Original Research Article

Effect of Zinc levels on growth and yield of cowpea (*Vigna unguiculata* L.) Varieties

Abstract

The field experiment was conducted at Crop Research Farm(CRF),DepartmentofAgronomy,Sam Higginbottom University of Agriculture, Technology and Sciences,Prayagraj(U.P.)during *Zaid* season of 2022 on Cowpea crop.The treatments Consists of 3 levels of Zinc [20kg/ha, 0.6% and (10kg/ha + 0.3%)] and 3 different varieties (GOMTI, HIMANI-06, KASHI-KANCHAN) and a Control. The experiment was laid out in Randomized Block Design with 10 treatments replicated thrice. The application of Zinc (10kg/ha + 0.3%) + GOMTI variety recorded higher plant height (83.96 cm),more number of nodules per plant (9.20), maximum plant dry weight (12.55 g/plant), and yield attributes namely Number of Pods per plant (14.44), Number of seeds per pod(18.55), Test weight(91.00 g), Seed yield (1.03 t/ha), Stover yield (5.33 t/ha) and Harvest index (16.12%) was found maximum in treatment 3 that is Zinc (10kg/ha + 0.3%) + GOMTI variety as compared to other treatment combinations.

Keywords: Cowpea, zinc, varieties, growth parameters, yield attributes and yield.

INTRODUCTION

Cowpea (*Vigna unguiculata* L.)is a native to Central Africa and belongs to the family *Leguminaceae*with subfamily *Papilionaceae*. The common names are Black-eye-pea, Southern pea, China pea, Marble pea. Cowpea is annual herbaceous plant known for its drought hardy nature with large tap root system and alternate trifoliate leaves with ovate leaflets. It also has the useful ability to fix atmospheric nitrogen through its root nodules. In India, during 2022-23 the production of pulses was 27.69 metric ton. Cowpea is grown over an area about 58000ha with an average production of 4.8 lakh tons and average productivity is 8.44 t/ha. During 2022-23 the total coverage under cowpea in Uttar Pradesh 16900 ha with a production will be around 113200 tones and the productivity 6.70t/ha**.** It consists ofhighquality protein for human consumption and it is rich in protein for livestock fodder.

Zincis an essential micronutrient for plants, due its role as a functional, structural or regulatory cofactor in a large number of enzymes. The element is necessary for the synthesis of tryptophan, which is a precursor of indoleacetic acid. Zinc participates in chlorophyll formation, and also activates many enzymes. Symptoms of zinc deficiency include chlorosis and stunted growth.Application of Higher levels of zinc to cowpea leads to increase in the higher auxin activity in plant which promoted growth attributes and higher biomass accumulation in plants. This resulted in higher plant dry matter. The results were in resonance with **Kumar and Bohra (2014)**.the involvement of zinc in different physiological processes like enzyme activation, electron transport, chlorophyll formation, stomatal regulation, etc. With the increase in levels of zinc the plant height gradually increased, which might be attributable to greater photosynthetic activity and chlorophyll synthesis due to zinc fertilization resulting into better vegetative growth. Similar results were reported by **Kumar *et al.* (2016)**

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Comment [D2]: In this section, indicate clearly the major problem identified, the causes of the major problem, zinc accumulation and how the problem can be solved.

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MATERIALS AND METHODS

The field experiment was conducted at Crop Research Farm(CRF),DepartmentofAgronomy,Sam Higginbottom University of Agriculture, Technology and Sciences,Prayagraj(U.P.)during *Zaid* season of 2022 on Cowpea crop.The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep.The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.49%), available N (219kg/ha), available P (21.3kg/ha) and available K (235.8kg/ha). The treatments Consists of 3 levels of Zinc [20kg/ha, 0.6% and (10kg/ha + 0.3%)] and 3 different varieties (GOMTI, HIMANI-06, KASHI-KANCHAN) and a Control. The experiment was laid out in Randomized Block Design with 10 treatments replicated thrice.T_1: GOMTI (SPL.) + 20kg/ha $ZnSo_4$,T_2: GOMTI (SPL.) + 0.6% $ZnSo_4$,T_3: GOMTI (SPL.) + [10kg/ha + 0.3%] $ZnSo_4$,T_4: HIMANI-06 + 20kg/ha $ZnSo_4$,T_5: HIMANI-06 + 0.6% $ZnSo_4$,T_6: HIMANI-06 + [10kg/ha + 0.3%] $ZnSo_4$,T_7: KASHI-KANCHAN + 20kg/ha $ZnSo_4$,T_8: KASHI-KANCHAN + 0.6% $ZnSo_4$,T_9: KASHI-KANCHAN + [10kg/ha + 0.3%] $ZnSo_4$,T_{10}: Control[N:P:K (25:50:25) kg/ha]

Note

Comment [D4]: Indicate the software used for data analysis, the version of the software and the probability level used.

