Original Research Article

Effect of Zinc and Spacing on Growth and Yield of Groundnut (*Arachis hypogea* L.)

Abstract

A field experiment entitled "Effect of Zinc and spacing on growth and yield of ground nut (*Arachis hypogea L.*)" was conducted to during the *Zaid* season 2021CRF Crop Research Farm), Department of Agronomy, SHUATS, Prayagraj (U.P). Soil of the experimental field is sandy loam in texture, nearly neutral in soil reaction (pH 7.4). The treatments consisted of Zinc levels at 10 kg/ha, 12.5 kg/ha and 15kg/ha and Spacing at 25 × 10, 30 × 10 and 35 × 10 whose effect is observed in Groundnut (Var – K6). The experiment was laid out in Randomized Block Design with nine treatments replicated thrice. The treatment 6 with (Zn 15 kg/ha + 30×10) recorded significantly maximum in plant height (40.36 cm), number of nodules (49.43), plant dry weight (21.88 g), crop growth rate (26.09g/m^2/day) The treatment 6 with (Zn 15 kg/ha + 30×10) also recorded significantly higher in yield attributes viz. Number of pods/pant (27.72), number of kernels per pod (1.92) and seed index (39.21 g), pod yield (3565.00kg/ha), seed yield (1494.67 kg/ha), haulm yield (5907.67 kg/ha), harvest index (20.18%),oil content (48.26%). The treatment 6 with (Zn 15 kg/ha + 30×10) also recorded significantly the maximum cost of cultivation (50,449.50 INR/ha), gross return (119218.55 INR/ha), net return (68769.05 INR/ha) and B: C ratio (1.36).

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Key words: Groundnut, Zinc, Spacing, Yield, Oil Content and Economics.

Introduction

Groundnut (*Arachis hypogea* L.) is an important oilseed and supplementary food crop of the world. It is fourth most important source of edible oil and third most important source of vegetable protein. It belongs to family Leguminaceae. It is premier oilseed crop of India popularly known as peanut, monkey nut, manila nut. India ranks first in respect of area and second in production after China. Globally, the crop is raised on 26.4 million hectares with a total production of 37.1 million MT. In India, it is cultivated over an area of 4596.33 in hectares with production of 6733.33 MT. The average productivity is 1400 kg/ha **(Anon, 2017)**. India accounts for about 27% ~~per cent~~ of global area and contributes 19% ~~per cent~~ to world groundnut

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production. Globally, 50% of groundnut is used for oil extraction, 37% confectionary and 12% for seed purpose **(Rai et al., 2016)**.

Groundnut is a major oilseed crop contributing around 37% ~~per cent~~ of the total oilseeds production in the country during 2020-21. Groundnut acreage in the country is fluctuating over the years and from the last two decades the area had declined from 83 lakh ha to 47 lakh ha as farmers are shifting from Groundnut to other remunerative crops after the introduction of the green revolution which mainly focused on cereal crops. The consumption of Groundnut is highest in the form of Groundnut oilseed (5540 thousand tonnes) followed by Groundnut meal (1590 thousand tonnes) and Groundnut oil (1260 thousand tonnes) during 2020. Gujarat is the largest producer contributing 33% ~~per cent~~ of the total production of Groundnut followed by Rajasthan (21 %), Tamil Nadu (14 %). Andhra Pradesh contributes 7% ~~per cent~~ and Telangana contributes 5% ~~per cent~~ to total Groundnut production. Groundnut production contributes around 87% ~~per cent~~ of acreage and 91% ~~per cent~~ of production to total oilseeds in Andhra Pradesh. Groundnut contributes 19.1% ~~per cent~~ area and 21.3% ~~per cent~~ production to total oilseeds area and production in India respectively.**(Agricultural Market Intelligence Centre, ANGRAU, Lam)**.

In nutrition a new era is emerging that is characterized by search for dietary constituents that have benefits beyond those ascribed to the macro and micronutrients **(Das et al., 2005)**.Nowadays zinc deficiency is virtually an all India problem and in West Bengal 9-68% of soils are Zn deficient **(Katyal*et al*., 1993)**. Zinc is required in various metabolic processes as catalysts. Zinc also increases the content of protein, calorific value, amino acid and fat in oilseed crop Balanced fertilization helps to improve the quality of the produce. **(Katyal JC, and Vlek1995).** It is well established that zinc is one of the most important nutrient required for plant growth as it plays as an activator of several enzymes in plants and is directly involved in the biosynthesis of growth substances such as auxin which produces more plant cells and more dry matter. Zinc deficiency start yellowing of leaves from lamina to base, mid-rib and veins remain green. In Maharashtra 34 per cent soils were deficient in available zinc application of zinc in such deficient soils may improve the quality of farm produce **(Shukla*et al*., 2014).**

