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Sangam Nagwanshi
M.Sc. Scholar, Department of
Agronomy, School of Agriculture
Science, Technology & Research,
Sardar Patel Agriculture
University, Balaghat, Madhya
Pradesh, India

JS Bisen
Associate Professor, Department of
Agronomy, School of Agriculture
Science, Technology & Research,
Sardar Patel Agriculture
University, Balaghat, Madhya
Pradesh, India

Devendra Turkar
Assistant Professor, Department of
Agronomy, School of Agriculture
Science, Technology & Research,
Sardar Patel Agriculture
University, Balaghat, Madhya
Pradesh, India

Navneet Satankar
Director, School of Agriculture
Science, Technology & Research,
Sardar Patel Agriculture
University, Balaghat, Madhya
Pradesh, India

Corresponding Author:
Sangam Nagwanshi
M.Sc. Scholar, Department of
Agronomy, School of Agriculture
Science, Technology & Research,
Sardar Patel Agriculture
University, Balaghat, Madhya
Pradesh, India

Impact of different levels of potash on growth yield and quality of pigeon pea (*Cajanus cajan* (L.) Huth)

Sangam Nagwanshi, JS Bisen, Devendra Turkar and Navneet Satankar

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Abstract

A field experiment titled “Impact of different levels of potash on growth yield and quality of pigeon pea (*Cajanus cajan* (L.) Huth)” was conducted at the Research Farm of the Department of Agronomy, School of Agriculture Science, Technology & Research, Sardar Patel University, Balaghat (M.P.) during the Kharif season of 2023. The experimental design employed was a Randomized Block Design (RBD) featuring eight treatments with three replications. The results indicated that the treatment where application of 30:50:35 Kg NPK ha⁻¹ proved significantly superior over all the treatments in respect of vegetative growth i.e. plant height (140.68 cm), number of branches per plant (21.22), yield attributes such as number of pods per plant (226.67), pod yield (20.12 q/ha) and harvest index (41.83%) highest net return for pigeon pea. Economic analysis highlighted that the NPK @ 30:50:35kg/ha treatment offered the best gross return, net return, and B: C ratio, making it the most economically viable. Therefore, it is recommended to utilize potassium at elevated levels to enhance crop productivity and overall

Keywords: Benefit cost ratio, DAP, Harvest index, MOP, Pigeon pea and Urea

Introduction

Pulse crops constitute an essential category of agronomic plants cultivated primarily for their protein-rich edible seeds, which are esteemed for their profound nutritional benefits to both human and animal diets. Exemplary members of this crop group encompass lentils, chickpeas, beans, peas, and soybeans. These leguminous species significantly bolster global agricultural systems by augmenting the availability of plant-derived proteins, thereby diversifying dietary regimes and fortifying global food security. Notably, pulses have been ascribed the moniker “poor man's meat” due to their indispensable role as a primary protein source for vegetarian populations worldwide.

Pigeon pea is extensively cultivated across tropical and subtropical regions, with predominant consumption in South Asia, Southeast Asia, Africa, Latin America, and the Caribbean. Taxonomically classified within the Fabaceae family, it is indigenous to the Eastern Hemisphere. Potassium (K) is an indispensable macronutrient in plant physiology, playing a pivotal role in regulating stomatal dynamics, which govern gaseous exchange and transpiration water loss. Stomata serve as conduits through which leaves exchange carbon dioxide (CO₂), oxygen (O₂), and water vapor with the external atmosphere. When potassium ions accumulate within guard cells encircling the stomatal aperture, osmotic pressure ensues, leading to the influx of water, cellular turgidity, and stomatal opening, thereby facilitating efficient gas exchange. An inadequate potassium supply disrupts this regulatory mechanism, rendering stomatal function sluggish and inefficient, which exacerbates transpirational water loss. Closure of stomata, which ordinarily occurs within minutes under optimal potassium levels, is significantly delayed, leaving plants highly susceptible to desiccation and abiotic stress. Additionally, potassium accumulation in root tissues engenders an osmotic gradient that facilitates water uptake. Deficiency in potassium impairs this osmotic regulation, thereby diminishing root water absorption capacity and predisposing plants to drought susceptibility (Kumar *et al.*, 2020) [4]. Consequently, potassium-deprived plants exhibit diminished biomass accumulation and retarded physiological development. Given its indispensable role in stomatal regulation, photosynthetic and optimization, potassium is a fundamental determinant for crop productivity and ecological

adaptability.

Materials and Methods

This study aimed to explore how varying potassium levels influence the growth and yield of the pigeon pea variety UPAS 120. The research was conducted at the Student Research Farm within the Department of Agronomy at the School of Agriculture Science Technology and Research, Sardar Patel University, Balaghat, Madhya Pradesh, during the Kharif season of 2023.

