Effect of Boron and Plant Growth Regulators on Growth and Yield of *Zaid* Cowpea (*Vigna unguiculata* L.)

ABSTRACT

The experiment was conducted at crop research farm in the department of agronomy during summer season in the department of agronomy during summer season of 2022 on cowpea crop. The treatments consisted of 3 levels of Boron (0.75,1,1.25 kg/ha) and Plant Growth Regulators (GA_3 30 ppm, NAA 35 ppm, ABA 40 ppm) as a foliar spray. The experiment was laid out in a Randomized block design with 9 treatments and replicated “thrice”.0.75 kg/ha as soil application combination with 30 ppm gibberellic acid as foliar spray recorded maximum plant height (69.48cm), highest plant dry weight (22.22gm), crop growth rate (3.0g/m^2/day), number of nodules/plant (24.37), test weight (85.6g), number of pods/plant (15.45), number of seeds/pod (13.57), seed yield (2.68t/ha), stover yield(6.09t/ha), harvest index (30.56%). However, relative growth rate was not influenced by the application of boron and plant growth regulators and it recorded maximum in treatment 1 (Boron 0.75 kg/ha +GA_3 30 ppm) (0.1005 g/g/day). 0.75 kg/ha Boron + 30 ppm gibberellic acid as foliar spray recorded highest gross return (161,040.00 ₹/ha), net return (113,394.00 ₹/ha), and benefit: cost ratio (2.38).

***Key words*: Boron, Plant Growth Regulators, Economics, Growth, cowpea, Yield**

Introduction:

India has become self sufficient with respect to the production of cereals but still lags behind with respect to the production of pulses. The current availability of cereals (430 g/ capita/day) has steadily increased from 330 g over the last fifty five years whereas the same for pulses has decreased from 61 to 32 g. Ever increasing population pressure, resulting in protein malnutrition causes a serious concern and urgently calls for stepping up the productivity of pulses. The role of pulses in human diet and in diversified systems of farming is well known. Pulses are cheap and major source of lycine rich good quality protein providing essential supplement to cereal based diet. India produced 13.1 million tonnes of pulses from 22.4 million hectare with an average productivity of 585 kg ha-1in 2005-06. “Among the pulses, cowpea (*Vigna unguiculata* L. Walp) occupies a prominent position as its green pods form vegetable while, decorticated split grain (dal) is used for making delicious preparations. Cowpea straw is considered a valuable fodder for milch cattle. A good crop of cowpea fully covers the ground and thus checks erosion and water loss from the field. Hence, it is of considerable importance in dryland farming". [11] Cowpea commonly known as Lobia is valued for its protein rich grains (25%) in human consumption. It forms major staple food in many parts of Africa. The scorched seeds are also used as coffee substitute. It is also extensively grown for forage purpose and in terms of quality , it is comparable to lucerne. It is used for both human consumption and as a concentrate feed for cattle. Cowpea grains also contain 60.3% carbohydrates and 1.8% fat. Its pods are eaten as vegetable and tender leaves form important food in Africa. In Sudan and Ethiopia, the roots are roasted and eaten. Cowpea with drought tolerance and ability to grow in poor soils, forms an important crop in Savanna regions that are notsuitable for raising any other crop.

Boron plays an important role in regulating plants hormone levels and promoting proper growth.Boron increase flower production and retention, pollen tube elongation and germination and seed and fruit development.It is a component of plant cell walls and reproductive structures. It is a mobile nutrient within the soil. It helps in movement of sugar or energy into growing parts of plants, and pollination and seed set. Adequate boron is also required for effective nitrogen fixation and nodulation in legume crop.

