

Original Research Article

Effect of gypsum and foliar application of zinc on growth and yield of groundnut

(Arachis hypogaea L.)

Abstract

A field experiment was conducted at the Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Zaid season 2022. The experiment comprised of ten treatments of different combinations of Gypsum and Zinc nutrient management replicated thrice in a Randomized Block Design. The main objective of the experiment was to evaluate the “Effect of gypsum and foliar application of zinc on growth and yield of groundnut (*Arachis hypogaea*)”. The three level of gypsum were 200, 300, 400 kg/ha. Where-as three levels of zinc included foliar application of 2000, 3000, 4000 ppm. From the present investigation it may be concluded that the profitable production of groundnut can be secured by Gypsum 400 kg/ha + Zinc 4000 ppm (T9).

Keywords: *Growth, yield, gypsum levels and zinc foliar spray*

Introduction

Groundnut (*Arachis hypogaea*) is an important oil seed crop and a grain legume. India is the second largest producer of groundnut after China. Groundnut belonging to family Leguminaceae is the fourth most important source of edible oil also known as “The King of Oilseeds” and third most important source of vegetable protein. Groundnut is the largely produced oil seed in India; it is also an important cash crop. It contributed to sustainable agriculture being a legume and is cultivated in both kharif and *Zaid* by farmers. India’s groundnut cropping area for the year 2019 was estimated to be 41.35 lakh hectares and the production 37.70 lakh tons. According to (Satish *et al.* 2011), groundnut is primarily used for extraction of oil, with an analysis of about 46.70%. It is also consumed directly because of its

high food value, which is again due to its higher content of protein (22.0%), carbohydrate (10.0%) and minerals (3.0%).

Groundnut plays an important role in dietary requirements of poor women and children. Haulm is used as livestock feed. Groundnut oil is composed of mixed glycerides and contains a high proportion of unsaturated fatty acids viz., oleic (50 to 65%) and linoleic acid (18 to 30%). Groundnut contains amino acids including cysteines which are essential for animal growth. The groundnut cake obtained after oil extraction is rich in protein and considered as valuable organic manure and animal feed, which contains 7 to 8% N, 1.5% P and 1% K. Being a leguminous crop groundnut helps in maintenance of soil fertility. And being rich in protein they supply major share of protein requirement of country. Exhaustive cultivation without legumes in rotation, has transformed many regions in to barn wastelands thus inclusion of legume crop in high intensity cropping programme has shown very encouraging effect in improving physical and to certain extent the chemical properties of soil. It is also efficient cover crop for lands exposed to soil erosion. Balanced nutrition is considered as one of the basic needs to achieve the potential yield (Yadav *et al.* 2017). Groundnut is feeder of soil nutrients. Being a legume crop, it needs more phosphorous, Sulphur and calcium for proper shell formation and filling. Besides NPK, Sulphur is one of the essential nutrient elements which plays an important role in carbohydrate metabolism and formation of chlorophyll, glycosides, oils and many other compounds that are involved in N-fixation and photosynthesis of plants. Its nutrition to crops is vital both from quality and quantity point of view.

In recent years most of the groundnut varieties were developed which are resistant to different stress conditions like drought, salinity, highly responsive to fertilizer application and also resistant to different pests and diseases. Among the factors limiting pod yield of groundnut in many areas is inadequate plant population and nutrition. Therefore, optimum plant population is essential to get good yields. Plant nutrition is considered to be one of the important factors in plant growth and development. It being an exhaustive crop absorbs huge quantity of nutrient from soil during different stages of growth. Due to its higher productivity potential, groundnut requires large amount of nutrients from the soil during different growth stages.

