Original Research Article

Influence of boron levels and plant growth regulators on growth, yield and economics of Cowpea (*Vigna unguiculata L.*)

Abstract

Background: Cowpeas thrive in poor dry conditions, growing well in soils up to 85% sand. This makes them a particularly important crop in arid, semidesert regions where not many other crops will grow. As well as an important source of food for humans in poor, arid regions, the crop can also be used as feed for livestock. Cowpea is primarily used in the form of dry seeds, fodder, green pod, green manure, and cover crops.

Objectives: Effects of boron levels and plant growth regulators on growth, yield and economics of cowpea.(*Vigna unguiculata* L.).

Methods: The field experiment was conducted in Zaid season of 2021, at crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj in North Eastern plains of Eastern Uttar Pradesh, under Randomized block design comprising of 10 treatments with different combination of boron levels and plant growth regulators which are replicated thrice.

Conclusion: Based on the above findings it can be concluded that the application of boron and plant growth regulators performs effective and improves the Plant height, Dry weight, No of Branches, No of pods per plant, No of seeds per pod, Test weight, Seed yield and stover yield of cowpea, the findings are based on research conducted during a single season, they may be repeated for further confirmation.

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Keywords: *Boron, GA3, NAA, Salicylic acid, Yield and Economics.*

Introduction

Cowpea (*Vigna unguiculata* L.) commonly known as "Lobia" is a pulse, fodder and green manure crop. It is popularly known as black eye pea. Cowpea is one of the oldest pulse crop in Asian and African tropics. The seeds represent a chief source of protein and carbohydrate. The cowpea seed contains 24.8% protein, 63.6% carbohydrate, 1.9% fat, 6.3% fiber, 7.4 ppm thiamine, 4.2 ppm riboflavin and 28.1 ppm niacin (Ahlawat and Shivkumar 2005). It is a crop that can be used as catch crop, mulch crop, intercrop, mixed crop and green crop. As a legumes, cowpea fixes substantial amounts of atmospheric nitrogen to meet its requirement. It is a annual herbaceous legume crop from the genus Vigna, belongs to family Fabaceae. Due to its tolerance for sandy soil and low rainfall, it is an important crop in the semiarid regions across Africa and Asia. The crop plays a crucial role in human nutrition because of its grain protein quality con-tents (rich in lysine, tryptophan) and high nutri-tional value (23–32 %). Its grain contains a substantial amount of mineral and vitamins (e.g., folic acid and vitamin B) and the hay is used for feeding animals during the dry season in many parts of West Africa. The whole plant is used as forage for animals, with its use as cattle feed likely responsible for its name. In India it is cultivated mainly in UP, MP, Bihar, Punjab, Karnataka etc., where it is growth for both vegetable and pulse puposes and is a highly remunerative crop. Most cowpeas are grown on the African continent, particularly in Nigeria and Niger, which account for 66% of world production.

In India pulses are grown nearly in 25.43 m ha with an annual production of 17.28 m t and productivity of 679 kg/ha. The per capita availability of pulses in India is 35.5g/day as against the minimum requirement of 70g/day/capita as advocated by Indian council of Medical Research. Cowpea grown across the world on an area 14.5 m ha of land planted each year and the total annual production is 6.2 m t. In India during 2020-21 cowpea is grown in about 13.3 m ha with an annual production of 8.06 m t and productivity of 596 kg/ha. Some of the states like Uttar Pradesh is about 2.38 m ha with an annual production of 2.56 and productivity of 1079 kg/ha major producer of cowpea in India as advocated by Ministry of Agriculture & Farmers welfare (GOI, 2020-21).

Legume crop 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). Boron is one of the mineral nutrients required for normal plant growth. 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).

Boron also plays an important role in production of any crop in terms of yield, quality and control of some diseases. Boron deficiency also known to adversely affect the formation and functioning of floral and fruiting organs and reduce the economic yield drastically.

The yield potential for this crop is very low and plaughed with number of diseases and pests. The production of pulse crop in our country including cowpea is not enough to meet the domestic demand of population. There is a scope to enhance the productivity of cowpea by proper agronomic practices and fertilizers. In India problems of cowpea such as low flowering and poor pod set in pulse crops. Productivity of pulse crops has been found to be increased by the use of different growth regulators. It also delays the onset of senescence. The hormone supply from roots to the leaves, consequently resulting into growth inhibition.

