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

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Abstract

Groundnut scientifically known as *Arachis hypogea*, is one of the important oilseed crop. It is famous for its importance in agriculture and industrial sector. Utilization of inorganic fertilizers decreases the fertility of soil and also causes loss in yield of groundnut crop. The application of organic and inorganic fertilizers somehow maintains fertility and provides profitable yield to groundnut crop. The present review aim is to collect the data published related to application of gypsum and zinc on groundnut crop and evaluated their effect on the basis of growth and yield attributes. The composition of gypsum is 18.6% sulfur and 23.3% calcium. By improving water penetration and reducing crusting, gypsum encourages the production and filling up of pods, which is known for its effective pegging. Zinc raises the protein, calorie, amino acid, and fat content of oilseed crops and is necessary as a catalyst for several metabolic processes. Hence, the usage of gypsum and zinc on groundnut crop enhances the growth, yield and quality attributes of groundnut.

Keywords: Application, groundnut, gypsum, foliar, yield, zinc

Introduction

Groundnuts, often known as peanuts, are usually referred to as poor men's nuts. This plant is indigenous to South America and has never been discovered uncultivated. Groundnut's scientific name, *Arachis hypogea* linn., is derived from two Greek words: arachis, which means legume, and hypogea, which means below ground, alluding to pod production in the soil (Kalpana *et al.*, 2024) [8]. Groundnut is a prostrate or uprooted annual plant. It is commonly found in the tropical, subtropical, and warm temperate zones. Ethnological study of the major Indian tribes of South America. The groundnut was brought to Asia and Africa by later traders, and it is currently grown between latitudes 400 north and south (Shokri *et al.*, 2024; Kadirimangalam *et al.*, 2024) [22, 7]. The main use of groundnuts is to extract oil, which has an analysis of around 46.70%. Because of its high food value which is again a result of its greater protein (22.0%), carbohydrate (10.0%), and mineral (3.0%) contents it is also directly consumed. Haulm is utilized as fodder for animals (Kadirimangalam *et al.*, 2024) [7]. With 25–30% protein, it is also the third most significant source of vegetable protein. Groundnuts are grown on 295 lakh hectares worldwide, yielding 487 lakh tons of product with a productivity of 1647 kg per hectare (Kumar *et al.*, 2023) [10]. About 15% of the world's peanuts are produced in India, which leads the globe in groundnut acreage and is the world's second-largest producer with 101 lakh tons and a productivity of 1816 kg per hectare in 2020–21. Thirty percent of the nation's total oilseed production comes from groundnuts (Dhumgond *et al.*, 2022) [4]. Gujarat is the top groundnut producer in India, accounting for 33% of total output, while Uttar Pradesh comes in at number ten with 0.89%. Because groundnuts have symbiotic nitrogen-fixing bacteria in their root nodules, they can fix atmospheric nitrogen, reducing the need for fertilizers that contain nitrogen. They also increase the amount of nitrogen in the soil, which makes them a beneficial crop rotation plant (Reddy and Debbarma, 2023) [20]. Nowadays, the country's population is growing and using more chemical fertilizer. In addition to the fact that using inorganic fertilizer alone is harmful to soil and environmental health, the expense of chemical fertilizer has been steadily rising at the same time (Kumar *et al.*, 2023; Aruna *et al.*, 2022) [10, 1]. Therefore, using both organic and inorganic fertilizers together increases crop yields and maintains soil fertility. Despite being a legume that can fix nitrogen from the atmosphere, groundnuts are quite sensitive

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to fertilizer treatment. A greater nitrogen dosage may result in fewer nodules and slower nodule formation, which would negatively impact the nitrogen fixation capability (Brar and Manhas, 2023) ^[2]. Around the world, groundnuts rely on gypsum as a supply of calcium and sulfur. Gypsum is composed of 23.3% calcium and 18.6% sulfur. In groundnuts, gypsum promotes the formation and filling up of pods by increasing water penetration and decreasing crusting, which is recognized for its efficient pegging (Ullah *et al.*, 2019) ^[25]. In order to increase peanut productivity and production, calcium and sulfur are also crucial. Apart from supplying calcium and sulfur, gypsum is an important component in alkaline soil restoration (Reddy and Debbarma, 2023) ^[20].

