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Effect of sulphur and spacing on growth and yield of kharif groundnut (*Arachis hypogaea*)

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Abstract
The present part of the research work captioned Effect of sulphur and spacing on growth and yield of kharif groundnut (*Arachis hypogaea*) was conducted at experimental farm of Lovely Professional University, Phagwara, Jalandhar, Punjab during *kharif* season of 2022. The experiment was laid out in Randomized complete block design with a set of ten treatments with each replicated thrice on the basis of one year experimentation. The treatments included T_1 (Sulphur @ 45 kg/ha + 20 cm x 20 cm), T_2 (Sulphur @ 45 kg/ha + 25x 25 cm), T_3 (Sulphur @ 45 kg/ha + 30 x 10 cm), T_4 (Sulphur @ 60 kg/ha + 20 cm x 20 cm), T_5 (Sulphur @ 60 kg/ha + 25 cm x 25 cm), T_6 (Sulphur @ 60 kg/ha + 30 cm x 10 cm), T_7 (Sulphur @ 75 kg/ha + 20 cm x 20 cm), T_8 (Sulphur @ 75 kg/ha + 25 cm x 25 cm), T_9 (Sulphur @ 75 kg/ha + 30 cm x 10 cm), T_{10} (control). Growth parameters (plant height, number of leaves per plant, number of branches per plant, 50% of flowering,) were recorded at 30 DAS, 60 DAS and at 90 DAS. The yield parameters (No of pods per plant, Pod yield/plant, number of kernel per pod, kernel yield/plant, harvest index (%), Shelling (%)) were recorded at the time of harvest. Results indicated that Sulphur @ 60 kg/ha + 30 cm x 10 cm showed significant positive impact on plant height, number of leaves per plant, number of branches per plant, 50% of flowering, No of pods per plant, Pod yield/plant, number of kernel per pod, kernel yield/plant, harvest index, Shelling (%) of groundnut.

Keywords: Groundnut, spacing, RDF, nutrient content

Introduction
The most significant food legume and oilseed crop in India is thought to be groundnut, which is grown on 4.91 million ha of land and produces 9.18 million tonnes per year with an average productivity of 1.86 t/ha (DES, 2018). Being an erratic legume, groundnut's response to fertilizer administration is seldom positive. Mixed glycerides make up groundnut oil, which has a high content of unsaturated fatty acids including oleic acid (50-65%) and linoleic acid (18-30%). Cysteines, an amino acid that is necessary for animal growth, are found in groundnuts. The groundnut cake that is left behind after the oil has been extracted is high in protein, valuable organic manure, and animal feed. It also includes 7 to 8% N, 1.5% P, and 1% K. Low seed rates and improper agronomic techniques were significant factors in the low average yield of groundnut in farmers' fields. To address this problem, the most crucial micronutrients such as sulphur, gypsum, and others should be utilized appropriately because they significantly increase the groundnut seed yield.

The metabolism of groundnuts is significantly influenced by sulphur. For the production of proteins, it is necessary. It is necessary for the synthesis of chlorophyll. In addition to nitrogen and phosphorus, sulphur is a secondary vital plant nutrient component that aids in the production of protein. By increasing the amount of pegs and pods per plant, the kernel to shell ratio, and other factors, it has been discovered that the application of sulphur fertilizer and groundnut has been successful.

The physiological development and productivity of crops like groundnuts are significantly influenced by variety and sulphur. The most crucial component in the development of groundnuts is variety. The country has virtually attained a level of peanut sufficiency as a result of the notable rise in the use of high-yielding cultivars in recent years. In terms of growing habits, the types that might be suitable for early *Kharif* are considerably different from those for the other seasons. Keeping above points in mind present investigation was conducted. The main objective of the investigation to study the effect of sulphur and spacing on growth, yield of groundnut.

Materials and Methods

The field trial was carried out at Agronomy experimental field, School of Agriculture, Lovely Professional University, Phagwara, Punjab during *Kharif* season of 2022. Geographically, Lovely Professional University is located at a distance of 8 km from the Phagwara. It falls in sub-tropical climate situated at 31° 13'28'' North latitude and 75° 46' 25'' East longitude with an altitude of 245 m above the mean sea level (AMSL). The crop (KADIRI 6) was sown in 29 June 2022. The experiment was laid out in Randomized Block Design comprising of 10 treatments which are replicated thrice. Each treatment plot size is 5×4 m2. Sulphur were applied and spacing was maintained as per the treatment details in combinations as follows, with T_1: Sulphur at 45 kg/ha + 20 x 20 cm, T_2: Sulphur at 45 kg/ha + 25 x 25 cm, T_3: Sulphur at 45 kg/ha + 30 x 10 cm, T_4: Sulphur at 60 kg/ha + 20 x 20 cm, T_5: Sulphur at 60 kg/ha + 25 x 25 cm, T_6: Sulphur at 60 kg/ha + 30 x 10 cm, T_7: Sulphur at 75 kg/ha + 20 x 20 cm, T_8: Sulphur at 75 kg/ha + 25 x 25 cm, T_9: Sulphur at 75 kg/ha + 30 x 10 cm, T_{10}: Control are used. The growth parameters and yield, production were recorded at harvest from randomly selected plants in each plot. The data was computed and analysed by following statistical method of Gomez and Gomez (1984) [24].

