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Influence of Sulphur and Liquid Organic Nutrient on Growth and Yield of Groundnut (*Arachis hypogea* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Zaid* season of 2023 at Crop Research Farm Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Sciences and Technology. The experiment was laid out in RBD (Randomized Block Design) with 10 treatments each replicated thrice. To determine the "Influence of Sulphur and Liquid Organic Nutrient on Growth and Yield of Groundnut.'' The result revealed that treatment 9 [sulphur (40 kg/ha) + seaweed (3%)] recorded significantly higher plant height (37.36 cm), maximum number of nodules/plant (18.66), higher plant dry weight (25.38 g), maximum number of pod/plant (24.92), higher number of kernels/pod (2.60), higher seed index (41.92 g), higher seed yield (2.72 t/ha), higher haulm yield (6.33t/ha) and higher harvest index (30.01%).

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1. INTRODUCTION

"Groundnut (*Arachis hypogea* L.) belongs to Leguminosae family and also known as peanut, monkey nut, earthnut, manila nut, and goober. Groundnut is one of the most important edible oilseed crop in the world India occupying two third areas under oilseeds which constitute the second major agricultural crop in the country. Groundnut is premier oilseed crop of India popularly known as peanuts. The percentage of oil content is about 50%, 25% to 30%, protein, 20% carbohydrate and 5% fibre. It is valuable sources of vitamins E, K and B. It is richest source of thiamine and also rich in niacin which is low in cereals" [1].

"Groundnut rank fist in area and second in production after soyabean and is grown in almost all part of the country over wide range of agro-climatic condition. Globally, groundnut cover on area of 28.89 million hectares with the production of 54.41 million tons with the productivity of 1.88 tonnes/ha" [2]. "In India Groundnut is grown over an area of about 5.75 million hectors with a production of 10.11 million tons and productivity of 1.7 t/ha" (GOI, 2022). "Total area coverage under groundnut in Uttar Pradesh is 1.21 million hectares with a production of 1.24 million tone and the productivity 1.02 t/ha" (GOI, 2022).

"Important reasons for low average yield of groundnut are improper or excessive agronomic practices and application of fertilizers. The country is currently dealing with an edible oil consumption due to population growth. The primary cause of the low peanut production is the crop restricted kharif season cultivation, the issue is made harder during above average rainfall seasons by water logging, poor drainage, and difficulty the field for weed control techniques. Deficiency of sulphur has been frequently observed due to a number of reasons like increased removal of sulphur by the crop high yielding fertilizer responsive crop varieties increasing cropping intensity and extensive use of sulphur free fertilizer" [1]. Insufficient availability of sulphur to oil seed crops not only decline their growth and yield but can also deteriorate nutritional quality of the produce.

"Sulphur plays an important role in groundnut metabolism protein synthesis, formation of chlorophyll. Sulphur is a secondary essential plant nutrient factor that plays a role in the formation of protein alongside nitrogen and phosphorus. The application of sulphur fertilizer in groundnut has been found effective due to increament of number of pegs and pods/plant, kernel to shell ratio etc. Sulphur plays a significant role in the physiological growth and yield of crops such as groundnut" [3].

"The fish amino acid is liquid organic manure made from fish waste. Fish amino acid is of great value to both plants and microorganisms in their growth, because it contains various nutrients and types of amino acids. Foliar application or soil drenching of fish amino acid could maximize uptake and minimize runoff or leaching, providing just enough N to the plant for the production of chlorophyll to maintain plant health. Fish amino acid diluted with water with other natural farming inputs and applied as a foliar spray as well as soil drench increased the yield" [4].

"Panchagavya an organic product has potential to play the role in promoting growth and providing immunity in plant system. Use of organic liquid product such as *panchagavya* resulted in higher growth, and quality of crops. These liquid organic solutions are prepared from five product (milk, urine, dung, ghee and curd) of cow" [5].

Seaweed extracts contain unidentified physiologically useful chemicals that commonly cause plants to produce phytohormones via internal signalling. Seaweed extracts are not biologically equivalent to chemical fertilizers. They are biodegradable and non-hazardous, making them ecologically benign substances with no chemical residues or risks [6,7,8].