Calcium & Sulphur are absorbed by pegs & developing pods and the common source of supply is gypsum. Adequate calcium is essential in root and pod zones for yield and quality

of kernels. Calcium deficiency leads to unfilled pods called pops and darkening of plumules of embryo. Sulphur is highly essential as it is directly involved in the biosynthesis of oil. It improves nodulation of *Rhizobium* and prevents the premature leaf fall & increase the pod & oil yield. Sulphur plays an important role in the metabolism of groundnut. It is important for the synthesis of proteins. It plays an important role in chlorophyll formation. Sulphur is one of the secondary essential plant nutrient element and it ranks importance with Nitrogen and Phosphorous in the formation of protein. The application of Sulphur fertilizer and groundnut has been found effective through increasing the number of pegs and pods/plant, kernel to shell ratio etc.

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. Zinc entered into the constituents of enzyme system that regulate initial metabolic reactions in the plants body. Zinc catalyses the process of oxidation in plant cells and is vital for the transformation of carbohydrates. It regulates the consumption of sugars and increases the source of energy for the production of chlorophyll. Zinc also aids in the formation of auxin and synthesis of protein.

The following objectives have been undertaken to study the “**Effect of gypsum and zinc on growth and yield of groundnut (*Arachis hypogaea*)**”

1. To evaluate the effect of gypsum and zinc on growth and yield of groundnut.
2. To work out the economics of different treatment combinations.

Materials and Methods

The current study was carried out in the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, during the *Zaid* season 2022, (U.P.). The experimental field is situated on the left side of the Prayagraj-Rewa Road, about seven kilometers from Prayagraj city and close to the Yamuna River, at 25.57° N latitude, 87.19° E longitude and at an altitude of 98m above mean sea level. The subtropical region of Uttar Pradesh, where Prayagraj is located, has scorching summers and nice winters. The region's typical temperature ranges varied between 21.80 to 43.47°C in the month of April, 22.40 to 39.17°C in the month of May, 20.13 to 41.83°C in the month of June, 22.97 to 36.83°C in the

month of July and 24.60 to 34.60 °C in the month of August were recorded for groundnut crop for various phenophases. The relative humidity levels range from 79.11% and 37.60%. In this location, the average annual rainfall is of 3.42 mm in June and zero rainy days were occurred in July and August months, respectively. The soil chemistry analysis revealed a sandy loam texture with a pH of 7.20, low amounts of organic carbon (0.72 percent) and potassium (233.24 kg/ha), and a low quantity of accessible phosphorus (27.80 kg/ha). The soil was electrically conductive and had a conductivity of 0.187 dS/m. For each of the ten treatment combinations, three replications were employed. The therapy details and treatment combinations are shown in Tables 1 and 2, respectively. Gypsum levels and foliar application of zinc were maintained according to the treatment combinations. Growth parameters at 60 DAS i.e., Plant height (cm), Number of nodules per plant, dry weight and yield parameters at harvest i.e., number of pods per plant, number of kernels per pod, Seed index, Seed yield, Haulm yield were all successfully measured, and an economic analysis of each treatment was completed to determine the best treatment combination for groundnut cultivation.

Table 1. Treatment details

Gypsum: Three levels	G1	200 kg/ha
	G2	300 kg/ha
	G3	400 kg/ha
Zinc: Three levels	Z1	2000 ppm
	Z2	3000 ppm
	Z3	4000 ppm

Table 2: Treatment combinations

Treatment	Treatment combinations Symbol	Treatment combinations
1	G1Z1	Gypsum 200 kg/ha + Zinc 2000 ppm
2	G1Z2	Gypsum 200 kg/ha + Zinc 3000 ppm
3	G1Z3	Gypsum 200 kg/ha + Zinc 4000 ppm
4	G2Z1	Gypsum 300 kg/ha + Zinc 2000 ppm
5	G2Z2	Gypsum 300 kg/ha + Zinc 3000 ppm
6	G2Z3	Gypsum 300 kg/ha + Zinc 4000 ppm
7	G2Z1	Gypsum 400 kg/ha + Zinc 2000 ppm
8	G3Z2	Gypsum 400 kg/ha + Zinc 3000 ppm