Result and Discussion

Effect of sulphur and spacing on growth parameters of groundnut

Plant Height (cm)

Treatment 6 (Sulphur at 60 kg/ha + 30 cm x 10 cm) recorded maximum plant height 34.46 cm. However, plant height 33.06 cm with Treatment 2 (Sulphur at 45 kg/ha + 25 cm x 25 cm) was found at par with Treatment 6 compared to control plot. The application of sulphur resulted in the highest and most significant plant height, which may be because other macro- and micronutrients are also accessible that are crucial for the growth and development of plants. It appears to have encouraged meristematic processes, increasing apical growth and broadening the photosynthetic surface.
(Dileep *et al.*, 2021) [1] & (Raja *et al.*, 2007) [5]. Further, the spacing practises had a considerable impact on plant height. This may be because plants competed less for nutrients, sunshine, and water when they were spaced optimally, leading to increased plant height. (Gadade *et al*., 2018) [2] reported similar results.

Number of leaves per plant

The number of leaves per plant (221.93) was substantially higher in Treatment 6 (Sulphur at 60 kg/ha + 30 cm x 10 cm). However, when compared to the control plot, 209.06 in Treatment 8 (Sulphur at 75 kg/ha + 25 cm x 25 cm) was statistically equivalent to Treatment 6 (Sulphur at 60 kg/ha + 30 cm x 10 cm).

Number of branches per plant

In Treatment 6 (Sulphur at 60 kg/ha + 30 cm x 10 cm), a significant maximum number of branches per plant of 14.40 was noted. When compared to the control plot, Treatment 4 (Sulphur at 60 kg/ha + 20 cm × 20 cm) had the same number of branches per plant (13.60), which was on par with Treatment 6.

Days to 50% flowering

Treatment 6 (Sulphur at 60 kg/ha + 30 cm x 10 cm) measured at most 50% of flowering 10.80. Sulphur at 75 kg/ha plus 25 cm x 25 cm was used in Treatment 8; nevertheless, when compared to the control plot, plant height was determined to be 8.33 cm, which is comparable to Treatment 6.

Effect of sulphur and spacing on yield attributes of groundnut

Number of Pods/plant

The highest number of pods per plant (28.46) was found in T_6 (Sulphur at 60 kg/ha + 30 x 10 cm). When compared to the control plot, Treatment 5 (Sulphur at 60 kg/ha + 25 x 25 cm) produced 27.19 pods/plant, which was statistically equal to Treatment 6 (Sulphur at 60 kg/ha + 30 x 10 cm). Higher doses of sulphur treatment may promote root growth, cell multiplication, elongation, and expansion in the plant body, leading to an increase in the number of pods per plant and seed yield. Kundu and colleagues (2010) [4]. Higher number of pods/plant may have been feasible due to increased vigour and strength attained by the plants as a result of higher photosynthetic activities with appropriate light availability and supply of nutrients in balanced quantities to the plants at developing phases. Hamakareem and colleagues (2016) [3].

Pod yield/plant (g)

Pod yield ranged from 8.17 to 16.47 g. The highest value for pod yield was recorded for T_6 (16.47 g/ha) i.e Sulphur at 60 kg/ha + 30 x 10 cm followed by T_7 (Sulphur @ 75 kg/ha + 20 cm x 20 cm) is (14.08 g/ha). The lowest value for pod yield was recorded in T_{10} (8.17 g/ha). Sulphur accelerated nutrient uptake which helped the plants to put optimum growth and later on get converted in to reproductive phase. The results were in accordance with Wadile *et al.* (2005) [23]

Number of kernels/pod

No. of kernels per pod ranges from 1.63 to 2.06. The highest kernels/pod was recorded for T_6 (2.06) followed by T_5 (2.02). The lowest value for kernels/pod was recorded for T_{10} (1.63). The fact that sufficient sulphur was accessible throughout the entire time of crop growth for improved vegetative growth and development of groundnut plants is what caused the increase in value of yield-contributing features with larger dosages of sulphur. Sharma *et al.* (2004) [9] observed that the results were comparable.

Kernel yield per plant (g)

Kernel yield/plant ranged from 3.20g to 8.67g. The highest kernel yield/plant was recorded for T_6 (8.67 g) followed by T_9 (7.60 g). The lowest value for kernels/pod was recorded for T_{10} (3.20 g). The ideal spacing of 30x15 cm allowed plants to absorb enough amounts of heat, water, and nutrients from the soil, which in turn led to an increase in the number of pods per plant, the number of seeds per pod, and the test weight, all of which directly contributed to an increase in groundnut seed output. Singh *et al.* (2007) [12] found results that were comparable to those.

