Effect of potassium and boron on growth, yield and economics of cowpea

ABSTRACT

The treatments consist of Potassium (40, 50, 60 kg/ha) 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), 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, yield attributes, yield and economics.*

INTRODUCTION

One of the most significant vegetable crops is the cowpea, which is used as a pulse, vegetable, and fodder. It is regarded as one of the oldest human food sources and is the main protein source for the common man. It has likely been cultivated since the Neolithic era (Ng and Marechal 1985). In the arid and semiarid tropics, the cowpea is a crucial multipurpose grain legume that is widely farmed. It is a crucial source of nutrients and offers high-quality, affordable protein for a diet heavy in starchy foods and cereal grains. According to Singh et al. (2012), cowpea is a good source of food, fodder, veggies, and some snacks. This crop can be grown as a green crop, an intercrop, a mulch crop, or a catch crop. In conjunction with symbiotic bacteria, it has the capacity to fix 56 kg/ha of atmospheric N2 in the soil when conditions are favourable (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 world cowpea covers an area of 14.5 m ha, with annual production of 6.2 m t. In India during 2020-21 cowpea is grown in about 13.3 m ha and an annual production of 8.06 m t and productivity of 596 kg/ha. Ministry of Agriculture and Farmers Welfare" (GOI, 2020-21).

Potassium mostly affects the nodulation of pulse crops, increasing seed output through improved nitrogen fixation. It is one of the main elements that the plant absorbs. Potassium is the mineral that plants absorb the most, followed by nitrogen. It aids in the production of chlorophyll and proteins. A crucial mineral for plants, potassium helps them withstand stresses including extreme heat or cold, drought, disease, and pest activity. Although it is not a component of organic structures, it modulates enzymatic activity and photosynthetic translocation and significantly increases chickpea seed output when used as fertiliser. Khan and Samiullah (2003).

Legume crops need more boron than the majority of other field crops because boron is essential for the healthy development of reproductive organs. Due to reproductive tissue malformation that affects pollen germination, its shortage causes plants to become sterile, which increases flower drop and decreases fruit set (Subasinghe et al., 2003). One of the mineral nutrients needed for typical plant growth is boron. According to Ahmed et al. (2009), boron's structural significance in cell wall construction, cell division, seed development, and stimulation or inhibition of particular metabolic pathways for sugar transport and hormone generation are regarded as the most significant roles of boron in plants. In terms of yield, quality, and the prevention of specific diseases like tobacco topsiekte, some potato leaf-roll diseases, and sugar beet crown rot, raan is a crucial component of the production of any crop. Brencley (1937)

MATERIALS AND METHODS

The experiment was conducted during *kharif* 2022, at Crop Research Farm, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj. The experimental 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/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 also calculated.

RESULTS AND DISCUSSION

GROWTH PARAMETERS

Plant height (cm)

At 60 DAS, [Table 1] higher plant height

(49.41 cm) was recorded significantly in the treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (49.33 cm) [Potassium 60kg/ha + Boron 0.8kg/ha] was found to be statistically at par with treatment 9.

"Potassium application may be the likely cause of the increase in plant height, as potassium is essential for photosynthesis, respiration, protein synthesis, enzyme activation, water uptake, osmoregulation, plant development, and yield". Reddy et al., 2021). "Boron plays a role in a variety of physiological functions, including the activation of enzymes, electron transport, chlorophyll synthesis, stomatal regulation, and others that gradually raise plant height". Kanakapudi et al., 2022).

Nodules/plant

At 60DAS, [Table 1] higher nodules/plant (29.33) was recorded significantly in the treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (28.32) [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

"Boron could be responsible for the beneficial effects on plant metabolism and biological process activity, as well as their stimulating effect on photosynthetic pigments and enzyme activity, which in turn supported vegetative development". Kanakapudi Bhavana et al., 2022.

Dry weight (g)

At 60DAS, [Table 1] maximum plant dry weight (18.02 g) was recorded significantly in the treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (17.79 g) [Potassium 60kg/ha + Boron 0.8kg/ha] and treatment 7 (17.55 g) [Potassium 60kg/ha + Boron 0.6kg/ha] were statistically at par with treatment 9.

