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Effect of different levels of potassium on growth, seed yield and economics of vegetable cowpea

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Abstract
A field experiment was carried out on variety PDKV Rutuja during *Summer* season of 2023, at Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the effect of different levels of potassium on growth, seed yield and economics of vegetable cowpea and experiment was laid out in RBD consisting of 07 treatments i.e., T_1 - absolute control, T_2 - 25:50:00 NPK kg ha^{-1}, T_3 - 25:50:10 NPK kg ha^{-1}, T_4 - 25:50:20 NPK kg ha^{-1}, T_5 - 25:50:30 NPK kg ha^{-1}, T_6 - 25:50:40 NPK kg ha^{-1}, T_7 - 25:50:50 NPK kg ha^{-1} replicated thrice. Results of present investigation indicated that growth parameters like, maximum plant height (74.96 cm), maximum number of branches plant^{-1} (6.96), maximum number of flower stalks plant^{-1} (26.44) and yield contributing parameters like, maximum number of pods cluster^{-1} (2.93), highest number of green pods plant^{-1} (34.82), highest number of seeds pod^{-1} (14.90), highest average weight of green pod (8.54 g), maximum pod length (24.80 cm), maximum seed index (15.53 g), highest seed yield plot^{-1} (1.23 kg) and seed yield ha^{-1} (1020 kg ha^{-1}) were recorded maximum with application of 25:50:40 NPK kg ha^{-1} (T_6). When taking into account cost-benefit analysis, potassium levels with the application of 25:50:40 NPK kg ha^{-1} (T_6) showed the best gross returns (Rs. 1,53,000), highest net returns (Rs. 1,06,550), and highest B:C ratio (3.29). The application of 25:50:30 NPK kg ha^{-1} (T5) came closely behind. which showed gross returns of Rs. 1,49,400, net returns of Rs. 1,03,250, and a 3.23 B:C ratio. It has been discovered that applying potassium (K_2O) in the range of 30 to 40 kg K_2O ha^{-1} is more suitable, profitable, and pays the farmers for the production of cowpea seeds.

Keywords: Vegetable cowpea, potassium (K), Growth, Seed yield and Economics

Introduction
Vegetable Cowpea [*Vigna unguiculata* (L.) Walp], also known as southern pea or black-eyed pea, is a member of the Fabaceae sub-family and the Leguminosae family of plants. Its chromosome number is 2n=22 (Vavilov, 1939) [19]. It is an annual herbaceous legume of the warm season. Originating in Africa, cowpeas are widely grown throughout the continent as well as in South America, Southeast Asia, and the southern United States. Cowpeas are grown on around 58,000 hectares in India, where their productivity and production are 764 kg ha^{-1} and 4.8 lakh tons, respectively (Anon. 2022) [1]. 24.8% protein, 63.6% carbohydrates, 1.9% fat, 6.3% fibre, 0.00074% thiamine, 0.00042% riboflavin, and 0.00281% niacin are found in a mature cowpea seed (Davis *et al.*, 2000) [4]. Additionally, each hundred grams of pods contains 72.0 mg of calcium, 59.0 mg of phosphorous, 2.5 mg of iron, 25.0 mg of vitamin C, and 564.0 mg of carotene (Gopalan *et al.*, 1971) [8].
Applying fertilizer to cowpeas yields good results. The initial soil fertility as well as variables related to moisture availability dictate the amount of fertilizer needed. Cowpeas can fix atmospheric nitrogen despite being legumes (Yadav, 2001) [21]. Applying 15-20 kg N ha^{-1} has been found to produce the best reaction. Applying more nitrogen would reduce the number and growth of nodules, which would negatively affect the capacity to fix nitrogen (Singh and Nair, 1995) [15].
For pulse crops, phosphorus is the most important mineral nutrient that must be given to the soil in order to maintain plant growth and crop productivity (Singh, 2000) [16]. In addition to being essential for respiration, energy storage, cell elongation, and photosynthesis, phosphorus also enhances crop quality. Early root development is stimulated (Yawalker *et al.*, 1996) [22].
Additionally essential to crop productivity is potassium (K). K has been called the "quality element" in crop productivity (Rao and Srinivasrao, 1996; Pettigrew, 2000) [13, 12]. Physiological processes such as starch and protein synthesis, photosynthetic translocation (Tiwari *et al.*, 1998) [18], water energy relations and it's efficient use, photosynthesis are all

aided by potassium. It also plays a role in turgor potential maintenance (William, 1999) [20].