The treatments were

T₁ Control

T₂ 30:50:15 Kg NPK ha⁻¹

T₃ 30:50:20 Kg NPK ha⁻¹

T₄ 30:50:25 Kg NPK ha⁻¹

T₅ 30:50:30 Kg NPK ha⁻¹

T₆ 30:50:35 Kg NPK ha⁻¹

T₇ 30:50:40 Kg NPK ha⁻¹

T₈ 30:50:45 Kg NPK ha⁻¹

The height of five randomly selected plants from each plot was measured from the ground level to the tip of the shoot, at 20, 40, and 60 days after sowing (DAS) while number of branches was recorded at 40 and 60 DAS. The total count of root nodules recorded at 35 DAS, following the uprooting of the plants. In addition the number of flowers, pods produced by each plant and count of seeds per pod was recorded. The seeds harvested from individual plots were combined and weighed to determine the seed yield per plot, categorized by treatment and replication, and subsequently analyzed. The weight of 1000 seeds was measured using a physical balance from seeds of five randomly selected plants for parameter observation, and the results were averaged and statistically analyzed.

Harvest index was computed by using following formula as suggested by Singh and Stoskoff (1971) [5]. The harvest index was worked out by using following formula:

$$\text{Harvest index (\%)} = \frac{\text{Seed yield (g)}}{\text{Biological yield (g)}} \times 100$$

The statistical analysis was conducted using Fisher and Yates (1967).

Results and Discussion

A) Growth parameters

The data depicted in Table 1 revealed that the statistically significant differences in plant height were observed among all the treatments at all recorded stages, i.e. at 20, 40, and 60 DAS, among the different combinations applied. The tallest plants measured 39.97 cm, 96.97 cm, and 140.68 cm at 20, 40, and 60 DAS, respectively, with treatment T₆ (30:50:35 Kg NPK ha⁻¹) leading the results. Treatment T₇ (30:50:40 Kg NPK ha⁻¹) followed closely, yielding heights of 37.32 cm, 91.76 cm, and 137.63 cm at the same intervals. In contrast, the control group (T₁) exhibited the shortest heights of 24.99 cm, 73.00 cm, and 117.77 cm at 20, 40, and 60 DAS, respectively, while the other treatments displayed moderate growth patterns. The highest number of branches per plant (15.67 and 21.22 branches) was observed with treatment T₆ (30:50:35 Kg NPK ha⁻¹) followed by T₇ (30:50:40 Kg NPK ha⁻¹) with 14.75 and 20.51 branches observed at 40 and 60 DAS. Minimum number of branches per plant (8.56 and 12.78 branches) was observed in T₁ (Control plot). The application of 30:50:35 kg NPK ha⁻¹ in pigeon pea

likely results in better plant height, more trifoliate leaves, and a greater number of branches per plant due to the balanced and sufficient availability of essential nutrients. The findings were well supported by Chavan *et al.*, (2020) [3] who worked to find out the effect of graded levels of potassium and micronutrients on yield, quality and nutrient uptake in Pigeon pea through soil and foliar and concluded that application of 100% NP + 50 kg K₂O ha⁻¹ + Grade-I improved plant height, branching in plants.

The maximum (table 1) number of root nodules per plant (22.51 nodules) was observed with treatment T₆ (30:50:35 Kg NPK ha⁻¹) followed by T₈ (30:50:45 Kg NPK ha⁻¹) with 21.19 nodules. Minimum number of root nodules per plant (15.91 nodules) was observed in T₁ (Control). The application of 30:50:35 kg NPK ha⁻¹ in pigeon pea enhances the number of root nodules per plant compared to other potassium doses due to the balanced nutrient availability, particularly the optimal potassium supply. Bagadkar *et al.*, (2020) [1] investigated the effect of various potassium levels with addition of foliar spray of KCL (potassium chloride) on growth, yield and quality of greengram. Findings revealed that growth traits viz., plant height (cm), number of branches plant⁻¹, dry matter plant⁻¹ (gm) and chlorophyll content index were found significantly superior in the treatment with application of RDF + 40 kg K₂O ha⁻¹ than rest of graded potassium level treatments.

