E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(8): 507-509
Received: 15-05-2024
Accepted: 19-06-2024

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Influence of boron and plant growth regulators on growth and yield of chickpea (*Cicer arietinum* L.)

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i8Sg.1310

Abstract
A field experiment was conducted during *Rabi* 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experiment was laid out in Randomized Block Design with ten treatments which are replicated thrice on the basis of one year experimentation. The treatments consisted of 3 levels of Boron levels (1, 1.5, 2 kg/ha), and 3 levels of plant growth regulators (Gibberellic acid: 30 ppm, Naphthalene acetic acid: 45 ppm, Abscisic acid: 60 ppm) as a foliar spray and a control. The application of Boron 2 kg/ha + Gibberellic acid 30 ppm recorded significantly higher Plant height (56.6 cm), Plant dry weight (45.7 g/plant), number of nodules per plant (11.7). Significantly maximum number of pods per plant (31.60), number of seeds per pod (2.53), Seed yield (1103.90 kg/ha).

Keywords: Boron, chickpea, gibberellic acid, naphthalene acetic acid, abscisic acid

Introduction
Chickpea (*Cicer arietinum* L.) is the largest food legume produced in South Asia. It also ranks third in the production of food legumes in the world, after common bean (*Phaseolus vulgaris* L) and field pea (*Pisum sativum* L). Its common name is Bengal gram, Garbanzo and Egyptian pea. It is a member of the Fabaceae family. It is a herbaceous perennial with a long root system that allows it to withstand drought. Chickpeas are the main source of protein for millions of people, especially in developing countries, mainly due to food preferences or economic reasons. Legumes are an integral part of the cropping system of farmers across the country because these crops fit well into the crop rotation and crop mix. Vegetarians mostly depend on pulses, which are a major component of the Indian diet. Desi and Kabuli represent two widely grown chickpea cultivars worldwide.

Morphologically different, Desi (microsperma) is characterized by its pink flowers and a seed coat that is colorful and remarkably dense. Conversely, Kabuli (macrosperma) is characterized by white flowers and seeds that are either white or beige, with a distinct ram's head shape, a thin seed coat, and a seed surface that is smooth to the touch [Moreno 1978] [2]. An intermediate type known for its pea-shaped seeds with local significance is also recognized in India [Jukanti 2012] [1]. Chickpeas are mainly used for the preparation of chola dish and other table purposes. Chickpeas are rich in protein content (17-30%). Two distinct types of chickpeas namely Desi and Kabuli. (Kumar *et al.* 2022) [3].

The use of PGRs such as gibberellins and cytokinins or their synthetic compounds is becoming popular to ensure efficient production. There are many reports indicating that PGR application increased plant growth and crop yield. PGRs modify growth and development in different ways under normal growth conditions. Gibberellins (GA3) are known as growth promoters that mediate many responses in plants, from seed germination to senescence. One commonly used gibberellic acid (GA3) increases stem length, number of flowers on the plant and induces pod set. Cytokinins have been shown to be involved in the regulation of many aspects of plant development, including bud initiation, flowering, abscission and yield by increasing cell expansion. Kinetin is a cytokinin-type PGR with the primary role of extending plant life by promoting cell division and cell enlargement. Judicious application of plant growth regulators (PGRs) to crops results in: (1) Increased chickpea yield, (2) Improved quality, and (3) Reduced

overall production costs. Growth, yield and nutritional quality of chickpeas will thus be increased with PGR. (Chauhan *et al*. 2018) [6].

Materials and Methods

Experiments on the effect of Boron and Plant Growth Regulators along with Recommended Fertilizer Rate (RDF) on growth and yield enhancement of chickpea were conducted in Rabi season 2023 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj which located at 250 24 42 north latitude, 810 50 56 east longitude and 98 m altitude above mean sea level. This area is located on the right side of the river Yamuna by the Prayagraj Rewa Road about 5 km from Prayagraj town. A composite soil sample was collected at a depth of 0-30 cm. It was air-dried, crushed and tested for physical and chemical properties. The soil was sandy loam texture with soil reaction (pH 7.1), 0.55 organic matter (0.61%), available nitrogen (160.00 kg/ha), phosphorus (9.15 kg/ha), potassium (142 .44 kg/ha), Sulphur (6.6 mg/kg), Zn (0.45 mg/kg) and available B (0.36 mg/kg). *Radhe* chickpea variety was selected for sowing. The seeds were sown by hand in the line in 2023. The seeds were covered with soil immediately after sowing. Spacing adopted was 10 cm between plant and 30 cm row to row 30 cm as per treatment details and seeds were sown at 3 to 4 cm depth.

Results and Discussion

Plant height: At harvest there was significant difference among the treatments. However, highest plant height (56.6 cm) was recorded with the application of Boron 2 kg/ha + Gibberellic acid 30 ppm, whereas treatment Boron 2 kg/ha + Abscisic acid 60 ppm (54.1 cm) were found to be statistically at par with T_7, and minimum was reported in control (46.2 cm).

Plant dry weight: At harvest there was significant difference among the treatments. However, highest plant dry weight (45.7 g) was recorded with the application of Boron 2 kg/ha + Gibberellic acid 30 ppm, whereas treatment Boron 2 kg/ha + Abscisic acid 60 ppm (44.7 g) was found to be statistically at par with T_7, and minimum was reported in control (37.3 g).

Number of pods per plant

There was significant difference among the treatments. However, maximum number of pods per plant (31.60) was recorded with the application of Boron 2 kg/ha + Gibberellic acid 30 ppm, whereas treatment Boron 2 kg/ha + Abscisic acid 60 ppm (30.87) and Boron 2 kg/ha + Naphthalene acetic acid 45 ppm (30.07) were found to be statistically at par with T_7, and minimum was reported in control (24.93).

