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Effect of sulphur and growth regulators on growth and yield of groundnut (*Arachis hypogea* L.)

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Abstract
The field experiment was conducted at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) during Kharif, 2023. The treatments consisted of three levels of sulphur (10, 25 & 40 kg/ha) and three levels of plant growth regulator (GA3 50 ppm, NAA 100 ppm, GA3 25 ppm + NAA 50 ppm). The experiment was laid out in a Randomized Block Design with ten treatments each replicated thrice. The treatments which are T_1: 10 kg/ha Sulphur + GA3 50 ppm, T_2: 10 kg/ha Sulphur + NAA 100 ppm, T_3: 10 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm, T_4: 25 kg/ha Sulphur + GA3 50 ppm, T_5: 25 kg/ha Sulphur + NAA 100 ppm, T_6: 25 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm, T_7: 40 kg/ha Sulphur + GA3 50 ppm, T_8: 40 kg/ha Sulphur + NAA 100 ppm, T_9: 40 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm, T_{10}: Control (NPK 20:60:40 kg/ha). The results showed that application of sulphur at 25 kg/ha with GA3 25 ppm and NAA 50 ppm (Treatment-6) recorded highest maximum plant height (44.85 cm), plant dry weight (34.29 g), number of pods per plant (11.67), number of kernels per pod (2.20), seed index (34.10 g), seed yield (1.94 t/ha), shelling Percentage (69.23%) and haulm yield (5.67 t/ha).

Keywords: Sulphur, NAA, GA3, groundnut, yield

Introduction
Groundnut is one of the most important edible oil seed crop in India. It is often referred to as the "King of Vegetable Oil Seeds" and is often termed Poor Man's Almond. The legume groundnut is allotetraploid and self-pollinating. Groundnut kernels are high in P, Ca, and Mg as well as micronutrients like Fe and Zn. Groundnut seeds include 47–53% oil, 26 percent protein, and 11.5% starch. Groundnut kernels are also a good source of all vitamins B, except B12, and vit-E. Groundnut oil is composed of mixed glycerides and unsaturated fatty acids, such as oleic acid (50- 65%) and linoleic acid (18-30%). A little over eighty-one percent of seeds are extracted for oil, 12% are utilized as seeds, 6% are used as raw materials, and 1% are exported after being hand- selected. The oil cakes, which contain N-7.3%, P-1.5%, and K-1.3%, are fed to livestock (Dileep *et al*., 2021) [20]. It is the world's largest source of edible oil and ranks 13th among the food crops as well as the 4th most important oilseed crop in the world. It is a leading oilseed crop in India with an area of 6.64 million hectares and production of 6.77 million tones of groundnut at an average productivity of 1020 kg/ha during the summer season. (FAO STAT, 2007). It is commercially grown in more than a Hundred countries like India, China, USA, and West Africa. Groundnut was introduced in India in the middle of the 19th Century on the east coast of the South Apricot district in Tamil Nadu. The crop grows best on Sandy loam and loamy soil and in black soil with good Drainage. Heavy and stiff clays are unsuitable for groundnut cultivation. Low yield of groundnut in India specially in Uttar Pradesh during kharif season is due to inappropriate practice of required planting methods, inadequate fertilizers use, low seed rate and poor agronomic practices (Dileep *et al*., 2021) [20]. Sulphur deficiency in plants have direct impact on yield by delaying maturity, reduce nodulation, increase nitrate content in forage and reduce quality of yield. Sulphur is not mobile in plants as N, P and K and Sulphur deficient plants are generally shows stunted growth and deficiency symptoms at younger leaves. Sulphur is an essential nutrient for oilseed production and it is the 13th most abundant element in the earth crust with an average concentration of 0.06%. Sulphur is now recognized a fourth

major plant nutrient after Nitrogen, Phosphorus and Potassium (Nagesh *et al*., 2019) [10]. Groundnuts absorbed more different macro and micronutrients when sulfur was applied. Since one unit of sulfur fertilizer produces three to five units of edible oil, sulfur is the primary nutrient for the production of oil seeds. Sulfur is linked to development and metabolism, particularly through its impact on proteolytic enzymes, and aids in the synthesis of cysteine, methionine, chlorophyll, vitamins (B, biotin, and thiamine), the metabolism of carbohydrates, oil content, and protein content. According to Ariraman and Kalaichelvi (2020) [1], sulfur is also known to encourage nodulation in legumes, which results in N fixation and raises the supply of other nutrients.