9	G3Z3	Gypsum 400 kg/ha + Zinc 4000 ppm
10	G0Z0	CONTROL RDF (20:60:40 NPK kg/ha)

UNDER PEER REVIEW

Result and Discussion

Growth parameters Plant height (cm)

Table 3 shows gypsum and zinc on plant height at 60 DAS. The Data indicated that significant impact on plant height during the crop growth period. Application of T9- Gypsum 400 kg/ha + Zinc 4000 ppm significantly influenced the plant height in groundnut at 60 DAS. The maximum plant height (24.33 cm) was recorded in T9- Gypsum 400 kg/ha + Zinc 4000 which was statistically at par with T8,T6 and minimum plant height (14.33 cm) was recorded in application of T10 : Control (RDF).

Plant height increased with the increasing dose of gypsum from 0 to 400 kg/ha (**Adhikari et al., 2003**). This may be attributed due to better plant development through efficient utilization of soil resources by the plant, where primary growth element was available in sufficient amount (**Kalaiyarasan et al., 2003**).

Foliar spraying with zinc encouraged the vegetative growth and increased the plant capacity for building metabolites. Such response may be due to that zinc is known to play 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. Similar results were obtained by **Darwish et al., Tomar et al., Malewar et al., Tripathy et al., and Shankar et al.**

Number of nodules per plant

Application of T9: Gypsum 400 kg/ha + Zinc 4000 ppm significantly influenced the number of nodules per plant. Table 3 shows gypsum and zinc on number of nodules per plant at 60 DAS. The Data indicated that, groundnut at 60 DAS, The maximum number of nodules per plant (115.73) was recorded in T9: Gypsum 400 kg/ha + Zinc 4000 ppm which was statically at par with T8, T7, T6, T5 and lowest number of nodules per plant (69.73) was recorded in Farmers practice (T10).

Synergistic consequence of Ca and S may be attributable to consumption hefty amounts of nutrients in the course of their growing improved root system and nodules that valor boast resulted in plant development as well as straw yield at ripeness (**Mandal et al., 2005**).

These might be due to role of Zn and Mo in enzymes activities as they are essential constituent of N₂ fixing enzymes complex “nitrogenase” which are responsible for increase in leg haemoglobin which ultimately increase nodulation and N- fixation (**Radhika et al. 2021**) **Bagal (2006)** reported that application of ZnSO₄ at rate of 20 kg/ha. Recorded maximum nodulation in groundnut at most active growth stage of crop i.e. (45DAS).

Dry weight of plant (g)

Application of T9: Gypsum 400 kg/ha + Zinc 4000 ppm. significantly influenced the dry weight in Table 3 shows gypsum and zinc on dry weight per plant at harvest. The Data indicated that, groundnut at 60 DAS. The maximum dry weight (15.00 g) was recorded in T9: Gypsum 400 kg/ha + Zinc 4000 ppm. Were statically at par with T8, T6 and lowest dry weight (12.73 g) was recorded in Farmers practice.

The increase in dry weight due to the application of gypsum, which results in the highest growth of groundnut, highest growth of groundnut might be due to increased availability and uptake of macro and micronutrients and improving soil conditions for water and nutrient supply required for better plant growth and dry matter accumulation **Abhigna et al., (2021)**.

Foliar spraying with zinc encouraged the vegetative growth and increased the plant capacity for building metabolites. Such response may be due to that zinc is known to play 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. Similar results were obtained by **Darwish et al., Tomar et al., Malewar et al., Tripathy et al., and Shankar et al.**

Yield parameters

Number of pods per plant

The information on the number of pods per plant impacted by treatments is reported in a table for in general. The number of pods per plant rose with crop stage progression regardless of treatment and peaked at harvest. Number of pods per plant recorded non-significant difference among the treatments. Gypsum 400 kg/ha + Zinc 4000 ppm. recorded maximum number of pods (25.20/plant) and minimum was recorded in control plot (17.73/plant), respectively.

