Original Research Article

"Influence of Molybdenum and Foliar application of Boron on Yield and Economics of Cowpea (*Vigna unguiculata*)"

ABSTRACT

The field experiment was undertaken at Crop Research Farm (CRF) during the *Zaid season* (march to June – 2022). The Department of Agronomy at SHUATS in Prayagraj (UP) on soil with sandy loam in texture to investigate the effect Molybdenum and Foliar application of Boron on Growth and Yield of Cowpea. The treatments consist of three doses of Molybdenum viz., 0.5kg ha^{-1}, 0.75kg ha^{-1} and 1kgha^{-1} and Boron 0.5% at 3 intervals viz., 30DAS, 45DAS and 30DAS & 45DAS whose effect is observed on Cowpea (var. Gomati). The experiment was laid out in Randomized Block Design with Ten treatments replicated thrice. The treatment with application of Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS recorded significantly higher number of pods per plant (16.73), number of seeds per pod (11.67), seed index (18.38g), seed yield (1.59 t ha^{-1}) and Haulm yield (4.16 t ha^{-1}) and BC ratio (1.97) compared to other treatment combinations.

Keywords: *Boron, Cowpea, Economics, Molybdenum, Yield.*

1.Introduction

One of the significant pulse crops is the cowpea (Vigna unguiculata), which is primarily grown in the rainy season during the month of Zaid. It is cultivated for grains, fodder plants, and green manuring. Cowpeas are regarded as an important crop in Uttar Pradesh due to their short season, large yields, and rapid rate of growth. The protein in seeds of cowpea is rich in lysine and tryptophan amino acids compared to cereal grains. The mature cowpea seed contains protein (24.8%), carbohydrate (63.6%), fat (1.9%), fiber (6.3%), thiamine (7.4 ppm), riboflavin (4.2 ppm) and niacin (28.1 ppm) (Ahlawat and Shivkumar, 2005) and is a good source of calcium and iron. There is a significant discrepancy between cowpea's average productivity (550.90 kg/ha) and its potential yield (10–12 q/ha), with its inadequate nutrition being the primary cause. The crop is typically grown on marginal and sub-marginal fields that receive little to no fertilisation and are especially deficient in micronutrients, N, P, and S. It provides a lot of opportunity to boost yield through good crop husbandry. Boron is an essential component for wholesome plant growth and development. Foliar feeding practice would be more useful in early maturing short duration crops, where the soil applied fertilizer may not become fully available before maturity of crop (Somla Naik et al. 2018) It makes a major contribution to the blooming and fertilisation processes, boosting crop quality and yield (Subasinghe et al. 2003). The formation of oilseeds requires boron, which is essential for several physiological processes including cell wall synthesis, root elongation, glucose metabolism, synthesis of nucleic acids, lignification, and tissue differentiation. Along with being essential for glucose transport, it is also essential for cellular differentiation and proliferation. Boron insufficiency is one of the biggest challenges to agricultural output (Kumar et al. 2016). Its scarcity has been noted as the second-largest micronutrient restriction in crops globally, behind zinc (Zn) (Ahmad et al., 2012). Due to the widespread lack of this element, boron has become a crucial micronutrient in Indian agriculture. In India, there are B deficiencies in about one-third of the farmed soils. The prevalence of B insufficiency in India has increased from 2% in 1980 to 52% in 2012 (Singh 2012). Similar to phosphorus, molybdenum is another micronutrient that lowers the seed production of pulses in soils in Uttar Pradesh that are deficient in molybdenum (Anonymous, 1986). The enzyme nitrate reductase, which catalyses the conversion of NO3- to NO2, requires molybdenum as a necessary component. Additionally, it is a structural part of the nitrogenase enzyme, which helps bacteria in the root nodules of leguminous plants fix atmospheric nitrogen Bhuiyan et al (2008) (Togay et al, 2008). For the atmospheric nitrogen fixation process to take place, molybdenum is necessary. Molybdenum works in enzyme systems to cause oxidation-reduction reactions, particularly the conversion of nitrates to ammonia prior to the creation of amino acids and proteins in plant cells. Additionally, it serves as a co-factor in the manufacture of ascorbic acid and activates a few dehydrogenases and phosphatases. If nitrates are to be converted into amino acids and proteins, they need to be found in plants. Micronutrients are thus now viewed as one of the factors limiting the best agricultural yield in recent years. By considering all the above mentioned facts this experiment was laid out to find the optimum doses of boron and molybdenum to maximise the yield and productivity.

2. Materials and Methods

A field experiment was conducted during *Zaid season* (march – June, 2022) at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (UP). The Crop Research Farm is situated at 25.4137˚ N latitude, 81.8491˚ E longitude and at an altitude of 98 m above mean sea level. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), medium in organic carbon (0.48%), medium in available Nitrogen (278.93 kg/ha), low in available Phosphorous (19.03 kg/ha) and medium in available Potash (238.1 kg ha^{-1}). The treatments consist of three doses of Molybdenum viz., 0.5kg ha^{-1}, 0.75kg ha^{-1} and 1kg ha^{-1} and Boron 0.5% at 3 intervals viz., 30DAS, 45DAS and 30DAS & 45DAS whose effect is observed on Cowpea (var. Gomati). The experiment was laid out in Randomized Block Design with ten treatments replicated thrice. The experiment comprising ten treatment possible combination of above factor, *viz.,* T_1: Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS T_2: Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 45DAS, T_3: Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS, T_4: Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS, T_5: Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 45DAS, T_6: Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS, T_7: Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS, T_8: Molybdenum 1kg ha^{-1} + Boron 0.5% at 45DAS, T_9: Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS, T_{10}: Control (R D F: 25: 50: 25). Observations regarding growth and yield attributes was recorded during the field experiment.

