Effect of gypsum and foliar application of zinc on growth and yield of groundnut (*Arachis hypogaea L.*)

Abstract

At the Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Zaid season 2022, a field experiment was carried out. The experiment consisted of 10 distinct treatments using three replications of a Randomized Block Design for the management of Gypsum and Zinc nutrients. Evaluation of the "Effect of gypsum and foliar application of zinc on growth and yield of groundnut (Arachis hypogaea)" was the major goal of the experiment. Gypsum levels were 200, 300, and 400 kg/ha. In contrast, three levels of zinc were applied topically at 2000, 3000, and 4000 ppm. From the current experiment, it can be inferred that Gypsum 400 kg/ha + Zinc 4000 ppm can ensure the profitable production of groundnuts. (T9).

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

Introduction

A significant grain legume and oil seed crop is groundnut (Arachis hypogaea). After China, India is the second-largest producer of groundnuts. The Leguminaceae family member groundnut, often known as "The King of Oilseeds," is the third-most significant source of vegetable protein and the fourth-most significant source of edible oil. The most widely produced oil seed and a significant cash crop in India is groundnut. Being a legume, it helped promote sustainable agriculture and is grown by farmers in both the kharif and the zaid seasons. According to estimates, India's 2019 groundnut planting area would be 41.35 lakh hectares, with a yield of 37.70 lakh tonnes. Groundnut is generally utilised for oil extraction, with an analysis of roughly 46.70%, claims (Satish *et al.* 2011). Because of its high food value, which is again a result of its higher amount of protein (22.0%), carbohydrates (10.0%), and minerals (3.0%), it is also consumed directly.

Poor women and children's dietary needs include groundnuts significantly. Haulm is utilised as animal feed. Mixed glycerides make up groundnut oil, which has a high concentration of the unsaturated fatty acids oleic (50–65%) and linoleic acid (18–30%). Cysteines, an amino acid that is necessary for animal growth, are found in groundnuts. Following oil extraction, groundnut cake is produced, which is high in protein, important organic manure, and animal feed. It also includes 7 to 8% N, 1.5% P, and 1% K. Due to its leguminous nature, groundnut contributes to the preservation of soil fertility. Additionally, because they are protein-rich, they meet a large portion of the nation's protein needs. The introduction of legume crops in high intensity cropping programmes has shown highly encouraging results in enhancing the physical and, to some extent, the chemical qualities of soil. Exhaustive agriculture without legumes in rotation has turned many locations into barn wastelands. It works well as a cover crop for areas at risk of soil erosion.

One of the fundamental requirements for achieving the potential yield is a diet that is balanced. (Yadav *et al.* 2017). Nutrients in the soil are fed by groundnuts. It needs additional calcium, phosphorus, and sulphur because it is a legume crop, which is necessary for effective shell production and filling. In addition to NPK, Sulfur is one of the essential nutrients that is necessary for the metabolism of carbohydrates and the production of chlorophyll, glycosides, lipids, and several other chemicals essential for plant N-fixation and photosynthesis. From a quality and quantity perspective, it is essential to the nourishment of crops.

Most groundnut cultivars that are resistant to various stresses, including salt, drought, and high fertiliser uptake, as well as resistance to a variety of pests and diseases, have been created in recent years. Inadequate plant population and nutrition are some of the issues limiting groundnut pod yield in many regions. Consequently, a healthy plant population is necessary to produce good harvests. One of the key components in the growth and development of plants is nutrition. Being a thorough crop, it takes in a significant amount of nutrients from the soil during various stages of growth. Due to its higher capacity for productivity, groundnut needs a lot of nutrients from the soil at different stages of growth.

Pegs and growing pods absorb calcium and sulfur, and gypsum is the usual source of supplies. For the quantity and quality of the kernels, sufficient calcium must be present in the root and pod zones. Lack of calcium causes empty pods called pops and discoloration of the embryo's plumules. Due to its direct involvement in the biosynthesis of oil, sulphur is a highly necessary element. It enhances Rhizobium nodulation, delays premature leaf fall, and increases pod and oil yield. When it comes to groundnut metabolism, sulphur is crucial. For the synthesis of proteins, it is crucial. In the production of chlorophyll, it is crucial. Sulfur ranks in importance for the synthesis of protein together with nitrogen and phosphorus as one of the secondary essential plant nutrients. By increasing the amount of pegs and pods per plant, the kernel to shell ratio, and other factors, the application of sulphur fertiliser and groundnut has been found to be efficient.

As catalysts, zinc is necessary for several metabolic processes. Additionally, zinc raises the protein, caloric value, amino acid, and fat contents of oilseed crops. Balanced fertilisation aids in raising the produce's quality. Zinc was incorporated into the enzyme system that controls the plant's earliest metabolic processes. In plant cells, zinc catalyses the oxidation process and is essential for the transformation of carbohydrates. It controls sugar consumption and expands the source of energy used to produce chlorophyll. Additionally, zinc supports the production of auxin and protein synthesis.