RESULTS AND DISCUSSION

Growth parameters

Plant height(cm): The data revealed that significant and higher plant height (83.96 cm) was recorded in treatment 3 that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$, which was significantly superior over rest of the treatments (Table 1). Significant increase of plant height might be due to the increasein involvement of zinc in different physiological processes like enzyme activation, electron transport, chlorophyl formation, stomatal regulation, etc. With the increase in levels of zinc the plant height gradually increased, which might be attributable to greater photosynthetic activity and chlorophyll synthesis due to zinc fertilization resulting into better vegetative growth. Similar results were reported by **Kumar *et al.* (2016)**.

Number of nodules/plant: The data revealed that significant and higher number of nodules/plant (9.20) was recorded in Treatment 3 that is GOMTI +[10kg/ha + 0.3%] $ZnSo_4$, However Treatment 2that isGOMTI +0.6% $ZnSo_4$were found to be statistically at par with treatment 3 GOMTI + [10kg/ha + 0.3%] $ZnSo_4$(Table 1) Application of zinc increased significantly number of nodules per plant, active nodule per plant and active nodule weight per plant. Significant increase of nodules/plant might be duethe maximum number of nodules per plant and active nodule were recorded in 15 kg Zn / ha while minimum in recorded in control. Similar trend was also observed by **Singh and Shukla (1986) and Wani and khan (2006).**

Dry weight(g): The data revealed that significant and higher plant dry weight (12.55 g/plant) was recorded in Treatment 3 that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$which was significantly superior over rest of all the treatments (Table 1).Significant increase of plant dry weight might be due to Application of Higher levels of zinc to cowpea leads to increase in the higher auxin activity in plant which promoted growth attributes and higher biomass accumulation in plants. This resulted in higher plant dry matter. The results were in resonance with **Kumar and Bohra (2014).**

Crop growth rate(g/ m^2/ days): The data revealed thatsignificant and maximum crop growth rate (8.23 g/ m^2/ days) was recorded in treatment 4that is [HIMANI-06 + 20kg/ha $ZnSo_4$], however treatment 1 GOMTI +20kg/ha $ZnSo_4$, treatment 2 GOMTI + 0.6% $ZnSo_4$, treatment 3 GOMTI + [10kg/ha + 0.3%] and treatment 5 HIMANI-06 + 0.6% $ZnSo_4$were found to be statistically at par with treatment 4 [HIMANI-06 + 20kg/ha $ZnSo_4$] (Table 1). The significant increase in crop growth rate observed with the application of[10kg/ha + 0.3%] $ZnSo_4$ might be duethe dry matter yield

increase in the Zn treatments over the control suggests that Zn was one of the limiting nutrients in the soils. This indicates that, at this level, the soil Zn was further improved with better Zn nutrition leading to high dry matter production which in turn increases CGR. The similar results were reported by**Evangeline Marngar and Joy Dawson (2017).**

Relative growth rate(g/g/day): The data revealed thatsignificant and maximum relative growth rate (0.054g/g/day) was recorded in treatment 9that is KASHI-KANCHAN + [10kg/ha + 0.3%] $ZnSo_4$, however treatment 4 is found to be statistically at par with treatment 9 KASHI-KANCHAN + [10kg/ha + 0.3%] $ZnSo_4$ (Table 1). The significant increase in relative growth rate observed with the application of[10kg/ha + 0.3%] $ZnSo_4$ might be duethe application of micronutrients on growth of cowpea, in terms of dry matter and crop growth rate can be interpreted in terms of the metabolic function of micronutrients in the plant which ultimately increases the relative growth rate. The similar results were reported by**Lal Babu Singh *et al.* (2015).**

Yield parameters

No. of Pods/plant: The data revealed that significant and higher No. of Pods/plant (14.44) was recorded in Treatment 3 that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$**,** However treatment 1 GOMTI + 20kg/ha $ZnSo_4$is statistically at Par with the treatment 3 GOMTI + 20kg/ha $ZnSo_4$ (Table 2).Number of pods/plant was significantly increased with application of [10kg/ha + 0.3%] $ZnSo_4$. It could possibly be explained by the fact that zinc application increased the realization of flower into pods.The similar results were reported by**Kumar *et al.* (2012)**.