Sulphur increases the oil percentage in groundnut. Sulphur also plays a vital role in chlorophyll formation as it is constituent of succinyl Co-A which is involved in chlorophyll synthesis (Pirson *et al*., 2005) [14]. The higher content of sulphur in plants is known to have role in better development and thickening of xylem and collenchyma tissues. The improved nutritional environment at the cellular level and leaf chlorophyll content appears to have increased the photosynthetic rate. Since groundnut is rich both in oils and protein, requirement of Sulphur for this crop is substantial. In addition application of sulphur significantly increased photosynthesis rate thereby increased the haulm yield and its also increased the pod yield. Sulphur deficiency and consequent crop response, particularly in oilseed crops like groundnut are quite ostensible (Schonhof *et al*., 2007) [19].

Plant growth regulators (NAA & GA3) increase root, stem & leaf growth. Stimulate flowering & pod formation, increase grain yield and quality, and help in the synthesis of chlorophyll. Plant growth regulators are known to improve the source-sink connection and promote photo-assimilate translocation, which aids in fruit and seed development, efficient flower formation, and ultimately increases crop output. Growth regulators promote physiological efficiency, especially photosynthetic capacity, and can help field crops divide nutrients more effectively between sources and sinks. It is possible to enhance yield parameters like as grains/pod, pods/plant, haulm yield, and grain yield by applying a growth regulator foliar spray at 45 DAS. It has been demonstrated that foliar nutrient administration is a valuable tool for applying fertilizer with the express goal of boosting nutrient availability when needed, particularly in the later stages of plant growth.

Materials and Methods

During the kharif season of 2023, a field experiment was carried out in alluvial soil at the Crop Research Farm of the Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. The soil of the experimental plot was sandy loamy, having a nearly neutral soil reaction (pH 6.8), and electrical conductivity (0.296 ds/m). The experiment was conducted in a Randomised Block Design consisting of ten treatments and three replications. The treatments consisted of three levels of sulphur (10, 25 & 40 kg/ha) and three levels of plant growth regulator (GA3 50 ppm, NAA 100 ppm, GA3 25 ppm + NAA 50 ppm).

The treatments which are T_1: 10 kg/ha Sulphur + GA3 50 ppm, T_2: 10 kg/ha Sulphur + NAA 100 ppm, T_3: 10 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm, T_4: 25 kg/ha Sulphur + GA3 50 ppm, T_5: 25 kg/ha Sulphur + NAA 100 ppm, T_6: 25 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm, T_7: 40 kg/ha Sulphur + GA3 50 ppm, T_8: 40 kg/ha Sulphur + NAA 100 ppm, T_9: 40 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm, T_{10}: 20:60:40 NPK kg/ha (control). Plant growth parameters, such as plant height (cm), plant dry weight (g/plant), CGR(g/m^2/day), RGR(g/g/day) were measured at 20 days intervals from germination till harvest and yield attributes, such as No. of pods/plant, No. of kernels/pod, seed index, shelling percentage, seed yield, haulm yield, and harvest index (%) were measured at harvest. The observed data were statistically analysed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

Results and Discussion

Growth Parameters

Plant height: Data in Table 1, tabulated that significantly the highest plant height (44.85 cm) was observed in treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm) over all the other treatments. However, treatment-7 (40 kg/ha Sulphur + GA3 50 ppm) and treatment- 9 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm) were found to be significantly at par with treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm) as compared to all the treatments. This indicates a positive impact of Sulphur is due to rapid cell multiplication and higher chlorophyll content, thereby accelerating photosynthesis rate and eventually more supply of assimilates to plants that in turn increased the growth in terms of greater canopy, height and accumulation of dry matter at successive growth stages. A similar result was also reported by Yadav *et al*., (2017) [21]. Further, the increase in plant height has been thought to be stimulated by auxin (NAA) which softens the cell wall or alters the plasticity of the cell wall. These osmotic-driven responses under the influence of GA3 might have attributed to an increase in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, thus resulting in increased cell elongation and rapid cell division in the growing portion. Similarly, increase in plant height was observed in groundnut by Gardner *et al*., (1988) [7] and Reddy *et al*., (1984) [16].