"Cowpea (*Vigna unguiculata* (L.) Walp) is a major staple food crop in sub-Saharan Africa, especially in the dry savannah regions of West Africa. There is a big market for the sale of cowpea grain and fodder in West Africa. In Nigeria, farmers who cut and store cowpea fodder for sale at the peak of the dry season have been found to increase their annual income by 25%" (Dugje et al., 2009). "Cowpea also plays an important role in providing soil nitrogen to cereal crops (such as maize, millet, and sorghum) when grown in rotation, especially in areas where poor soil fertility isa problem. It does not require a high rate of nitrogen fertilization; its roots have nodules in which soil bacteria called Rhizobia inhabit and help to fix nitrogen from the air into the soil in the form of nitrates" (Sheahan, 2012). "Cowpea can be grown under rain fed conditions as well as by using irrigation or residual moisture along river or lake flood plains during the dry season, provided that the range of minimum and maximum temperatures is between 28 and 30°C (night and day) during the growing season. Cowpea performs well in agro ecological zones where the rainfall range is between 500 and 1200 mm/year" (Madamba et al., 2006). "However, with the development of extraearly and early maturing cowpea varieties, the crop can thrive in the Sahel where the rainfall is less than 500 mm/ year. It is tolerant of drought and well adapted to sandy and poor soils. It has little tolerance of salinity but is somewhat tolerant of soils high in aluminium. Like most legumes, it does not withstand waterlogged or flooded conditions. However, best yields are obtained in well-drained sandy loam to clay loam soils with the pH between 6 and 7" (Ecocrop, 2009). "Cowpea does not require too much nitrogen fertilizer because it fixes its own nitrogen from the air using the nodules in its roots. However, in areas where soils are poor in nitrogen, there is a need to apply a small quantity of about 15 kg of nitrogen as a starter dose for a good crop. If too much nitrogen fertilizer is used, the plant will grow luxuriantly with poor grain yield". (Ecocrop, 2009)

Plant growth regulators are chemicals used to modify plant growth such as increasing branching, suppressing shoot growth, increasing return bloom, removing excess fruit, or altering fruit maturity. Numerous factors affect PGR performance including how well the chemical is absorbed by the plant, tree vigour and age, dose, timing, cultivar and weather conditions before, during and after application. Gibberellins (GA) helps in seed germination, promote cell elongation, shoot growth and are involved in regulating dormancy. The hormone causes elongation in the stem. The hormone is responsible for the bolting effect in the rosette plants. NAA is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticultural product. It is a rooting agent and used for the vegetative propagation of plants from stem and leaf cuttings. It is also used for plant tissue culture. Abscisic acid is a sesquiterpene which has important role in seed development and maturation in the synthesis of protein and compatible osmolytes which enables plants to tolerate stresses due to environmental or biotic factors and as a general inhibitor of growth and metabolic activities.

Keeping in view of the importance of cowpea and role of boron and plant growth regulators in crop physiology, morphology and ultimately in the economics, this experiment entitled, **"Effect of Boron and Plant Growth Regulators on Growth and Yield of Zaid Cowpea (*Vigna unguiculata* L.) var. 'Kashi Kanchan''**, was conducted at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Faculty of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during Zaid season of 2022.

Material and Methods:

A field experiment was conducted during *zaid* season of 2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of agriculture Technology and Sciences, Prayagraj (U.P.) India. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.35%), The treatments consist of boron 0.75 kg/ha + GA_3 30 ppm, boron 0.75 kg/ha + NAA 35 ppm, boron 0.75 kg/ha + ABA 40 ppm, boron 1 kg/ha + GA_3 30 ppm, boron 1 kg/ha + NAA 35 ppm, boron 1 kg/ha + ABA 40 ppm, boron 1.25 kg/ha + GA_3 30 ppm, boron 1.25 kg/ha + NAA 35 ppm, boron 1.25 kg/ha + ABA 40 ppm .

