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Effect of foliar application of liquid organic manures and sulphur on growth and yield of ground nut (*Arachis hypogaea* L.)

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Abstract
A field experiment was conducted during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: Water + Sulphur 20Kg/ ha, T_2: Water + Sulphur 30Kg/ ha, T_3: Water + Sulphur 40Kg/ ha, T_4: Panchagavya – 3% + Sulphur 20Kg/ ha, T_5: 5 Panchagavya – 3% + Sulphur 30Kg/ ha, T_6: Panchagavya – 3% + Sulphur 40Kg/ ha, T_7: Vermiwash 10% + Sulphur 20Kg/ ha, T_8: Vermiwash 10% + Sulphur 30Kg/ ha, T_9: Vermiwash 10% + Sulphur 40Kg/ ha are used. The results showed that application of Panchagavya – 3% + Sulphur 40 Kg/ha was recorded significantly higher plant height (42.05 cm), Plant dry weight (19.38 g/plant), pods/plant (26.43), kernals/pod (2.18), Test weight (37.33 g), Seed yield (2.22 t/ha), Haulm yield (5.65 t/ha), Harvest index (21.99%) as compared to other treatments.

Keywords: Panchagavya, Vermiwash, Sulphur and yield

Introduction
Groundnut is considered to be the most important food legume and oilseed crops of India, which is cultivated in 4.91 million ha area with the production of 9.18 million tonnes and average productivity of 1.86 t/ha (DES, 2018). Groundnut, being an unpredictable legume, its response to nutrient application is always not optimistic. Groundnut oil is composed of mixed glycerides and contains a high percentage of unsaturated fatty acids, such as oleic (50 to 65 percent) and linoleic acid (18 to 30 percent). Groundnut contains amino acids including cysteines which are essential for animal growth (Krishna *et al.,* 2019) [5]. The groundnut cake obtained after oil extraction is rich in protein and considered as valuable organic manure and animal feed, which contains 7 to 8% N, 1.5% P and 1% K. Important reasons for low average yield of groundnut at farmers field were the use of low seed rate and improper agronomic practices, to overcome this issue the appropriate utilization of micro nutrients like sulphur, gypsum etc. are the most important which contribute substantially to the seed yield of groundnut (Kumar *et al.,* 2019) [6].

Groundnut contributes about 40 per cent to the total oilseeds production in the country (Sathya Priya *et al.,* 2013) [10]. At this level of contribution the projected demand of groundnut by 2020 will reached near about 14 million tonnes while the present production level are around the 6.9 million tonnes. Therefore, a gap of about 7.1 million tonnes needs to be filled and this can be possible if the production rate will increase about 2.2 percent per annum. This growth has to come mainly by the increase in productivity though continuous cropping system.

Sulphur plays an important role in groundnut metabolism. It is essential for protein synthesis. It is essential for the 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 and groundnut has been found effective through increasing the number of pegs and pods /plant, kernel to shell ratio etc (Yadav *et al.,* 2018) [15]. Sulphur is also known to promote nodulation in legumes there by N fixation and associated with the crops of spurious nutrition and market quality.

Panchagavya has got reference in the scripts of Vedas (divine scripts of Indian wisdom) and Vrikshayurveda, Panchagavya, an organic product has potential to play the role in promoting growth and providing immunity in plant system.

The use of panchagavya results in higher growth, yield, and quality of crops (Choudhary *et al.*, 2013) [3].

Materials and Methods

The present examination was carried out during *Kharif* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: Water + Sulphur 20Kg/ ha, T_2: Water + Sulphur 30Kg/ ha, T_3: Water + Sulphur 40Kg/ ha, T_4: Panchagavya – 3% + Sulphur 20Kg/ ha, T_5: 5 Panchagavya – 3% + Sulphur 30Kg/ ha, T_6: Panchagavya – 3% + Sulphur 40Kg/ ha, T_7: Vermiwash 10% + Sulphur 20Kg/ ha, T_8: Vermiwash 10% + Sulphur 30Kg/ ha, T_9: Vermiwash 10% + Sulphur 40Kg/ ha are used. The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.1), low in Organic carbon (0.38%), medium available N (225 kg ha^{-1}), higher available P (19.50 kg ha^{-1}) and medium available K (213.7 kg ha^{-1}). In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, and plant dry weight are recorded. The yield parameters like no. of pods/plant, kernals/pod, test weight, Seed yield (t/ha), haulm yield (t/ha) and harvest index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussion

Growth attributes

Plant height

Significantly maximum plant height 42.05 cm was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, plant height 41.97 cm with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) and 41.81 cm with T_9 (Vermiwash 10% + Sulphur 40Kg/ ha) were found at par with T_6 compared to other treatments.

