



Influence of Boron and Molybdenum on Growth, Yield and Economics of Kabuli Chickpea (*Cicer kabulium* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A Field experiment titled "Influence of Boron and Molybdenum on growth, yield and economics of Kabuli chickpea (*Cicer kabulium* L.)" was conducted during Rabi 2022-2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.58%), available N (225 kg/ha), available P (32.30 kg/ha) and available K (350 kg/ha). The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The result showed that growth parameters of Kabuli Chickpea viz., Higher plant height (68.49 cm), dry weight (24.34 g), number of nodules per plant (41.03) and the yield attributes namely pods per plant (14.29), seeds per pod (2.00), seed yield (3.29 t/ha), stover yield (3.36 t/ha) and harvest index (43.80%) were recorded significantly higher with application of treatment 9 Boron 2 kg/ha + Molybdenum 1.5 kg/ha. The higher net returns (122,782 INR/ha), gross return (165,977 INR/ha) and B:C ratio (2.84) was recorded with application of Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

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1. INTRODUCTION

“Chickpea, scientifically known as *Cicer arietinum*, is a versatile legume cultivated worldwide. India holds a prominent position in chickpea production and consumption. The country has a rich history of cultivating chickpeas, with major production areas in states like Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, and Andhra Pradesh. These regions provide favorable agro-climatic conditions for chickpea cultivation, such as well-drained soils and moderate temperatures. Chickpea contains 18-22 per cent protein, 52-70 per cent carbohydrate, 4-10 per cent fat and sufficient quantity of minerals, calcium, phosphorus, iron and vitamins” [1]. “Its deep roots open up the soil, improving aeration, while leaf shedding increases the organic matter in the soil. It can fix nitrogen up to 25-30 kg/ha through symbiosis, thus reducing the dependency on chemical fertilizer. Therefore, chickpeas play an important role in improving the soil. Molybdenum (Mo) plays an important role in increasing chickpea yield through its effects on the plant itself and the symbiotic process of nitrogen fixation because Mo plays a direct role in nitrogen fixation in legumes” [2]. “Mo is the key to nitrogen fixation by legumes” [3]. “The total molybdenum content of the soil ranges from 0.2 to 5.0 mg/kg” [4]. “Molybdenum deficient chickpeas produce fewer and smaller flowers, and many flowers do not open or mature, resulting in reduced seed yield” [5].

“Boron deficiency and excess can cause physical and physiological disorders in plants” [6]. “Symptoms of boron deficiency are weak roots, poor apical meristem development, poor leaf growth, decreased chlorophyll and photosynthetic ratio, problematic ion channels; high phenol and lignin concentrations and low yields” [7] It has been reported that boron application may increase the growth of chickpea, and boron deficiency may seriously affect chickpea production.

By combining B and Mo sources and applying them at appropriate times, farmers can enhance improve crop performance, and contribute to sustainable chickpea production systems.

2. MATERIALS AND METHODS

The experiment was conducted during rabi 2022, at Crop Research Farm, Naini Agricultural

Institute, SHUATS, Prayagraj. The experimental site of the study is geographically located at 25.28°N latitude, 81.54°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. The soil was sandy loam in texture, organic carbon (0.58%) and available nitrogen (225 kg/ha), phosphorous (32.30 kg/ha) and low in potassium (350 kg/ha). The experiment was laid out in randomized block design with three replications comprising ten treatment *viz.*, T₁: Boron 1 kg/ha + Molybdenum 0.5 kg/ha, T₂: Boron 1 kg/ha + Molybdenum 1 kg/ha, T₃: Boron 1 kg/ha + Molybdenum 1.5 kg/ha, T₄: Boron 1.5 kg/ha + Molybdenum 0.5 kg/ha, T₅: Boron 1.5 kg/ha + Molybdenum 1 kg/ha, T₆: Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha, T₇: Boron 2 kg/ha + Molybdenum 0.5 kg/ha, T₈: Boron 2 kg/ha + Molybdenum 1 kg/ha, T₉: Boron 2 kg/ha + Molybdenum 1.5 kg/ha and T₁₀: Control (RDF 20:60:60 NPK kg /ha). Dollar variety chickpea was used for sowing. Recommended nutrient dose 20:60:60 NPK kg/ha were applied in the plot through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively at the time of sowing. All other recommended agronomic practices were followed and plant protection measures were adopted as per need. The plots were prepared with dimension of 3m x 3m and seeds were sown with a spacing of 30cm x 10cm. Irrigations were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was completely harvested at physiological maturity stage and their post-harvest observations such as number of pods per plant, number of seeds per pod, 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 [8].

