Effect of potassium and boron on growth and yield of cowpea

ABSTRACT

The treatments consist of Potassium (40, 50, 60 kg/h) and Boron (0.6, 0.8, 1.0 kg/ha) along with control. The experiment was layout in Randomized Block Design with ten treatments each replicated thrice. Application of Potassium 60kg/ha and Boron 1.0kg/ha (treatment 9) in cowpea was recorded significantly higher Plant height (49.41cm), more number of nodules/plant (29.23), maximum plant dry weight (18.02g/plant), maximum no. of Pods/plant (15.4), seeds/pod (11.67), higher Test weight (21.83 g), Seed yield (1.26 t/ha), stover yield (3.62 t/ha) and harvest index (35.29 %), higher gross returns (INR 63,000.00/ha), net return (INR 40,133.00/ha) and benefit cost ratio (1.76) was obtained in the treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha].

Keywords: *Cowpea, potassium, boron, growth attributes, yield attributes, yield and economics.*

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) is one of the most important vegetable crops grown as pulse, vegetable and fodder. It is poor man's protein source and considered one of the most ancient human food sources and has probably been used as a crop plant since Neolithic times (Ng and Marechal 1985). Cowpea is a vital multipurpose grain legume extensively cultivated in arid and semiarid tropics. It is an important source of nutrients and provides high quality, inexpensive protein diet based on cereal grains and starch foods. Cowpea is a good source of food, fodder, vegetables and certain snakes (Singh et al., 2012). It is a crop that can be used as catch crop, mulch crop, intercrop and green crop. It has ability to fix atmospheric N2 in the soil 56 kg/ha in association with symbiotic bacteria under favorable conditions (Mandal et al. 2009). The mature cowpea seed contains 24.8% protein, 63.6% carbohydrates, 1.9% fat, 6.3% fiber, 7.4 ppm thiamine, 4.2 ppm riboflavin and 28.1 ppm niacin (Ahlawat and Shivkumar 2005). The protein concentration ranges from about 3 to 4% in green leaves, 4 to 5% in immature pod and 25 to 30% in mature seeds. The amino acid profile reveals that lysine, leusine and phenylamine contents are relatively high in cowpea. In India pulses are grown nearly in 25.43 m ha with an annual production of 17.28 m t and an average productivity of 679 kg/ha (Anonymous, 2012). The per capita availability of pulses in India is 35.5 g/day as against the minimum requirement of 7 g/day/capita as advocated by Indian Council of Medical Research.

Potassium mainly effects the nodulation of pulse crop thus increases the seed yield through better fixation of nitrogen. It is one of the major elements taken up by the plant. Plants absorb Potassium in larger amounts as compared to other minerals except nitrogen. It helps in formation of proteins and chlorophyll. Potassium is a key nutrient in the plants which is tolerance to stress such as high/low temperatures, drought, disease and pest occurrences. Though, it is not a constituent of organic structures but it regulates enzymatic activities, translocation of photosynthates and considerably improves seed yield of chickpea if applied as a fertilizer Samiullah and Khan (2003).

Legume crops required more amount of boron compared to most field crops as boron plays vital role in proper development of reproductive organs. Its deficiency leads to sterility in plants by malformation of reproductive tissues affecting pollen germination, resulting in increased flower drop and reduced fruit set (Subasinghe et al. 2003). Boron is one of the mineral nutrients required for normal plant growth. The most important functions of boron in plants are thought to be its structural role in cell wall development, cell division, seed development and stimulation or inhibition of specific metabolic pathways for sugar transport and hormone development (Ahmed et al. 2009). Boron also plays an important role in production of any crop in terms of yield, quality and control of some diseases.

MATERIALS AND METHODS

The materials and methodology and techniques adopted in the present experiment entitled, Effect of potassium and boron on growth and yield of *kharif* cowpea (*Vigna unguiculata*) with a brief description regarding site of experiment, soil properties, sampling techniques, climatic conditions during crop growing period, cropping history, calendar operations and statistical analysis are presented in this chapter with following headings.

In order to study the two micronutrients with foliar spray, potassium and boron are taken. The experiment was conducted at during *kharif* 2022, at Crop Research Farm, Naini Agricultural Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28^{o}N latitude, 81.54^{o}E longitude and 98 m altitude above the mean sea level (MSL). The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. Pre- sowing soil samples were taken from a depth of 15 cm with the help of an auger. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.36%) and medium in available nitrogen (171.48 kg/ha), phosphorous (15.2 kg/ha) and low in potassium (232.5 kg/ha). The treatments consist of potassium (40, 50, 60 kg/ha) and boron (0.6, 0.8, 1.0 kg/ha) respectively. The experiment was laid out in randomized block design with ten treatments each replicated thrice and control i.e., recommended N, P and K (20:40:20 kg/ha). The plots were prepared with dimension of 3m × 3m and seeds were sown with a spacing of 30cm × 10cm. Growth characteristics namely plant height (cm), nodules/plant, plant dry weight (g) were recorded. Post-harvest observations such as number of seeds per pod, pods/plant, test weight (g), seed yield (t/ha), stover yield (t/ha) and harvest index (%) were recorded. The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez (1984). Economics such as gross return, net return, B: C ratio were calculated.