B) Yield parameters

Number of pods per plant, seeds per pod and seed yield per plant

Treatment T₆ (30:50:35 Kg NPK ha⁻¹) achieved the highest pod count, totalling 220.67 pods, closely trailed by T₇ (30:50:40 Kg NPK ha⁻¹) with 218.67 pods. In stark contrast, the control treatment T₁ produced the lowest pods 137.00 pods per plant (table 2). The greatest number of seeds per pod, recorded at 12.33 seeds per pod, was also found in treatment T₆, closely followed by T₇ 10.33 seeds per pod. The T₁ had the lowest seed count per pod, averaging just 5.33 seeds. Furthermore, the highest seed yield per plant was noted in treatment T₆ at 72.37 grams, with T₇ close behind at 68.59 grams. The control treatment T₁ yielded the least, at only 34.35 grams per plant. The application of 30:50:35 kg NPK ha⁻¹ in pigeon pea leads to better pod development, higher seed count per pod, and increased seed yield per plant due to the balanced supply of essential nutrients, particularly potassium. Kumar *et al.* (2020) [4] studied the effect of integrated nutrient management for sustaining the productivity of pigeon pea concluded the same.

Test weight and seed yield per plot

The highest seed yield (table 2) recorded per plot was an impressive 2.50 kg, achieved with treatment T₆ (30:50:35 Kg NPK ha⁻¹), closely followed by T₇ (30:50:40 Kg NPK ha⁻¹), which yielded 2.41 kg. In contrast, the lowest seed yield of 1.27 kg was noted in the control plot (T₁). Furthermore, the maximum test weight reached an elegant 9.60 grams with treatment T₆, while T₇ followed closely with a weight of 9.55 grams. The control plot (T₁) exhibited the minimum test weight of 7.36 grams. The application of 30:50:35 kg NPK per hectare in pigeon pea cultivation significantly enhances test weight and elevates seed yield per plot, owing to the meticulously balanced provision of vital nutrients, with potassium being particularly noteworthy.

Seed yield, Stover yield and harvest index

The highest seed yield recorded per hectare (table 2) was 20.12 q/ha, achieved with treatment T₆ (30:50:35 Kg NPK ha⁻¹),

closely followed by T₇ (30:50:40 Kg NPK ha⁻¹) which yielded 19.42 q/ha. In contrast, the lowest seed yield of 14.19 q/ha was observed in the control plot (T₁). When it comes to Stover yield, treatment T₆ also led the way with an impressive 50.37 q/ha, while T₇ trailed just behind at 48.67 q/ha. The control plot (T₁) recorded the least Stover yield at 36.11 q/ha. As for the harvest index (table 2), the peak was 41.83% with treatment T₆ (30:50:35 Kg NPK ha⁻¹), which was nearly equal to T₃ (30:50:20 Kg NPK ha⁻¹) that achieved 40.77%. The control plot (T₁) had the lowest Harvest index at 39.35%. The application of 30:50:35 kg NPK ha⁻¹ in pigeon pea results in better seed and stover yield per hectare due to the optimal balance of essential nutrients, particularly potassium, which plays a key role in enhancing both vegetative and reproductive growth. Singh and Debbarma (2023) [5] conducted research in randomized block design consisting of 10 treatments with 3 different levels of phosphorus 40 kg/ha, 50 kg/ha, 60 kg/ha and different levels of potassium 25, 30 and 35 with three replications and the treatments were allocated randomly in each replication in pigeon pea and

concluded the same better test weight, yield and harvest index

C) Economics parameters

Maximum cost of cultivation incurred in treatment T₈ (30:50:45 Kg NPK ha⁻¹) with (Rs 34582 ha⁻¹) and the minimum (Rs 33382 ha⁻¹) was recorded in treatment T₁ (Control). Maximum gross returns were recorded in treatment T₆ (30:50:35 Kg NPK ha⁻¹) with (Rs 1,55,951 ha⁻¹) followed by T₇ (30:50:40 Kg NPK ha⁻¹) having Rs 1,50,519 ha⁻¹ and the minimum (Rs 1,10,139 ha⁻¹) was recorded in treatment T₁ (Control). Maximum net returns were recorded in treatment T₆ (30:50:35 Kg NPK ha⁻¹) with (Rs 1,21,636 ha⁻¹) followed by T₇ (30:50:45 Kg NPK ha⁻¹) having Rs 1,16,070 ha⁻¹ and the minimum (Rs 76,757 ha⁻¹) was recorded in treatment T₁ (Control). Highest benefit cost ratio was recorded in treatment T₆ (30:50:35 Kg NPK ha⁻¹) with 4.54 followed by T₇ (30:50:45 Kg NPK ha⁻¹) having 4.37 and the minimum (3.30) was recorded in treatment T₁ (Control). Similar findings were reported by Bharti and Dwarka (2023) and Abraham *et al.* (2021).