3. RESULTS AND DISCUSSIONS

3.1 Growth Parameters

Table 1 Pertaining the details of Influence of Boron and Molybdenum on growth attributes of Kabuli Chickpea.

3.2 Plant Height (cm)

Significantly higher plant height (68.49 cm) was recorded in Boron 2 kg/ha + Molybdenum 1.5

kg/ha at 120 DAS. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (67.77cm) and Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (67.22 cm) were found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

This may be due to the presence of molybdenum, fixed nitrogen which increases vegetative growth and plant height. On the other hand, boron plays an important role in cell division, differentiation and growth of plants. Our results were also supported by [9] who reported that continuous planting was done using boron and molybdenum. Mo fertilization at 1.5 kg/ha is equivalent to plant height, nodulation, number of pods, dry matter yield and seed yield [10] and others. 2019).

3.3 Dry Weight (g)

Significantly higher dry weight (24.34 g) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha at 120 DAS. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (23.40 g), Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (23.39 g) and Boron 1.5 kg/ha + Molybdenum 1 kg/ha (23.12 g) were found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

Dry weight per plant increased at harvest time. Plants fertilized with boron had higher total dry matter yield (30.36 g) and boron fertilization of 3 kg/ha increased plant growth [11]. Plant growth is affected by molybdenum application; Plants fertilized with molybdenum have higher total dry matter during growth because foliar application of molybdenum can improve plant growth [12] and [13]. The increase in dry matter with the increase in molybdenum supply is due to the increase in the number of pods (including seeds) per plant, and also because, according to [5], there were more flowers produced.

3.4 Number of Nodules/Plant

At 120 DAS, significantly higher number of nodules/plant (2.80) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (2.44) was found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

The improvement in crop growth and nodulation due to Mo and B can be attributed to their important role in nodule synthesis and nitrogen fixation [14]. Similar studies were also found by [15], who reported that molybdenum application

responds well to increasing the number of nodules in legumes. In terms of boron, the number of nodules increases as the boron content increases. Foliar boron sprays increased the number of root nodules compared to the control. These findings are corroborated by [16].

3.5 Crop Growth Rate (g/m²/day)

During 100-120 DAS, significantly higher crop growth rate (8.26 g/m²/day) was recorded in Boron 1.5 kg/ha + Molybdenum 1 kg/ha. However, Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (8.22 g/m²/day), Boron 2 kg/ha + Molybdenum 1 kg/ha (6.50 g/m²/day) and Boron 2 kg/ha + Molybdenum 1.5 kg/ha (6.04 g/m²/day) were found statistically at par with Boron 1.5 kg/ha + Molybdenum 1 kg/ha.

B (10 kg/ha) + Mo (0.2%) application (0.25 g/plant/day) recorded the maximum CGR. The increase in CGR in B and Mo with application indicates improved stem development of the crop, resulting in higher seed yield [17].

3.6 Yield Attributes

Table. 2 and 3 Pertaining the details of Influence of Boron and Molybdenum on growth and yield of Kabuli chickpea.

3.6.1 Number of pods/plant

Significantly higher number of pods/plant (14.29) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (14.12), Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (13.63), Boron 1 kg/ha + Molybdenum 1.5 kg/ha (13.80) and Boron 1 kg/ha + Molybdenum 1 kg/ha (13.60) were found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

The reason for this may be the use of molybdenum, which increases production [18]. These results were supported by [19] who reported that molybdenum application increased pods/plant yield. Rabani et al. [20] also showed a positive effect of molybdenum and noted that molybdenum fertilization had a significant effect on pods/plants. Molybdenum application increased active nodules and nodule weight per plant in chickpea [21]. Boron works in reproductive tissues and controls flower shedding, thus increasing the number of pods/plants. It is consistent with our findings [22] listed improved pods/plants of molybdenum and boron.