Keeping in view of the above fact, the experiment was conducted to find out "Influence of Sulphur and Liquid organic nutrient on growth and yield of Groundnut".

2. MATERIALS AND METHODS

The experiment was conducted during *Zaid* season 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental field was sandy loam in texture, with soil (pH 7.8), low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 kg/ha), K (240.7 kg/ha) and zinc (2.32 mg/kg). The treatment consists of three levels of Sulphur along with the combination of

three levels of organic nutrients. The experiment was laid out in RBD (Randomized Block Design) with 10 treatments each replicated thrice. The treatment combinations are T1- Sulphur (20 kg/ha) + Fish amino acid (3%), T2- Sulphur (20 kg/ha) + *Panchgavya* (3%), T3- Sulphur (20 kg/ha) + Seaweed (3%), T4- Sulphur (30 kg/ha) + Fish amino acid (3%), T5- Sulphur (30 kg/ha) + *Panchgavya* (3%), T6- Sulphur (30 kg/ha) + Seaweed (3%), T7- Sulphur (40 kg/ha) + Fish amino acid (3%), T8- Sulphur (40 kg/ha) + *Panchgavya* (3%), T9- Sulphur (40 kg/ha) + Seaweed (3%), T10- Control. Data recorded on different aspects of crop, *viz*., growth, yield attributes & yield were statistically analysed by using analysis of variance method [9].

3. RESULTS AND DISSCUSSION

3.1 Growth Attributes

3.1.1 Plant height (cm)

The data revealed that significantly higher plant height (37.36 cm) was recorded in treatment 9 [Sulphur (40 kg/ha) + Seaweed (3%)]. However, treatment 8 [Sulphur (40 kg/ha) + *panchgavya* (3%)] was found statistically at par with treatment 9 [Sulphur (40 kg/ha) + Seaweed (3%)]. Significantly higher plant height with the application of sulphur (40kg/ha) might be due increased supply of sulphur to the plants that played a vital role in meristematic activities, higher apical growth, photosynthetic surface, and strong stem. Similar results are reported by Dileep et al. [3]. Further, the higher plant height was observed with the application of seaweed (3%) which might be due increase in biological activity and cytokinin through utilization of seaweed via foliar application. Dalwale et al. [10] reported the similar results.

3.1.2 Number of nodules/plants

Significant maximum number of nodules/plant (18.66) was recorded in treatment 9 [Sulphur (40 kg/ha) + seaweed (3%)]. However, treatment 8 [Sulphur (40 kg/ha) + *Panchgavya* (3%)] was found statistically at par with treatment 9 [Sulphur (40 kg/ha) + seaweed (3%)]. Significant and maximum number of nodules/plants was observed with the application of sulphur (40 kg/ha), that might be due to increased leghaemoglobin, additional nitrogen, sufficient amount of glucose, ATP and ferredoxin. Similar findings was reported by Rawal (2022). Further the maximum number of nodules/plants was observed with the application of seaweed (3%) that might be increased photosynthetic efficiency, chlorophyll content, increase the activity of rhizobia. Similar result was reported by Kumawat et al. [11].

3.1.3 Plant dry weight (g)

Results revealed that significant higher plant dry weight (25.38 g) was recorded in treatment 9 [Sulphur (40 kg/ha) + seaweed (3%)]. However, treatment 8 [Sulphur (40 kg/ha) + *Panchgavya* (3%)] was found to be statistically at par with treatment 9 [Sulphur (40 kg/ha) + seaweed (3%)]. “Significant and higher plant dry weight was observed with application of sulphur (40 kg/ha), might be due to more synthesis of amino acid, increase in chlorophyll content in growing region and improving the photosynthetic activity, ultimately enhancing cell division” [12]. Similar result were reported by Kalaiyarasan et al. [13]. Further, significant and higher plant dry weight was observed with the application of Seaweed (3%) which might be due to positive effect on plant as better partitioning of photosynthates from source to sink, ultimately increased plant dry weight. Similar results was reported by Kewat et al. [14].

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

The data recorded during 60-80 DAS, highest crop growth rate (16.15 g/m2/ day) was observed in treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. There was no any significant difference among all the treatments.