A numbers of hormones such as NAA have been found to be useful in minimizing the effects of poor quality water on crop through different ways. There is also a possibility to overcome these constraints by foliar application of plant growth regulators at the pre-flowering stage, which is one of the latest trends in agriculture. The plant growth regulators plays an important role in overcoming the hurdles in manifestation of biological productivity in pulses. Considering the above points in the view the experiment was conducted to study the influence of boron levels and plant growth regulators on growth and yield of cowpea.

Materials and Methods

This experimental trial was carried out during *Zaid* 2021 at Crop Research Farm , Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences , Prayagraj (U.P.) located at 25˚39”42” North latitude, 81˚67”56” East longitude and 98 m altitude above the mean sea level (MSL). The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The plot size of each treatment was 3 x 3m. Factors with three different levels of boron (1, 2 and 3 kg/ha) and foliar application of plant growth regulators (GA3 50 ppm, NAA 50 ppm and Salicylic acid 100 ppm). And both are applied at the time of sowing. The cowpea variety Ankur gomati was sown on 11 April 2021 by maintaining a spacing of 30cm x 10cm.

The treatment details are : T1: (Boron 1.0 Kg/ha + Gibberellic Acid 50ppm), T2: (Boron 1.0 Kg/ha + NAA 50 ppm), T3: (Boron 1.0 Kg/ha + Salicylic Acid 100 ppm), T4: (Boron 2.0 Kg/ha + Gibberellic Acid 50 ppm), T5: (Boron 2.0 Kg/ha + Gibberellic Acid 50 ppm), T6: (Boron 2.0 Kg/ha + Salicylic Acid 100 ppm), T7: (Boron 3.0 Kg/ha + Gibberellic Acid 50 ppm), T8: (Boron 3.0 Kg/ha + NAA 50 ppm), T9: (Boron 3.0 Kg/ha + Salicylic Acid 100 ppm), T10: Control.The data were subjected to statistical analysis by analysis of variance methods.

Results and Discussions

Growth parameters

Plant height (cm) - Significant and higher plant height (88.35) was recorded in treatment T_8 (Boron 3.0 Kg/ha + NAA 50ppm). However, treatment T_7 (Boron 3.0 Kg/ha + Gibberllic Acid 50ppm), T_9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) and T_5 (Boron 2.0 Kg/ha + NAA 50ppm) was found to be statistically at par with treatment T_8 (Boron 3.0 Kg/ha + NAA 50ppm) [Table 1]. The higher plant height was gradually increased significantly, with the foliar application growth promotive substance NAA which might be increased photosynthetic activity, enhancement in the mobilization of photosynthates and change in the membrane permeability. (Kapase *et al.*, 2014).

Branches/plants - Significant and maximum number of branches/plant (6.31) was recorded in treatment T_8 (Boron 3.0 Kg/ha + NAA (50ppm). However, treatment T_7 -Boron 3.0 Kg/ha + Gibberllic Acid 50ppm) and T_9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) was found to be statistically at par with treatment T_8 (Boron 3.0 Kg/ha + NAA 50ppm) [Table 1]. The significantly maximum number of branches was with application of boron might be due to the reason for the increase in this yield attribute that the boron plays important role in plant metabolism and translocation of photosynthates from source to sink. (Janaki *et al.*, 2018).

Dry weight/plant - Significant and higher plant dry weight/plant (15.87 g) was recorded in treatment T8 (Boron 3.0 Kg/ha + NAA 50ppm). However, treatment T7 (Boron 3.0 Kg/ha + Gibberlic Acid 50ppm) and treatment T9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) was found to be statistically at par with treatment T8 (Boron 3.0 Kg/ha + NAA 50ppm) [Table 1]. Significantly higher and increase in dry weight/plant might be due to application of NAA on green foliage yield and dry weight to increase in cellulose, an accelerated rate of respiration and rapid synthesis of proteins mono saccharides and polysaccharides. (Singh *et al.,* 2020).

