio). For phosphorus and potassium estimation, the samples were digested using a tri-acid mixture (HNO₃:H₂SO₄:HClO₄ in a 9:4:1 ratio). The pre-digested samples were then heated on a hot plate until a clear, colourless solution was obtained, indicating complete digestion.

2.4.1.1 Nitrogen uptake (kg ha⁻¹)

The nitrogen content in plant samples was determined using the modified Micro Kjeldahl method with a Kel Plus instrument, after digesting the powdered samples in a di-acid mixture of sulphuric acid (H₂SO₄) and hydrogen peroxide (H₂O₂), following the procedure described by Piper (1966) ^[14]. Nitrogen uptake was calculated using the following formula

$$\text{Nitrogen uptake [Stover]} (\text{kg ha}^{-1}) = \frac{\text{Nitrogen content (\%)} \times \text{Total dry weight (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nitrogen uptake [Seed]} (\text{kg ha}^{-1}) = \frac{\text{Nitrogen content (\%)} \times \text{Total dry weight (kg ha}^{-1}\text{)}}{100}$$

2.4.1.2 Phosphorus uptake (kg ha⁻¹)

The phosphorus content in plant samples (seed and haulm) was determined after digesting the powdered material with a tri-acid mixture consisting of nitric acid, sulphuric acid, and perchloric acid (HNO₃:H₂SO₄:HClO₄ in a 9:4:1 ratio), following the method described by Piper (1966) ^[14]. The phosphorus concentration in

the digested extract was estimated using the vanadium molybdate phosphoric yellow colour method. The intensity of the yellow colour developed was measured at 420 nm using a spectrophotometer, and the phosphorus content was expressed as a percentage. Phosphorus uptake was calculated using the following formula:

$$\text{Phosphorus uptake [Stover]} (\text{kg ha}^{-1}) = \frac{\text{Phosphorus content (\%)} \times \text{Total dry weight (kg ha}^{-1})}{100}$$

$$\text{Phosphorus uptake [Seed]} (\text{kg ha}^{-1}) = \frac{\text{Phosphorus content (\%)} \times \text{Total seed weight (kg ha}^{-1})}{100}$$

2.4.1.3 Potassium uptake (kg ha⁻¹)

The potassium content in plant samples was determined from the tri-acid digested extract using a flame photometer, following the

method described by Piper (1966) ^[14]. The potassium concentration was expressed as a%. Potassium uptake was calculated using the following formula

$$\text{Potassium uptake [Stover]} (\text{kg ha}^{-1}) = \frac{\text{Potassium content (\%)} \times \text{Total dry weight (kg ha}^{-1})}{100}$$

$$\text{Potassium uptake [Seed]} (\text{kg ha}^{-1}) = \frac{\text{Potassium content (\%)} \times \text{Total seed weight (kg ha}^{-1})}{100}$$

3. Results and Discussion

3.1 Nitrogen uptake

The data on nitrogen uptake by seed and stover as influenced by spacing, growth regulators and nipping were presented in Table 1.

3.1.1 Effect of spacing

Among the spacing treatments, 75 × 20 cm spacing (M₂) recorded significantly higher nitrogen uptake by seed (45.9 kg ha⁻¹), which was on par with 90 × 20 cm spacing (M₁) (41.7 kg ha⁻¹), but was significantly superior to 60 × 20 cm spacing (M₃) (35.7 kg ha⁻¹). The higher nitrogen uptake under optimum spacing may be attributed to greater seed yield coupled with improved nitrogen accumulation in the seed.

Nitrogen uptake by stover was significantly influenced by spacing treatments. Among the spacing treatments 75 × 20 cm spacing (M₂) recorded significantly higher nitrogen uptake by stover (47.8 kg ha⁻¹) and was on par with 90 × 20 cm spacing (M₁) (43.6 kg ha⁻¹). In contrast, the lower uptake (41.2 kg ha⁻¹) was recorded under 60 × 20 cm spacing (M₃). The higher uptake under optimum spacing could be attributed to increased stover yield and better nutrient accumulation. These results are in congruity with Singh *et al.* (2012) ^[17], Patra *et al.* (2021) ^[16] and Dash *et al.* (2024) ^[15].