3.1.5 Relative Growth Rate (g/g/day)

The data revealed that during 60-80 DAS, higher relative growth rate (0.0341 g/g/day) was recorded in treatment 1 [Sulphur (20 kg/ha) + fish amino acid (3%)]. There was found no any significant difference among all the treatments.

3.2 Yield and Yield Parameters

3.2.1 Number of pods/plant

Significant and maximum number of pods/plant (24.92) was recorded in treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. However, treatment 8 [sulphur (40 kg/ha) + *panchgavya* (3%)] and treatment 7 [sulphur (40 kg/ha) + fish amino acid (3%)] were found to be statistically at par with the treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. Significant and maximum number of pods/plant

with the application of sulphur might be due to increase photosynthetic activity over all growing environment, greater partition of metabolites and adequate translocation of nutrient to developing structure. The present findings are within the close proximity of Gokila et al. [15]. Further, significant and maximum number of pods/ plants with the application of seaweed may be due to increase in photosynthate transport from the vegetative portion to the developing grains responsible for the improvement in groundnut yield parameters. These results were corroborated by Layek et al. [16] in rice.

3.2.2 Number of kernels/pods

The data recorded that significant and maximum number of kernels/pod (2.60) was recorded in treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. Similarly, treatment 8 [sulphur (40 kg/ha) + *panchgavya* (3%)] was found to be statistically at par with treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. Significant and maximum number of kernels/pod obtained with the application of Sulphur (40kg/ha) might be due facts that the adequate sulphur was available during the entire period of crop growth for better vegetative growth and development of groundnut crop. Similar result was reported by Yeswanth and Debbarma [17]**.** Further, significant and maximum number of kernels/pods was with the application of seaweed may be due to the presence of plant growth regulator in sap as well as the minerals element present in the seaweed exact which increase the rate of photosynthate available for gain filling. The findings agreed with those of Singh et al. [18].

3.2.3 Seed index (g):

The data recorded that significant and higher seed index (41.92 g) was recorded in treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. However, the treatment 8 [sulphur (40kg/ha) + *panchgavya* (3%) treatment 7 [sulphur (40 kg/ha) + fish amino acid (3%)] and treatment 6 [sulphur (30 kg/ha) + seaweed (3%)] were found to be statistically at par with the treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. Significant and higher seed index was obtained with application of Sulphur (40kg/ha) might due to better for root growth, cell multiplication, elongation and cell expansion in the plant body, which ultimately increased the seed yield. Similar result was reported by Yeswanth and Debbarma [17]. Further the higher seed index observed with application of seaweed might be due to increase nutrient mobilization and partitioning, chlorophyll content and development of vigorous root system. These results are similar to that of Kumawat et al. [11].

3.2.4 Seed yield (t/ha)

The data shows significantly higher seed yield (2.72 t/ha) in treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. However, treatment 8 [sulphur (40 kg/ha) + panchgavya (3%)] was found to be statistically at par with the treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. The application of sulfur may have resulted in a significant and greater seed output because of the strong growth, which may have assisted in increasing dry weight production and more photosynthetic accumulation in the sink, both of which eventually translated into higher seed yield. Similar result was reported by Vyas et al. [19]. Further, higher seed yield with the application of seaweed might be due to the presence of plant growth regulator in sap as well as the minerals elements present in the seaweed extract, which increased the phosynthetic rate for a longer duration or delay the senescence of the leaves the present findings are within the close proximity of Singh et al. [18].

3.2.5 Haulm yield (t/ha)

Significant and higher haulm yield (6.33 t/ha) was recorded in treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. Whereas, treatment 8 [sulphur (40 kg/ha) + panchgavya (3%)] was found to be statistically at par with the treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. The application of sulfur may result in a significant and higher haulm production since it may improve photosynthetic activity and plant metabolism. Similar result was reported by Raj et al. [20]. Further higher haulm yield with the application of seaweed might be due to increase root proliferation and establishment, mining of more nutrient by crops even from distance places and deeper soil horizons, in balanced proportion. These findings are within the close proximity of Dilavarnaik et al. [21].