In the United States, gypsum was one of the first types of fertilizer. It has been used for almost 250 years on agricultural soils. Gypsum is a fairly soluble source of sulfur and calcium, two vital plant nutrients that can enhance overall plant development. Calcium and sulfur, two vital plant nutrients, are soluble in gypsum, which can enhance plant development in general (Dhumgond *et al.*, 2022) ^[4]. Certain soils' physical characteristics, particularly those of heavy clay soils, can also be enhanced by gypsum additions. These supplements boost the rate of water penetration and flow through the soil profile, encourage soil aggregation, inhibit soil particle dispersion, decrease the formation of surface crust, and encourage seedling emergence (Brar and Manhas, 2023; Sagar *et al.*, 2020) ^[2, 21]. Additionally, it can lower soluble phosphorus concentrations in surface water runoff and minimize soil and nutrient erosion losses. Gypsum application improves chemical qualities such as reducing aluminum toxicity and subsurface acidity. In times of drought, this improves deep roots and the plants' capacity to absorb sufficient amounts of water and nutrients (Laxmanarayanan *et al.*, 2020) ^[11]. Gypsum, in addition to delivering calcium and sulphur, plays an important function in alkaline soil reclamation. The oil and protein content of groundnut kernels rose considerably after gypsum treatment. Groundnut plants have a high calcium need that rises throughout the pod filling stage (Ngulube *et al.*, 2018) ^[14]. Groundnuts have an extraordinary capacity to absorb calcium and sulphur through the formation of pegs and pods. The use of gypsum considerably raised the groundnut kernel's oil and protein content. Throughout the pod-filling stage, groundnut plants' high calcium requirements grow. Because groundnuts developed pegs and pods, they had the unique capacity to absorb calcium and sulphur (Prakash *et al.*, 2020) ^[16]. Growth of roots and nodules is facilitated by boron, which also acts as a regulator for other chemicals and directly aids in nitrogen fixation in plant tissues. When soils and groundnut plants lack boron, hollow hearts are produced, which lowers kernel quality and yield (Reddy and Debbarma, 2023) ^[20]. By improving soil structure, gypsum application promotes improved pod development and filling up of groundnut pods, increases water permission, and decreases crusting, all of which are favorable for efficient pegging (Ullah *et al.*, 2019) ^[25].

Zinc is required for a number of metabolic activities as a catalyst. Furthermore, zinc increases the oilseed crops' protein, calorie, amino acid, and fat levels. Raising the quality of the produce is facilitated by balanced fertilization. The enzyme system that governs the plant's initial metabolic activities was modified to include zinc (Brar and Manhas, 2023; Sagar *et al.*, 2020) ^[2, 21]. Zinc is necessary for the conversion of carbohydrates and catalyzes the oxidation process in plant cells. It increases the source of energy utilized to make chlorophyll and regulates the intake of sugar. Furthermore, zinc facilitates the synthesis of

proteins and auxin (Laxmanarayanan *et al.*, 2020) ^[11]. The present review focuses on the effect of gypsum and zinc on growth and yield of groundnut.