Planting geometry is an important agronomical management practice and nonmonetary input, which has key role in increased crop production. Crop planted in appropriate geometry

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enhances use of natural resources as well as inputs given to the crop. Groundnut crop competes with each other above and below the ground. Planting geometry varies according to species and region **(Meena 2011)**.Planting patterns play an important role in enhancing overall productivity of crops as it is likely to affect interception, absorption, penetration and utilization of incoming solar radiation. Plant density is another important character, which can be manipulated to attain the maximum production from per unit land area. The optimum plant density with proper geometry of planting is dependent on variety, its growth habit and agro-climatic conditions **(Sondhiya*et al.*, 2019).** It is imperative to adjust plant population through planting method which may help in avoiding excessive crowding. Higher plant population per unit area beyond an optimum limit results in competition among the plants for natural resources, resulting weaker plant and may cause severe lodging **(Jangir*et al.*, 2017).**

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Materials and methods

The experiment was conducted during the *Zaid* season 2021 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.). The Crop Research Farm is situated at 25.57^{o} N latitude, 87.19^{o} E longitude and at an altitude of 98 m above mean sea level. This area is situated on the right side of the river *Yamuna* and by the opposite side of Prayagraj City. All the facilities required for cultivation of crop were available. The treatments consisted of Zinc levels at 10 kg/ha, 12.5 kg/ha and 15kg/ha and Spacing at 25 × 10, 30 × 10 and 35 × 10 whose effect is observed in Groundnut (Var – K6). The treatment combinations which are T_1: 25 X 10 cm + 10 kg/ha, T_2: 25 X 10 cm + 12.5 kg/ha, T_3: 25 X 10 cm + 15 kg/ha, T_4: 30 X 10 cm + 10 kg/ha, T_5: 30X 10 cm + 12.5 kg/ha, T_6: 30 X 10 cm + 15 kg/ha, T_7: 35 X 10 cm + 10 kg/ha, T_8: 35 X 10 cm + 12.5 kg/ha, T_9: 35 X 10 cm + 15 kg/ha. The soil of the experimental field constituting a part of central gangetic alluvium and is neutral and deep. Pre-sowing soil samples were taken from a depth of 15 cm with the help of an auger which were tried in randomized block design replicated thrice. The composite samples were used for the chemical and mechanical analysis. The soil was sandy loam in texture, low in organic carbon (0.536%) and medium in available nitrogen (163.42 kg/ha), low in phosphorus (21.96 kg/ha) and high in potassium (256.48 kg/ha). The recommended dose of fertilizers (RDF) used in the experiment are 20 kg N, 40 kg P_2O_5 and

20 kg K_2O/ha were supplied in all plots as basal doses. The nutrient sources were Urea, DAP and MOP. Whereas, based on the treatment combinations Zinc ($ZnSO_4$) is supplied to the plots as basal wherever required as soil application. Irrigation was based on the necessity and as per the time of sowing. The growth parameters *viz*. plant height, number of nodules/plant, dry weight/plant was recorded at harvest. The yield parameters *viz*. number of pods/plant, number of seeds/plant, 100 seeds weight, grain yield, stover yield and harvest index were recorded with standard process of observation. The data was statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez and Gomez, 1984).

Chemical analysis of soil

Composite soil samples are collected before layout of the experiment to determine the initial soil Properties. The soil samples are collected from 0-15 cm depth and were dried under shade, Powdered with wooden pestle and mortar, passed through 2 mm sieve and were analyzed for Organic carbon by rapid titration method by Nelson (1975). Available nitrogen was estimated by Alkaline permanganate method by Subbiah and Asija (1956), available phophorus by Olsen's Method as outlined by Jackson (1967), available potassium was determined by using the flame Photometer normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973) and available ZnSO4 was estimated by Atomic Absorption Spectrophotometer method as outlined by Lindsay and Norvell (1978).