Harvest Index (%)

Harvest Index ranges from 36.00 to 58.00. The highest Harvest Index was recorded for T_9 (58.00) followed by T_8 (56.00). The lowest value for kernels/pod was recorded for T_5 (36.00). The availability of sufficient sulphur for better

vegetative growth and development of groundnut plants during the full period of crop growth is what caused the increase in value of yield-contributing features with larger dosages of sulphur. Sharma *et al*. (2004) [9] 's findings were found to be consistent with these findings.

Shelling (%)

Shelling (%) ranges from 55.10 to 73.60. The highest kernels/pod was recorded for T_9 (73.60) followed by T_3 (68.60). The lowest value for kernels/pod was recorded for T_5 (55.10).

Table 1: Effect of Sulphur and spacing on Growth parameters of groundnut

Treatments	Plant height	No. leaves/plant	No. branches/plant	50% of flowering
T_1: Sulphur @ 45 kg/ha + 20 cm x 20 cm	28.66	177.13	10.93	4.93
T_2: Sulphur @ 45 kg/ha + 25x 25 cm	33.06	165.26	11.46	4.26
T_3: Sulphur @ 45 kg/ha + 30 x 10 cm	30.86	171.56	10.86	6.33
T_4: Sulphur @ 60 kg/ha + 20 cm x 20 cm	32.73	190.80	13.60	6.06
T_5: Sulphur @ 60 kg/ha + 25 cm x 25 cm	32.06	160.26	10.46	8.06
T_6: Sulphur @ 60 kg/ha + 30 cm x 10 cm	34.46	221.93	14.40	10.80
T_7: Sulphur @ 75 kg/ha + 20 cm x 20 cm	31.20	193.03	11.06	7.60
T_8: Sulphur @ 75 kg/ha + 25 cm x 25 cm	30.06	209.06	11.66	8.33
T_9: Sulphur @ 75 kg/ha + 30 cm x 10 cm	30.86	182.10	11.66	6.00
T_{10}: Control (Only RDF)	25.73	180.12	9.93	7.33
C.D.	3.282	40.494	2.624	3.182
SE(m)	1.151	14.197	0.920	1.116
SE(d)	1.627	20.078	1.301	1.578
C.V.	6.506	40.494	13.846	28.541

Table 2: Effect of Sulphur and spacing on Yield attributes of groundnut

Treatments	No. of Pods/ plant	Pod yield/plant (g)	No. of kernels/pod	Kernel yield/plant (g/ha)	Harvest Index (%)	Shelling (%)
T_1: Sulphur @ 45 kg/ha + 20 cm x 20 cm	24.92	9.17	1.69	4.15	45.30	63.90
T_2: Sulphur @ 45 kg/ha + 25x 25 cm	25.29	9.69	1.73	4.80	54.70	68.00
T_3: Sulphur @ 45 kg/ha + 30 x 10 cm	26.14	13.52	1.87	4.53	50.70	68.60
T_4: Sulphur @ 60 kg/ha + 20 cm x 20 cm	25.89	11.94	1.83	3.87	52.00	63.00
T_5: Sulphur @ 60 kg/ha + 25 cm x 25 cm	27.19	10.87	2.02	3.33	36.00	55.10
T_6: Sulphur @ 60 kg/ha + 30 cm x 10 cm	28.46	16.47	2.06	8.67	54.00	60.50
T_7: Sulphur @ 75 kg/ha + 20 cm x 20 cm	25.58	14.08	1.77	6.80	54.00	67.70
T_8: Sulphur @ 75 kg/ha + 25 cm x 25 cm	26.45	12.94	1.91	6.93	56.00	64.90
T_9: Sulphur @ 75 kg/ha + 30 cm x 10 cm	26.86	14.19	1.98	7.60	58.00	73.60
T_{10}: Control (Only RDF)	24.61	8.17	1.63	3.20	58.00	67.50
C.D.	0.70	3.002	0.15	0.34	0.86	0.81
SE(m)	0.25	1.053	0.45	0.89	0.19	0.27
SE(d)	1.25	1.489	1.07	1.12	1.34	1.31
C.V.	8.59	15.964	9.56	12.56	10.12	11.12

Conclusion

Based on the results of the present investigation, the following conclusions have been drawn: Incorporating Sulphur @ 60 kg/ha + 30 cm x 10 cm was found superior than all other treatments for plant height (34.46 cm), number of leaves per plant (221.93), number of branches per plant (14.40), 50% of flowering (10.80), No of pods per plant (28.46), pod yield per plant (16.47), No of kernel per pod (2.06), kernel yield per plant (8.67) and Incorporating Sulphur @ 75 kg/ha + 30 cm x 10 cm was found superior for harvest index (58.00%), and also for shelling (%) (73.60). Hence Treatment 6 which is, Sulphur @ 60 kg/ha + 30 cm x 10 cm is more preferable and recommend to the farmers.

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