Origin and distribution of groundnut

South America is where the cultivated peanut, also known as groundnut (*Arachis hypogaea* L.), first appeared. The Greek words "arachos" (weed) and "hypogaea" (underground chamber) are the origins of the phrase *Arachis*. In botanical terms, this means a weed that bears fruit below the soil's surface (Krapovickas, 2017) ^[9]. This crop is most commonly referred to as either peanut or groundnut. Most nations in Asia, Africa, Europe, and Australia use the name "groundnut," while in North and South America, it's more usually called "peanut." Groundnut refers to the pods with seeds that mature underground; peanut is associated with this crop since it is a member of the *leguminous* family, which also includes peas and beans (Rami *et al.*, 2014) ^[17]. The global groundnut (in shell) harvested area in 2007 was 23.4 million hectares, with a total yield of 34.9 million metric tons. The overall harvested area in 2007 grew by 3.7 million ha over 1990, while output climbed by 11.7 million Mt. In 2007, the world's average production was around 1490 kg/ha (Mothilal, 2012) ^[13]. It is grown in as many as 90 countries. Groundnuts are therefore a worldwide oilseed crop. It is a legume crop unrelated to other nuts (such as walnuts, hazelnuts, and cashews). The word "nut" refers to the peculiar growth habit in which flowers appear above ground (soil), then following fertilization, the gynoecium enters the earth and forms pods containing seeds (kernels) (Rami *et al.*, 2014; Mothilal, 2012) ^[17, 13]. The name groundnut will be used in this publication since it is more widely accepted. The earliest archeological evidence of groundnut farming are from Peru, dating back 3750-3900 years. By the time Europeans arrived in South and Central America, groundnuts had been widely distributed, most likely by the Arawak Indians (Rani *et al.*, 2024) ^[19]. Archaeological evidence from Mexico dating back to 1300-2200 BP supports their existence. Groundnuts spread globally following European contact. The Peruvian runner type has spread to the Western Pacific, China, Southeast Asia, and Madagascar (Tadesse and Nepir, 2024) ^[23]. The Virginia type was most likely brought to Mexico by the Spanish via the Philippines in the sixteenth century. The Portuguese subsequently transported it to Africa and, eventually, to India via Brazil. Virginia kinds appear to have arrived in the Southeast United States via the slave trade (Ibrahim *et al.*, 2024) ^[6]. Rami *et al.* (2014) ^[17] found significant secondary diversity in Africa and Asia. The varieties they discovered and their locations supported the various dispersion hypotheses.

Application of groundnut

Groundnuts are an important subsistence food crop in the tropics. It is farmed primarily for the kernels, edible oil and meal obtained from them, and vegetative debris. Groundnut kernels generally include 47-53% oil and 25-36% protein, as well as 10-15% carbohydrate and a high P content; they are also high in vitamins B and E (Duc *et al.*, 2019) ^[5]. Groundnuts are utilized in a variety of ways, including groundnut oil, roasted and salted groundnuts, boiling or raw groundnuts, and a paste known as groundnut (or peanut butter). In certain regions of West Africa, the fragile leaves are cooked as a vegetable in soup (Veeramani and Subrahmaniyan, 2011) ^[26]. The most valuable byproduct of the crop, groundnut oil finds application in both residential and industrial settings. Approximately 75% of the groundnuts produced worldwide are used to extract edible oil. In India,

groundnut oil is the most affordable and widely used vegetable oil (Lenin *et al.*, 2010) ^[12]. It is mostly utilized for cooking, salads, deep-frying, margarine, vegetable ghee, shortening bread and pastries, medicinal and cosmetic items, lubricating and emulsifying pesticides, and powering diesel engines. The press cake, which contains 40-50% protein, is used primarily as a high-protein animal feed and fertilizer (Tarfa *et al.*, 2017) ^[24]. The dried pericarp of mature pods (also known as shells or husks) is used for fuel, soil conditioner, filler in fertilizers and feeds, or as a substitute for cork or hardboard in composting with lignin degrading bacteria (Der *et al.*, 2015) ^[3]. The crop's leaves can also be used as silage or fodder. With the recent emphasis on bioenergy, the possibility of utilizing groundnut as a biodiesel crop is being investigated, as groundnut produces more oil per hectare than any other food crop (Vishwakarma *et al.*, 2012) ^[27].