3.6.2 Number of seeds/pod

Significantly higher number of seed/pod (2.00) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (1.80), Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (1.87) and Boron 1.5 kg/ha + Molybdenum 1 kg/ha (1.67) were found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

Data analysis showed that molybdenum and boron had a significant effect on the number of seeds per pod. While maximum number of the pods were found at the Mo application rate of 0.6 kg/ha, the least number of pods was found in the plants without Mo. Our results are similar to those [23], which explained that molybdenum fertilization improves bean seed. In the case of boron, higher seed yield per pod was used at 3.6 kg/ha, while lower seed yield was recorded in plants not treated with boron. This is because boron plays a role in seed sowing and can increase the number of seeds per pod, which may be responsible for increasing seed yield. This result is consistent with [24] and [25] claiming that boron application increases the number of seeds per pod.

3.6.3 Seed index (g)

Significantly higher seed index (41.28 g) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (40.83 g), Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (41.12 g), Boron 1.5 kg/ha + Molybdenum 1 kg/ha (41.10 g), Boron 1 kg/ha + Molybdenum 1.5 kg/ha (40.89) and Boron 1 kg/ha + Molybdenum 1 kg/ha (40.58) were found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

This may be because molybdenum improves nitrogen fixation, leading to maximum utilization and more thousand seed weights. The use of boron has been found to be beneficial. Our results are consistent with the result [26] showing that boron application increased 100 grain weight. These results are consistent with those of Kaisher et al. [27].

3.6.4 Seed yield (t/ ha)

Significantly higher seed yield (3.29 t/ha) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (3.18 t/ha), Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (3.16 t/ha) and Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (2.94 t/ha) were found

statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

The increase in yield may be due to the growth of plants due to the rhizobial activity of molybdenum, which increases the vegetative growth of the crop. These results are consistent with [19]. They reported that molybdenum increased crop yields compared to control. Boron plays an important role in chickpea seed yield as it increases chickpea yield by regulating phytohormone levels, photosynthetic activity and plant growth. Our results are similar to [28]. Mekkei [29] concluded that the foliar application of zinc, boron and molybdenum produced more chickpea seeds. Kobraee [30] also reported similar findings.

3.6.5 Stover yield (t/ha)

Significantly higher haulm yield (3.36 t/ha) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (3.30 t/ha) was found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

Sarker et al., [31] show that the use of boron and molybdenum has a positive effect on straw yield. Hoque et al., [14] reported a significant change in straw yield due to the use of boron and molybdenum. BARI Chola-9 had the highest yields (3.45 t/ha) when B and Mo were applied to the crop by foliar spraying and seed preparation, respectively.

3.7 Harvest Index (%)

Significantly higher harvest index (43.80%) was recorded in Boron 2 kg/ha + Molybdenum 1.5 kg/ha. However, Boron 2 kg/ha + Molybdenum 1 kg/ha (43.12%), Boron 2 kg/ha + Molybdenum 0.5 kg/ha (39.27%), Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (43.92%), Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha (42.60%) and Boron 1 kg/ha + Molybdenum 0.5 kg/ha (38.92%) were found statistically at par with Boron 2 kg/ha + Molybdenum 1.5 kg/ha.

Mekkei [29] reported an 8.2% increase in yield in B + Mo application compared to control. This is because the increase in seed yield is greater than the increase in biomass. In both seasons, the highest yield (23.6% and 24.1%) was observed in (B+Mo) application. Therefore, increasing the seed yield can increase the product index. These results are consistent with [32,33,34,35], and (Kobaraee 2019) reported that molybdenum application increased the index (%) of chickpeas and lentils.