Application of potassium (K) have been shown to have a synergistic effect on the available nitrogen status of the soil and to increase the availability of nitrogen in the soil (Ghosh *et al.*, 2001) [7]. Because of the potassium application, the available phosphorus content also somewhat increased. This could be because the soil solution's balanced nutrient concentration leads to improved phosphorus use efficiency. Thus, it is imperative to supplement potassium from outside sources. Given its significance in raising crop yields, potassium (K) occupies a unique place. In light of the aforementioned variables, the current study was conducted to determine the impact of varying potassium levels on the economics, growth, and seed yield of vegetable cowpea.

Materials and Methods

In the *summer* of 2023, an experiment was carried out at the Instructional Farm, Vegetable Science Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS).

This area experiences semi-arid weather. In terms of soil reaction (pH 7.87), the experimental plot's soil had a medium-black texture, EC (0.25 dS m^{-1}), organic carbon (5.30 g kg^{-1}), available nitrogen (193 kg ha^{-1}), available phosphorus (13.0 kg ha^{-1}), and available potassium (307 kg ha^{-1}). The following treatments were replicated three times using a Randomized Block Design (RBD): T_1 was the absolute control, T_2 was 25:50:00 NPK kg ha^{-1}, T_3 was 25:50:10 NPK kg ha^{-1}, T_4 was 25:50:20 NPK kg ha^{-1}, T_5 was 25:50:30 NPK kg ha^{-1}, T_6 was 25:50:40 NPK kg ha^{-1}, and T_7 was 25:50:50 NPK kg ha^{-1}. A fertilizer dose of 25:50:00 NPK kg ha^{-1} is recommended. Recommended dose of fertilizer was applied as N: Split dose (50% N at basal and 50% N @ 30DAS); P & K: Basal dose in the form of Urea, SSP, MOP.

Observations recorded

Growth metrics

Plant height (cm)

Plant height was measured in cm at 30, 60, and 90 days following sowing, starting from the ground and ending at the tip of the main axis of randomly selected plants.

Number of branches plant^{-1}

For every plant under observation, the count of branches emerging from the main stem was recorded for every plant. Following mean computation, it was reported as the number of cowpea branches plant^{-1}. At the 30th, 60th, and 90th DAS, the branches were counted.

Number of flower stalks plant^{-1}

For every plant under observation, the count of flower stalks emerging from the node region on the main stem was made. Following the mean computation, the number of flower stalks plant^{-1} was noted. The 60th and 90th DAS were used to count the flower shoots.

Yield parameters

Number of pods cluster^{-1}

At the time of harvesting each individual observational plant, the total number of pods cluster^{-1} was counted.

Number of green pods plant^{-1}

After calculating the mean and multiplying the number of clusters per plant by the number of pods per cluster from each treatment combination, the total number of green pods plant^{-1} was computed.

Number of seeds pod^{-1}

Each plant's average number of seeds pod^{-1} was calculated using five randomly chosen pods.

Average weight of green pod (g)

The well-matured pods obtained from the tagged plants were collected and their weight was recorded on an analytical balance.

Pod length (cm)

Using a scale or thread, the length of the pod was measured in centimeters from the point where it was joined to the bunch to the tip, and the average length was calculated. When the pods were harvested, five were chosen at random for this purpose.

Seed index (g)

A random sample of 100 seeds of green pods were taken from the produce of each of the selected plants and weighed in gram by electronic balance.

Seed yield plot^{-1} (kg)

The harvested pods from each plot were dried for one week, threshed and seed yield was recorded from the gross experimental plot. The average was worked out for individual plots.