Number of kernels per pod

Maximum number of kernels per pod (2.20) was recorded in Gypsum 400 kg/ha + Zinc 4000 ppm. However, treatment with Gypsum 400 kg/ha + Zinc 3000 ppm, Gypsum 400 kg/ha + Zinc 2000 ppm, Gypsum 300 kg/ha + Zinc 4000 ppm and Gypsum 300 kg/ha + Zinc 3000 ppm were observed statistically at par with treatment Gypsum 400 kg/ha + Zinc 4000 ppm.

Seed Index

Treatment with Gypsum 400 kg/ha + Zinc 4000 ppm was recorded significantly highest seed index (40.53). However, treatment with Gypsum 400 kg/ha + Zinc 3000 ppm and Gypsum

300 kg/ha + Zinc 4000 ppm were observed statistically at par with treatment Gypsum 400 kg/ha + Zinc 4000 ppm.

The rise in number of pods per plant could be attributed to sulphur's crucial involvement in energy storage and transformation, carbohydrate metabolism and enzyme activation, all of which improves plant's photosynthetic activity (**Ruskar Banu *et al.*, 2017**). The pods/plant significantly increased with the increase in gypsum levels. Higher number of kernels/pod were highest under 400 kg/ha gypsum, followed by 200 kg/ha. Shelling percentage increased with increasing level of gypsum, due to the fact that gypsum appeared at early flowering reduced the number of empty pods. The 100-kernel weight was highest with gypsum 400 kg/ha (**Adhikari *et al.*, 2003**). The results are in cognizance with the findings of **Ismael *et al.* (1999)** and **Ingole *et al.* (1998)**.

Yield

Seed Yield (t/ha):

Treatment with Gypsum 400 kg/ha + Zinc 4000 ppm was recorded significantly highest seed yield (2.89). However, treatment with Gypsum 400 kg/ha + Zinc 3000 ppm and Gypsum 300 kg/ha + Zinc 4000 ppm were observed statistically at par with treatment Gypsum 400 kg/ha + Zinc 4000 ppm.

Haulm yield (t/ha)

Treatment with Gypsum 400 kg/ha + Zinc 4000 ppm was recorded significantly highest haulm yield (4.65). However, treatment with Gypsum 400 kg/ha + Zinc 3000 ppm and Gypsum 300 kg/ha + Zinc 4000 ppm were observed statistically at par with treatment Gypsum 400 kg/ha + Zinc 4000 ppm.

Harvest Index (%)

Treatment with Gypsum 400 kg/ha + Zinc 4000 ppm was recorded significantly highest harvest index (33.49%). However, treatment with Gypsum 400 kg/ha + Zinc 3000 ppm, Gypsum 400 kg/ha + Zinc 2000 ppm, Gypsum 300 kg/ha + Zinc 4000 ppm and Gypsum 300 kg/ha + Zinc 3000 ppm were observed statistically at par with treatment Gypsum 400 kg/ha + Zinc 4000 ppm.

The increase in haulm and kernel yield due to application of gypsum was attributed to concomitant influence of Sulphur released from the gypsum on availability of other nutrients from the soil and their extraction by the plant seems to have provided congenial nutritional environment for the plants. Further, calcium plays an important role in the reproductive

development of the groundnut crop, thereby increased the pod yield (**Sagar et al., 2020**). Application of reduced NPK fertilizers with FYM + 300 kg/ha gypsum resulted to 2521.98 kg/ha seed yield. All gypsum treatments had also positive effect on yield components and 300 kg/ha gypsum with full dose of NPK fertilizers or reduced dose of NPK fertilizers + 10 t/ha FYM were the optimum level for obtaining the higher pod and seed yields of groundnuts (**Seran 2016**). Calcium content both in pod and haulm also increased along with the increase in the level of gypsum. More yield of pod and haulm and higher concentration of Ca with increasing levels of gypsum resulted in higher uptake of this nutrient either by pod and haulm and ultimately the total uptake (**Patro et al., 2016**).