Table 1. Influence of Boron and Molybdenum on growth attributes of Kabuli Chickpea

| S. No. | Treatments | Plant height (cm) | Dry weight (g) | Nodules/plant | CGR (g/m ² /day) | RGR (g/g/day) |
|--------|--|-------------------|----------------|---------------|-----------------------------|---------------|
| 1. | Boron 1 kg/ha + Molybdenum 0.5 kg/ha | 61.70 | 18.40 | 1.40 | 6.58 | 0.01206 |
| 2. | Boron 1 kg/ha + Molybdenum 1 kg/ha | 65.40 | 18.87 | 1.80 | 4.48 | 0.00770 |
| 3. | Boron 1 kg/ha + Molybdenum 1.5 kg/ha | 66.01 | 20.08 | 1.93 | 4.35 | 0.00696 |
| 4. | Boron 1.5 kg/ha + Molybdenum 0.5 kg/ha | 62.80 | 18.34 | 1.40 | 4.63 | 0.00823 |
| 5. | Boron 1.5 kg/ha + Molybdenum 1 kg/ha | 66.59 | 23.12 | 2.13 | 8.26 | 0.01210 |
| 6. | Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha | 67.22 | 23.39 | 2.30 | 8.22 | 0.01184 |
| 7. | Boron 2 kg/ha + Molybdenum 0.5 kg/ha | 64.15 | 18.31 | 1.40 | 4.43 | 0.00786 |
| 8. | Boron 2 kg/ha + Molybdenum 1 kg/ha | 67.77 | 23.40 | 2.44 | 6.50 | 0.00911 |
| 9. | Boron 2 kg/ha + Molybdenum 1.5 kg/ha | 68.49 | 24.34 | 2.80 | 6.04 | 0.00806 |
| 10. | Control (RDF 20:60:60 NPK kg/ha) | 61.11 | 17.68 | 0.80 | 4.41 | 0.00805 |
| | F Tab (5%) | S | S | S | S | NS |
| | SEm (±) | 0.50 | 0.47 | 0.13 | 0.81 | 0.001 |
| | CD (p=0.05%) | 1.40 | 1.33 | 0.37 | 2.26 | - |

Table 2. Influence of boron and molybdenum on yield attributes of Kabuli Chickpea

| S.No. | Treatments | Pods/plant | Seeds/pod | Seed index |
|-------|--|------------|-----------|------------|
| 1. | Boron 1 kg/ha + Molybdenum 0.5 kg/ha | 12.20 | 1.20 | 39.38 |
| 2. | Boron 1 kg/ha + Molybdenum 1 kg/ha | 13.60 | 1.33 | 40.58 |
| 3. | Boron 1 kg/ha + Molybdenum 1.5 kg/ha | 13.80 | 1.33 | 40.89 |
| 4. | Boron 1.5 kg/ha + Molybdenum 0.5 kg/ha | 12.33 | 1.13 | 39.56 |
| 5. | Boron 1.5 kg/ha + Molybdenum 1 kg/ha | 13.44 | 1.67 | 41.10 |
| 6. | Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha | 13.63 | 1.87 | 41.12 |
| 7. | Boron 2 kg/ha + Molybdenum 0.5 kg/ha | 12.67 | 1.40 | 39.72 |
| 8. | Boron 2 kg/ha + Molybdenum 1 kg/ha | 14.12 | 1.80 | 40.83 |
| 9. | Boron 2 kg/ha + Molybdenum 1.5 kg/ha | 14.29 | 2.00 | 41.28 |
| 10. | Control (RDF 20:60:60 NPK kg/ha) | 11.68 | 1.00 | 37.46 |
| | F-Test | S | S | S |
| | SEm (±) | 0.28 | 0.16 | 0.40 |
| | CD (p = 0.05) | 0.80 | 0.47 | 1.11 |

Table 3. Influence of boron and molybdenum on yield attributes of Kabuli Chickpea.