3.1.2 Effect of growth regulators and nipping

Among the subplot treatments, application of MC @ 500 ppm (S₁) recorded significantly higher nitrogen uptake by seed (46.4 kg ha⁻¹) followed by Paclobutrazole @ 100 ppm (S₂) (44.4 kg ha⁻¹), nipping practice (S₃) (41.1 kg ha⁻¹) and control (S₄) (32.5 kg ha⁻¹). Improved crop growth, higher seed yield and enhanced nutrient utilization under MC might have contributed to greater nitrogen uptake.

Nitrogen uptake by stover was significantly influenced by growth regulator and nipping treatments. Among the subplot treatments, MC @ 500 ppm (S₁) recorded significantly higher nitrogen uptake by stover (48.2 kg ha⁻¹) followed by Paclobutrazole @ 100 ppm (S₂) (46.6 kg ha⁻¹), nipping (S₃) (43.9 kg ha⁻¹) and control (S₄) (38.1 kg ha⁻¹). Similar findings were reported by Chandewar *et al.* (2016) ^[20], Kolhe *et al.* (2019) ^[18], Dhaka *et al.* (2020) ^[4], Pandey *et al.* (2022) ^[7] and Madhu *et al.* (2024) ^[19]. The interaction effect between spacing, growth regulators and nipping was non-significant.

3.2 Phosphorus uptake

The uptake of phosphorus by seed and stover was significantly influenced by spacing, as well as growth regulators and nipping as shown in Table 1.

3.2.1 Effect of spacing

Among the spacing treatments 75 × 20 cm spacing (M₂) recorded significantly higher phosphorus uptake by seed (8.9 kg ha⁻¹), which was on par with 90 × 20 cm spacing (M₁) (8.7 kg ha⁻¹), while the lower uptake (7.7 kg ha⁻¹) was observed under 60 × 20 cm spacing (M₃). The higher phosphorus uptake under optimum spacing was mainly due to increased seed yield and efficient phosphorus utilization.

The phosphorus uptake by stover also differed significantly due to spacing treatments. Among the spacing treatments, 75 × 20 cm spacing (M₂) recorded significantly higher phosphorus uptake by stover (7.0 kg ha⁻¹). This was on par with 90 × 20 cm spacing (M₁) (6.6 kg ha⁻¹), whereas the lower uptake (5.4 kg ha⁻¹) was recorded under 60 × 20 cm spacing (M₃). These results are consistent with Singh *et al.* (2012) ^[17], Patra *et al.* (2021) ^[16] and Dash *et al.* (2024) ^[15].

3.2.2 Effect of growth regulators and nipping

Among the subplot treatments, application of Mepiquat Chloride @ 500 ppm (S₁) recorded the higher phosphorus uptake by seed (9.5 kg ha⁻¹) followed by Paclobutrazole @ 100 ppm (S₂) (8.7 kg ha⁻¹), nipping practice (S₃) (8.5 kg ha⁻¹) and control (S₄) (7.1 kg ha⁻¹).

Among the subplot treatments MC @ 500 ppm (S₁) recorded significantly higher phosphorus uptake by stover (7.3 kg ha⁻¹) followed by Paclobutrazole @ 100 ppm (S₂) (6.8 kg ha⁻¹), nipping practice (S₃) (6.2 kg ha⁻¹) and control (S₄) (5.1 kg ha⁻¹). The results are in agree with Kolhe *et al.* (2019) ^[18], Pandey *et al.* (2022) ^[7] and Madhu *et al.* (2024) ^[19]. The interaction between spacing, growth regulators and nipping remained non-significant.

3.3 Potassium uptake

Potassium uptake by seed and stover was significantly influenced by spacing, growth regulators and nipping were represented in Table 1.

3.3.1 Effect of spacing

Among the spacing treatments, 75 × 20 cm spacing (M₂) recorded significantly higher potassium uptake by seed (8.0 kg ha⁻¹), which was on par with 90 × 20 cm spacing (M₁) (7.3 kg ha⁻¹), while the lower uptake (6.1 kg ha⁻¹) was recorded under 60 × 20 cm spacing (M₃). The greater uptake under optimum spacing may be attributed to higher seed yield and efficient potassium translocation to the developing seeds.

