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Effect of planting methods and zinc on growth and yield of chick pea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out on Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: Broadcasting + Zinc 5 Kg ha^{-1}, T_2: Line sowing + Zinc 5 Kg ha^{-1}, T_3: Ridge sowing + Zinc 5 Kg ha^{-1}, T_4: Broadcasting + Zinc 10 Kg ha^{-1}, T_5: Line sowing + Zinc 10 Kg ha^{-1}, T_6: Ridge sowing + Zinc 10 Kg ha^{-1}, T_7: Broadcasting + Zinc 15 Kg ha^{-1}, T_8: Line sowing + Zinc 15 Kg ha^{-1}, T_9: Ridge sowing + Zinc 15 Kg ha^{-1} are used. The results showed that application of Line sowing + Zinc 15 Kg ha^{-1} was recorded significantly higher Plant height (43.39 cm), Nodules/plant (20.29), Plant dry weight (8.18 g/plant), whereas significantly highest Crop growth rate (3.75 g/m^2/day) was recorded with the treatment Ridge sowing + Zinc 5 Kg ha^{-1}. However, Pods/plant (30.29), Number of Seeds/Pod (1.87), Test weight (224.30 g), Seed yield (1.82 t/ha), Stover yield (3.29 t/ha, Harvest index (35.59%) was obtained in the treatment of Line sowing + Zinc 15 Kg ha^{-1} compared to other treatments.

Keywords: Broadcasting, economics, line, ridge**,** sowing, yield, zinc

Introduction
Chickpea (*Cicer arietinum* L.) is the major pulse crop of India. At global level, it ranks third in terms of area and production under legumes. It is grown with less care and less manurial requirement. The earliest record of chickpea in India is from Atranji Khera in Uttar Pradesh and this dates backs to 2000 BC. With an estimated global production of 13.1 million tons in 2013, chickpea is grown in about 50 countries around the world covering an area of 14 million ha with an average global productivity of 968 kg ha-1 (Karwasra *et al.*, 2007) [7].

Chickpea is mostly consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed, sprouted etc.) or dal or as dal flour (besan). It is used in preparing a variety of snacks, sweets and condiments. It is mixed with wheat flour for "chapati" making. Fresh green seeds are consumed as green vegetable. Green leaves are used as vegetable. Grains are also used as vegetable (chole). Husk and bits of dal are used as nutritious feed for animals. Chickpea can also be used as green fodder for animals. It is mainly grown in more than 50 countries including India, Pakistan, Turkey, Iran, Myanmar, Australia, Ethopia, Canada, Mexico and Iraq (Gaur *et al.*, 2010) [5].

Adoption of proper sowing methods substantially contributes to increase the productivity of late sown wheat. Generally, cross and line sowing had already been proved better than other methods of sowing, but due to increasing cost wages and unavailability of labour, lack of time for land preparation and many other factors, force to farmers to broadcast the in the field instead of line sowing (Dagash *et al.*, 2014) [3].

Zinc is directly or indirectly required by several enzyme systems, auxin and protein synthesis. Zinc is believed to promote RNA synthesis, which in turn is needed for protein production. Chickpea has an average of 2.2–20 mg of zinc per 100 g edible portion. At several places normal yield of crops could not be achieved despite judicious use of NPK fertilizers due to deficiency of micronutrients in soil, in general, that of Zn in particular. A favourable balance between phosphorus and zinc should be maintained for optimum growth of plant (Ashok *et al.*, 2005) [1].

Materials and Methods

The present examination was carried out during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: Broadcasting + Zinc 5 Kg ha^{-1}, T_2: Line sowing + Zinc 5 Kg ha^{-1}, T_3: Ridge sowing + Zinc 5 Kg ha^{-1}, T_4: Broadcasting + Zinc 10 Kg ha^{-1}, T_5: Line sowing + Zinc 10 Kg ha^{-1}, T_6: Ridge sowing + Zinc 10 Kg ha^{-1}, T_7: Broadcasting + Zinc 15 Kg ha^{-1}, T_8: Line sowing + Zinc 15 Kg ha^{-1}, T_9: Ridge sowing + Zinc 15 Kg ha^{-1} are used. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha^{-1}), higher available P (19.50 kg ha^{-1}) and medium available K (213.7 kg ha^{-1}). In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, no. of nodules/plant and plant dry weight are recorded. The yield parameters like No. of pods/plant, No. of seeds/pod, Test weight (g), seed yield, stover yield and harvest index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussion

Growth attributes

Plant height

Significantly higher plant height (43.39 cm) was recorded with the treatment Line sowing + Zinc 15 Kg ha-1. However, the treatments Ridge sowing + Zinc 15 Kg ha-1 (43.26 cm) was found to be statistically at par with Line sowing + Zinc 15 Kg ha-1as compared to all the treatments.