Result and discussion

Growth parameters

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Data presented in Table 1 indicated that the highest plant height was observed in the treatment with spacing of 30x10 cm (S_2) + Zinc at 15 kg/ha (40.36 cm) which was significantly higher over rest of the treatments except treatment five (39.85 cm) with spacing of 30x10 cm (S_2) + Zinc at 12.5 kg/ha and treatment nine (40.34 cm) with spacing of 35x10 cm (S_3) + Zinc at 15 kg/ha which were statistically at par with spacing of 30x10 cm (S_2) + Zinc at 15 kg/ha. The spacing practices had significant effects on plant height (cm); however, an optimum spacing resulted in lesser competition for sun light, water, nutrients and space between the plants which resulted in higher plant height. Similar findings were reported by **Gadade *et al*. (2018).** Increase in plant height might be the involvement of micronutrients 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. The results were in accordance to **Upadhyay and Anita Singh (2016).**

Significantly highest plant dry weight (21.88 g) was observed in the treatment with spacing of 30x10 cm (S_2) + Zinc at 15 kg/ha. However, dry weight (21.62 g) with spacing of 30x10 cm (S_2) + Zinc at 12.5 kg/ha and (21.74 g) with spacing of 35x10 cm (S_3) + Zinc at 15 kg/ha which were statistically at par with spacing of 30x10 cm (S_2) + Zinc at 15 kg/ha.Higher dry matter production was observed in 30x10 cm spacing due to better photosynthetic activity due to greater exposure of sunlight, and increased availability of nutrients. The results were in accordance to the findings of **Gadade *et al*. (2018).**The highest of biomass increase was observed because of increasing levels of zinc. Although the application of zinc as basal dose to groundnut increased its dry matter significantly, High dry matter in those treatments is due to long plant height, high stem girth, and high root weights **Shekhawat *et al.* (2017).**

Highest Root nodules per plant was observed in the treatment with spacing of 30x10 cm (S_2) + Zinc at 15 kg/ha (7.23) which was significantly higher over rest of the treatments except treatment five (6.83) with spacing of 30x10 cm (S_2) + Zinc at 12.5 kg/ha and treatment nine (6.90) with spacing of 35x10 cm (S_3) + Zinc at 15 kg/ha which were statistically at par with spacing of 30x10 cm (S_2) + Zinc at 15 kg/ha. Zinc is an important micronutrient for nodulation and nitrogen fixation and involved in leghaemoglobin synthesis. Deficiency of Zn in legumes is reported to reduce the number and size of nodules as it is involved in leghaemoglobin synthesis. So the application of higher levels of zinc resulted in highest root nodules. The results were found to be similar with **Debnath *et al.* (2018).**

Table 1 Effect of Zinc levels and plant spacing on growth parameters in ground nut

S. No.	Treatments	Plant height (cm)	Dry weight (g/plant)	Root nodules /plant
T_1	1. 25 X 10 cm (S_1) + Zn 10 kg/ha	37.85	19.96	5.30
T_2	2. 25 X 10 cm (S_1) +Zn 12.5 kg/ha	38.38	20.52	5.83
T_3	3. 25 X 10 cm (S_1)+ Zn 15 kg/ha	39.62	21.49	6.20
T_4	4. 30 X 10 cm (S_2)+ Zn 10 kg/ha	38.61	20.93	5.83
T_5	5. 30 X 10 cm (S_2)+ Zn 12.5 kg/ha	39.85	21.62	6.83
T_6	6. 30 X 10 cm (S_2)+ Zn 15 kg/ha	40.36	21.88	7.23
T_7	7. 35 X 10 cm (S_3)+ Zn 10 kg/ha	38.17	20.16	5.50
T_8	8. 35 X 10 cm (S_3)+ Zn 12.5 kg/ha	39.24	21.20	6.00
T_9	9. 35 X 10 cm (S_3)+ Zn 15 kg/ha	40.34	21.74	6.90
	SEm±	0.20	0.16	0.25
	CD (P=0.05)	0.60	0.48	0.76