Among the spacing treatments 75 × 20 cm spacing (M₂) recorded significantly higher potassium uptake by stover (49.3 kg ha⁻¹) and was on par with 90 × 20 cm spacing (M₁) (45.9 kg ha⁻¹). In contrast, the lower uptake (40.4 kg ha⁻¹) was recorded under 60 ×

20 cm spacing (M_3). The higher uptake under optimum spacing was mainly associated with greater stover production and enhanced potassium accumulation. These results are corroborated by Singh *et al.* (2012) ^[17], Patra *et al.* (2021) ^[16] and Dash *et al.* (2024) ^[15].

3.3.2 Effect of growth regulators and nipping

Among the subplot treatments, application of MC @ 500 ppm (S_1) recorded significantly higher potassium uptake by seed (8.0 kg ha⁻¹). This result was statistically on par with PBZ @ 100 ppm (S_2) (7.9 kg ha⁻¹), but both were significantly superior to nipping practice (S_3) (7.0 kg ha⁻¹) and control (S_4) (5.7 kg ha⁻¹).

Among the subplot treatments MC @ 500 ppm (S_1) recorded the

highest potassium uptake by stover (48.9 kg ha⁻¹) followed by Paclobutrazole @ 100 ppm (S_2) (45.7 kg ha⁻¹), nipping practice (S_3) (42.3 kg ha⁻¹) and control (S_4) (38.2 kg ha⁻¹). The results are in congruity with Kolhe *et al.* (2019) ^[18], Pandey *et al.* (2022) ^[7] and Madhu *et al.* (2024) ^[19]. Although the treatments differed significantly, the interaction between spacing, growth regulators and nipping was non-significant.

Overall, nutrient uptake was consistently higher in the stover than in the seed for nitrogen and potassium, whereas nitrogen and phosphorus uptake by seed also increased substantially under optimum spacing (75 × 20 cm) and application of MC @ 500 ppm, reflecting improved biomass production, seed yield and nutrient acquisition efficiency.

Table 1: Effect of nipping, growth regulators and spacing on nutrient uptake (kg ha⁻¹)

Treatment	N		P		K	
	Seed	Stover	Seed	Stover	Seed	Stover
Main plots (M): Spacing						
M_1 : 90 × 20 cm	41.7	43.6	8.7	6.6	7.3	45.9
M_2 : 75 × 20 cm	45.9	47.8	8.9	7.0	8.0	49.3
M_3 : 60 × 20 cm	35.7	41.2	7.7	5.4	6.1	40.4
SE(m)±	1.7	1.3	0.2	0.1	0.3	1.3
CD (P=0.05)	6.6	5.0	0.9	0.5	1.4	5.1
Sub plots (S): Growth regulators and nipping at 60 DAS						
S_1 : Application of Mepiquat Chloride @ 500 ppm	46.4	48.2	9.5	7.3	8.0	48.9
S_2 : Application of Paclobutrazole @ 100 ppm	44.4	46.6	8.7	6.8	7.9	45.7
S_3 : Nipping practice	41.1	43.9	8.5	6.2	7.0	42.3
S_4 : Control	32.5	38.1	7.1	5.1	5.7	38.2
SE(m)±	1.0	1.3	0.3	0.2	0.1	2.2
CD (P=0.05)	3.5	4.4	1.2	0.8	0.6	7.6
M at levels of S						
SE(m)±	3.2	4.3	0.81	0.43	0.6	4.3
CD (P=0.05)	NS	NS	NS	NS	NS	NS
S at levels of M						
SE(m)±	2.7	4.1	0.80	0.45	0.5	4.4
CD (P=0.05)	NS	NS	NS	NS	NS	NS

4. Conclusion

Among the spacing treatments, 75 × 20 cm recorded the highest nutrient uptake. Among the growth regulators and nipping treatments, Mepiquat Chloride @ 500 ppm recorded significantly nutrient uptake. The interaction between spacing and growth regulator treatments was non-significant. Overall, the results indicate that 75 × 20 cm spacing combined with Mepiquat Chloride @ 500 ppm at 60 DAS is an effective agronomic practice for improving the productivity of HDPS pigeonpea under rainfed conditions.

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