| S.No. | Treatments | Seed yield (t/ha) | Haulm yield (t/ha) | Harvest Index (%) |
|-------|--|-------------------|--------------------|-------------------|
| 1. | Boron 1 kg/ha + Molybdenum 0.5 kg/ha | 1.52 | 2.16 | 38.92 |
| 2. | Boron 1 kg/ha + Molybdenum 1 kg/ha | 2.24 | 2.91 | 34.00 |
| 3. | Boron 1 kg/ha + Molybdenum 1.5 kg/ha | 2.46 | 2.98 | 36.61 |
| 4. | Boron 1.5 kg/ha + Molybdenum 0.5 kg/ha | 1.88 | 2.24 | 35.74 |
| 5. | Boron 1.5 kg/ha + Molybdenum 1 kg/ha | 2.94 | 3.06 | 42.60 |
| 6. | Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha | 3.16 | 3.21 | 43.92 |
| 7. | Boron 2 kg/ha + Molybdenum 0.5 kg/ha | 2.19 | 2.41 | 39.27 |
| 8. | Boron 2 kg/ha + Molybdenum 1 kg/ha | 3.18 | 3.30 | 43.12 |
| 9. | Boron 2 kg/ha + Molybdenum 1.5 kg/ha | 3.29 | 3.36 | 43.80 |
| 10. | Control (RDF 20:60:60 NPK kg/ha) | 1.26 | 2.01 | 26.30 |
| | F-Test | S | S | S |
| | SEm (±) | 0.112 | 0.03 | 2.52 |
| | CD (p = 0.05) | 0.313 | 0.09 | 7.04 |

Table 4. Influence of boron and molybdenum on economics of Kabuli Chickpea

| S.No. | Treatments | Economics(INR) | | | |
|-------|--|------------------------------|-----------------------|---------------------|---------------|
| | | Cost of Cultivation (INR/ha) | Gross return (INR/ha) | Net return (INR/ha) | B C ratio (%) |
| 1. | Boron 1 kg/ha + Molybdenum 0.5 kg/ha | 41,645.00 | 76,760.00 | 35,115.00 | 0.84 |
| 2. | Boron 1 kg/ha + Molybdenum 1 kg/ha | 42,295.00 | 113,120.00 | 70,825.00 | 1.67 |
| 3. | Boron 1 kg/ha + Molybdenum 1.5 kg/ha | 42,945.00 | 124,230.00 | 81,285.00 | 1.89 |
| 4. | Boron 1.5 kg/ha + Molybdenum 0.5 kg/ha | 41,770.00 | 94,940.00 | 53,170.00 | 1.27 |
| 5. | Boron 1.5 kg/ha + Molybdenum 1 kg/ha | 42,420.00 | 148,470.00 | 106,050.00 | 2.50 |
| 6. | Boron 1.5 kg/ha + Molybdenum 1.5 kg/ha | 43,070.00 | 159,580.00 | 116,510.00 | 2.70 |
| 7. | Boron 2 kg/ha + Molybdenum 0.5 kg/ha | 41,894.00 | 110,595.00 | 68,701.00 | 1.63 |
| 8. | Boron 2 kg/ha + Molybdenum 1 kg/ha | 42,545.00 | 160,759.00 | 118,213.00 | 2.77 |
| 9. | Boron 2 kg/ha + Molybdenum 1.5 kg/ha | 43,195.00 | 165,977.00 | 122,782.00 | 2.84 |
| 10. | Control (RDF 20:60:60 NPK kg/ha) | 40,745.00 | 63,630.00 | 22,885.00 | 0.56 |

*MSP (minimum support price) for chickpea= 5050 per quintal

3.7.1 Gross return (INR/ha)

The higher gross return was recorded with application of Boron 2 kg/ha + Molybdenum 1.5 kg/ha (165,977 INR/ha).

3.7.2 Net returns (INR/ha)

The higher net return was recorded with application of Boron 2 kg/ha + Molybdenum 1.5 kg/ha (122,782 INR/ha).

3.7.2 Benefit cost ratio (B:C)

Higher B:C was recorded with application of Boron 2 kg/ha + Molybdenum 1.5 kg/ha (2.84), as compared to rest of the treatments.

Hence, boron 2 kg/ha + molybdenum 1.5 kg/ha is economically profitable. There was considerable increase in the net return and B:C ratio with foliar spraying of Mo and B.