Table 1: Effect of Sulphur and Growth Regulators on Growth Attributes of Groundnut

S. No.	Treatments	Plant height (cm) 100 DAS	Plant dry weight (g/plant) 100 DAS	Number of nodules/plant 60 DAS	CGR (g/m^2/day) 40-60 DAS	RGR (g/g/day) 20-40 DAS
1.	10 kg/ha Sulphur + GA3 50 ppm	41.71	26.01	36.49	11.84	0.0787
2.	10 kg/ha Sulphur + NAA 100ppm	39.90	25.91	36.07	12.42	0.0788
3.	10 kg/ha Sulphur + GA3 25ppm + NAA 50ppm	40.21	26.86	37.94	12.69	0.0793
4.	25 kg/ha Sulphur + GA3 50 ppm	36.50	29.34	41.46	13.93	0.0872
5.	25 kg/ha Sulphur + NAA 100ppm	41.12	30.96	44.37	14.74	0.0947
6.	25 kg/ha Sulphur + GA3 25ppm + NAA 50ppm	44.85	34.29	37.32	16.71	0.0968
7.	40 kg/ha Sulphur + GA3 50 ppm	43.11	31.96	51.00	15.76	0.0986
8.	40 kg/ha Sulphur + NAA 100 ppm	41.56	24.44	34.00	11.41	0.0652
9.	40 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm	42.51	31.46	45.61	15.16	0.0847
10.	NPK – 20:60:40 kg/ha (control)	39.80	25.73	47.68	12.15	0.0768
	F-Test	S	S	S	S	NS
	Sem (+)	1.42	0.51	1.49	0.74	0.0047
	CD (P=0.05)	4.22	1.52	4.41	2.21	--

Table 2: Effect of Sulphur and Growth Regulators on yield attributes of Groundnut

S. No.	Treatments	Number of pods/Plant	Number of kernels/Pod	Seed index (g)	Seed yield (t/ha)	Haulm yield (t/ha)
1.	10 kg/ha Sulphur + GA3 50 ppm	10.33	2.07	29.59	1.41	4.37
2.	10 kg/ha Sulphur + NAA 100ppm	9.80	1.80	29.93	1.18	4.58
3.	10 kg/ha Sulphur + GA3 25ppm + NAA 50ppm	10.27	2.00	28.96	1.32	4.65
4.	25 kg/ha Sulphur + GA3 50 ppm	10.60	1.60	29.97	1.13	5.39
5.	25 kg/ha Sulphur + NAA 100ppm	10.40	2.00	32.32	1.49	5.39
6.	25 kg/ha Sulphur + GA3 25ppm + NAA 50ppm	11.67	2.20	34.10	1.94	5.67
7.	40 kg/ha Sulphur + GA3 50 ppm	11.27	2.20	33.19	1.83	5.28
8.	40 kg/ha Sulphur + NAA 100 ppm	10.33	2.00	30.07	1.38	4.05
9.	40 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm	10.20	2.00	32.77	1.49	5.51
10.	NPK – 20:60:40 kg/ha (control)	10.07	8.8	28.32	1.18	4.53
	F-Test	S	S	S	S	S
	Sem (+)	0.29	0.10	0.66	0.08	0.33
	CD (P=0.05)	0.86	0.29	1.95	0.25	0.97

Plant dry weight

Treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm) was recorded with a significantly maximum dry weight (34.29 g/plant) over allthe treatments. However, the treatment-7 (40 kg/ha Sulphur + GA3 50 ppm) (31.96 g/plant), treatment 9 (31.46 g/plant) and treatment 5 (30.96 g/plant) which were found to be statistically at par with treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm). Further, significant and higher plant dry weight is due to growth and development of plants, which obtained by enhanced metabolic activities and photosynthetic rate, resulting in improvement in the accumulation of dry matter at the successive growth stages. Similar result was also reported by Dileep *et al*., (2021) [20].

Number of nodules/plant

At 60 DAS the highest nodules per plant (51.00) was observed in the treatment-7 (40 kg/ha Sulphur + GA3 50 ppm), which was significantly higher over rest of the treatments. However, the treatments 10 (control) was found to be statistically at par with treatment-7 (40 kg/ha Sulphur + GA3 50 ppm). Significant and maximum number of nodules/plant was due to higher content of Sulphur in plants, which helps in development of xylem tissues and stimulating photosynthesis, Sulphur containing amino acids, proteins and higher chlorophyll content which results in better root development and promoting nodulation. Similar result was also reported by Yadav *et al*., (2017) [21]. As gibberellic acid (GA3) increase root length, the concentration of GA3 has shown direct effect on the number of root nodules/plant. Similar result was also reported by Emonger *et al*., (2011) [4].