The experiment was laid out in Randomized Block Design, with 9 treatments replicated thrice. The observations were recorded for plant height, plant dry weight, Crop growth rate (g/m2/day), Relative growth rate, Number of nodules, Number of pods/plant, seeds/pod, Length of pod/plant, Test weight, seed yield, Stover yield, Harvest index. The collected data was subjected to statistical analysis by analysis of variance method **(Gomez and Gomez, 1976).**

Result and Discussion

Pre harvest Observations

Plant height – At 75 DAS, the significant higher plant height (69.48 cm) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1. The application of boron has increased maximum plant height and enhanced nutrient uptake from soil **Rajani and Meitei (2004) .** Boron is important for root and shoot growth, chlorophyll synthesis and nitrogen utilization as well as increase translocation of photosynthates which characters and ultimately resulted in increased in plant height **Kabir *et al.* (2013)**

Dry Weight (g/plant) - At 75 DAS, the significant higher plant dry weight (22.22 g) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1.

The increase in plant dry weight at harvest might be attributed to beneficial effect of boron and plant growth regulators. Application of Gibberellic acid has significantly increased plant dry weight and also helped in growth of the plant **.** Gibberellic acid influenced on flowering and yield of Cowpea .**(Yadav and Sreenath 1975) ,(Medhi 2000)** . Whereas **(Dinesh Kumar and Rajeev Padbhushan 2014)** reported that soil application of boron has more influence on mean dry matter yield.

Crop growth rate

During 45-60 DAS significantly higher crop growth rate (4.11g/m^2/day) was recorded in treatment 1 with the application of boron 0.75 kg/ha alongwith Gibberellic acid 30 ppm.

Post harvest Observations.

Number of pods/plant - At 75 DAS, the significant higher number of pods/plant (No.) (15.45) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1.

Length of pod (cm) - At 75 DAS, the significant higher length of pods (27.02 cm) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1.

Seeds/pod - At 75 DAS, the significant higher seeds/pod (13.57) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1.

“The highest number of pods per plant , length of pod , and seed/pod by application of boron might be due to increased dry matter accumulation in the reproductive parts and steady supply of nutrients which enhanced the dry matter production and supply of Sulphur in adequate amount also helps indevelopment of primordial i.e., reproductive parts, which results in the development of pods in plant” **Shailendra Singh *et* al. (2012).** The yield attributing characters increase under higher levelof boron might be due to increase in the nodules per plant and which helped in fixed the more atmospheric nitrogen and hence resulted in more number of pods per plant **Ram prasad *et al.* (2020)**

Seed yield (t/ha) - At 75 DAS, the significant higher seed yield (2.684 t/ha) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1.

Stover yield (t/ha) - At 75 DAS, the significant higher stover yield (6.097 t/ha) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1.

Harvest index (%) - At 75 DAS, the significant higher harvest index (30.56%) was recorded in treatment-1 with the application of Boron 0.75 kg/ha as basal dose and Gibberellic acid 30 ppm as foliar spray. However in treatment 2 in which boron 0.75 kg/ha was applied alongwith Naphthalene acetic acid 35 ppm was found to be statistically at par with treatment 1.

Higher seed yield and stover yield was recorded following the application of gypsum, with Sulphur produced from the gypsum influencing the availability of other nutrients in the soil and their uptake by the plant, resulting in a nutritionally favorable environment for the plant. With the higher levels of boron applications evidently resulted from higher seed yield and stover yield. Boron is important for root and shoot growth, sugar translocation and protein synthesis as well as increase translocation of photosynthates which characters and ultimately resulted in increased pod yield. These results agree with the findings of **Sreelatha *et al.* (2004)**, **Ramprasad *et al.*(2020)**.

C. Economic Analysis

Gross Returns (₹/ha)

Maximum gross return (161,040.00 ₹/ha) was obtained in treatment 1 with the application of boron 0.75 kg/ha along with Gibberellic acid 30 ppm as compared to other treatments. **Net Returns (₹/ha)**

Maximum net returns (113,394.00 ₹/ha) was found to be highest in treatment 1 with thr application of boron 0.75 kg/ha alongwith Gibberellic acid 30 ppm as compared to other treatments.

Benefit Cost Ratio (₹/ha)

Maximum benefit: cost ratio (2.38) was found to be highest in treatment 1 with the application of boron 0.75 kg/ha alongwith Gibberellic acid 30 ppm as compared to other treatments.