Sowing methods guarantee proper crop establishment and optimum plant population in the field, as well as facilitating plants to utilize the land and other resources more efficiently and purposefully toward growth and development. The results were in accordance to Narendra *et al*. (2015) [9].

Increase in plant height might be 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 Singh *et al.* (2015) [10].

Number of nodules/plant

Significantly higher nodules/plant (20.29) was recorded with the treatment Line sowing + Zinc 15 Kg ha-1. However, the treatments Ridge sowing + Zinc 15 Kg ha-1 (19.96) was found to be statistically at par with Line sowing + Zinc 15 Kg ha-1 as compared to all other treatments.

The better spacing due to line spacing increased the surface area of the plant, which increased nodules number due to sustainable conditions. The results found are in confirmation of the findings of Kumar *et al*. (2015).

The reported positive effect of application of Zn on an enhanced nodules in pulses mainly attributed to promotion of root development by the auxins whereas Zn application ultimately increased the availability of other nutrients and accelerated the translocation of photo assimilates. Similar results were reported by Upadhyay and Anita Singh (2016).

Plant dry weight (g/plant)

Significantly higher dry weight/plant (8.18 g/plant) was recorded with the treatment Line sowing + Zinc 15 Kg ha-1. However, the treatments Ridge sowing + Zinc 15 Kg ha-1 (8.07 g/plant) was found to be statistically at par with Line sowing + Zinc 15 Kg ha-1 as compared to all other treatments.

The line sowing helps in the uniform plant pattern and higher use of natural resources like sunlight, water and less competition for minerals among plants helped in higher growth and wider elongation of plant stem and also higher biomass accumulation which resulted in higher plant dry weight. The results were in resonance with Shashikumar *et al*. (2013).

Yield attributes and Yield

Number of Pods/plant

Significantly Maximum Number of Pods/plant (30.29) was recorded with the treatment of application of Line sowing + Zinc 15 Kg ha-1 over all the treatments. However, the treatment Ridge sowing + Zinc 15 Kg ha-1 (29.97) which were found to be statistically at par with Line sowing + Zinc 15 Kg ha-1**.**

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 observed by Upadhyay and Anita Singh (2016).

Number of Seeds/pod

Significantly Maximum Number of Seeds/Pod (1.87) was recorded with the treatment of application of Line sowing + Zinc 15 Kg ha-1 over all the treatments. However, the treatment Ridge sowing + Zinc 15 Kg ha-1 (1.81) and Line sowing + Zinc 10 Kg ha-1 (1.70) which were found to be statistically at par with Line sowing + Zinc 15 Kg ha-1**.**

Application of Zinc chick pea crop generally improves fruit growth by synthesizing tryptophan and auxin. The enhancement effect on seeds/pod and pods/plant attributed to the favorable influence of the Zn application to crops on nutrient metabolism, biological activity and growth parameters and hence, applied zinc resulted in taller and higher enzyme activity which in turn encouraged more seeds/pod and pods/plant. Similar findings have been reported earlier by Srivastava *et al*. (2017) [11]

Test weight (g)

Significantly highest Test weight (224.30 g) was recorded with the treatment of application of Line sowing + Zinc 15 Kg ha-1 over all the treatments. However, the treatment Ridge sowing + Zinc 15 Kg ha-1 (222.04 g) which were found to be statistically at par with Line sowing + Zinc 15 Kg ha^{-1}**.**

The lesser planting density from the lesser seed rate used, which decreased the plant competition and eventual increased in the individual grain weight. The results were found in accordance with Jafari *et al*. (2014) [6].

Seed yield (t/ha)

Significantly highest Seed yield (1.82 t/ha) was recorded with the treatment of application of Line sowing + Zinc 15 Kg ha-1 over all the treatments. However, the treatment Ridge sowing + Zinc 15 Kg ha-1 (1.77 t/ha) which were found to be statistically at par with Line sowing + Zinc 15 Kg ha-1**.**

The yield was minimal in broadcasting because the overcrowding of the seeds and shallow placement of the seeds which in later stages leads to less root development and poor nutrient uptake while line sowing recorded the highest. The results are in confirmation with the findings of Bhooshan and Singh (2014) [2].