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

At 40-60 DAS, a significant and higher crop growth rate (16.71 g/m^2/day) was recorded in treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm) as compared to rest of the treatments. However, treatment-7 (40 kg/ha Sulphur + GA3 50 ppm) and treatment-9 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm) were found to be statistically at par with treatment-6. Significant and higher crop growth rate was due to an improved nutritional environment at the cellular level and higher leaf area index through which may have leads to maximum dry matter accumulation and further increase crop growth rate. Similar findings were also reported by Sarkar and Banik, (2002) [18] and Dileep *et al*., (2021) [20].

Yield attributes and Yield

Pods / Plant

Significantly maximum pods/plant (11.67) was recorded at treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm) over all the treatments. However, the treatment-7 (40 kg/ha Sulphur + GA3 50 ppm) found to be statistically at par with treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm). Significant and maximum number of pods/plant is due to supply of Sulphur in adequate amount also help in the development of floral and reproductive parts, which results in the maximum development of pods and kernels in plant. Similar result was also reported by Yadav *et al*., (2017) [21].

Kernels / Pod

Application of Sulphur 25 kg/ha with GA3 25ppm & NAA 50 ppm (treatment 6) has recorded the highest number of kernels per plant (2.20) over all the treatments. However, the treatment-7 (40 kg/ha Sulphur + GA3 50 ppm) and treatment-1 (10 kg/ha Sulphur + GA3 50 ppm) were found to be statistically at par with treatment-6 (25 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm). Significant and maximum number of kernels/pod is due to synthesis of sulphur containing amino acids, proteins, which leads to stimulating photosynthesis and seed formation and also sulphur plays vital role in energy storage and transformation, carbohydrate metabolism and activation of enzymes, which results in the development of kernels in plants. Similar findings is also reported by Hinduja *et al*., (2020) [11] and Bhadiyatar *et al*., (2022) [2].

Seed index (g)

Treatment-6 (25 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm) was recorded with a significantly highest test weight (34.10 g) over all the treatments. However, the treatment-7 (40 kg/ha Sulphur + GA3 50 ppm), treatment - 9 (40 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm), and treatment 5 were found to be statistically at par with treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm). Significant and higher seed index is due to Sulphur, which is essential for nitrogen fixing nodules in legumes and in formation of chlorophyll, promotes proteins formation, amino acids and seed development. Similar result was also reported by Aier and Nongmaithem (2020) [22].

Seed yield (t/ha)

The highest seed yield (1.94 t/ha) was recordedwith treatment-6 (25 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm) over all the treatments. However, treatment-7 (40 kg/ha Sulphur + GA3 50 ppm) was found to be statistically at par with treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm). Significant and higher kernel yield is be due to overall improvement in growth and development by sulphur fertilization with increased

photosynthesis and greater mobilization of photosynthates towards reproductive structures leads to increase in yield of groundnut. Similar result was also reported by Yadav *et al*., (2018) [23].

Haulm yield (t/ha)

Significantly highest haulm yield (5.87 t/ha) was recorded with the treatment-6 (25 kg/ha Sulphur + GA3 25 ppm + NAA 50 ppm) over all the treatments. However, the treatment 9 (5.51 t/ha), treatment 4 (25 kg/ha Sulphur + GA3 50 ppm) and treatment 5 (5.39 t/ha) was found to be statistically at par with treatment-6 (25 kg/ha Sulphur + GA3 25ppm + NAA 50 ppm). Significant and higher haulm yield is due to applying sulphur promotes overall improvement in crop growth and vigour, as reflected in plant height, dry matter accumulation and number of nodules/plant which marked improvements in haulm yield. Similar result was also reported by Reddy *et al*., (2022) [17].

Conclusion

Based on the above findings it is concluded that, application of Sulphur 25 kg/ha with GA3 25 ppm & NAA 50 ppm (treatment 6) perform better in growth parameters and yield in groundnut and hence can be recommended to the farmer.

