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Effect of gypsum and boron on growth and yield of groundnut [*Arachis hypogaea* L.]

Pasala Ramya and Rajesh Singh

Abstract
A Field experiment was conducted during *Kharif* season 2021, at Crop Research Farm, Department of Agronomy, SHUATS Prayagraj (U.P.) on sandy loam soil with neutral soil reaction to evaluate the effect of gypsum and boron on growth and yield of groundnut. The treatments Consists of three levels of Gypsum at 200 kg/ha, 300 kg/ha, 400 kg/ha, and three levels of boron *viz.*, 5 kg/ha, 10 kg/ha, 15 kg/ha as a soil application, whose effect was observed on groundnut. The experiment was laid out in Randomized Block Design. There were nine treatments each replicated thrice. From the results, it was observed that the growth parameters *viz.,* plant height (64.67 cm), dry weight (42.29 g/plant), number of nodules per plant (38.71), crop growth rate (12.18g/m^2/day) were recorded highest in the treatment 8 with the application of 400 kg/ha gypsum + boron 10 kg/ha. Whereas, relative growth rate (0.0150 g/g/day) recorded maximum with application of 400 kg/ha gypsum and 5 kg/ha boron. The yield parameters and yield *viz.,* No. of pods per plant (31.36), shelling percentage (71.65%), Seed yield (2674.17 kg/ha), Haulm yield (3345.13 kg/ha), harvest index (44.43%) were also recorded highest with the treatment of gypsum at 400 kg/ha and boron 10 kg/ha.

Keywords: Gypsum, boron, growth, yield, groundnut

Introduction
Groundnut (*Arachis hypogaea* L.) is an unpredictable legume is also known as earthnut, peanut, monkey nut. Groundnut is an important source of edible oil and is referred to as "King of Oilseeds" due to its high oil content (45-50%). It is also the third most important source of vegetable protein (25-30% protein). Globally groundnut covers 295 lakh hectares with the production of 487 lakh tonnes with the productivity of 1647 kg per hectare (FAOSTAT, 2019) [7]. India ranks first in groundnut acreage and is the second-largest producer of groundnut in the world with 101 lakh tonnes with a productivity of 1816 kg per hectare in 2020-21 (agricoop.nic.in), producing about 15% of the world's peanut. Groundnut contributes 30% of the total oilseeds production in the country (Annual Report 2020-21) [2]. Among India, Gujarat is the leading producer of groundnut with a share of 33% and Uttar Pradesh ranks 10th in groundnut production (0.89%). Groundnut can fix atmospheric nitrogen through symbiotic nitrogen-fixing bacteria in root nodules thus it requires less nitrogen-containing fertilizers, it also improves nitrogen content in the soil which make this plant valuable in crop rotation (Haneena *et al.,* 2021) [9]. Gypsum is widely used as a source of calcium and sulphur for groundnut worldwide. Gypsum contains 18.6% sulphur and 23.3% calcium. Gypsum enhances soil structure by improving water penetration and reducing crusting, which is known for its effective pegging and supports the creation and filling up of pods in groundnut. Calcium and sulphur also plays an important role in enhancing production and productivity of groundnut (Ramjeet yadav *et al.* 2015) [15]. Apart from providing calcium and sulphur, gypsum plays a significant role in the reclamation of alkaline soil. Oil and protein content of groundnut kernel increased significantly under gypsum application (Rao *et al.,* 2001) [16]. Groundnut plants have a high calcium need, which increases throughout the pod filling stage. Groundnut possessed the unusual ability to absorb calcium and suphur through the development of pegs and pods. Boron aids in the growth of root and nodules, which directly helps in nitrogen fixation in plant tissues while also functioning as a regulator for other substances. Boron shortage in soils and groundnut plants causes the production of hollow hearts, which results in poor kernel quality and yield. Boron is involved in the transformation of sugar and starch formation and it also influences cell development, cell elongation and also involved in the synthesis of protein. (Naiknaware *et al.,* 2015) [13].

Most of the light-textured soils of India where groundnut is grown are deficient in boron and there is a good response for boron application in these soils (Ansari *et al.*, 2013) [3]. The positive role of boron in quality improvement through its improvement in the synthesis of proteins and amino acids, further increases the pod yield of groundnut (Chitdeshwari and Poogothai 2003) [5]. Boron is engaged in plant nitrogen fixation, which has improved soil nitrogen content.