Seed yield ha^{-1} (kg ha^{-1})

With the support of the necessary calculations, the seed yield ha^{-1} was determined based on the seed yield per plot.

Results and Discussion

Growth observations

Plant height (cm)

Table 1 displays the data that was collected at 30, 60, and 90 days after planting with respect to the effects of varying potassium levels on plant height. With the exception of 30 DAS, plant height varied significantly between the various potassium levels at 60 and 90 DAS.

The treatments T_6 25:50:40 NPK kg ha^{-1} attained the considerably highest plant height at 60 DAS (51.28 cm), which was found to be at par with treatments T_7 - 25:50:50 NPK kg ha^{-1} (50.63 cm) and T_5 - 25:50:30 NPK kg ha^{-1} (50.10 cm).

At 90 days after sowing, T_6 - 25:50:40 NPK kg ha^{-1} recorded the highest plant height (74.96 cm), which was determined to be substantially comparable to treatments T_7 - 25:50:50 NPK kg ha^{-1} (73.37 cm) and T_5 - 25:50:30 NPK kg ha^{-1} (72.68 cm). On the other hand, treatment T_1 - absolute control, showed the minimal plant height at 60 DAS (47.48 cm) and 90 DAS (70.09 cm). Thriveni *et al.* (2023) [17] in black gram reported similar results.

Number of branches plant^{-1}

At 30, 60, and 90 DAS, data on the number of branches plant^{-1} were recorded; they are presented in Table 2.

In every stage of a plant's growth, the number of branches per plant has varied significantly. At 30, 60, and 90 DAS, the maximum number of branches plant^{-1} was recorded in T_6 - 25:50:40 NPK Kg ha^{-1} with 3.99, 5.90, and 6.96. This result was statistically comparable to that of treatments T_7 - 25:50:50 NPK kg ha^{-1}, which displayed 3.90, 5.78, and 6.88, and T_5 - 25:50:30 NPK kg ha^{-1}, which showed 3.78, 5.59, and 6.68 at 30, 60, and 90 DAS, respectively. However, T_1-absolute control had the lowest number of branches (3.14, 4.83, and 6.05), at 30, 60, and 90 DAS, respectively. In the case of French beans, Kumar *et al.* (2004) [10] reported identical results.

Number of flower stalks plant^{-1}

Table 3 displays data collected at 60 and 90 days after sowing that indicates the total number of flower stalks per plant as impacted by different potassium levels.

At 60 DAS, T_6 - 25:50:40 NPK Kg ha^{-1} (9.61) had the highest number of flower stalks plant^{-1}, which was statistically comparable to T_7 - 25:50:50 NPK kg ha^{-1} (8.93).

T_6 - 25:50:40 NPK kg ha^{-1} (26.44) had the highest number of flower stalks plant^{-1} at 90 DAS, matching T_7 - 25:50:50 NPK kg ha^{-1} (25.78) and T_5 - 25:50:30 NPK kg ha^{-1} (25.12). However, treatment T_1 - absolute control, revealed the lowest number of flower stalks plant^{-1} at 60 DAS (5.49) and 90 DAS (16.46). Furtuse *et al.* (2018) [6] reported similar outcomes with cowpea.

Yield attributes

Number of pods cluster^{-1}

Table 4 displayed the data about how different potassium levels impacted the number of pods per cluster.

T_6 - 25:50:40 NPK kg ha^{-1} (2.93) had the highest number of pods per cluster, which was statistically comparable to T_7 - 25:50:50 NPK kg ha^{-1} (2.88) and T_5 - 25:50:30 NPK Kg ha^{-1} (2.76). On the other hand, T_1 - absolute control had the lowest pods per cluster (1.95), as witnessed. These outcomes correspond with the cowpea research conducted by Balai *et al.* (2005) [2].

Number of green pods pod^{-1}

Table 4 showed the information about how varying potassium levels affected the number of green pods produced by each plant.