Table 1: Effect of Boron levels and Plant growth regulators on growth parameters of Cowpea

S. No	Treatments	Plant height (cm) At Harvest	Branches/plant Per plant At Harvest	Dry weight (g/plant) At Harvest
1	Boron1.0 Kg/ha + Gibberllic Acid(50ppm)	85.85	5.71	15.14
2	Boron1.0 Kg/ha + NAA (50ppm)	86.33	5.78	15.22
3	Boron1.0 Kg/ha + Salicylic Acid(100ppm)	86.58	5.64	15.09
4	Boron 2.0 Kg/ha + Gibberlic Acid (50ppm)	86.98	5.88	15.40
5	Boron 2.0 Kg/ha + NAA (50ppm)	87.47	5.98	15.52
6	Boron 2.0 Kg/ha + Salicylic Acid(100ppm)	86.96	5.81	15.34
7	Boron 3.0 Kg/ha + Gibberlic Acid (50ppm)	87.96	6.13	15.80
8	Boron 3.0 Kg/ha + NAA (50ppm)	88.35	6.31	15.87
9	Boron 3.0 Kg/ha + Salicylic Acid(100ppm)	87.91	6.09	15.71
10	Control	85.28	5.54	14.77
	SEm$\pm$	0.48	0.06	0.07
	CD (P=0.05)	1.01	0.17	0.21

Yield attributes :

Number of pods/plant - At harvest Significant and maximum number of pods/plant (10.35) was recorded in treatment T_8 (Boron 3.0 Kg/ha + NAA 50ppm). However, treatment T_7 (Boron 3.0 Kg/ha + Gibberllic Acid 50ppm) and T_9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) was found to be statistically at par with treatment T_8 (Boron 3.0 Kg/ha + NAA 50ppm). [Table 2]. The maximum number of pods/plant was increased with application of boron that might have influenced the flowering and pod setting and ultimately increases the number of pods and total pod yield/plant. (Chatterjee *et al.*, 2017).

Number of seeds/pods - At harvest significant and maximum number of seeds/pod (9.66) was recorded in treatment T8 (Boron 3.0 Kg/ha + NAA 50ppm). However, treatment T_7 (Boron 3.0 Kg/ha + Gibberllic Acid 50ppm) and treatment T_9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) was found to be stastistically at par with treatment T_8 (Boron 3.0 Kg/ha + NAA 50ppm) [Table 2]. The maximum number of seeds/pod was increased might be due to the reasons that NAA has enhanced the cell elongation and reduced flower drop and helped in fruit setting. (Aslam *et al.*, 2010)

Test weight – At harvest Significant and test weight (129.35 g) was recorded maximum in treatment T8 (Boron 3.0 Kg/ha + NAA 50ppm). However, treatment T7 (Boron 3.0 Kg/ha + Gibberllic Acid 50ppm) and treatment T9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) was statistically at par with treatment T8 (Boron 3.0 Kg/ha + NAA (50ppm) [Table 2]. It increases in this attribute might be due to the application of boron in enzyme activation, membrane integrity, chlorophyll formation, stomatal balance and starch utilization at early stages which enhanced accumulation of assimilating in the grains resulting in heavier grains. (Shil *et al.*, 2007).

Seed yield (kg/ha) - At harvest, significant and maximum seed yield (856.00 kg/ha) was recorded in treatment T8 (Boron 3.0 Kg/ha + NAA 50ppm). However, treatment T7 (Boron 3.0 Kg/ha + Gibberllic Acid 50ppm) (833.76 kg/ha) and treatment T9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) (813.16 kg/ha) was found to be statistically at par with treatment T8 (Boron 3.0 Kg/ha + NAA (50ppm) [Table 2]. The significantly higher seed yield was increased due to the foliar application of NAA at pre-flowering and pod-filling stages per plant which in turn responsible for bearing high number of pods/plant which is responsible for the increased seed yield. This might be due to cell elongation, shoot development, increased in leaf area, root growth, uptake of more nutrients and efficient transport of nutrients to sink. (Meyyappan *et al.*, 2020).

Stover yield (kg/ha) - At harvest, significant and maximum stover yield (1408.82 kg/ha) was recorded in treatment T8 (Boron 3.0 Kg/ha + NAA 50ppm). However, treatment T7 (Boron 3.0 Kg/ha + Gibberllic Acid 50ppm) (1381.76 kg/ha) and treatment T9 (Boron 3.0 Kg/ha + Salicylic Acid 100ppm) (1360.36 kg/ha) was statistically at par with treatment T8 (Boron 3.0 Kg/ha + NAA (50ppm) [Table 2]. Significantly higher stover yield might have due to influence of boron on various metabolic processes like photosynthesis, enzyme activity which augments the production of metabolites and their translocation to different parts include seed which ultimately increases the concentration of nutrients in seed and stover. (Uddin *et al.,* 2020)

Harvest index (%) - Treatment with application of T8 (Boron 3.0 Kg/ha + NAA 50ppm) was recorded maximum (37.78 %) harvest index and with control was recorded minimum (35.07 %) as compared to other treatments.