No. of Seeds/Pod:The data revealed that significant and higherno. of seeds /pods (18.55) was obtainedin treatment 3that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$, However treatment 2 GOMTI + 0.6% $ZnSo_4$is statistically at Par with the treatment 3 GOMTI + [10kg/ha + 0.3%] $ZnSo_4$ (Table 2).Number of seeds/pod was significantly increased with application of [10kg/ha + 0.3%] $ZnSo_4$. zinc plays a very important role in the metabolism of the plant process by influencing the activity of growth enzymes as well as it is involved in carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, and regulation of auxin synthesis and pollen formation.The similar results were reported by**Abid Khan *et al.* (2019)**.

Test weight (g): The significant and maximum Test weight (91.00 g) was obtained in treatment 3that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$, however treatment 2 GOMTI + 0.6% $ZnSo_4$ is statistically at par with the treatment 3 GOMTI + [10kg/ha + 0.3%] $ZnSo_4$ (Table 2). test weight was significantly

increased with application of [10kg/ha + 0.3%] $ZnSo_4$. Similarly higher yield attributes and yield were noticed with the combined foliar spray of micro nutrients with zinc attributed to optimum availability of nutrients for luxurious crop growth and efficient partitioning of assimilates from source to sink. The similar results were reported by**Masih, A. *et al.* (2020).**

Seed yield (t/ha): The significant and maximum Seed yield (1.03 t/ha) was obtained in treatment 3 that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$, however treatment 2 GOMTI + 0.6% $ZnSo_4$ is statistically at par with the treatment 3 GOMTI + [10kg/ha + 0.3%] $ZnSo_4$ (Table 2). Seed yield was significantly increased with application of [10kg/ha + 0.3%] $ZnSo_4$. Zn influenced the synthesis of IAA in plants which indirectly enhanced the growth and development and uptake of nutrient in plants.Application of Zn also influenced the grain yield of cowpea.The similar results were reported by**Chavan *et.al.* (2012).**

Stover yield (t/ha): The significant and maximum Stover yield (5.33 t/ha) was obtained in treatment 3 that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$, which was significantly superior over all the treatments.stover yield was significantly increased with application of [10kg/ha + 0.3%] $ZnSo_4$(Table 2). It might be due to its direct influence on auxin production which in turn enhanced the elongation processes of plant development.The similar results were reported by**Masih*et al.*(2020)**.

Harvest index (%): The significant and maximum Harvest index (16.12 %) was obtained in treatment 3that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$, however treatment 2 GOMTI + 0.6% $ZnSo_4$, treatment 4 HIMANI-06 + 20kg/ha $ZnSo_4$, treatment 5 HIMANI-06 + 0.6% $ZnSo_4$ and treatment 9 KASHI-KANCHAN + [10kg/ha + 0.3%] $ZnSo_4$ is statistically at par with the treatment 3 GOMTI + [10kg/ha + 0.3%] $ZnSo_4$ (Table 2).Harvest index was significantly increased with application of [10kg/ha + 0.3%] $ZnSo_4$. It is found due to the increase in grain yield and straw yield the harvest index increases. The similar results were reported by**Abid Khan *et al.* (2019).**

Conclusion: In view of the obtained results, it could be concluded that among the studied treatments, treatment 3 that is GOMTI + [10kg/ha + 0.3%] $ZnSo_4$ was found to be more desirable that give higher growth parameters, yield attributes, seed yield, stover yield and harvest index.

	Treatment	60 DAS			45-60 DAS	
		Plant height (cm)	**No. of nodules/plant**	**Plant dry weight (g)**	**Crop Growth Rate ($g/m^2/day$)**	**Relative Growth Rate (g/g/day)**
1	GOMTI + 20kg/ha $ZnSo_4$	80.98	8.60	11.21	7.54	0.040
2	GOMTI + 0.6% $ZnSo_4$	81.96	8.93	11.85	7.65	0.038
3	GOMTI + [10kg/ha + 0.3%] $ZnSo_4$	83.96	9.20	12.55	7.94	0.037
4	HIMANI-06 + 20kg/ha $ZnSo_4$	77.68	7.40	10.20	8.23	0.053
5	HIMANI-06 + 0.6% $ZnSo_4$	78.80	7.80	10.38	7.70	0.046
6	HIMANI-06 + [10kg/ha + 0.3%] $ZnSo_4$	79.48	8.20	11.19	7.28	0.039
7	KASHI-KANCHAN + 20kg/ha $ZnSo_4$	72.97	6.40	8.71	6.25	0.044
8	KASHI-KANCHAN + 0.6% $ZnSo_4$	74.95	6.67	9.15	5.92	0.038
9	KASHI-KANCHAN + [10kg/ha + 0.3%]$ZnSo_4$	76.57	7.00	10.27	6.33	0.036
10	Control[N:P:K (25:50:25) kg/ha]	68.45	5.87	8.37	6.82	0.054
	F test	S	S	S	S	S
	SEm(±)	0.38	0.10	0.17	0.31	0.00