T_6 - 25:50:40 NPK kg ha^{-1} (34.82) showed the highest total number of green pods plant^{-1}, which was statistically equivalent to T_7 - 25:50:50 NPK kg ha^{-1} (34.23). On the other hand, T_1 - absolute control showed the lowest number of green pods plant^{-1} (20.48), respectively. Buriro *et al.* (2015) [3] have reported similar results.

Number of seeds per pod

Table 4 exhibited the information on the number of seeds pod^{-1} as a result of potassium levels.

Statistically, T_6 - 25:50:40 NPK kg ha^{-1} (14.90) had the highest proportion of seeds pod^{-1}, matching T_7 - 25:50:50 NPK kg ha^{-1} (14.15) and T_5 - 25:50:30 NPK kg ha^{-1} (13.82). T_1 - the absolute control showed the fewest seeds per pod (9.81). The outcomes of Muoneke *et al.* (2015) [11] in relation to vegetable cowpea are consistent with what we found.

Average weight of green pod (g)

Table 4 provided information on the average weight of green pods (g) in relation to various potassium levels.

The statistical comparison of T_6 - 25:50:40 NPK kg ha^{-1} (8.54 g) and T_5 - 25:50:30 NPK kg ha^{-1} (8.12 g) and T_4 - 25:50:20 NPK kg ha^{-1} (7.78 g) revealed that T_6 had the highest average weight of green pod (g). On the other hand, T_1 - the absolute control exhibited the lowest average weight of green pod (6.06 g). Balai *et al.* (2005) [2] have found findings similar to these in Cowpea.

Pod length (cm)

The data in Table 4 demonstrate the significant outcome for the impact of varying potassium levels on pod length (cm). There was noticeable variation between the treatments and the control.

T_6 - 25:50:40 NPK kg ha^{-1} (24.80 cm) had the highest pod length (cm), which was statistically comparable to T_7 - 25:50:50 NPK kg ha^{-1} (24.15 cm) and T_5 - 25:50:30 NPK kg ha^{-1} (23.75 cm). On the other hand, T_1 - full control had the smallest pod length (18.37 cm). The outcomes in the French bean were similar to those of Kumar *et al.* (2004) [10].

Seed index (g)

Table 4 displayed the information on the seed index (g) as impacted by various potassium levels.

With a seed index of 15.53g, the highest was reported in T_6 - 25:50:40 NPK kg ha^{-1}, which was statistically comparable to T_7 - 25:50:50 NPK kg ha^{-1} (15.18 g) and T_5 - 25:50:30 NPK kg ha^{-1} (14.8 g). On the other hand, T1- the absolute control had the lowest seed index (12.36 g). Farhad *et al.* (2010) [5] have observed similar findings for soyabean.

Seed yield plot^{-1} (g)

Table 4 depicts the significant result of varying potassium levels on the quantity of seed produced plot^{-1} (kg).

The results showed that treatment T_6 - 25:50:40 NPK kg ha^{-1} (1.23 kg) had the highest seed yield plot^{-1} (kg). This treatment was statistically comparable to treatment T_7 - 25:50:50 NPK kg ha^{-1} (1.20 kg) and treatment T_5 - 25:50:30 NPK kg ha^{-1} (1.18 kg). On the other hand, the absolute control treatment, T1, produced the lowest seed yield plot^{-1} (0.74 kg). Similar trend was found by Goud *et al.* (2014) [9] in chickpea, Rupes *et al.* (2023) [14] and Thriveni *et al.* (2023) [17] in black gram.

Seed yield ha^{-1} (kg ha^{-1})

Table 4 displayed the results on seed yield ha^{-1} (kg ha^{-1}) as influenced by various potassium levels.

T_6 - 25:50:40 NPK kg ha^{-1} (1020 kg ha^{-1}) had the highest seed yield ha^{-1} (kg ha^{-1}) and was statistically comparable to T_7 - 25:50:50 NPK kg ha^{-1} (1001 kg ha^{-1}) and T_5 - 25:50:30 NPK kg ha^{-1} (996 kg ha^{-1}). On the other hand, T1, the absolute control, had the lowest seed yield ha^{-1} (615 kg ha-1). In chickpea, Goud *et al.* (2014) [9], Rupes *et al.* (2023) [14], and Thriveni *et al.* (2023) [17] saw a similar tendency.