RESULTS

GROWTH PARAMETERS

Plant height (cm)

At 60 DAS, higher plant height (49.41 cm) was recorded significantly in the treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] was found to be statistically at par with treatment 9.

The probable reason for increases plant height might due to the potassium in that application plays crucial role in photosynthesis, respiration, protein synthesis, enzyme activation, water uptake, osmoregulation, growth and yield of plant. (Reddy. *et al.*, 2021). Boron in different physiological processes like enzymes activation, electron transport, chlorophyll formation, stomatal regulation, etc. which gradually increased plant height. (Kanakapudi *et al.*, 2022).

Nodules/plant

At 60DAS, higher nodules/plant (29.33) was recorded significantly in the treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

Boron might have attributed to the favorable influence of them on plant metabolism and biological process activity and their stimulating effect on photosynthetic pigments and enzyme activity which in turn encouraged vegetative growth. (Kanakapudi Bhavana *et al.*, 2022).

Dry weight (g)

At 60DAS, maximum plant dry weight (18.02 g) was recorded significantly in the treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] and treatment 7 [Potassium 60kg/ha + Boron 0.6kg/ha] were statistically at par with treatment 9.

The application of micronutrients on growth of cowpea, in terms of dry matter and crop growth rate can be interpreted in terms of the metabolic function of micronutrients in the plant. Shaik Karimunnisa *et al.* (2021).

YIELD ATTRIBUTES AND YIELD

Seeds/pod

At harvest, the data recorded more seeds/pod (11.67) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

Boron plays the vital role in increasing because it takes place in many physiological process of plant such as chlorophyll formation, stomatal regulation, starch utilization which enhanced seed yield", Mallik and Raj (2015).

Pods/plant

At harvest, the data recorded more pods/plant (15.40) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] and treatment 7 [Potassium 60kg/ha + Boron 0.6kg/ha] was statistically at par with treatment 9.

K is found to influence the total chlorophyll and carotenoid contents of the leaves. It may also directly and/or indirectly improve crop yield through increased photosynthesis, resulted in vigorous growth and consequently produce higher number of pods per plant and also providing better nutrition throughout the growth period and availability of potassium at pod formation stages which help in formation of more number of pods per plant by Senthurpandian *et al.,* (2008). This might be due to its positive influence on pod set and mobilization of assimilate reserves to the sink. Vanum., 2022.

Test weight (g)

At harvest, the data recorded higher test weight (21.83 g) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

Efficient transfer of metabolites and subsequent accumulation of these metabolites in the seed with the resultant increase in the size and weight of individual seed. Similar findings also recorded by Farhad *et al.,* (2010).

Seed yield (t/ha)

At harvest, the data recorded higher seed yield (1.26 t/ha) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

Boron is a required for many physiological processes and plant growth, also adequate nutrition is a critical for increase yields and quality of crops. Shaik Karimunnisa (2021).

Stover yield (t/ha)

At harvest, the data recorded more stover yield (3.62 t/ha) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] and treatment 7 [Potassium 60kg/ha + Boron 0.6kg/ha] was statistically at par with treatment 9.

The improvement in the haulm yield might be due to indirect and positive role of potassium in formation and proliferation of lateral and fibrous roots, which increases the root absorbing surface area for nutrients, which in turn promotes the growth parameters and ultimately enhanced the Haulm yield Chavan *et al.,* (2012). Boron also enhances chlorophyll content in leaf and there by bio mass and phosynthates production is increased, which are effectively transferred towards the roots for its development and to provide required energy for nutrient uptake this uptake results in higher biological yields. Aluri Manoj Kumar *et al.,* (2021).

Harvest index (%)

At harvest, the data recorded maximum harvest index (35.29%) in treatment 9 [[Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

This could be attributed due to better root proliferation, higher root development, increased availability and uptake of nutrients, energy transformation and metabolic processes in plant. Hussain *et al,* (2011).

ECONOMICS

Gross return

Gross return (63000.00 INR/ha) was found to be highest in treatment no.9 [Potassium 60kg/ha + Boron 1.0kg/ha].

Net return

Net return (40133.00 INR/ha) was found to be highest in treatment no.9 [Potassium 60kg/ha

+ Boron 1.0kg/ha].

Benefit cost ratio

The maximum Benefit cost ratio (1.76) was recorded in treatment no.9 [Potassium 60kg/ha + Boron 1.0kg/ha].

This might be attributed to higher seed and Stover yields obtained with comparatively less cost than additional income under these treatments. Similar results were also reported by Goud *et al.,* (2014).