CONCLUSION

The application of boron 0.75 kg/ha and Gibberellic acid 30 ppm in treatment 1 recorded significantly higher plant height (69.48 cm), dry weight (22.22g/plant), crop growth rate (3.0 g/m^2 /plant), nodules per plant (24.37), pods per plant (15.45), seeds per pod (13.57) , test weight (85.6 g), seed yield (2.684 t/ha), Stover yield (6.097 t/ha) and harvest index (30.56%) whereas maximum Gross return (161,040.00 INR/ha), Net return (113,394.00 INR/ha), and benefit cost ratio (2.38) were recorded hence, the use of boron and Gibberellic acid can be recommended to the farmers in Cowpea crop.

REFERENCES

1. Borkar D.H, Matte A.D, Bhelkar M.V, Bagde T.R ,. (1991). Effect of seed treatment with different plant growth regulators on growth and yield of Cowpea . *Journal of soils and crops* **1**(2): 165-168.
2. Ganiger T.S, Kareekatti S.R, Patil B.C,. (2002). Effect of plant growth regulators on yield and yield components in Cowpea. *Karnataka Journal of Agricultural Sciences* **15**(4):693695.
3. Gomez, K.A., Gomez, A. A., (1976) Three or more factor experiment. (In*:) Statistical Procedure for Agricultural Research 2nd ed*.139 -141.
4. Kabir, R., Yeasmin, S., Islam, A. K, M. M and Sarkar, M. A. R. 2013. Effect of phosphorus, calcium and boron on the growth and yield of groundnut (*Arachis hypogaea* L.). *Int J Bio Sci Technol* **5**:51-60.

5. Meena, S.M. Malarkodi and P. Senthivalavan (2007). Secondary and micronutrients for groundnut – A review.*Agriculture Review,* **28** (4):295-300.
6. Ramprasad Nandi, Hasim Reja, Nitin Chatterjee, Animesh Ghosh Bag and Gora Chand Hazra (2020). Effect of Zn and B on the growth and nutrient uptake in Groundnut. *Current Journal of Applied Science and Technology* **39** (1):1-10.
7. Rajani D. Manoharrao A. , Kumar Suresh,. (2016). Effect of plant growth regulators on growth and yield of French bean. *Andhra Pradesh journal of Agricultural Sciences.* **2**(4): 256259.
8. Singh Shailendra, Chopra Shailendra, Reddy K.S, and Leelavati.(2012) Influence of sulphur and boron on yield attributes and yield of soyabean . *Crop Research* **44** (3): 318-321.
9. Sreelatha, N., Seshaiah, B. V. and Sankara Rao, V. (2004). Effect of phosphorus and sulphur nutrition on nutrient composition, oil content and yield of groundnut. *The Andhra Agricultural* Journal. **15** (3 & 4):380-383.
10. Yadav R.B, Sreenath P.R, (1975). Influence of some growth regulators on growth , flowering and yield of Cowpea. *Indian journal of plant physiology.* **18**(2): 135-139.

11. Wakudkar D, Swaroop N, Ravindra J, Thomas T. Effects of different level of phosphatic fertilizers on soil health and yield of cowpea (Vigna unguiculata L.). The Pharma Innovation Journal 2022; 11(5): 2547-2549

12. Nkaa F, Nwokeocha OW, Ihuoma O. Effect of phosphorus fertilizer on growth and yield of cowpea (Vigna unguiculata). Journal of Pharmacy and Biological Sciences. 2014;9(5):74-82.