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 conducted in Prayagraj, India, during the Zaid season 2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS). (U.P.). The experimental field is located at 25.57o N latitude, 87.19o E longitude, 98m above mean sea level, on the left side of the Prayagraj-Rewa Road, about seven kilometres from Prayagraj city and close to the Yamuna River. Prayagraj is located in the subtropical region of Uttar Pradesh, which experiences hot summers and pleasant winters. The region's usual temperature ranges were 20.13 to 41.830 degrees Celsius in June, 21.80 to 43.470 degrees Celsius in April, 22.40 to 39.170 degrees Celsius in May, and 22.97 to 36.830 degrees Celsius in the month of July. For the groundnut crop, temperatures ranging from 24.60 to 34.600C in the month of August and 24.60 to 34.600C in the month of July were noted. There is a difference in relative humidity between 79.11% and 37.60%. The average monthly rainfall in this location is 3.42 mm in June, while there were no wet days in either July or August. The results of the soil chemistry examination showed that the soil had a sandy loam texture, a pH of 7.20, low levels of organic carbon (0.72 percent) and potassium (233.24 kg/ha), and low levels of phosphorus that was readily available (27.80 kg/ha). The soil exhibited a conductivity of 0.187 dS/m and was electrically conductive. Three replications were used for each of the ten treatment combinations. Tables 1 and 2, respectively, contain information about the therapies and various treatment combinations. According to the treatment combinations, zinc was applied foliarly and gypsum levels remained constant. Growth parameters at 60 DAS, including Plant height (cm), Number of nodules per plant, dry weight, and yield parameters at harvest, including Number of pods per plant, Number of kernels per pod, Seed index, Seed yield, and Haulm yield, were all successfully measured. To determine the best treatment combination for groundnut cultivation, an economic analysis of each treatment was carried out.

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)

Result and Discussion

Growth parameters Plant height (cm)

Gypsum and zinc on plant height at 60 DAS are shown in Table 3. The data showed that during the crop growing period, there was a considerable impact on plant height. The plant height in groundnut at 60 DAS was considerably influenced by the application of T9- Gypsum 400 kg/ha + Zinc 4000 ppm. The greatest plant height (24.33 cm) was recorded in the T9- Gypsum 400 kg/ha + Zinc 4000 treatment, which was statistically comparable to the T8,T6 treatment, while the minimum plant height (14.33 cm) was recorded in the application of the T10: Control treatment. (RDF). Gypsum dosage increased from 0 to 400 kg/ha, resulting in an increase in plant height. (Adhikari *et al.,* 2003). This could be explained by more effective plant growth caused by the plant's efficient use of the soil resources where the primary development material was available in adequate amounts (Kalaiyarasan *et al.,* 2003).

Zinc foliar spraying promoted vegetative development and enhanced the plant's ability to produce metabolites. This reaction could be caused by zinc, which is known to play a role in activating a number of enzymes in plants and is directly engaged in the manufacturing of growth factors like auxin, which results in the production of more plant cells and dry matter. Darwish *et al.,* Tomar *et al.,* Malewar *et al.,* Tripathy *et al.,* and Shankar *et al.* all came to similar conclusions.

Number of nodules per plant

The number of nodules per plant was dramatically influenced by the application of T9: Gypsum 400 kg/ha + Zinc 4000 ppm. Gypsum and zinc are shown on the amount of nodules per plant at 60 DAS in Table 3. The data showed that for groundnut at 60 DAS, the highest number of nodules per plant (115.73) was found in T9: Gypsum 400 kg/ha + Zinc 4000 ppm, which was statistically comparable to T8, T7, T6, and T5, and the lowest number of nodules per plant (69.73) was found in Farmers practise. (T10).

The intake of large amounts of nutrients over the course of Ca and S's glowing increased root system and nodules' valorous brag resulted in plant development as well as straw yield at maturity (Mandal *et al.,* 2005).

These may be related to the involvement of Zn and Mo in enzyme activities as they are crucial components of the "nitrogenase" N2 fixing enzymes complex that cause an increase in leg hemoglobin, which in turn increases nodulation and N-fixation. (Radhika *et al.* 2021) According to Bagal (2006), ZnSO4 was applied at a rate of 20 kg/ha. Maximum nodulation in groundnuts was seen at the crop's most active growth stage, i.e. (45DAS).

Dry weight of plant (g)

Gypsum 400 kg/ha plus 4000 ppm zinc is how T9 is applied. Gypsum and zinc have a considerable impact on the dry weight per plant at harvest, as seen in Table 3. According to the data, groundnut was at 60 DAS. T9: Gypsum 400 kg/ha + Zinc 4000 ppm recorded the highest dry weight (15.00 g). Were statically comparable to T8, T6, and Farmers practise had the lowest dry weight (12.73 g).

The higher growth of groundnuts observed following the application of gypsum may be attributable to increased availability and uptake of macro and micronutrients as well as improved soil conditions for the water and nutrient supply necessary for better plant growth and dry matter accumulation. Abhigna *et al.,* (2021).