"In terms of dry matter and crop growth rate, the impact of micronutrient application on cowpea growth can be characterised in terms of the metabolic role of micronutrients in the plant". Shaik Karimunnisa et al., 2021

YIELD ATTRIBUTES AND YIELD

Seeds/pod

At harvest, [Table 2] the data recorded more seeds/pod (11.67) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (11.53) [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

"Boron plays a crucial role in boosting since it is involved in numerous physiological processes of plants, including chlorophyll production, stomatal control, and starch utilisation, which increased seed output" Mallik and Raj (2015),

Pods/plant

At harvest, [Table 2] the data recorded more pods/plant (15.40) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (14.93) [Potassium 60kg/ha + Boron 0.8kg/ha] and treatment 7 [Potassium 60kg/ha + Boron 0.6kg/ha] was statistically at par with treatment 9.

It has been discovered that K affects the amount of total chlorophyll and carotenoids in the leaves. Through improved photosynthesis, which leads to aggressive development and subsequently produces a bigger number of pods per plant as well as better nutrition during the growth period, it may also directly or indirectly increase crop production. According to Senthurpandian et al. (2008), potassium availability during the pod-formation stages aids in the development of more pods per plant. Its favourable effects on pod set and the mobilisation of assimilate reserves to the sink may be the cause of this. Vanum., 2022.

Test weight (g)

At harvest, [Table 2] the data recorded higher test weight (21.83 g) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (20.81 g) [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

Efficient metabolite transfer, which leads to their buildup in the seed and an increase in the size and weight of each individual seed. Similar findings were also recorded by Farhad et al. (2010).

Seed yield (t/ha)

At harvest, [Table 2] the data recorded higher seed yield (1.26 t/ha) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (1.22 t/ha) [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

"In addition to being essential for many physiological processes and plant growth, nutrition is also important for boosting crop yields and quality". Shaik Karimunnisa, 2021.

Stover yield (t/ha)

At harvest, [Table 2] the data recorded more stover yield (3.62 t/ha) in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (3.58 t/ha) [Potassium 60kg/ha + Boron 0.8kg/ha] and treatment 7 (3.50 t/ha) [Potassium 60kg/ha + Boron 0.6kg/ha] was statistically at par with treatment 9.

The increased haulm production may be attributable to potassium's indirect and beneficial effects on the development and growth of lateral and fibrous roots, which increase the roots' nutrient-absorbing surface area and, in turn, improve growth metrics and haulm yield. Chavan et al. (2012) Boron also increases the amount of chlorophyll in leaves, which increases the generation of biomass and photosynthates, which are efficiently transmitted to the roots for growth and to supply the energy needed for nutrient intake, which results in higher biological yields. Aluri Manoj Kumar et al., 2021.

Harvest index (%)

At harvest, [Table 2] the data recorded maximum harvest index (35.29 %) in treatment 9 [[Potassium 60kg/ha + Boron 1.0kg/ha]. However, treatment 8 (34.80 %) [Potassium 60kg/ha + Boron 0.8kg/ha] was statistically at par with treatment 9.

"Better root proliferation, higher root development, enhanced nutrient availability and uptake, energy transformation, and metabolic processes in the plant may all be responsible for this". Hussain et al. (2011)

ECONOMICS

Higher gross return (63000.00 INR/ha), net returns (40133.00 INR/ha) and Benefit cost ratio (1.76) were found to be highest in treatment 9 [Potassium 60kg/ha + Boron 1.0kg/ha] [Table 3].

This could be explained by the larger seed and Stover yields that these treatments produced for comparatively lower costs than additional revenue. Similar results were also reported by Goud *et al.*, (2014).

CONCLUSION

It is concluded that with the application of Potassium 60kg/ha and Boron 1.0kg/ha (treatment 9) in cowpea recorded significantly higher plant height (49.41cm), more number of nodules/plant (29.23), maximum plant dry weight (18.02g/plant), more 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), 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).

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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-test	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-test	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