Table 1: Effect of boron and plant growth regulator on growth attributes of Cowpea

S No	Treatments	75 DAS			During 60-75 DAS	
		plant height (cm)	Number of nodules/plant	Plant dry weight (g/plant)	Crop Growth Rate ($g/m^2/day$)	Relative growth rate (g/g/day)
1.	Boron 0.75 kg/ha + GA_3 30 ppm	69.48	24.37	22.22	3	0.0213
2.	Boron 0.75 kg/ha + NAA 35 ppm	69.22	24.40	21.95	2.97	0.0213
3.	Boron 0.75 kg/ha + ABA 40 ppm	58.61	15.77	16.59	2.19	0.0207
4.	Boron 1 kg/ha + GA_3 30 ppm	62.2	18.28	18.46	2.37	0.0201
5.	Boron 1 kg/ha + NAA 35 ppm	60.68	16.98	17.57	2.29	0.0205
6.	Boron 1 kg/ha + ABA 40 ppm	55.74	13.33	14.95	2.15	0.0229
7.	Boron 1.25 kg/ha + GA_3 30 ppm	66.53	21.28	20.36	2.58	0.0198
8.	Boron 1.25 kg/ha + NAA 35 ppm	64.63	19.75	19.36	2.44	0.0197
9.	Boron 1.25 kg/ha + ABA 40 ppm	57.07	14.55	15.92	2.16	0.0215
	F-test	S	S	S	S	NS
	Sem±	0.12	0.20	0.12	0.01	0.00020
	CD at 5%	1.36	0.59	0.36	0.04	-

Table 2: Effect of boron and plant growth regulators on Yield of cowpea.

S. No.	Treatments	No. of pods/plant	Length of pod/plant	Seeds /pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.	Boron 0.75 kg/ha + GA_3 30 ppm	15.45	27.02	13.57	85.6	2.684	6.097	30.56
2.	Boron 0.75 kg/ha + NAA 35 ppm	15.13	26.87	13.35	85.19	2.544	6.077	29.5
3.	Boron 0.75 kg/ha + ABA 40 ppm	12.15	23.22	11.14	81.38	1.641	5.74	22,22
4.	Boron 1 kg/ha + GA_3 30 ppm	13.29	24.65	11.93	82.69	1.95	5.876	24.91
5.	Boron 1 kg/ha + NAA 35 ppm	12.72	23.81	11.64	81.65	1.764	5.806	23.29
6.	Boron 1 kg/ha + ABA 40 ppm	10.85	21.31	10.44	80.06	1.348	5.552	19.52
7.	Boron 1.25 kg/ha + GA_3 30 ppm	14.45	26.06	12.81	84.86	2.333	5.991	28.02
8.	Boron 1.25 kg/ha + NAA 35 ppm	13.85	25.43	12.12	84.25	2.082	5.911	26.03
9.	Boron 1.25 kg/ha + ABA 40 ppm	11.49	22.24	10.56	80.73	1.459	5.63	25.63
	F-test	S	S	S	S	S	S	S
	Sem±	0.11	0.11	0.21	0.19	0.50	0.09	0.49
	CD at 5%	0.32	0.32	0.63	0.57	1.49	0.28	1.48

Table 3 :Effect on economics of Cowpea by boron and plant growth regulators.

S No	Treatments	Total cost of cultivation (INR)	Gross Returns	Net Returns	B:C ratio
1	Boron 0.75 kg/ha + GA_3 30 ppm	47,646	161,040	113,394	2.38
2	Boron 0.75 kg/ha + NAA 35 ppm	45,409	152,640	107,231	2.36
3	Boron 0.75 kg/ha + ABA 40 ppm	43,171	98,460	55,289	1.28
4	Boron 1 kg/ha + GA_3 30 ppm	47,896	117,000	69,104	1.44
5	Boron 1 kg/ha + NAA 35 ppm	45,659	105,840	60,181	1.32
6	Boron 1 kg/ha + ABA 40 ppm	43,421	80,880	37,459	0.86
7	Boron 1.25 kg/ha + GA_3 30 ppm	43,296	139,980	96,684	2.23
8	Boron 1.25 kg/ha + NAA 35 ppm	41,059	124,920	83,861	2.04
9	Boron 1.25 kg/ha + ABA 40 ppm	38,821	87,540	48,719	1.25