Table 1: Effect of different levels of potash on growth parameters of pigeon pea

Treatment Symbols	Treatment combination	Plant height (cm)			No of branches per plant		Number of root nodules per plant
		At 20 DAS	At 40 DAS	At 60 DAS	At 40 DAS	At 60 DAS	
T ₁	Control	24.99	73.00	117.77	8.56	12.78	15.91
T ₂	30:50:15 Kg NPK ha ⁻¹	28.32	77.14	124.96	9.76	15.76	17.08
T ₃	30:50:20 Kg NPK ha ⁻¹	28.25	79.42	127.02	10.22	17.84	16.55
T ₄	30:50:25 Kg NPK ha ⁻¹	32.33	83.72	131.79	11.42	18.33	18.47
T ₅	30:50:30 Kg NPK ha ⁻¹	36.24	87.12	134.78	14.08	19.17	22.17
T ₆	30:50:35 Kg NPK ha ⁻¹	39.97	96.97	140.68	15.67	21.22	22.51
T ₇	30:50:40 Kg NPK ha ⁻¹	37.32	91.76	137.63	14.75	20.51	21.17
T ₈	30:50:45 Kg NPK ha ⁻¹	36.65	87.68	137.44	14.42	19.74	22.19
CD _{0.05}		2.38	4.23	3.29	4.23	3.29	1.50
SE. m (±)		0.79	1.39	1.08	1.39	1.08	0.49

Table 2: Effect of different levels of potash on yield parameters of pigeon pea

Treatment Symbols	Treatment combination	Number of pods per plant	No of seeds per pod	Seed yield per plant (grams)	Seed yield per plot (kg)	Test weight (grams)	Seed yield per hectare (q/ha)	Stover yield per hectare (q/ha)	Harvest index (%)
T ₁	Control	137.00	5.33	34.35	1.27	7.36	14.19	36.11	39.35
T ₂	30:50:15 Kg NPK ha ⁻¹	148.33	6.33	45.13	1.49	7.99	16.78	40.12	40.67
T ₃	30:50:20 Kg NPK ha ⁻¹	152.33	7.67	53.79	1.72	8.18	17.40	42.67	40.77
T ₄	30:50:25 Kg NPK ha ⁻¹	175.00	7.33	58.78	2.05	8.44	17.63	45.40	38.84
T ₅	30:50:30 Kg NPK ha ⁻¹	201.33	7.67	62.34	2.34	8.60	18.70	46.41	40.31
T ₆	30:50:35 Kg NPK ha ⁻¹	220.67	12.33	72.37	2.50	9.60	20.12	50.37	41.83
T ₇	30:50:40 Kg NPK ha ⁻¹	218.67	10.33	68.59	2.41	9.55	19.42	48.67	39.89
T ₈	30:50:45 Kg NPK ha ⁻¹	213.33	8.33	66.68	2.31	9.23	19.32	47.50	39.95
CD _{0.05}		15.86	1.50	3.35	0.37	0.34	0.30	1.54	1.72
SE. m (±)		5.22	0.49	1.10	0.12	0.11	0.10	0.51	0.57

Table 3: Economics as influenced by different treatments applied in Pigeon Pea

Treatment Symbols	Treatment combination	Cost of cultivation (Rs)	Gross return (Rs)	Net return (Rs)	BC ratio
T ₁	Control	33382	1,10,139	76,757	3.30
T ₂	30:50:15 Kg NPK ha ⁻¹	33782	1,29,473	95,691	3.83
T ₃	30:50:20 Kg NPK ha ⁻¹	33915	1,34,578	1,00,663	3.97
T ₄	30:50:25 Kg NPK ha ⁻¹	34054	1,37,054	1,03,000	4.02
T ₅	30:50:30 Kg NPK ha ⁻¹	34182	1,44,845	1,10,663	4.24
T ₆	30:50:35 Kg NPK ha ⁻¹	34315	1,55,951	1,21,636	4.54
T ₇	30:50:40 Kg NPK ha ⁻¹	34449	1,50,519	1,16,070	4.37
T ₈	30:50:45 Kg NPK ha ⁻¹	34582	1,49,490	1,14,908	4.32

Selling price of Pigeon pea: Rs 70/kg, Selling price of stover: Rs 3/kg

Conclusion

The overall results obtained from this present investigation clearly revealed that the application of T₆ (30:50:35 Kg NPK ha⁻¹) showed the better performance for vegetative growth viz.,

plant height (140.68 cm), number of branches per plant (21.22 branches), yield attributes like number of pods per plant (226.67 pods), pod yield (20.12 q/ha) and harvest index (41.83%) of Pigeon pea. T₆ also recorded highest net return and benefit cost

ratio. Thus, use of potassium at higher dose may be suggested for higher crop productivity along with over all betterment of pigeon pea under Balaghat (M.P.) conditions.

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