Zinc plays a vital role in increasing seed yield because zinc takes place in many physiological process of plant such as chlorophyll formation, stomatal regulation, starch utilization which enhance seed yield. Zinc also converts ammonia to nitrate in crops which contribute to yield. These results are in confirmatory with the work of Debnath *et al.* (2018) [4]

Stover yield (t/ha)

Significantly highest Stover yield (3.29 t/ha) was recorded with the treatment of application of Line sowing + Zinc 15 Kg ha-1 over all the treatments. However, the treatment Ridge sowing + Zinc 15 Kg ha-1 (3.21 t/ha) which were found to be statistically at par with Line sowing + Zinc 15 Kg ha^{-1}**.**

The plants developed well in line sowing due to better growing conditions as compared to broadcasting method and ridge method of sowing it also found that stover yields were more because of wider and taller plants which leads to more accumulation of dry matter. The results were found to be confirmatory with Khan *et al*. (2000) [8].

Harvest Index (%)

Significantly highest Harvest index (35.59%) was recorded with the treatment of application of Line sowing + Zinc 15 Kg ha-1 over all the treatments. However, the treatment Ridge sowing + Zinc 15 Kg ha-1 (35.50%), Ridge sowing + Zinc 5 Kg ha-1 (34.79%), Line sowing + Zinc 10 Kg ha-1 (34.61%), Broadcasting + Zinc 15 Kg ha-1 (34.51%) and Ridge sowing + Zinc 10 Kg ha-1 (34.48%) which were found to be statistically at par with Line sowing + Zinc 15 Kg ha-1.

Table 1: Effect of planting methods and zinc on Growth attributs of Chickpea

Treatments		Plant height (cm)	Nodules/plant	Dry weight (g/plant)
1.	Broadcasting + Zinc 5 Kg ha-1	40.82	16.88	7.12
2.	Line sowing + Zinc 5 Kg ha-1	41.87	18.53	7.63
3.	Ridge sowing + Zinc 5 Kg ha-1	41.41	17.97	7.49
4.	Broadcasting + Zinc 10 Kg ha-1	41.22	17.40	7.30
5.	Line sowing + Zinc 10 Kg ha-1	43.04	19.59	7.96
6.	Ridge sowing + Zinc 10 Kg ha-1	42.67	19.26	7.81
7.	Broadcasting + Zinc 15 Kg ha-1	42.33	18.87	7.72
8.	Line sowing + Zinc 15 Kg ha-1	43.39	20.29	8.18
9.	Ridge sowing + Zinc 15 Kg ha-1	43.26	19.96	8.07
F- test		S	S	S
S. EM (±)		0.10	0.14	0.05
C. D. (P = 0.05)		0.29	0.41	0.14

Table 2: Effect of planting methods and zinc on Yield attributes and Yield of Chickpea

Treatments		Pods/plant	Seeds/pod	Test Weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1.	Broadcasting + Zinc 5 Kg ha-1	26.89	1.30	200.40	1.27	2.57	33.07
2.	Line sowing + Zinc 5 Kg ha-1	28.17	1.53	212.15	1.51	2.91	34.19
3.	Ridge sowing + Zinc 5 Kg ha-1	27.81	1.50	206.60	1.48	2.77	34.79
4.	Broadcasting + Zinc 10 Kg ha-1	27.31	1.40	203.28	1.36	2.70	33.57
5.	Line sowing + Zinc 10 Kg ha-1	29.72	1.70	219.82	1.67	3.16	34.61
6.	Ridge sowing + Zinc 10 Kg ha-1	29.27	1.63	215.59	1.62	3.08	34.48
7.	Broadcasting + Zinc 15 Kg ha-1	28.85	1.60	213.87	1.57	2.98	34.51
8.	Line sowing + Zinc 15 Kg ha-1	30.29	1.87	224.30	1.82	3.29	35.59
9.	Ridge sowing + Zinc 15 Kg ha-1	29.97	1.80	222.04	1.77	3.21	35.50
F test		**S**	**S**	**S**	**S**	**S**	**S**
S. EM (±)		0.12	0.07	0.87	0.03	0.03	0.44
CD (P = 0.05)		0.37	0.20	2.62	0.08	0.08	1.32

Conclusion

It is concluded that application of treatment Line sowing + Zinc 15 Kg ha^{-1} was recorded significantly higher Seed yield (1.82 t/ha) as compared to other treatments. Since, the findings based on the research done in one season.

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