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

For the growth attributes Kalpana *et al.* (2024) ^[8] evaluated the effect of gypsum and micronutrients on growth attributes of groundnut crop. The gypsum applied at 3 levels (200, 250, 300 kg/ha) and micronutrients (boron, molybdenum, zinc) at 3 levels (1, 2.5, 5 kg/ha). The highest plant height (59.40 cm), dry weight (45.47 g) and no. of nodules/plant (17.00) was reported by treatment T7. The application of T7 treatment at gypsum at 300 kg/ha and zinc at 5 kg/ha recorded significant growth attributes. Shokri *et al.* (2024) ^[22] determined the growth of groundnut crop by the effect of gypsum and zinc at varying levels in Iran. The gypsum was applied at 4 levels (0, 10, 20 and 30 g/m²) and Zn at 3 levels (0, 1 and 2 g/l) as foliar application. The results revealed that interaction of gypsum and zinc provide significant growth to groundnut crop. The highest plant height (25.67 cm) was revealed by groundnut crop. The highest yield and quality was revealed by treatment gypsum 20 and zinc 1 level in groundnut crop. Kumar *et al.* (2023) ^[10] conducted the study to determine the influence of gypsum and zinc on groundnut crop. The gypsum levels (200, 300 and 400 kg/ha) and zinc levels (2000, 3000 and 4000 ppm) was utilized on ten treatments. The results highlighted that the T9 treatment with gypsum 400 kg/ha and zinc 4000 ppm ensure the best growth and profitable production for groundnut crop. The highest plant height was 24.33 cm, no. of nodules per plant 115.73 and dry weight 15 g for the T9 treatment for groundnut crop. Dhumgond *et al.* (2022) ^[4] evaluated the field experiment for the influence of yellow gypsum on growth and yield of groundnut crop. The results revealed that out of ten treatments control treatment had low value for growth and yield attributes. The treatment T9 with gypsum 200 kg/ha and zinc 2000 ppm indicated highest values for growth parameters.

Sagar *et al.* (2020) ^[21] found the effect of gypsum and zinc on the growth of groundnut crop. Total 9 treatments were utilized with zinc at 3 levels (0.25, 0.5, 0.75%) and gypsum at 3 levels (300, 400, 500 kg/ha) on groundnut crop. The treatment T9 with 0.75% zinc and gypsum 500 kg/ha had highest growth attributes. The highest plant height (58.33 cm), no. of nodules/plant (106.88) and dry weight (39.3 g) was reported by treatment T9 in groundnut crop. Ullah *et al.* (2019) ^[25] evaluated the effect of gypsum application on groundnut growth. The gypsum was applied 5 different levels including 0, 25, 50, 75 and 100%. The ground nut plant's root length varied greatly depending on the gypsum treatment; the longest root length was seen with a 50% gypsum requirement application. In terms of shoot length, 25%, 50%, and 75% gypsum application exhibited statistically

comparable results, although gypsum application demonstrated superior shoot length compared to no gypsum. Yadav *et al.* (2015) ^[28] studied the effect of gypsum and RDF on groundnut crop. The gypsum (0, 100, 200, 300 and 400 kg/ha) and NPK (25:50:20 kg/ha) at varying amount with 4 treatments and 3 replications was utilized on groundnut crop. The results revealed that gypsum and RDF levels have significant effect on growth attributes of groundnut crop. The highest plant height (23.16 cm), no. of branches/plant (9.80), no. of nodules (122), fresh weight (37.88 q/ha) and dry weight of pods (26.10 q/ha) was reported by T2 treatment. The application of gypsum at 200 kg/ha was best for growth attributes of groundnut crop.