References

1. Ariraman R, Kalaichelvi K. Effect of Sulphur nutrition in groundnut. Agricultural Reviews. 2020;41(2):132-138.
2. Bhadiyatar AA, Patel JM, Malav JK. Effect of potassium and sulphur on growth, yield attributes and yield of summer groundnut in loamy sand. The Pharma Innovation Journal. 2022;11(2):2704-2707.
3. Dudekula D, Vikaram S, Dhananjay T, Shruti G, Padachala S. Effect of variety and sulphur on growth and yield of groundnut. Biological Forum. 2021;13(1):475-478.
4. Emongor VE, Ndambole CM. Effect of gibberellic acid on performance of cowpea. Africa Crop Science Conference Proceedings. 2011;10:87-92.
5. Faldu TA, Kataria GK, Singh CK, Savaliya HG. Effect of plant growth regulation on dry matter production and attributes of groundnut (*Arachis hypogaea* L.) cv. GJG-9. International Journal of Chemical Studies. 2018;6(3):2852-2855.
6. Fisher RA. Discussion of statistical problems in agricultural experimentation. Statistical Society. 1950;2:154-180.
7. Gardner FP. Growth and partitioning in peanut as influenced by gibberellic acid and diminozide. Agronomy Journal. 1988;80(2):159-163.
8. Imnatemjen A, Nongmaithem D. Response of groundnut to lime and different levels of sulphur. IJBSM. 2018;11(6):585-589.
9. Maekawa T, Maekawa YM, Takeda N, Imaizumi AH, Murooka Y, Hayashi M, *et al*. Gibberelin controls the nodulation signaling pathway in Lotus japonicus. The Plant Journal. 2005;58(2):183-194.
10. Nagesh Y, Yadav S, Yadav N, Yadav MR, Kumar R, Yadav LR, *et al*. Sulphur management in groundnut for higher productivity and profitability under semi-arid conditions of Rajasthan, India. Legume Res. 2019;42(4):512-517.
11. Narreddy H, Shikha S, Dhanjay T, Mahapatra AB, Mahanta S, Kumar S, *et al*. Effect of phosphorus and sulphur on growth and yield of groundnut. The Bioscan. 2020;15(4):459-462.
12. Patel PK, Viradiya MB, Kadivala VH, Shinde RD. Effect of potassium and sulphur on yield attributes, yield and quality of summer groundnut (*Arachis hypogaea* L.) under middle Gujarat condition. International Journal of Current Microbiology and Applied Sciences. 2018;7(9):2268-2273.
13. Patil MB. Response of groundnut (*Arachis hypogea* L.) to the exogenous application of growth hormones (IAA and GA3). Journal of Bioscience and Agriculture Research. 2019;22(01):1829-1834.
14. Pirson A. Functional aspects of mineral nutrition of green plant. A Review of Plant Physiology. 2005;6:71-144.
15. Rajanarasimha M, Rajesh S, Ekta S. Effect of sulphur and calcium on growth and yield of groundnut. The Pharma Innovation Journal. 2021;10(9):1685-1688.
16. Reddy BS. Effect of bioregulators on growth and yield of groundnut (*Arachis hypogaea* L.). M.Sc. (Agri.) Thesis. Andhra Pradesh Agricultural University, Hyderabad; c1984.
17. Reddy NT, Mehera B, Priya NS. Effect of Zinc and Sulphur on growth and yield of groundnut and yield validation using SPSS model. The Pharma Innovation Journal. 2022;11(4):132-136.
18. Sarkar RK, Banik P. Effect of planting geometry, direction of planting and sulphur application on growth and productivity of sesame (*Sesamum indicum*). Indian Journal of Agricultural Sciences. 2002;72(2):70-73.
19. Schonhof I, Blankenburg D, Muller S, Krumbein A. Sulphur and nitrogen supply influence growth, product appearance, and glucosinolate concentration of broccoli. Journal of Plant Nutrition and Soil Science. 2007;170:65-72.
20. Dileep MR, Navaneeth AV, Abhishek M. A novel approach for credit card fraud detection using decision tree and random forest algorithms. In 2021 Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV); c2021 Feb 4. p. 1025-1028.
21. Yadav R, Pathak GS. Determinants of consumers' green purchase behavior in a developing nation: Applying and extending the theory of planned behavior. Ecological economics. 2017 Apr 1;134:114-122.
22. Aier I, Nongmaithem D. Response of groundnut (*Arachis hypogaea* L.) to lime and different levels of Sulphur. International Journal of Bio-resource and Stress Management. 2020;11(6):585-589.
23. Yadav KK, Gupta N, Kumar A, Reece LM, Singh N, Rezania S, *et al*. Mechanistic understanding and holistic approach of phytoremediation: A review on application and future prospects. Ecological engineering. 2018 Sep 1;120:274-298.