Materials and Methods

The Experiment was carried out during the *Kharif* season 2021, at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj(U.P), which is situated at 25.75^0 N latitude, 87.19^0 E longitude and 98 m altitude above the mean sea level the soil type of the experimental field is sandy loam, which is low in organic carbon (0.52%) and medium in available Nitrogen (276 kg/ha), phosphorous (13.5kg/ha), potassium (215 kg/ha). The experiment was laid out in Randomized Block Design. There were nine treatments each replicated thrice. The treatments comprised of three levels of gypsum and three levels of boron T_1- 200 kg/ha gypsum + 5 kg/ha Boron, T_2- 200 kg/ha gypsum + 10 kg/ha Boron, T_3- 200 kg/ha gypsum + 15 kg/ha Boron, T_4- 300 kg/ha gypsum + 5 kg/ha Boron, T_5- 300 kg/ha gypsum + 10 kg/ha Boron, T_6- 300 kg/ha gypsum + 15 kg/ha Boron, T_7- 400 kg/ha gypsum + 5 kg/ha Boron, T_8- 400 kg/ha gypsum + 10 kg/ha Boron, T_9- 400 kg/ha gypsum + 15 kg/ha Boron. Gypsum and boron were applied through the soil, At 35 days after sowing the plants were given a side dressing of gypsum. Kadiri-6 variety of groundnut was planted in the last week of July. The crop was grown by providing timely protection measures for pests and diseases and package of practices. At regular intervals, observations were taken from five randomly selected plants on each plot in each replication. The statistical analysis was carried out at a probability level of 5% for significant results.

Results and Discussion

Growth parameters

Observations regarding the Growth Parameters of groundnut were given in table (1) which shows the impact of gypsum and boron.

Plant height

Plant height was significantly increased from 15 DAS to 90 DAS. Plant Height at 90 DAS varied from 59.96 cm to 64.67 cm, the maximum plant height (64.47 cm) was recorded at 90 DAS with the application of 400 kg/ha gypsum and 10 kg/ha boron which is significantly higher over rest of all the treatment combinations except with application of 300 kg/ha gypsum + 10 kg/ha boron (64.0 cm) and 300 kg/ha gypsum + 15 kg/ha boron (63.59 cm). The increase in plant height might be due to the increased supply of sulphur through gypsum and associated nutrients might have helped in rapid cell multiplication and higher chlorophyll content, thereby accelerating photosynthesis rate and activity and eventually more supply of assimilates to plants that in turn increased the growth in terms of a greater canopy, plant height at the successive growth stages. The results conform with Nagesh Yadav *et al.*, (2018) [12].

Number of nodules per plant

At 90 DAS Significantly higher number of nodules per plant (38.71) was observed with the soil application of 400 kg/ha gypsum along with 10 kg/ha boron, However the treatment with application of 300 kg/ha gypsum + 10 kg/ha boron shows statistically at par with treatment 400 kg/ha gypsum + 10 kg/ha boron. Which is given in the table (1). It shows the successive increase in nodules from 15 DAS TO 45 DAS and then a decrease in the number of nodules per plant up to harvest by the impact of gypsum and boron on groundnut. Because the plant feeds nutrients to the growing seed instead of the nodule during pod formation and filling, legume nodules lose their ability to fix nitrogen. Where nodules get **s**ulphur addition through gypsum is a main responsible factor for root nodules formation and calcium created a congenial soil environment for root growth and nodules development (Prabhu 2019) [14] and also boron is essential for nodule forming bacteria, Hence the number of nodules per plant is increased (Naiknaware *et al.* 2015) [13]. The improvement in nodulation might have resulted in a higher amount of nitrogen fixation and thereby better vegetative growth and dry matter production. These results were similar to the findings of Hirpara *et al.*, (2017) [10].