4. CONCLUSION

From the observations, it was concluded that with the combination of Boron 2 kg/ha + Molybdenum 1.5 kg/ha in treatment no. 9 significantly recorded higher in all the growth and yield attributes namely, plant height, dry weight, pods per plant, seeds per pod, seed index, seed yield, pod yield and haulm yield. Also recorded higher net return and B.C ratio and therefore is a fitting practice for augmenting higher Kabuli chickpea yields for farmer.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Pujitha J, Singh V, George SG, Vivek. Effect of spacing and sulphur levels on growth and yield of chickpea (*Cicer arietinum* L.). The Pharma Innovation Journal. 2022;11(3):1611-1613.
2. Roy RN, Finck A, Blair GJ, Tandon HLS. Plant nutrition for food security. A guide for integrated nutrient management. FAO fertilizer and plant nutrition bulletin 16. FAO, Rome, Italy. 2006;368.
3. Meagher WR, Johnson M, Stout PR. Molybdenum requirement of leguminous plants supplied with fixed nitrogen. Plant Physiol. 1991;27(2):623-629.
4. Sims TT. Soil fertility evaluation. In: Handbook of soil science (Summer M.E., ed). CRC Press LLC, Boca Raton, FL, USA. 2000;113-154.
5. Ahlawat IPS, Gangaiah B, Zahid MA. Nutrient management in chickpea. Centre for agric. and bioscience res. Int. Wallingford. Oxon. UK. 2007;213-232.
6. Kastori R, Maksimovic I, Kraljevic-Balalic M, Kobiljski B. Physiological and genetic basis of plant tolerance to excess boron. Zbornik Matice Srpske Za Prirodne Nauke. 2008;144:41-51.
7. Wang N, Yang C, Pan Z, Liu Y, Peng XA. Boron deficiency in woody plants: Various responses and tolerance mechanisms. Front. Plant Sci. 2015;6(916).
8. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley and Sons, New York. 1984;680.
9. Singh DK, Kumar P, Mishra, Neelam, Singh AK. Interactive effect of cobalt, boron and molybdenum at different fertility status on percentage translocation of nitrogen, phosphorus and sulfur in grain of pea. Environ. and Ecol. 2012;30(2):262-265.
10. Meera S, Pandian PS, Indirani R, Ragavan T. Influence of phosphorus and molybdenum on growth attributes and yield of black gram in typic haplustalf. International Journal of Chemical Studies. 2019;7(3):2533-2536.
11. Kumar AM, Umesha C, Raju GV. Effect of Phosphorus and Boron Levels on Growth and Yield of Chickpea (*Cicer arietinum* L.). International Journal of Plant & Soil Science. 2022;34(21):266-271.
12. Bhanavase DB, Patil PL. Effects of molybde-num on nodulation in gram. Journal Maharashtra Agric Univ. 1994;19: 127-129.
13. Johansen C, Musa AM, Kumar Rao JV, Harris D, Ali MY, Shahidullah AKM, Lauren JG. Correcting molybdenum deficiency of chickpea in the High Barind Tract of Bangladesh. Journal Plant Nutr Soil Sci. 2007;170:752-761.
14. Hoque A, Alam MS, Khatun S, Salahin M. Response of chickpea (*Cicer arietinum* L.) to boron and molybdenum fertilization. Journal. Bio-Sci. 2021;29(2):43-51.
15. Chakraborty A. Growth and yield of lentil (*Lens culinaris* L.) as affected by boron and molybdenum application in lateritic soil. Journal. Crop. Weed. 2009;5(1):88- 91.
16. Hasnain A, Mahmood S, Akhtar S, Malik SA, Bashir N. Tolerance and toxicity levels of boron in mung bean (*Vigna radiata* L.)