Number of seeds per pod

Significant difference among the treatments. However, maximum number of seeds per pod (2.53) was recorded with the application of Boron 2 kg/ha + Gibberellic acid 30 ppm, whereas treatment Boron 2 kg/ha + Abscisic acid 60 ppm (2.47) and Boron 2 kg/ha + Naphthalene acetic acid 45 ppm (2.40) were found to be statistically at par with T_7, and minimum was reported in control (1.80).

Seed yield (kg/ha)

Significantly Maximum seed yield (1103.90 kg/ha) was recorded with the application of Boron 2 kg/ha + Gibberellic acid 30 ppm, whereas treatment Boron 2 kg/ha + Abscisic acid 60 ppm (1087.10 kg/ha) was found to be statistically at par with T_7, and minimum was reported in control (1021.40 kg/ha). Shinde et al. (2016) [5] A field experiment was conducted to study the effect of micronutrient polymer seed coating and foliar spray on chickpea seed yield. seeds with combination of $ZnSO_4$ + boron + ammonium molybdate + $FeSO_4$ (each @ 2 g/kg) seeds along with two foliar sprays (0.5% + 0.2% + 0.1% + 0.5% respectively , $ZnSO_4$ and $FeSO_4$ in the form of EDTA) at an interval of 10 days during the flowering phase (50 and 60 DAS) recorded significantly higher leaf area index, chlorophyll content, plant height, effective root nodules plant-1, pod plant-1, seed yield compared with all other treatments and control. Rajni and Meitei (2004) [4] conducted an experiment to determine the effect of boron and zinc on the growth and yield of French bean. The results showed a significant increase in plant height, number of branches and number of leaves when boron (1.0 ppm) and zinc (0.10 ppm) were applied after 20 and 40 days of sowing.

Economics

Benefit cost ratio (1.94) was found to be highest in the treatment Boron 2 kg/ha + Gibberellic acid 30 ppm, and minimum Benefit cost ratio (1.77) was found to be in Boron
1 kg/ha + Naphthalene Acetic acid 45 ppm) as compared to other treatments

Table 1: Effect of Boron and Plant growth regulators on growth and yield of chickpea

S. No	Treatments	Plant height	Plant dry weight	Number of pods per plant	Number of seeds per pod	Seed yield (Kg/ha)
1.	Boron 1 kg/ha + Gibberellic acid 30 ppm	49.2	41.6	28.00	1.73	1046.90
2.	Boron 1 kg/ha + Naphthalene acetic acid 45 ppm	47.0	41.0	26.80	1.60	1027.80
3.	Boron 1 kg/ha + Abscisic acid 60 ppm	48.7	42.7	27.40	1.60	1041.50
4.	Boron 1.5 kg/ha + Gibberellic acid 30 ppm	52.0	42.7	29.93	2.20	1062.70
5.	Boron 1.5 kg/ha + Naphthalene acetic acid 45 ppm	50.1	40.8	28.40	1.80	1051.40
6.	Boron 1.5 kg/ha + Abscisic acid 60 ppm	51.3	43.7	29.07	1.93	1057.40
7.	Boron 2 kg/ha + Gibberellic acid 30 ppm	56.6	45.7	31.60	2.53	1103.90
8.	Boron 2 kg/ha + Naphthalene acetic acid 45 ppm	52.8	43.6	30.07	2.40	1064.50
9.	Boron 2 kg/ha + Abscisic acid 60 ppm	54.1	44.7	30.87	2.47	1087.10
10.	Control RDF- NPK 20:60:40 kg/ha.	46.2	37.3	24.93	1.80	1021.40
	SEm±	0.63	0.59	0.44	0.11	13.16
	CD (p=0.05)	2.01	1.75	1.30	0.32	39.10

Table 2: Evaluation of boron and plant growth regulators on economics of chickpea.

Treatments	Total cost of cultivation	Gross Return	Net Return	B:C ratio
Boron 1 kg/ha + Gibberellic acid 30 ppm	34300	94221.00	60421.00	1.79
Boron 1 kg/ha + Naphthalene acetic acid 45 ppm	33900	92502.00	59102.00	1.77
Boron 1 kg/ha + Abscisic acid 60 ppm	34200	93735.00	60035.00	1.78
Boron 1.5 kg/ha + Gibberellic acid 30 ppm	34300	95643.00	61843.00	1.83
Boron 1.5 kg/ha + Naphthalene acetic acid 45 ppm	33900	94626.00	61226.00	1.83
Boron 1.5 kg/ha + Abscisic acid 60 ppm	34200	95166.00	61466.00	1.82
Boron 2 kg/ha + Gibberellic acid 30 ppm	34300	99351.00	65551.00	1.94
Boron 2 kg/ha + Naphthalene acetic acid 45 ppm	33900	95805.00	62405.00	1.87
Boron 2 kg/ha + Abscisic acid 60 ppm	34200	97839.00	64139.00	1.90
Control RDF- NPK 20:60:40 kg/ha.	32500	91926.00	59926.00	1.87

Conclusion

From the experiment, it is concluded that the application of Boron at 2 kg/ha along with Gibberellic acid @ 30ppm in Treatment 7 has been recorded the highest seed yield and benefit-cost ratio.

Acknowledgement

I would like to express my sincere gratitude to my advisor Prof. (Dr.) Biswarup Mehera, Dean, Naini Agricultural Institute, SHUATS for his constant support and expert guidance throughout my research process.

Ethical Statement: Not applicable

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