Economics

The maximum gross return, net profit and benefit cost ratio (43656.00 ₹/ha, 25661.00 ₹/ha and 1.42) was recorded in treatment (T8) in which (Boron 3.0 Kg/ha + NAA 50ppm) followed by treatment (T7) in which (Boron 3.0 Kg/ha + Gibberlic Acid 50ppm). The minimum gross return, net return and benefit cost ratio were recorded in treatment (T10) which is control. [Table 3].

Table 2: Effect of Boron levels and plant growth regulators on Yield attributes of Cowpea

Treatments	Number of pods per plant	Number of seed per pod	Test weight(g)	Seed yield (Kg/ha)	Stover yield (Kg/ha)	Harvest Index (%)
T_1-Boron1.0Kg/ha + Gibberllic Acid(50ppm)	8.89	8.74	126.25	692.03	1248.10	35.65
T_2- Boron1.0 Kg/ha + NAA (50ppm)	9.21	8.96	126.79	724.36	1285.70	36.03
T_3 - Boron1.0 Kg/ha +Salicylic Acid(100ppm)	8.97	8.63	126.60	681.98	1238.77	35.49
T_4 -Boron 2.0 Kg/ha +Gibberllic Acid (50ppm)	9.70	9.14	127.48	766.95	1325.35	36.66
T_5- Boron 2.0 Kg/ha + NAA (50ppm)	9.91	9.30	127.89	784.94	1348.19	36.79
T_3 - Boron2.0 Kg/ha +Salicylic Acid(100ppm)	9.53	9.08	127.20	746.07	1303.95	36.39
T_7 -Boron 3.0 Kg/ha +Gibberllic Acid(50ppm)	10.15	9.52	128.82	833.76	1381.76	37.62
T_8-Boron 3.0 Kg/ha + NAA (50ppm)	10.35	9.66	129.35	856.00	1408.82	37.78
T_9 -Boron 3.0 Kg/ha +Salicylic Acid(100ppm)	10.05	9.45	128.45	813.60	1360.36	37.42
T_{10} –Control	8.69	8.37	125.97	645.51	1197.48	35.07
F test	S	S	S	S	S	NS
S. Em (±)	0.11	0.10	0.30	14.35	17.01	0.53
CD (P=0.05)	0.32	0.29	0.90	42.64	50.54	1.59

Table 3. Effect of Boron levels and plant growth regulators on economics of Cowpea

Treatments	Total cost of cultivation - (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
$\mathbf{T_1}$-Boron1.0Kg/ha + Gibberllic Acid(50ppm)	17760.00	35293.53	17533.53	0.98
$\mathbf{T_2}$ - Boron1.0 Kg/ha + NAA (50ppm)	17775.00	36942.36	19167.36	1.07
$\mathbf{T_3}$ - Boron1.0 Kg/ha +Salicylic Acid(100ppm)	17800.00	34780.98	16980.98	0.95
$\mathbf{T_4}$ **-**Boron 2.0 Kg/ha +Gibberlic Acid (50ppm)	17870.00	39114.45	21244.45	1.18
$\mathbf{T_5}$ - Boron 2.0 Kg/ha + NAA (50ppm)	17885.00	40031.94	22146.94	1.23
$\mathbf{T_3}$ - Boron2.0 Kg/ha +Salicylic Acid(100ppm)	17910.00	38049.57	20139.57	1.12
$\mathbf{T_7}$ -Boron 3.0 Kg/ha + Gibberlic Acid(50ppm)	17980.00	42521.76	24541.76	1.36
$\mathbf{T_8}$ -Boron 3.0 Kg/ha + NAA (50ppm)	17995.00	43656.00	25661.00	1.42
$\mathbf{T_9}$ -Boron 3.0 Kg/ha +Salicylic Acid(100ppm)	18020.00	41493.60	23473.60	1.30
$\mathbf{T_{10}}$ –Control	17290.00	32972.01	15682.01	0.90

Conclusion :

Based on the above findings it can be concluded that the application of boron and plant growth regulators performs effective and improves the the Plant height (88.35cm), Dry weight (15.87g/plant), No of Branches (6.31), No of pods/plant (10.35), No of seeds/pod(9.66), Test weight (129.35gm), Seed yield(856.00kg/ha) and stover yield(1408.82kg/ha) of cowpea cowpea. The application of 3 kg boron and NAA (50ppm) for obtaining the better growth and production of cowpea in addition to the recommended doses of fertilizers. These findings are based on one season; therefore, further trials may be required for further confirmation.

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