3. Result and Discussion

3.1 Yield attributes

According to the yield characteristics data that was collected and analysed at harvest, maximum number of pods per plant (16.73), maximum number of seeds per pod (11.67) and higher seed index (18.38g) was recorded in treatment with the application of Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.

The higher performance of yield attributes might be due to the fact that, boron is proved to increase pollen viability and significant effect on pollen formation and fertilization, hence higher grains number are direct index of pollen viability, whereas the prolong nutrient supplied by the inorganic and inorganic sources led to better translocation of photosynthates into form of grain resulting in better yield attributes. Similar findings were reported by Kannan *et al.* (2013).

3.2 Yield

After evaluated the data recorded post harvesting of crop show that significantly higher seed yield (1.59 t/ha), higher Haulm yield (4.16 t/ha) and harvest index (27.62%) was recorded in treatment with the application of Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.

The judicious use of Molybdenum and Boron showed beneficial effect on physiological process of plant metabolism viz. growth and yield there by leading to higher grain yield. similar findings were reported by Ranjit Chatterjee *et al.*, (2015) who observed that Molybdenum and Boron significantly increased grain yield of Cowpea.

3.3 Economics

The maximum Gross return (158666.67INR/ha), Net return (1,05,329.50INR/ha) and B: C ratio (1.97) were recorded in treatment with the application of Molybdenum 1kg/ha + Boron 0.5% at 30DAS & 45 DAS as compared to other treatments. This was attributed to great increase in seed yield as compared to cost of cultivation with combination of both Soil application of Molybdenum and Foliar application of Boron.

4. Conclusion

Based on the above experimental findings, it is concluded that application of nutrients in combination of Molybdenum 1kg ha^{-1} and Boron 0.5% at 30DAS & 45 DAS accomplished better growth parameters, yield attributes, higher seed yield, higher gross returns and net returns and B:C in cowpea under eastern Uttar Pradesh conditions.

5. References

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Table 1. Yield attributes of Cowpea at harvest as influenced by Molybdenum and Boron.

Treatment	Yield attributes		
	No. of pods plant^{-1}	**No. of seeds Pod^{-1}**	**Seed Index (g)**
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS.	11.93	10.47	16.53
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 45DAS.	12.20	10.73	16.68
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	12.80	10.87	17.19
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS.	12.93	11.13	16.91
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 45DAS.	14.40	10.93	17.19
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	16.53	11.4	18.15
Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS.	14.33	10.47	17.53
Molybdenum 1kg ha^{-1} + Boron 0.5% at 45DAS	14.73	11.33	17.68
Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	16.73	11.67	18.38
Control	10.53	10.27	16.25
F test	S	S	S
SEm(±)	0.08	0.1	0.03
CD (p=0.05)	0.23	0.3	0.10

Table 2. Yield of Cowpea at harvest as influenced by Molybdenum and Boron.

Treatment	Seed Yield (t ha^{-1})	Haulm Yield (t ha^{-1})	Harvest Index (%)
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS.	1.18	3.58	24.72
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 45DAS.	1.19	3.68	24.50
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	1.23	3.96	23.73
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS.	1.26	3.72	25.36
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 45DAS.	1.34	3.85	25.80
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	1.55	4.14	27.18
Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS.	1.35	3.88	25.79
Molybdenum 1kg ha^{-1} + Boron 0.5% at 45DAS	1.37	3.96	25.69
Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	1.59	4.16	27.62
Control	1.07	3.33	24.36
F test	S	S	S
SEm(±)	0.01	0.01	0.21
CD (p=0.05)	0.04	0.02	0.62

Table 3. Economics of Cowpea at harvest as influenced by Molybdenum and Boron.

S. No	Treatments	Economics			
		Cost of Cultivation	Gross returns	Net Returns	B:C ratio
1.	Molybdenum 0.5kg/ha + Boron 0.5% at 30DAS.	50,837.17	117666.67	66,829.50	1.31
2.	Molybdenum 0.5kg/ha + Boron 0.5% at 45DAS.	50,837.17	119333.33	68,496.16	1.35
3.	Molybdenum 0.5kg/ha + Boron 0.5% at 30DAS & 45 DAS.	52,587.17	123333.33	70,746.16	1.35
4.	Molybdenum 0.75kg/ha + Boron 0.5% at 30DAS.	51,212.17	126333.33	75,121.16	1.47
5.	Molybdenum 0.75kg/ha + Boron 0.5% at 45DAS.	51,212.17	134000.00	82,787.83	1.62
6.	Molybdenum 0.75kg/ha + Boron 0.5% at 30DAS & 45 DAS.	52,962.17	146666.67	93,704.50	1.77
7.	Molybdenum 1kg/ha + Boron 0.5% at 30DAS.	51,587.17	135000.00	83,412.83	1.62
8.	Molybdenum 1kg/ha + Boron 0.5% at 45DAS	51,587.17	137000.00	85,412.83	1.66
9.	Molybdenum 1kg/ha + Boron 0.5% at 30DAS & 45 DAS.	53,337.17	158666.67	1,05,329.50	1.97
10.	Control	48,337.17	107333.33	58,996.16	1.22