3.2.6 Harvest index (%)

Significant and higher harvest index (30.01%) was recorded in treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. However, treatment 8 [sulphur (40 kg/ha) + panchgavya (3%)] was found to be statistically at par with the treatment 9 [sulphur (40 kg/ha) + seaweed (3%)]. Application of sulfur may have resulted in a significant and higher

Table 1. Effect of sulphur and liquid organic nutrient on growth attributes of groundnut

S.No.	Treatment combinations	Plant height (cm) (80 DAS)	Number of nodules/plant	Plant dry weight (g)	Crop Growth Rate (g/m^2/day)	Relative Growth Rate (g/g/day)
1	Sulphur 20 kg/ha + Fish amino acid 3%	31.78	14.00	22.06	18.21	0.0341
2	Sulphur 20 kg/ha + *Panchgavya* 3%	31.14	14.66	20.46	15.68	0.0307
3	Sulphur 20 kg/ha + Seaweed 3%	32.22	14.73	20.82	14.30	0.0266
4	Sulphur 30 kg/ha + Fish amino acid 3%	30.65	15.86	21.75	15.97	0.0290
5	Sulphur 30 kg/ha + *Panchgavya* 3%	31.75	14.60	22.18	17.35	0.0316
6	Sulphur 30 kg/ha + Seaweed 3%	31.72	14.60	21.36	14.91	0.0271
7	Sulphur 40 kg/ha + Fish amino acid 3%	34.11	16.73	22.67	16.29	0.0282
8	Sulphur 40 kg/ha + *Panchgavya* 3%	36.09	17.26	23.55	15.89	0.0260
9	Sulphur 40 kg/ha + Seaweed 3%	37.36	18.66	25.38	16.15	0.0240
10	Control (RDF)	31.71	14.33	21.15	16.69	0.0321
	F-test	**S**	**S**	**S**	**NS**	**NS**
	SEm(±)	0.97	0.52	0.65	1.33	0.0023
	CD (P=0.05)	2.88	1.56	1.94	-	-

Table 2. Effect of sulphur and liquid organic nutrient on yield attributes and yield of groundnut

S.No.	Treatment combination	Number of Pod/plant	Number of kernels/pod	Seed index (g)	Seed Yield (t/ha)	Haulm Yield (t/ha)	Harvest Index (%)
1	Sulphur 20 kg/ha + Fish amino acid 3%	21.75	1.67	38.10	1.38	4.80	22.37
2	Sulphur 20 kg/ha + *Panchgavya* 3%	22.04	1.53	37.92	1.29	4.52	22.00
3	Sulphur 20 kg/ha + Seaweed 3%	22.62	1.80	38.33	1.56	4.71	24.90
4	Sulphur 30 kg/ha + Fish amino acid 3%	21.98	1.47	38.50	1.24	4.78	20.60
5	Sulphur 30 kg/ha + *Panchgavya* 3%	22.06	1.67	38.81	1.43	4.89	22.52
6	Sulphur 30 kg/ha + Seaweed 3%	21.46	1.60	38.93	1.34	4.59	22.54
7	Sulphur 40 kg/ha + Fish amino acid 3%	22.98	1.93	39.15	1.74	5.21	25.02
8	Sulphur 40 kg/ha + *Panchgavya* 3%	24.05	2.40	40.77	2.34	5.67	26.94
9	Sulphur 40 kg/ha + Seaweed 3%	24.92	2.60	41.92	2.72	6.33	30.01
10	Control	21.74	1.73	37.25	1.43	4.60	23.38
	F test	**S**	**S**	**S**	**S**	**S**	**S**
	SEm(±)	0.69	0.12	1.16	0.16	0.25	1.47
	CD (P=0.05)	2.04	0.37	3.44	0.47	0.75	4.37

harvest index because amino acids aid in the development of grains, photosynthetic processes, chlorophyll, and enzyme activity. These results are similar to that reported by Raj et al. [20]. Further, higher harvest index with the application of seaweed might be due to their effect on reduced flower and pod drop, delayed fruit senescence, increased size of flower and fruit. And also improves ability due trace elements, vitamins and amino acid. The present findings are within the close proximity of Ghosh et al. [22].

4. CONCLUSION

Insufficient availability of sulphur to oil seed crops not only decline their growth and yield but can also deteriorate nutritional quality of the produce. Application of Sulphur 40 kg/ha and Seaweed 3% recorded highest growth and seed yield of groundnut.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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