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M Prasanthi
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Umesha C
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Battula Sai Kumar Reddy
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Chilukuri Navya Sree
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Buduri Bhanuchandar
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
M Prasanthi
Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of zinc and spacing on growth and economics of chickpea

M Prasanthi, Umesha C, Battula Sai Kumar Reddy, Chilukuri Navya Sree and Buduri Bhanuchandar

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Abstract
A field experiment was conducted to find out the Zinc and Spacing on growth and yield of chickpea (var. Pusa 362) with nine treatments in the *rabi* 2019. With the different levels of Spacing (30 cm, 40 cm, 50 cm) and with the application of Zinc (10, 15, 20 kg $ZnSO_4$/ha) respectively, at Crop Research Farm, Department of Agronomy, Faculty of Agriculture, SHUATS, Prayagraj, Uttar Pradesh. By all these findings maximum plant height was recorded significantly higher *viz*., 68.00 cm, Number of root nodules recorded (3.94) and Economics *viz*., Gross return (₹ 111445/ha), net return (₹ 73599.3/ha) and B:C ratio (2.94) was recorded in treatment with the application of Spacing 30 cm + 20 kg $ZnSO_4$. Therefore, application of Zinc 20 kg/ha + Spacing 30 cm was more productive and economically feasible.

Keywords: Zinc, spacing, chickpea, growth and economics

Introduction
India is one of the major pulses growing country of the world. Among the pulses, chickpea has an average of 2.2–20 mg of Zinc per 100 g edible portion (Ray *et al*. 2014) [5]. Chickpea is the fourth largest grain legume crop in the world, In India with a total production of 11.09 million tons from an area of 14.56 million ha and a productivity of 1.31 t/ha. Major producing countries include India, Pakistan and Iran (FAO, 2019). Zinc is the major component of several enzymes, influencing the synthesis of proteins, auxins and photosynthetic activity. It also increases plant`s resistance to dry and hot weather conditions (Ashok *et al*., 2005) [1]. Zn application influence on synthesis of Auxin, nodulation and nitrogen fixation which enhance the plant growth and development of crop and ultimately influence the seed yield (Kasthurikrishna and Ahlawat, 2000) [2]. Row spacing is also one of the important factors which ultimately effect nutrient uptake growth and yield of plant. Increase in spacing decreases the total population, but with more nutrition to the individual plants grows better and yield more and vice versa. Row spacing is one of the important characters which can be manipulated to attain the maximum production from per unit land area.

Materials and Methods
The experiment was conducted during *Rabi* season of 2019-2020. The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications and was laid out with the different treatments allocated randomly in each replication. The soil of the experimental field was sandy loam in texture, slightly alkaline reaction (pH 7.6) with low level of organic carbon (0.36%), available P (13.05 kg/ha) and higher level of K (156.44 kg/ha). The treatment combinations are T_1 - Spacing 30 cm + Zinc 10 kg / ha, T_2 - Spacing 30 cm + Zinc 15 kg / ha, T_3 - Spacing 30 cm + Zinc 20 kg / ha, T_4 - Spacing 40 cm + Zinc 10 kg / ha, T_5 - Spacing 40 cm + Zinc 15 kg / ha, T_6 - Spacing 40 cm + Zinc 20 kg / ha, T_7 - Spacing 50 cm + Zinc 10 kg / ha, T_8 - Spacing 50 cm + Zinc 15 kg / ha, T_9 - Spacing 50 cm + Zinc 20 kg / ha. The observations were recorded on different growth parameters at harvest *viz*. plant height(cm), number of nodules and Economics *viz*. gross return, net return, B:C ratio.

Result and Discussion

A. Growth Parameters

Plant height (cm): At Harvest, the highest plant height was observed with the T_3(Spacing 30cm + Zinc 20 kg/ ha) (69.93 cm) which was significantly higher over rest of the treatments except T_5 (Spacing 40 cm + Zinc 15 kg/ ha) (68.67 cm), T_2 (Spacing 30 cm + Zinc 15 kg/ ha) (68.60 cm), T_6 (Spacing 40 cm + Zinc 20 kg/ ha) (67.73 cm), T_1 (Spacing 30 cm + Zinc 10 kg /ha) (67.70 cm), which are statistically on par. The increase in plant height under Zinc treatment might be due to its effect in the metabolism of growing plants which may effectively explain the response of Zinc application. This result might be due to the fact that as the spacing among plants decreased the interplant competition for light increased while sparsely populated plants intercepted sufficient sunlight that enhanced the lateral growth, which were confirmation with the results of (Agajie M 2018). In agreement with this, it was reported that plant height of chickpea was taller in higher plant population treatments due to more competition for light. This argument was also supported by Shamsi and Kobraee 2009, Sharar *et al.*, 2001, Singh and Singh 2002, Bicer 2008 [6, 7, 8].