The higher seed yield may be attributed to higher total dry matter accumulation due to better total nitrogen as well as Zn and Fe uptake and their translocation to the reproductive parts and improvement in yield attributing characters like number of pods/plant, pod weight, 100 kernel weight and shelling percentage. The data on haulm yield also differed significantly due to micronutrient application. Soil application of ZnSO₄ at 25 kg/ha + foliar application of ZnSO₄ at 0.5% recorded significantly higher haulm yield (3080 kg/ha) (**Gowthami et al., 2017**). Similar results were also observed by **Meena et al., (2007)**.

Conclusion

On the basis of results obtained in present investigation, it is concluded that the profitable production of groundnut can be secured by Gypsum 400 kg/ha + Zinc 4000 ppm. (T9). These practices may be passed on to the farmers for obtaining higher returns in this agro-climatic zone. It has also recorded the maximum gross return, net return and benefit cost ratio.

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Table 3. Effect of gypsum and zinc on growth attributes of Groundnut

S No.	Treatment combinations	60 DAS		
		Plant Height (cm)	Number of Nodules/plant	Dry weight (g)
1.	Gypsum 200 kg/ha + Zinc 2000 ppm	19.80	75.40	13.20
2.	Gypsum 200 kg/ha + Zinc 3000 ppm	21.87	79.27	13.27
3.	Gypsum 200 kg/ha + Zinc 4000 ppm	20.70	85.27	13.33
4.	Gypsum 300 kg/ha + Zinc 2000 ppm	22.30	89.40	13.40
5.	Gypsum 300 kg/ha + Zinc 3000 ppm	23.30	92.27	13.87
6.	Gypsum 300 kg/ha + Zinc 4000 ppm	23.77	107.00	14.47
7.	Gypsum 400 kg/ha + Zinc 2000 ppm	22.50	92.00	13.60
8.	Gypsum 400 kg/ha + Zinc 3000 ppm	24.07	109.70	14.73
9.	Gypsum 400 kg/ha + Zinc 4000 ppm	24.33	115.73	15.00
10.	Control (20-40-60 kg/ha N-P-K)	19.53	69.73	12.73
F-test		S	S	S
Sem±		0.27	8.62	8.62
C.D.(P=0.05)		0.81	25.62	25.62

Table 4. Effect of Yield and Yield attributes of Groundnut as influenced by gypsum and zinc

S No	Treatment combinations	At Harvest					
		No. of pods/plant	No. of kernels/ pod	Seed Index (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1.	Gypsum 200 kg/ha + Zinc 2000 ppm	19.53	1.87	33.70	2.50	4.36	31.33
2.	Gypsum 200 kg/ha + Zinc 3000 ppm	19.67	1.93	34.30	2.52	4.38	31.49
3.	Gypsum 200 kg/ha + Zinc 4000 ppm	19.60	2.00	34.60	2.57	4.40	31.86
4.	Gypsum 300 kg/ha + Zinc 2000 ppm	20.63	2.07	36.37	2.66	4.44	32.42
5.	Gypsum 300 kg/ha + Zinc 3000 ppm	21.67	2.12	37.47	2.74	4.51	32.83
6.	Gypsum 300 kg/ha + Zinc 4000 ppm	23.87	2.13	39.60	2.82	4.56	33.26
7.	Gypsum 400 kg/ha + Zinc 2000 ppm	20.87	2.07	36.90	2.71	4.48	32.70
8.	Gypsum 400 kg/ha + Zinc 3000 ppm	24.87	2.13	39.80	2.84	4.60	33.36
9.	Gypsum 400 kg/ha + Zinc 4000 ppm	25.20	2.20	40.53	2.95	4.65	33.49
10.	Control (20-40-60 kg/ha N-P-K)	17.73	1.80	30.63	2.1	4.20	30.20
F-test		S	S	S	S	S	S
Sem±		0.51	0.06	0.54	0.06	0.04	0.27
C.D.(P=0.05)		1.53	0.17	1.61	0.18	0.11	0.81