CD (5%)	1.14	0.29	0.51	0.92	0.007

Table 1: Effects of Zinc levels on Growth attributes of Cowpea varieties

S.No.TREATMENTS	No. of pods/plant	No. of seeds/pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvestindex (%)
1GOMTI + 20kg/ha $ZnSo_4$	13.44	17.00	86.33	0.88	5.15	14.54
2GOMTI + 0.6% $ZnSo_4$	13.22	17.89	88.00	0.98	5.20	15.80
3GOMTI + [10kg/ha + 0.3%] $ZnSo_4$	14.44	18.55	91.00	1.03	5.33	16.12
4HIMANI-06 + 20kg/ha $ZnSo_4$	11.78	14.67	81.00	0.84	4.67	15.31
5 HIMANI-06 + 0.6% $ZnSo_4$	12.22	15.33	84.33	0.87	4.78	15.43
6HIMANI-06 + [10kg/ha + 0.3%] $ZnSo_4$	13.00	16.33	86.67	0.87	4.98	14.90
7KASHI-KANCHAN + 20kg/ha $ZnSo_4$	8.55	13.11	74.00	0.79	4.63	14.65
8KASHI-KANCHAN + 0.6% $ZnSo_4$	10.00	13.22	76.00	0.77	4.64	14.17
9KASHI-KANCHAN + [10kg/ha + 0.3%] $ZnSo_4$	10.89	14.44	79.00	0.84	4.65	15.26
10Control[N:P:K (25:50:25) kg/ha]	7.89	10.45	72.00	0.74	4.44	14.24
F test	S	S	S	S	S	S
SEm (±)	0.41	0.28	1.21	0.02	0.03	0.34
CD (5%)	1.22	0.83	3.61	0.06	0.08	1.00

Table 2: Effects of Zinc levels on yield attributes of Cowpea varieties

References:

Abid Khan, Zafar Hayat, Asad Ali Khan, Junaid Ahmad, Muhammad Waseem Abbas, Haq Nawaz *etal.* Effect of foliar application of zinc and boron on growth and yield components of wheat. Agricultural Research and Technology: *Open Access Journal* 2019;21(1):3-6.

Chavan, A.S.; Khaf ,M.R.; Raj,A.D.; Parmar, R.M.(2012) Effect of Potassium and Znic on yield , Protien content and uptake of micronutrients on Cow pea [(*Vigna unguiculata* L.) Walp.] J. *AgriccultreScience Digest.* 32(2): 175

Evangeline Marngar, Joy Dawson. Effect of biofertilizers, levels of nitrogen and zinc on growth and yield of hybrid maize (*Zea mays L.*). *International Journal of Current Microbiology and Applied Sciences* 2017;6(9):3614-3622

Kumar, R., Singh, Y. V., Singh, S., Latare, A. M., Mishra, P. K. and Supriya. 2012. Effect of phosphorus and sulphur nutrition on yield attributes, yield of mungbean (*Vigna radiata* L. Wilczek). *Journal of Chemical and Pharmaceutical Research*. 4(5): 2571- 2573.

Kumar R, Bohra JS. Effect of NPKS and Zn application on growth, yield, economics and quality of baby corn. *Archives of Agronomy and Soil Science*. 2014;(60):1193-1206.

Kumar R, Rathore DK, Singh M, Kumar P, Khippal A. Effect of phosphorous and zinc nutrition on growth and yield of fodder cowpea. *Legume Research*, 2016;39(2):262-267.

Lal Babu Singh, Rajkumar Yadav, Thomas Abraham. Studies on the effect of zinc levels and methods of boron application on growth, yield and protein content of wheat (*Triticum aestivum*L.). *Bulletin of Environment, Pharmacology and Life Sciences* 2015;4(2):108-113.

Masih, A., Dawson, J., & Singh, R. E. (2020). Effect of Levels of Phosphorus and Zinc on Growth and Yield of Greengram (*Vigna radiata* L.). *International Journal of Current Microbiology and Applied Sciences*, *9*(10), 3106-3112.

Singh, K and Shukla,U C (1986).Evaluation of critical level of soil zinc for predicting response of maize to zinc fertilization in arid soil. *International J.Tropical Agriculture* 3: 288-292

Wani,M.R. and Khan,S (2006) Estimate of genetic variability in mutated populations and scope of selection for yield attributes in *Vigna radiate*(L) Wilezek. *Egyptian J. Bio.* 8: 1-6.