Original Research Article

"Influence of Molybdenum and Foliar application of Boron on Growth and Yield 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). Cowpea (*Vigna unguiculata*) is one of the important pulse crops grown mainly in *Zaid season* under rainfed conditions. Cowpea is considered as an important crop of Uttar Pradesh because of its short duration, high yielding and quick growing capacity. Boron has emerged as an important micronutrient in Indian agriculture in the context of the spread of its deficiency. About one third of the cultivated soils in India are deficient in Boron. Likewise, molybdenum is another micronutrient leading to poor seed yield of pulses in molybdenum deficient soils of Uttar Pradesh is looking into how molybdenum and foliar boron applications affect cowpea growth and yield on soil with a sandy loam texture. 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 plant height (72.55cm), number of branches $plant^{-1}$ (15.33) and plant dry weight (43.68 g), 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}) compared to other treatment combinations.

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

1.Introduction

One of the significant pulse crops is cowpea (Vigna unguiculata), which is primarily grown in the Zaid season under rainfed conditions. The crop is autogamous, but up to 5% outcrossing has been reported in the cultivated varieties, probably due to insect activities (Badiane et al. 2014). Cowpea grains have a nutritional profile of 23.4% protein, 60.3% carbohydrates and 1.8% fat, as well as a good source of vitamins (Venkatesan et al. 2003, Srivastava et al. 2016). Cowpea is also known for producing high-quality forage. It fixes nitrogen as it is a leguminous crop and improves fertility of the soil (Kumar et al. 2015). The young leaves are used as spinach in eastern and southern Africa (Boukar et al. 2015). Cowpea [Vigna unguiculata (L.) Walp] (2n=22) belong to family Leguminosae also known as southern pea and black eye pea, is one of the most important vegetables. Cowpea (Vigna unguiculata Walp.) is an important arid legume grown for its pods, leaves and grains (Ehlers and Hall, 1997, Boukar et al. 2011). Cowpea can be grown as fodder crop, while its tender pods can be used as vegetables. However, it is predominantly grown for its dried grains (Lioi et al. 2019). Cowpea is mainly cultivated in tropical and subtropical countries such as Africa, Asia, Central and South America. Because of its high protein content, cowpea is referred to as “vegetable meat” and have biological value on a dry weight basis (Ram, 2014). Trends in the production of pulse is adversely affected the per capita availability of pulses. In India per capita/day availability of pulses had decreased from 69g during sixties to 35g as against the FAO/WHO’s current recommendation of 80 g per day (Ali and Gupta 2012). 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). 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). 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) Boron insufficiency is one of the biggest challenges to agricultural output. Its deficiency has been noted as the second-largest micronutrient restriction in crops globally, after zinc (Zn) (Ahmad et al., 2012). Molybdenum is an essential element; it is constituent of the nitrogenase enzyme and every bacterium which fixes nitrogen needs molybdenum during the fixation processes. The functions of molybdenum in leguminous plants include nitrate reduction nodulation, nitrogen fixation and general metabolism (Togay *et al*. 2008). Molybdenum was required for normal plant growth, reduction supply with molybdenum to the growth media decreased the activities of nitrate reducate and glutamine synthesis involved at initial steps of nitrate assimilation (Hristozkora et al. 2006). Gungula and Gerjila (2006) reported that molybdenum at 0.13 kg/ ha increased plant height, number of branches, dry weight and yield parameters of cowpea plants. Molybdenum enhance cowpea root nodules efficiency, growth, minerals composition, yield quantity and quality compared with control plants. (Nadia gad et al. 2013). As a result, this study focused on the use of both Molybdenum and Boron to ensure the long-term viability of Cowpea production.

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 Growth

According to the recorded and tabulated data pertaining to growth parameters, the significantly higher plant height (72.55 cm), maximum number of Branches per plant (15.33) and higher plant dry weight (43.68 g) was recorded in treatment with application of Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS. Application of Molybdenum along with Boron resulted in significant increase in nutrient contents might be due to greater availability of N due to molybdenum is a constituent of enzyme nitrogenase, which is essential for the process of symbiotic nitrogen fixation. These results are in close conformity with findings of Salwinder Singh *et al.,* (2022), Shivakumar and Kumutha (2003). On the other hand, the increased plant growth may be due to Boron is considered to be essential for actively growing regions of plants, such as root tips, new leaf and bud development. These results were in close conformity with findings of Ahmad *et al.*, (2009), Ranjit Chatterjee *et al.,* (2015).

3.2 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).

3.3 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.

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 in cowpea under eastern Uttar Pradesh conditions.

5. References

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

Treatments	Plant Height (cm)	Plant Dry Weight (g)	No. of Branches per Plant	CGR ($g\ m^{-2}\ day^{-1}$)	RGR ($g^{-1} g^{-1} day^{-1}$)
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS.	63.20	34.27	12.07	12.15	0.0195
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 45DAS.	63.67	34.92	12.33	12.12	0.0190
Molybdenum 0.5kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	64.63	36.20	12.87	12.93	0.0196
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS.	65.57	37.19	13.33	13.03	0.0192
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 45DAS.	66.58	38.46	14.07	13.11	0.0186
Molybdenum 0.75kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	70.53	41.33	14.40	9.92	0.0123
Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS.	65.45	39.38	13.53	11.87	0.0160
Molybdenum 1kg ha^{-1} + Boron 0.5% at 45DAS	69.55	40.36	13.47	10.56	0.0136
Molybdenum 1kg ha^{-1} + Boron 0.5% at 30DAS & 45 DAS.	72.55	43.68	15.33	11.22	0.0133
Control	62.41	33.34	11.13	11.78	0.0194
F test	S	S	S	S	S
SEm(±)	0.06	0.03	0.11	0.05	0.00
CD (p=0.05)	0.19	0.09	0.33	0.15	0.00

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