Table 1: Effect of Different levels of Potassium on plant height (cm) at 30, 60 & 90 DAS

Tr. No.	Treatment	Plant height (cm)		
		30 DAS	60 DAS	90 DAS
T_1	Absolute control	26.23	47.48	70.09
T_2	25:50:00 NPK Kg ha^{-1}	26.31	48.47	71.02
T_3	25:50:10 NPK Kg ha^{-1}	26.62	48.67	71.36
T_4	25:50:20 NPK Kg ha^{-1}	27.03	49.45	72.08
T_5	25:50:30 NPK Kg ha^{-1}	27.37	50.10	72.68
T_6	25:50:40 NPK Kg ha^{-1}	27.65	51.28	74.96
T_7	25:50:50 NPK Kg ha^{-1}	27.55	50.63	73.37
SE (m)±		0.81	0.47	0.85
CD at 5%		NS	1.45	2.67

Economics

Table 5 displays the data, which indicates that treatment T_6 - 25:50:40 NPK kg ha^{-1} generated the highest gross returns (1,53,000 Rs ha^{-1}) and net returns (1,06,550 Rs ha^{-1}) of cowpea seed. Treatment T_7 - 25:50:50 NPK kg ha^{-1}, which recorded gross returns (1,50,150 Rs ha^{-1}) and net returns (1,03,400 Rs ha^{-1}) was closely followed. Conversely, treatment T_1 - the absolute control, had the lowest net returns (50,000 Rs ha^{-1}) and lowest gross returns (92,250 Rs ha^{-1}).

However, based on the information shown in Table 5. Due to lower cultivation costs and increased seed production, it was noted that a higher B:C ratio (3.29) was achieved when the crop was cultivated with 25:50:40 NPK kg ha^{-1} (T_6). This ratio was almost identical to the B:C ratio (3.23) when 25:50:30 NPK kg ha^{-1} (T_5) was applied. Rupes *et al.* (2023) [14] showed similar outcomes with black gram.

Table 2: Effect of Different levels of Potassium on Number of branches plant^{-1} at 30,60, and 90 DAS

Tr. No.	Treatment	Number of branches plant^{-1}		
		30 DAS	60 DAS	90 DAS
T_1	Absolute control	3.14	4.83	6.05
T_2	25:50:00 NPK Kg ha^{-1}	3.26	5.08	6.27
T_3	25:50:10 NPK Kg ha^{-1}	3.56	5.26	6.41
T_4	25:50:20 NPK Kg ha^{-1}	3.66	5.41	6.55
T_5	25:50:30 NPK Kg ha^{-1}	3.78	5.59	6.68
T_6	25:50:40 NPK Kg ha^{-1}	3.99	5.90	6.96
T_7	25:50:50 NPK Kg ha^{-1}	3.90	5.78	6.88
SE (m)±		0.13	0.12	0.89
CD at 5%		0.41	0.40	0.34

Table 3: Effect of Different levels of Potassium on Number of flower stalks plant^{-1} at 60 and 90 DAS

Tr. No.	Treatment	Number of flower stalks plant^{-1}	
		60 DAS	90 DAS
T_1	Absolute control	5.49	16.46
T_2	25:50:00 NPK Kg ha^{-1}	6.86	20.84
T_3	25:50:10 NPK Kg ha^{-1}	7.44	22.35
T_4	25:50:20 NPK Kg ha^{-1}	7.66	23.90
T_5	25:50:30 NPK Kg ha^{-1}	8.39	25.12
T_6	25:50:40 NPK Kg ha^{-1}	9.61	26.44
T_7	25:50:5 NPK Kg ha^{-1}	8.93	25.78
SE (m)±		0.24	0.79
CD at 5%		0.73	2.44

Table 4: Effect of different levels of potassium on number of pods cluster^{-1}, number of green pods plant^{-1}, number of seeds pod^{-1}, average weight of green pod (g), pod length (cm), seed index (g), seed yield plot^{-1} (kg) and seed yield ha^{-1} (kg ha^{-1})