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

Gypsum and foliar application of zinc improves the yield attributes including pod yield, test weight, stover yield, biological yield and harvest index. Figure 1. Represented the growth and yield improvement of groundnut by gypsum and foliar application of zinc. Kalpana *et al.* (2024) ^[8] determined the effect of gypsum and micronutrients on yield attributes of groundnut crop. The gypsum applied at 3 levels (200, 250, 300 kg/ha) and micronutrients (boron, molybdenum, zinc) at 3 levels (1, 2.5, 5 kg/ha). The treatment T7 with 300 kg/ha gypsum and 5 kg/ha zinc had highest number of pods/plant (17.00), number of kernels/pod (1.87), seed yield (2.75 t/ha), haulm yield (3.72 t/ha). Shokri *et al.* (2024) ^[22] determined the yield attributes of groundnut crop by the effect of gypsum and zinc at varying levels in Iran. The gypsum was applied at 4 levels (0, 10, 20 and 30 g/m²) and Zn at 3 levels (0, 1 and 2 g/l) as foliar application. The results revealed that interaction of gypsum and zinc provide significant yield to groundnut crop. Nikitha *et al.* (2023) ^[15] evaluated the effect of zinc and phosphorus application on yield attributes of groundnut crop. Total ten treatments were utilized which consists of 3 different levels of phosphorus (40, 50, 60 kg/ha) and zinc (0.5, 1g, 2 g/L) as a foliar spray. The results revealed that the application of 60 kg/ha of phosphorus and 2 g/L of zinc was recorded significantly higher seeds/pod (2.37), test weight (38.00 g), seed yield (3.80 t/ha), seed yield (2.74 t/ha) and haulm yield (4.87 t/ha). Kumar *et al.* (2023) indicated the influence of gypsum and zinc on groundnut crop yield attributes. The gypsum levels (200, 300 and 400 kg/ha) and zinc levels (2000, 3000 and 4000 ppm) was utilized on ten treatments. The results highlighted that the T9 treatment with gypsum 400 kg/ha and zinc 4000 ppm ensure the profitable production for groundnut crop. Dhumgond *et al.* (2022) ^[4] evaluated the field experiment for the influence of yellow gypsum on yield of groundnut crop. The results revealed that out of ten treatments control treatment had low value for yield attributes. The treatment T9 with gypsum 200 kg/ha and zinc 2000 ppm indicated highest values for yield parameters. Ramya *et al.* (2022) ^[18] investigated the effect of gypsum and boron application on yield attributes of groundnut crop. Total ten treatments composed of three different levels of gypsum 200, 300, 400 kg/ha and three boron levels 5, 10, 15 kg/ha. The results highlighted that application of 400 kg/ha gypsum with 10 kg/ha boron reported with highest seed yield (2674.17 kg/ha), no. of pods (31.36), haulm yield (3345.13 kg/ha) and harvest index (44.43%). The use of gypsum recorded in improved plant growth and yield indices, as well as improved groundnut crop economics.

Ullah *et al.* (2019) ^[25] studied the effect of gypsum application on groundnut yield attributes. The gypsum was applied 5 different levels including 0, 25, 50, 75 and 100%. The ground

nut plant's root length varied greatly depending on the gypsum treatment; the highest seed yield was seen with a 50% gypsum requirement application. In terms of test weight, biological yield and harvest index 25%, 50%, and 75% gypsum application exhibited statistically comparable results, although gypsum application demonstrated superior yield attributes for groundnut crop. Sagar *et al.* (2020) ^[21] found the effect of gypsum and phosphorus treatments on yield attributes of groundnut crop. Total 9 treatments were utilized with zinc at 3 levels (0.25, 0.5, 0.75%) and gypsum at 3 levels (300, 400, 500 kg/ha) on groundnut crop. The treatment T9 with 0.75% zinc and gypsum

500 kg/ha had highest yield attributes. Yield attributes including number of pods/plant and kernel yield was recorded with T9 treatment. Yadav *et al.* (2015) ^[28] studied the effect gypsum and NPK on yield attributes of groundnut crop. The gypsum (0, 100, 200, 300 and 400 kg/ha) and NPK (25:50:20 kg/ha) at varying amount with 4 treatments and 3 replications was utilized on groundnut crop. The highest fresh weight of pod and dry weight (pod yield) (37.88 and 26.10 q/ha) and straw yield (37.97 q/ha) were found by the application of NPK-25:50:20 kg/ha + gypsum 200 kg/ha.