Plant height exhibited an increasing trend with corresponding increase in level of sulphur at all the growth stages. Application of sulphur at 40 kg/ha produced the tallest plants and proved superior to all other doses of applied sulphur at all growth stages. Application of sulphur has been reported to improve not only the availability of sulphur itself but of other nutrients too, which are considered important for the growth and development of plant. which seem to have promoted meristematic activities causing higher apical growth and expansion of photosynthetic surface. (Raja *et al.* 2007) [8] and (Rajiv *et al.* 2012) [9].

Plant dry weight (g/plant)

significantly maximum dry weight 19.38 g was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, dry weight 19.27 g with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) and 19.10 g with T_9 (Vermiwash 10% + Sulphur 40Kg/ ha) were found at par with T_6 compared to other treatments.

Sulphur in the form of sulphate is involved in various metabolic and enzymatic activities of plant. It is also a constituent of glutathione, a compound supposed to play part in plant respiration and synthesis of oils (Jordon and Reisenaur, 2003) [4]. Further, sulphur also plays a vital role in chlorophyll formation as it is constituent of succynyl Co-A which is involved in chlorophyll synthesis (Pirson, 2005) [7].

Yield attrubutes and Yield

Pods/plant

The Pods/plant recorded at harvest, is presented in Table 2. The data shows that there was a significant effect of different treatments on the Pods/plant.

Significantly maximum pods/plant 26.43 was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, pods/plant 26.25 with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) and 26.06 with T_9 (Vermiwash 10% + Sulphur 40Kg/ ha) were found at par with T_6 compared to other treatments.

Kernals/pod

The number of kernals/pod recorded at harvest, is presented in Table 2. The data shows that there was a significant effect of different treatments on the kernals/pod.

Significantly maximum kernals/pod 2.18 was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, kernals/pod 2.10 with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) were found at par with T_6 compared to other treatments.

Test weight (g)

The test weight (g) recorded at harvest, is presented in Table 2. The data shows that there was significant effect of different treatments on the Test weight (g).

Significantly maximum test weight 37.33 g was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, test weight 37.17 g with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) were found at par with T_6 compared to other treatments.

The improvement in yield attributes seems to be due to the balanced nutritional environment. Another probable reason could be efficient and greater partitioning of metabolites and adequate translocation of nutrients towards the developing reproductive structures i.e. sink. Improvement in yield parameters was attributed to diversion of greater proportion of assimilates to the developing pods due to increased sink strength reflected through its larger demand of photosynthates. Supply of sulphur in adequate amount also helps in the development of floral primordia i.e. reproductive parts, which results in the development of capsules and seeds in plant. The application of sulphur thus might have increased the yield attributing parameters in sesame. The yield of a crop is the cumulative effect of yield attributing characters such as capsules per plant, seeds per capsule and test weight. Thus, the seed yield of ground nut also increased significantly due to application of sulphur as a consequence of highest values of above parameters Yadav *et al.* (2018) [15], Anonymous, (2006 and 2009) [1, 2].

Seed yield (t/ha)

The seed yield (t/ha) recorded at harvest, is presented in Table 2. The data shows that there was a significant effect of different treatments on the seed yield (t/ha).

Significantly maximum seed yield 2.22 t/ha was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, seed yield 2.13 t/ha with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) and 2.05 t/ha with T_9 (Vermiwash 10% + Sulphur 40Kg/ ha) were found at par with T_6 compared to other treatments.

Haulm yield (t/ha)

The haulm yield (t/ha) recorded at harvest, is presented in Table 2. The data shows that there was a significant effect of

different treatments on the haulm yield (t/ha).

Significantly maximum haulm yield 5.65 t/ha was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, haulm yield 5.55 t/ha with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) were found at par with T_6 compared to other treatments.