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Yield parameters

Number of pods per plant

A table summarises the data on the total number of pods per plant affected by treatments. Regardless of treatment, the number of pods per plant increased as the crop progressed through the stages and peaked at harvest. Non-significant differences were found in the number of pods per plant for each treatment. Gypsum 400 kg/ha + Zinc 4000 ppm recorded the highest number of pods (25.20/plant), whereas the lowest number (17.73/plant) was recorded in the control plot.

Number of kernels per pod

Gypsum 400 kg/ha + Zinc 4000 ppm had the highest number of kernels per pod (2.20). 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 treatments, on the other hand, were statistically comparable to Gypsum 400 kg/ha + Zinc 4000 ppm treatment.

Seed Index

Gypsum 400 kg/ha plus 4000 ppm of zinc treatment resulted in significantly higher seed index. (40.53). Gypsum 400 kg/ha + Zinc 3000 ppm and Gypsum 300 kg/ha + Zinc 4000 ppm treatments, on the other hand, were statistically comparable to Gypsum 400 kg/ha + Zinc 4000 ppm treatment.

Sulphur's critical role in energy storage and transformation, carbohydrate metabolism, and enzyme activation, all of which promote plant photosynthetic activity, could be the cause of the increase in pods per plant. (Ruskar Banu *et al.,* 2017). With an increase in gypsum levels, the plant's pod production surged dramatically. Under 400 kg/ha of gypsum, the largest number of kernels/pod was found, followed by 200 kg/ha. Gypsum levels increased with shelling % because gypsum emerged at an earlier stage of flowering, which decreased the quantity of empty pods. Gypsum 400 kg/ha had the highest 100-kernel weight. (Adhikari *et al.,* 2003). The outcomes are consistent with Ismael *et al.* (1999) and Ingole *et al.* (1998).

Yield

Seed Yield (t/ha):

The maximum seed yield was notably achieved when Gypsum 400 kg/ha plus Zinc 4000 ppm was used as a treatment. (2.89). Gypsum 400 kg/ha + Zinc 3000 ppm and Gypsum 300 kg/ha + Zinc 4000 ppm treatments, on the other hand, were statistically comparable to Gypsum 400 kg/ha + Zinc 4000 ppm treatment.

Haulm yield (t/ha)

The treatment with the maximum haulm yield was with gypsum 400 kg/ha + zinc 4000 ppm. (4.65). Gypsum 400 kg/ha + Zinc 3000 ppm and Gypsum 300 kg/ha + Zinc 4000 ppm treatments, on the other hand, were statistically comparable to Gypsum 400 kg/ha + Zinc 4000 ppm treatment.

Harvest Index (%)

Treatment with Gypsum 400 kg/ha + Zinc 4000 ppm resulted in the harvest index reaching its greatest level (33.49%). 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 treatments, on the other hand, were statistically comparable to Gypsum 400 kg/ha + Zinc 4000 ppm treatment.

The concurrent influence of Sulphur released from the gypsum on the availability of other nutrients from the soil and their uptake by the plant seems to have produced congenial nutritional environment for the plants, as evidenced by the increase in haulm and kernel yield as a result of the application of gypsum. Additionally, calcium is crucial for the reproductive system growth of the groundnut crop led to a rise in pod production. (Sagar *et al.,* 2020). Gypsum application of 300 kg/ha along with FYM and lowered NPK fertilisers led to a 2521.98 kg/ha seed yield. The best level for generating better pod and seed yields of groundnuts was 300 kg/ha gypsum with full dosage of NPK fertilisers or decreased dose of NPK fertilisers plus 10 t/ha FYM. All gypsum treatments also had favourable effects on yield components. (Seran 2016). Along with the rise in gypsum levels, the calcium content of both the pod and the haulm also rose. Greater uptake of this nutrient by pod and haulm, and eventually the overall uptake, was caused by increased yield of pod and haulm and greater concentration of Ca with rising levels of gypsum. (Patro *et al.,* 2016).

The better total nitrogen uptake, Zn and Fe uptake and their translocation to the reproductive parts, as well as improvements in yield attributing characters like number of pods/plant, pod weight, 100 kernel weight, and shelling percentage, may be responsible for the higher seed yield. Due to the application of micronutrients, the information on haulm yield also varied greatly. Significantly higher haulm production (3080 kg/ha) was obtained with soil applications of ZnSO4 at 25 kg/ha and foliar applications of ZnSO4 at 0.5%. (Gowthami *et al.,* 2017). Meena *et al.* also noted comparable outcomes. (2007).

Conclusion

Based on the findings of the investigation, it has been determined that Gypsum 400 kg/ha + Zinc 4000 ppm can ensure the economic production of groundnuts. (T9). These techniques could be taught to farmers to help them increase their yields in this agroclimatic region. Additionally, the greatest gross return, net return, and benefit cost ratio have been documented.

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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