Tr. No.	Treatment	Number of pods cluster^{-1}	Number of green pods plant^{-1}	Number of seeds pod^{-1}	Average weight of green pod (g)	Pod length (cm)	Seed index (g)	Seed yield plot^{-1} (kg)	Seed yield ha^{-1} (kg ha^{-1})
T_1	Absolute control	1.95	20.48	9.81	6.06	18.37	12.36	0.74	615
T_2	25:50:00 NPK Kg ha^{-1}	2.27	24.50	11.63	6.70	20.79	13.24	0.97	810
T_3	25:50:10 NPK Kg ha^{-1}	2.40	28.44	12.08	7.26	21.90	13.98	1.03	860
T_4	25:50:20 NPK Kg ha^{-1}	2.62	30.89	12.97	7.78	22.56	14.47	1.10	921
T_5	25:50:30 NPK Kg ha^{-1}	2.76	33.60	13.82	8.12	23.75	14.98	1.18	996
T_6	25:50:40 NPK Kg ha^{-1}	2.93	34.82	14.90	8.54	24.80	15.53	1.23	1020
T_7	25:50:50 NPK Kg ha^{-1}	2.88	34.23	14.15	8.33	24.15	15.18	1.20	1001
SE (m)±		0.07	0.43	0.60	0.29	0.73	0.63	0.04	31.95
CD at 5%		0.24	1.04	1.86	0.98	2.21	1.05	0.15	96.87

Table 5: Economics of different levels of potassium for seed yield (kg ha^{-1}) of vegetable cowpea

Treatment	Gross returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net returns (Rs ha^{-1})	B: C Ratio
T_1 - Absolute Control	92250	42250	50000	2.18
T_2 - 25:50:00 NPK Kg ha^{-1}	121500	45250	76250	2.68
T_3 - 25:50:10 NPK Kg ha^{-1}	129000	45550	83450	2.83
T_4 - 25:50:20 NPK Kg ha^{-1}	138150	45850	92300	3.01
T_5 - 25:50:30 NPK Kg ha^{-1}	149400	46150	103250	3.23
T_6 - 25:50:40 NPK Kg ha^{-1}	153000	46450	106550	3.29
T_7 - 25:50:50 NPK Kg ha^{-1}	150150	46750	103400	3.21

Conclusion

Based on the results of this investigation, it can be said that during the summer season, different potassium levels had a linearly significant effect on the growth and seed yield of vegetable cowpeas up to 40 kg K_2O ha^{-1} application. After that, growth and yield attributes slightly decreased at 50 kg K_2O ha^{-1}.

For growth observations such as plant height (cm), number of branches plant^{-1}, number of flower stalks plant^{-1}, and for yield parameters such as number of pods cluster^{-1}, number of green pods plant^{-1}, number of seeds pod^{-1}, average weight of green pod (g), pod length (cm), seed index (g), seed yield plot^{-1} (kg), seed yield ha^{-1} (kg ha^{-1}) application of 25:50:40 NPK kg ha^{-1} (T_6) was significantly superior. On the other hand, it was discovered that all growth and yield aspects were lower under the absolute control (T_1).

In terms of cost-benefit analysis, potassium levels given 25:50:40 NPK kg ha^{-1} (T_6) had the highest B:C ratio (3.29), closely followed by 25:50:30 NPK kg ha^{-1} (T_5). It has a 3.23 B:C ratio. For the production of cowpea seeds, it was generally reported that applying potassium (K_2O) in the range of 30 to 40 kg K_2O ha^{-1} is more suitable, profitable, and compensating for the farmers.