Number of nodules/plant

At Harvest, the highest number of nodules/plant was observed with the T_3 (Spacing 30cm + Zinc 20 kg/ ha) (3.21) which was significantly higher over rest of the treatments except T_5 (Spacing 40 cm + Zinc 15 kg/ ha) (2.50) which are statistically on par with T_3 (Spacing 30cm + Zinc 20 kg/ ha). The increase in the nodulation might be due to the enhanced and established good rooting system with the application of zinc Favorable responses of zinc application on nodulation have also been reported Pavadai *et al.*, (2004) [4]. The improvement in number of nodules of chickpea with the application of zinc could be ascribed to its pivotal role in regulating the nodulation in pulses. Zn acts as antioxidant and its application helps in reducing the lipid peroxidation and hydrogen peroxide concentration in plant and also involved in the functioning of transcriptional regulators responsible for nitrogen fixation (Weisany *et al.*, 2012) [9]. Zinc is required for synthesis of tryptophan, which is responsible for formation of indole acetic acid (IAA), which is involved in nodule formation.

Table 1: Effect of zinc and spacing on growth attributes of chickpea.

Treatments	Plant height (cm)	Number of Nodules per plant
T_1 - Spacing 30 cm + Zinc 10 kg / ha	67.70	1.89
T_2 - Spacing 30 cm + Zinc 15 kg / ha	68.60	2.28
T_3 - Spacing 30 cm + Zinc 20 kg / ha	69.93	3.21
T_4 - Spacing 40 cm + Zinc 10 kg / ha	65.53	1.64
T_5 - Spacing 40 cm + Zinc 15 kg / ha	68.67	2.50
T_6 - Spacing 40 cm + Zinc 20 kg / ha	67.73	1.89
T_7 - Spacing 50 cm + Zinc 10 kg / ha	64.00	1.48
T_8 - Spacing 50 cm + Zinc 15 kg / ha	65.80	1.78
T_9 - Spacing 50 cm + Zinc 20 kg / ha	65.74	1.64
S.Em(±)	3.437	0.771
CD (p=0.05)	1.147	0.257

Economics of Chickpea on levels of Zinc and Spacing

Gross Return, Net Return and B:C Ratio

Significantly higher gross return (₹ 111445/ha) was obtained in treatment T_3 (Spacing 30 cm and Zinc 20 kg/ha). Significantly higher net return (₹ 73599.3/ha) and B:C Ratio recorded significantly higher in treatment T_3 (Spacing 30 cm and Zinc 20 kg/ha) (2.94). Increase in gross returns, net returns and B:C ratio with increasing the amount of $ZnSO_4$ applied to crop through soil application treatments might be due to the reason that there was proportionately less increase in the cost of $ZnSO_4$ fertilizer as compared to increase in grain yield and straw yield of chickpea. The highest gross returns, net returns and B:C were achieved in the treatment of Spacing 30 cm and Zinc 20 kg/ha. This discussion supported by Pal *et al.*, 2020 [3].

Table 2: Effect of zinc and spacing on Economics of chickpea.

Treatments	Cost of cultivation	Gross return (₹)	Net return (₹)	B:C ratio
T_1 - Spacing 30 cm + Zinc 10 kg / ha	36046	100813.0	64767.3	2.80
T_2 - Spacing 30 cm + Zinc 15 kg / ha	36946	81469.20	44523.2	2.21
T_3 - Spacing 30 cm + Zinc 20 kg / ha	37846	111445.0	73599.3	2.94
T_4 - Spacing 40 cm + Zinc 10 kg / ha	36046	89582.90	53536.9	2.49
T_5 - Spacing 40 cm + Zinc 15 kg / ha	36946	94092.60	57146.6	2.55
T_6 - Spacing 40 cm + Zinc 20 kg / ha	37846	94802.80	56956.8	2.50
T_7 - Spacing 50 cm + Zinc 10 kg / ha	36046	79034.90	42988.9	2.19
T_8 - Spacing 50 cm + Zinc 15 kg / ha	36946	104578.0	67632.3	2.83
T_9 - Spacing 50 cm + Zinc 20 kg / ha	37846	86526.0	48680.0	2.29

* Data was not subjected to statistical analysis

Conclusion

It may be concluded that treatment T_3 (30cm spacing+20kg zinc/ha) was found to be the most desirable for obtaining highest, gross returns (₹111445.0/ha) net returns (₹73599.3/ha) and B:C ratio (2.94).

The above conclusion is a result of one season work and it may be considered for recommending to the farmers, after at least one more year field trial.

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