CONCLUSION

From the observations, it is concluded that with the application of Potassium 60kg/ha and Boron 1.0kg/ha (treatment 9) in cowpea was recorded significantly higher Plant height (49.41cm), more number of nodules/plant (29.23), maximum plant dry weight (18.02g/plant), maximum No. of Pods/plant (15.4), seeds/pod (11.67), higher Test weight (21.83 g), Seed yield (1.26 t/ha), Stover yield (3.62 t/ha) and Harvest index (35.29 %), Higher gross returns (INR 63,000.00/ha), net return (INR 40,133.00/ha) and benefit cost ratio (1.76) was obtained in the treatment 9 (Potassium 60kg/ha + Boron 1.0kg/ha),

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Table 1: Effect of potassium and boron on growth attributes of *kharif* cowpea.

S. No.	Treatment combination	Plant height (cm)	Nodules/plant	Dry weight (g)
1.	Potassium 40kg/ha + Boron 0.6kg/ha	45.40	17.60	15.75
2.	Potassium 40kg/ha + Boron 0.8kg/ha	46.03	18.83	16.50
3.	Potassium 40kg/ha + Boron 1.0kg/ha	44.62	20.22	15.74
4.	Potassium 50kg/ha + Boron 0.6kg/ha	44.02	24.86	14.84
5.	Potassium 50kg/ha + Boron 0.8kg/ha	47.44	23.66	15.65
6.	Potassium 50kg/ha + Boron 1.0kg/ha	43.59	25.64	17.10
7.	Potassium 60kg/ha + Boron 0.6kg/ha	49.16	27.56	17.55
8.	Potassium 60kg/ha + Boron 0.8kg/ha	49.33	28.32	17.79
9.	Potassium 60kg/ha + Boron 1.0kg/ha	49.41	29.23	18.02
10.	Control (20: 40: 20 NPK kg/ha)	42.59	14.36	11.92
	F Tab (5%)	S	S	S
	SEm (±)	0.51	0.38	0.29
	CD (p=0.05%)	1.22	1.12	0.88

Table 2: Effect of potassium and boron on yield attributes and yield of *kharif* cowpea.

S. No.	Treatment combination	Seeds/pod	Pods/plant	Test weight	Seed yield	Stover yield	Harvest Index
1.	Potassium 40kg/ha + Boron 0.6kg/ha	10.07	12.80	18.33	1.02	2.89	34.07
2.	Potassium 40kg/ha + Boron 0.8kg/ha	10.13	13.20	19.67	1.06	3.08	34.02
3.	Potassium 40kg/ha + Boron 1.0kg/ha	10.80	13.50	20.67	1.15	3.42	33.62
4.	Potassium 50kg/ha + Boron 0.6kg/ha	10.67	13.42	19.00	1.08	3.20	33.75
5.	Potassium 50kg/ha + Boron 0.8kg/ha	10.53	13.58	19.83	1.12	3.30	33.93
6.	Potassium 50kg/ha + Boron 1.0kg/ha	11.13	13.63	20.17	1.17	3.18	33.42
7.	Potassium 60kg/ha + Boron 0.6kg/ha	10.67	14.80	20.33	1.10	3.50	34.10
8.	Potassium 60kg/ha + Boron 0.8kg/ha	11.53	14.93	20.81	1.22	3.58	34.80
9.	Potassium 60kg/ha + Boron 1.0kg/ha	11.67	15.40	21.83	1.26	3.62	35.29
10.	Control (20: 40: 20 NPK kg/ha)	9.80	12.50	16.83	0.92	2.72	33.82
	F Tab (5%)	S	S	S	S	S	S
	SEm (±)	0.18	0.24	0.35	0.019	0.057	0.51
	CD (p=0.05%)	0.51	1.73	1.05	0.058	0.171	1.11

Table 3: Effect of potassium and boron on economics of *kharif* cowpea.

No.	Treatment combination	Cost of cultivation	Gross return	Net returns	B: C ratio
1.	Potassium 40kg/ha + Boron 0.6kg/ha	22585.00	51000.00	28415.00	1.26
2.	Potassium 40kg/ha + Boron 0.8kg/ha	22636.00	53000.00	30364.00	1.34
3.	Potassium 40kg/ha + Boron 1.0kg/ha	22687.00	57500.00	34813.00	1.53
4.	Potassium 50kg/ha + Boron 0.6kg/ha	22675.00	54000.00	31325.00	1.38
5.	Potassium 50kg/ha + Boron 0.8kg/ha	22726.00	56000.00	33274.00	1.46
6.	Potassium 50kg/ha + Boron 1.0kg/ha	22777.00	58500.00	35723.00	1.57
7.	Potassium 60kg/ha + Boron 0.6kg/ha	22765.00	55000.00	32235.00	1.42
8.	Potassium 60kg/ha + Boron 0.8kg/ha	22816.00	61000.00	38184.00	1.67
9.	Potassium 60kg/ha + Boron 1.0kg/ha	22867.00	63000.00	40133.00	1.76
10.	Control (20: 40: 20 NPK kg/ha)	22432.00	46000.00	23568.00	1.05