Harvest index (%)

The harvest index (%) recorded at harvest, is presented in Table 2. The data shows that there was a significant effect of different treatments on the harvest index (%).

Significantly maximum harvest index 21.99% was observed in T_6 (Panchagavya 3% + Sulphur 40Kg/ ha). However, harvest index 21.55% with T_5 (Panchagavya 3% + Sulphur 30Kg/ ha) and 21.10% with T_9 (Vermiwash 10% + Sulphur 40Kg/ ha), 20.01% with T_8 (Vermiwash 10% + Sulphur 30Kg/ ha) and 19.85% with T_4 (Panchagavya 3% + Sulphur 20Kg/ ha) were found at par with T_6 compared to other treatments.

Thus, the seed yield of ground nut also increased significantly due to application of sulphur as a consequence of highest values of above parameters. The increase in stalk yield due to sulphur application might be due to the cumulative effect of increased plant height, number of nodules per plant and dry matter production i.e., increased growth parameters. The seed and stalk yields combined together showed significant increase in biological yield of ground nut. The results of the present investigation are in close conformity with the findings of Sriramchandrasekharan (2004) [13], Saren *et al*. (2004) [11], Singh (2007) [12], Tripathi *et al*. (2007) [14] and Rajiv *et al*. (2012) [9].

Table 1: Effect of Liquid organic manures and Sulphur on growth attributes of Groundnut

S. No	Treatments	Plant height (cm)	Dry weight (g/plant)
1.	Water + Sulphur 20Kg/ ha	40.60	18.14
2.	Water + Sulphur 30Kg/ ha	40.75	18.37
3.	Water + Sulphur 40Kg/ ha	40.96	18.43
4.	Panchagavya – 3% + Sulphur 20Kg/ ha	41.35	18.72
5.	Panchagavya – 3% + Sulphur 30Kg/ ha	41.97	19.27
6.	Panchagavya – 3% + Sulphur 40Kg/ ha	42.05	19.38
7.	Vermiwash 10% + Sulphur 20Kg/ ha	41.05	18.60
8.	Vermiwash 10% + Sulphur 30Kg/ ha	41.44	19.05
9.	Vermiwash 10% + Sulphur 40Kg/ ha	41.81	19.10
	F- test	S	S
	S. EM (±)	0.19	0.10
	C. D. (P = 0.05)	0.56	0.31

Table 2: Effect of Liquid organic manures and Sulphur on yield attributes of Groundnut

S. No	Treatments	Pods/plant	Kernals/pod	Test weight (g)	Seed yield (t/ha)	Haulm yield (t/ha)	Harvest index (%)
1.	Water + Sulphur 20Kg/ ha	24.25	1.50	35.69	1.38	4.62	16.99
2.	Water + Sulphur 30Kg/ ha	24.72	1.58	35.91	1.52	4.74	17.37
3.	Water + Sulphur 40Kg/ ha	25.02	1.62	36.28	1.63	4.94	17.94
4.	Panchagavya – 3% + Sulphur 20Kg/ ha	25.59	1.76	36.73	1.91	5.20	19.85
5.	Panchagavya – 3% + Sulphur 30Kg/ ha	26.25	2.10	37.17	2.13	5.55	21.55
6.	Panchagavya – 3% + Sulphur 40Kg/ ha	26.43	2.18	37.33	2.22	5.65	21.99
7.	Vermiwash 10% + Sulphur 20Kg/ ha	25.20	1.67	36.47	1.81	5.06	18.59
8.	Vermiwash 10% + Sulphur 30Kg/ ha	25.91	1.84	36.87	1.99	5.32	20.01
9.	Vermiwash 10% + Sulphur 40Kg/ ha	26.06	1.98	37.01	2.05	5.39	21.10
F- test		S	S	S	S	S	S
S. EM (±)		0.15	0.04	0.06	0.03	0.05	0.83
C. D. (P = 0.05)		0.45	0.11	0.19	0.10	0.16	2.48

Conclusion

On the basis of the experimental findings, it is concluded that for obtaining better growth, yield and profit from production of groundnut the crop should be fertilized with 40kg sulphur and panchagavya 3%, in addition to the recommended doses of fertilizers. These findings are based on one season; therefore, further trails may be required for considering it as recommendation.

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