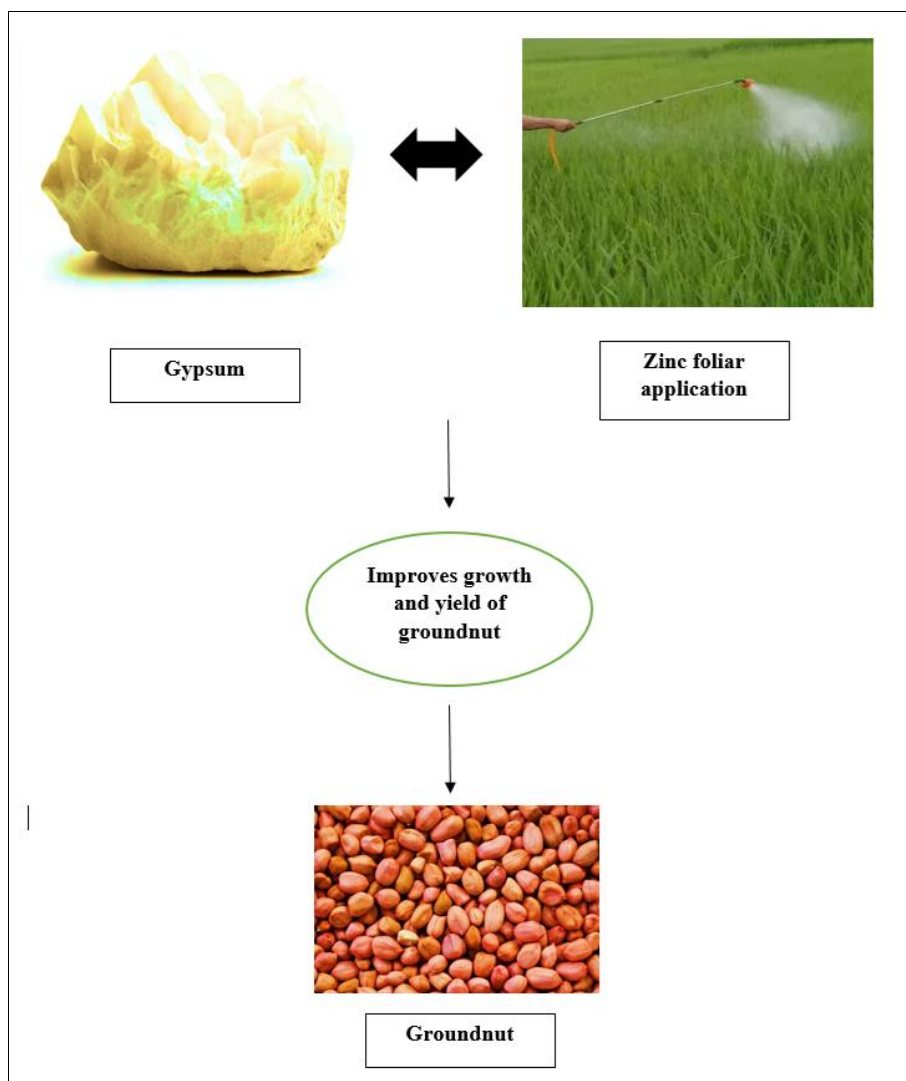


Fig 1: Pictorial representation of growth and yield improvement of groundnut by gypsum and foliar application of zinc

Conclusion

Groundnut being an important crop required potential growth and yield improvement. The utilization of different organic and inorganic fertilizers improved the production of groundnut crop. The application of gypsum with zinc is a cost-effective and potential source for alleviating the nutrient deficiencies in soils and a better alternative for reducing the consumption of chemical fertilizers. Also, gypsum and zinc improve the growth factors in groundnut and provides good profitability in production.

These applications (gypsum and zinc) could be taught to farmers to help them increase their yields and additionally enhances the greatest gross return, net return, and benefit cost ratio of crop.

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Statements and Declarations

Ethical Approval

- The manuscript is categorized as an "original review paper."
- It is an original work and has not been submitted to any other journal for publication.
- All authors have reviewed and approved the manuscript and are aware of its submission to the journal of Bulletin of the National Research Centre.

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Data Availability

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Declaration of Competing Interest

The authors declare no conflicts of interest.

Credit Authorship Contribution Statement

- **Antrix Parmar:** Data curation, formal analysis, methodology, writing – original draft, writing – review and editing, writing – review and editing
- **Mayur S. Darvhankar:** Conceptualization, supervision, validation, visualization, writing – review and editing.
- **Prashant Thakur:** Formal analysis, writing – review and editing.

Consent for Publication

The authors confirm that all necessary permissions for publication have been obtained.

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