Table 1: Effect of gypsum and boron on growth attributes of groundnut

S.No.	Treatment combinations	Plant Height (cm)	No. of Nodules	Dry weight (g/plant)	CGR ($g/m^2/day$)	RGR (g/g/day)
1	200 kg/ha gypsum + 5 kg/ha boron	61.67	32.95	35.94	9.37	0.0129
2	200 kg/ha gypsum + 10 kg/ha boron	61.9	33.62	37.04	10.12	0.0136
3	200 kg/ha gypsum + 15 kg/ha boron	59.96	32.55	35.78	10.10	0.0140
4	300 kg/ha gypsum + 5 kg/ha boron	63.11	35.60	38.43	10.62	0.0137
5	300 kg/ha gypsum + 10 kg/ha boron	64.0	37.19	40.81	11.53	0.0141
6	300 kg/ha gypsum + 15 kg/ha boron	63.59	36.73	39.41	10.74	0.0135
7	400 kg/ha gypsum + 5 kg/ha boron	62.84	34.82	39.02	11.70	0.0150
8	400 kg/ha gypsum + 10 kg/ha boron	64.67	38.71	42.29	12.18	0.0144
9	400 kg/ha gypsum + 15 kg/ha boron	62.8	35.73	38.20	10.71	0.0139
	S.Em (±)	0.49	0.56	0.23	0.52	0.00
	CD (p=0.05)	1.47	1.67	0.70	2.92	-

Dry Weight (g/plant)

Dry weight was increased from 15DAS to 90 DAS, the highest plant dry weight (42.29 g/plant) was observed at 90 DAS with the application of 400 kg/ha gypsum and 10 kg/ha boron, which is superior over the rest of all treatments. 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) [1]. Application of micronutrients in combination

increased the supply of micronutrients necessary for growth and development, which resulted in an increase of dry matter accumulation in the reproductive parts and the formation of higher sink capacity with the application of micronutrients. These results conform with the findings of Elayaraja and Singaravel (2012) [6].

Crop growth rate (g/m^2/day)

During 75 DAS to at harvest the maximum crop growth rate was observed (12.18g/m^2/day) under treatment number 8 with the application of 400 kg/ha gypsum + 10 kg/ha which is significantly higher over the rest of all the treatments.

Relative growth rate (g/g/day)

During 75 DAS to at harvest, the maximum relative growth rate was recorded under treatment with 400 kg/ha gypsum +5 kg/ha boron, there was no significant difference among all the treatment combinations.

Yield and yield attributes

Observations regarding yield and yield attributes were given in the table (2).

Number of pods per plant

At harvest, the maximum number of pods per plant (31.36) was recorded with the application of 400 kg/ha gypsum + 10 kg/ha boron. However the treatment 300 kg/ha gypsum+10 kg/ha boron (29.83) was statistically at par with 400 kg/ha gypsum + 10 kg/ha boron. The increase in the number of pods per plant might be due to the sulphur in the gypsum playing a vital role in energy storage and transformation, carbohydrate metabolism and activation of enzymes also increase the photosynthetic activity of the plant. These findings endorse the results of Ruskar Banu *et al.* (2017) [17], Kader and Mona (2013) [11]. Besides, this gypsum also provides Calcium and mobilization of Calcium from soil to the pod in groundnut crop takes place through the gynophores so the amount of calcium transported decides the pod yield. It also emphasized that Calcium application reduces ovule abortion and enhanced pod development, thus, resulting in higher number of pods and increased yields. Ruskar Banu *et al*., 2017) [17]. The results are in agreement with those of Giri *et al.* (2014) [8] and Naiknaware *et al*., (2015) [13].

Table 2: Effect of gypsum and boron on yield attributes and yield of groundnut

		Yield and Yield Attributes at Harvest				
S.No.	**Treatment combinations**	**No. of Pods (Per plant)**	**Shelling percentage (%)**	**Seed yield (Kg/ha)**	**Haulm yield (Kg/ha)**	**Harvest index (%)**
1	200 kg/ha gypsum + 5 kg/ha boron	24.7	70.55	2013.18	2892.13	41.04
2	200 kg/ha gypsum + 10 kg/ha boron	25.46	70.45	2119.67	2860.22	42.54
3	200 kg/ha gypsum + 15 kg/ha boron	24.1	69.62	1959.18	2827.82	40.92
4	300 kg/ha gypsum + 5 kg/ha boron	27	70.89	2197.87	3024.81	42.11
5	300 kg/ha gypsum + 10 kg/ha boron	29.83	71.33	2564.12	3271.76	43.93
6	300 kg/ha gypsum + 15 kg/ha boron	28.86	71.13	2415.02	3216.05	42.89
7	400 kg/ha gypsum + 5 kg/ha boron	26.63	70.59	2118.63	3087.93	40.72
8	400 kg/ha gypsum + 10 kg/ha boron	31.36	71.65	2674.17	3345.13	44.43
9	400 kg/ha gypsum + 15 kg/ha boron	26.1	70.89	2159.82	3011.75	41.76
	S.Em (±)	0.57	0.24	41.44	45.31	0.63
	CD(p=0.05)	1.71	0.72	124.24	135.85	1.88