Yield and yield attributes

Data presented in Table 2, pods per plant (27.72) was more and significant in treatment with treatment six with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha which was significantly higher over rest of the treatments except treatment five with (26.68) spacing of 25x10 cm (S_2)+ Zinc at 12.5 kg/ha and treatment nine with spacing of 30x10 cm (S_3)+ Zinc at 15 kg/ha which were statistically at par with spacing of 25x10 cm (S_2) + Zinc at 15kg/ha. 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 findings were found to be similar with **Srivastava*et al*. (2017).** Kernels per pod (1.92) was more and significant in treatment with treatment six with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha which was significantly higher over rest of the treatments except treatment five (1.85) with spacing of 25x10 cm (S_2)+ Zinc at 12.5 kg/ha and treatment nine (1.88) with spacing of 30x10 cm (S_3)+ Zinc at 15 kg/ha which were statistically at par with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha. Application of Zinc to groundnut crop generally improves fruit growth by synthesizing tryptophan and auxin. The enhancement effect on pods/plant and kernels/pods attributed to the favourable 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 encourage more pods/plant and kernels/pods. Similar findings have been reported earlier by **Mohammed and Getnet (2019).** Seed Index (39.21) was more and significant in treatment six with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha which was significantly higher over rest of the treatments except treatment nine with spacing of 30x10 cm (S_3)+ Zinc at 15 kg/ha which were statistically at par with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha. Pod yield (3565.00 kg/ha) was more and significant in treatment with treatment six with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha which was significantly higher over rest of the treatments except treatment nine (3468.67 kg/ha) with spacing of 30x10 cm (S_3) + Zinc at 15 kg/ha which were statistically at par with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha. Haulm yield (5907.67 kg/ha) was more and significant in treatment with treatment six with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha which was significantly higher over rest of the treatments except treatment nine (5787.33) with spacing of 30x10 cm (S_3) + Zinc at 15 kg/ha which were statistically at par with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha. Zinc plays a vital role in increasing haulm yield because zinc takes place in many physiological process of plant such as chlorophyll formation, stomatal regulation, starch utilization and biomass accumulatio which enhanced haulm yield. Zinc also converts ammonia to nitrate in crops which contribute to yield. The similar findings were reported by **Haider *et al.* (2018).** Harvest index (20.19 %) was more and significant in treatment with treatment nine with spacing of 30x10 cm (S_3) + Zinc at 15 kg/ha which was significantly higher over rest of the treatments except treatment three (19.86 %) with spacing of 20x10 cm (S_1) + Zinc at 15 kg/ha, treatment four (19.23 %) with spacing of 25x10 cm (S_2) + Zinc at 10 kg/ha, treatment five (19.96 %) with spacing of 25x10 cm (S_2) + Zinc at 12.5 kg/ha and treatment six (20.18 %) with spacing of 25x10 cm (S_2) + Zinc at 15 kg/ha which were statistically at par with spacing of 30x10 cm (S_3) + Zinc at 15 kg/ha. Zinc fertilization has beneficial effect on physiological process, plant metabolism and plant growth, which leads to higher yield. Increase in pod yield and haulm yield with application of zinc and along with optimum spacing 30x10 cm provided required space for the growth of plant and helped in increasing yield of groundnut. The results were supported by the findings of **Debnath *et al.*(2018)** and **Sokoto *et al*. (2013).**

Table 2. Effect of Zinc levels and plant spacing on yield and yield attributes in ground nut

Treatments	**No. of pods per plant**	**No. of kernels per pod**	**Seed index (g)**	**Pod yield (kg/ha)**	**Haulm yield (kg/ha)**	**Harvest index (%)**
1. 25 X 10 cm (S_1) + Zn 10 kg/ha	24.71	1.61	36.12	2964.67	5241.67	18.10
2. 25 X 10 cm (S_1) +Zn 12.5 kg/ha	24.66	1.70	36.77	3177.33	5434.33	19.08
3. 25 X 10 cm (S_1)+ Zn 15 kg/ha	26.25	1.81	37.93	3329.33	5669.67	19.86
4. 30 X 10 cm (S_2)+ Zn 10 kg/ha	25.30	1.72	37.03	3224.33	5533.67	19.23
5. 30 X 10 cm (S_2)+ Zn 12.5 kg/ha	26.68	1.85	38.17	3362.67	5728.33	19.96
6. 30 X 10 cm (S_2)+ Zn 15 kg/ha	27.72	1.92	39.21	3565.00	5907.67	20.18
7. 35 X 10 cm (S_3)+ Zn 10 kg/ha	24.53	1.63	36.44	3001.00	5315.00	18.48
8. 35 X 10 cm (S_3)+ Zn 12.5 kg/ha	25.38	1.78	37.57	3282.00	5643.00	19.18
9. 35 X 10 cm (S_3)+ Zn 15 kg/ha	27.19	1.88	38.72	3468.67	5787.33	20.19
F-Test	S	S	S	S	S	S
Sem±	0.37	0.03	0.30	55.13	41.00	0.33
CD (5%)	1.12	0.08	0.91	165.27	122.92	0.99

Conclusion

Study suggested that with spacing 30x10 cm (S_2) + Zinc at 15 kg/ha were recorded higher growth and yield parameters and more productive (3565 kg/ha). The conclusions drawn are based on one year data only which requires further confirmation for recommend.

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