- cultivars at early growth stages. Pak. Journal. Bot. 2011;43(2):1119-1125.
17. Karim F, Fattah QA. Growth analysis of chickpea as affected by foliar spray of growth regulators. Bangladesh Journal Bot. 2007;36:105-10.
 18. Awomi TA, Singh AK, Singh AP, Bordoloi LJ. Effect of phosphorus, molybdenum and cobalt on growth yield and nutrient content of mungbean and soil fertility. Journal. Soil & Crops. 2011;21(2):158-164.
 19. Khan N, Tariq M, Ullah K, Muhammad D, Khan I, Rahatullah K, et al. The effect of molybdenum and iron on nodulation, nitrogen fixation and yield of chickpea genotypes (*Cicer arietinum* L.). IOSR Journal Agric. and Vet. Sci. 2014;7:63-79.
 20. Rabbani MG, Solaiman AR, Hossain KM, Hossain T. Effects of Rhizobium Inoculant, nitrogen, phosphorus and molybdenum on nodulation, yield and seed protein in pea. Kor. Journal Genotypes Sci. 2005;50(2): 112-119.
 21. Khan K, Muhammad A, Iqbal S. Effect of molybdenum levels, bacterium inoculation and chickpea varieties on nodulation under diverse conditions. Bioscience Research. 2020;17(2):1323-1328.
 22. Singh AK, Khan MA, Arun S. Effect of boron and molybdenum application on seed yield of mungbean. Asian Journal Bio. Sci. 2014;9(2):169-172.
 23. Tahir M, Ali A. Aabidin N, Rehman MH. Effect of molybdenum and seed inoculation on growth, yield and quality of mungbean. Geno. Envir. 2011;2(2):37-40.
 24. Kushwaha BL. Studies on response of french bean to zinc, boron and molybdenum application. Indian Journal Pulses Res. 1999;12(1):44-48.
 25. Hossain MB, Hasan MM, Razia S, Bari AKMA. Growth and yield response of chickpea to different levels of boron and zinc. Fundamental and applied Agric. 2016;1(2):82-86.
 26. Bellaloui N, Hu Y, Mengistu A, Kassem MA, Abel CA. Effects of foliar boron application on seed composition, cell wall boron, and seed $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ isotopes in water-stressed soybean plants. Frontiers in Plant. Sci. 2013;4:270-282.
 27. Kaisher MS, Rahman MT, Amin MHH, Amanullah ASM and Ahsanullah ASM. Effects of sulphur and boron on the seed yield and protein content of mungbean. Bangladesh Res. Pub. Journal. 2010;3(4):1181-1186.
 28. Shil NC, Noor S, Hossain MA. Effect of boron and molybdenum on the yield of chickpea. Agri. Journal Rural Dev. 2007;5(1&2):17-24.
 29. Mekkei M. Effect of micronutrients (Zn, B and Mo) foliar application at different growth stages of chickpea (*Cicer arietinum* L.) on yield and yield components. Int Journal Res Agron. 2019;2(2):23-28.
 30. Kobraee S. Effect of foliar fertilization with zinc and manganese sulfate on yield, dry matter accumulation, and zinc and manganese contents in leaf and seed of chickpea (*Cicer arietinum* L.). Journal of Applied Biology and Biotechnology. 2019;7(03):20-28.
 31. Sarker SK, Chowdhury MAH, Zakir HM. Sulphur and boron fertilization on yield quality and nutrient uptake by Bangladesh soybean-4. Journal Bio-Sci. 2000;2:729-733.
 32. Sarbandi, H, Madani, H. Response yield and yield component of chickpea to foliar application of micronutrients. Technical Journal of Engineering and Applied Sciences. 2014;4(1):18-22.
 33. Ganga N, Singh RK, Singh RP. Effect of potassium level and foliar application of nutrient on growth and yield of late sown chickpea (*Cicer arietinum* L.). Environment & Ecology. 2014;32(1A):273- 275.
 34. Rahman IU, Ijaz F, Afzal A, Iqbal Z. Effect of foliar application of plant mineral nutrients on the growth and yield attributes of chickpea (*Cicer arietinum* L.) under nutrient deficient soil conditions. Bangladesh Journal Bot. 2017;46(1):111-118.
 35. Nasar J, Shah Z. Effect of iron and molybdenum on yield and nodulation of lentil. ARPN Journal of Agricultural and Biological Sci. 2017;12(11):332-339.

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