References

1. Anonymous. Indian Horticulture Database NHB; c2022.
2. Balai CM, Majumdar SP, Kumawat BL. Effect of soil compaction, potassium and cobalt on growth and yield of cowpea. Indian Journal of Pulses Research. 2005;18(1):38-39.
3. Buriro M, Hussain F, Talpur GH, Gandahi AW, Buriro B. Growth and yield response of mung bean varieties to various potassium levels. Pakistan Journal of Agriculture. 2015;31(2):203-210.
4. Davis DW, Oelke EA, Oplinger ES, Doll JD, Hanson CV, Putnam D. University of Mipesota, St Paul, MN5510. University of Wisconsin-Madison. Field Crops Research. 2000;9(1):329-331.
5. Farhad ISM, Islam MN, Hoque S, Bhuiyan MSI. Role of potassium and Sulphur on the growth, yield and oil content of soybean *(Glycine max* L.). An Academic Journal of Plant Sciences. 2010;3(2):99-103.
6. Furtuse AK, Aldoghachi KA, Jabail WA. Response of three varieties of cowpea (*Vigna sinensis* L.) to different levels of potassium fertilizer under southern region conditions of Iraq. Basrah Journal of Agricultural Sciences. 2019;32:25-34.
7. Ghosh A, Mandal SS, Sarkar S. Response of cotton to potassium, nitrogen and biofertilizers. Journal of Potassium Research. 2001;17:85-88.
8. Gopalan C, Rama Sastri BV, Balasubramanian SC. Nutritive value of Indian foods. ICMR, Natt. Inst. Nutrition, Hyderabad; c1971.
9. Goud VV, Konde NM, Mohod PV, Kharche VK. Response of chickpea to potassium fertilization on yield, quality, soil fertility and economic in vertisols. Legume Research. 2014;33:311.
10. Kumar M, Sinha KK, Roysherma RP. Effect of Organic manure, NPK and boron application on the productivity of French bean in sandy loam soil of North Bihar. Indian Journal of Pulses Research. 2004;17(1):42-44.
11. Muoneke CO, Ndukwe OO, Okocha PI, Akpan AU. Growth and yield responses of vegetable cowpea (*Vigna unguiculata* L.) to varying rates of phosphorus and potassium fertilizers. Journal of Applied Agricultural Research. 2015;7:123-131.
12. Pettigrew WT. Potassium deficiency increased specific leaf weights and leaf glucose levels in field grown cotton. Agronomy Journal. 2000;91:962–968.
13. Rao SA, Srinivasrao C. IPI Research Tropics No. 20, International Potash Institute, Basel, Switzerland; c1996. p. 1-57.
14. Rupes G, Singh NO, Mounika S. Effect of levels of potassium on yield and economics of different black gram varieties in Manipur sub-tropical condition. Journal of Eco-friendly Agriculture. 2023;18(1):32-36.
15. Singh B, Nair TVR. Effect of nitrogen fertilization on nodulation and nitrogen assimilation in cowpea. Crop Improvement. 1995;22:133-138.
16. Singh RV. Response of French bean (*Phaseolus Vulgaris* L.) to plant spacing and phosphorus fertilization. Indian Journal of Horticulture. 2000;57:338- 341.
17. Thriveni P, Rani BS, Sunitha N, Mohan MM, Sagar GK. Enhancing the Productivity and Quality of Black gram (*Vigna mungo* L.) with Potassium Fertilization. Legume Research. 2023;1:5.
18. Tiwari HS, Agarwal RM, Bhatt RK. Photosynthesis, stomatal resistance and related characteristics as influenced by potassium under normal water supply and water stress condition in rice (*Oryza sativa* L). Indian Journal of Plant Physiology. 1998;3:314-316.
19. Vavilov NI. The new systematic of cultivated plants. In: Huxley, J Ed., The New Systematic, Oxford University Press, London; c1939. p. 549-566.
20. William TP. Potassium deficiency increase specific leaf weights and leaf glucose levels in field grown cotton. Agronomy Journal. 1999;91:962-968.
21. Yadav OS. Effect of nitrogen sources and biofertilizer on growth and quality of cowpea. M.Sc. (Ag.) Thesis, Rajasthan Agricultural University, Bikaner; c2001.
22. Yawalker KS, Agrawal JP, Bokde S. Bulky organic manure. Manure and Fertilizers. Edition 5th; c1996. p.25-75.