Shelling percentage (%)

The maximum shelling percentage (71.65%) was recorded with the application of 400 kg/ha gypsum + 10 kg/ha boron and the treatments with application of 300 kg/ha gypsum + 10 kg/ha boron (71.33%) and 300 kg/ha gypsum + 15 kg/ha boron (71.13%) shows statistically at par with treatment 400 kg/ha gypsum + 10 kg/ha boron.

Seed yield (Kg/ha)

According to the observations recorded, at harvest, the significantly higher seed yield (2674.17 kg/ha) was recorded with the application of 400 kg/ha gypsum + 10 kg/ha boron. However, treatment with 300 kg/ha gypsum + 10 kg/ha boron shows statistically at par with 400 kg/ha gypsum + 10 kg/ha boron. The increased pod yield due to gypsum fertilization of the crop, which leads to an increase in haulm and kernel yield, was attributed to a concomitant influence of sulphur released from gypsum and the availability of other nutrients from the soil and their extraction by the plant, which appears to have provided the plants with a favourable nutritional environment. Further, the application of gypsum leads to the availability of Sulphur and calcium to crops during the grand growth phase leads to better growth and development of pods. calcium plays a vital role in the reproductive development of the groundnut crop, thereby increasing the pod yield. These results are in agreement with the findings of Sreelatha *et al*., (2004) [18]. The application of boron remarkably increases the yield attributing characters, because boron helps in the formation of chlorophyll, photosynthetic process & activation of enzymes as well as grain formation. They are also involved in carbohydrates metabolism which increases the uptake of nutrients & ultimately resulted in increasing the yield of groundnut. Naiknaware *et al.,* (2015) [13].

Haulm yield (Kg/ha)

At harvest significantly higher Haulm yield was (3345.13 kg/ha) observed in treatment 8 with the application of 400 kg/ha gypsum + 10 kg/ha boron, however, the treatment 300 kg/ha gypsum + 10 kg/ha boron, 300 kg/ha gypsum + 15 kg/ha boron shows statistically at par with treatment 8. The increase in haulm yield might be due to the synergistic effect of sulphur and calcium due to utilization of large quantities of nutrients through their well-developed root system and nodules which might have resulted in both plant development and ultimate straw yield at maturity the results conform with Ramjeet Yadav *et al.,* (2015) [15]. Boron increased nitrogen fixation which affects plant growth rate and metabolism which results in higher haulm yields Bhagiya *et al.,* (2005) [4].

Harvest index

The maximum harvest index was observed in treatment with the application of 400 kg/ha gypsum + 10 kg/ha boron (44.43%). Which is significantly higher over the rest of all treatment combinations except with the application of 300 kg/ha gypsum + 10 kg/ha boron and 300 kg/ha gypsum + 15 kg/ha boron. Gypsum treatments also increased the harvest index of groundnut over control on a pooled basis Rao *et al.*, (2001) [16]. It was observed that the increase in yield parameters was due to a greater number of filled pods and the least number of unfilled pods due to boron application (Ansari *et al.*, 2013) [3]. The positive role of boron in quality improvement through its involvement in the synthesis of protein and amino acids further increased the pod yield of groundnut (Chitdeshwari and Poongothai 2003) [5].

Conclusion

In conclusion from the present study, groundnut is having a positive effect with the soil application of 400 kg/ha gypsum + 10 kg/ha boron on growth and yield attributes. which is a suitable combination to be adopted for improving the groundnut yields for farmers as it was productive and profitable. Therefore it is suggested to farmers in order to increase groundnut growth and yield.

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