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The evaluate growth and yield of groundnut as influenced by different treatments

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Abstract
The present investigation entitled "Effect of Sulphur Management on Growth and Yield of Groundnut (*Arachis hypogea* L.))" was conducted during the *kharif* season of 2024-25 at Agronomy Research Farm of Vivekananda Global University, Jaipur. The experiment consisted of seven level of sulphur (0, 10 kg, 20 kg, 30 kg , 40 kg, 50 kg and 60 kg ha^{-1}). The 7 treatment combinations were tested in randomized block design with three replications. The application of sulphur @ 60 kg ha^{-1} recorded significantly higher value of seed and haulm yield**,** dry pod yield, number of pods and number seeds per pod ascomparedwithallsulphurtreatments. However,drymatter accumulation and yield and number of seeds per pods were at par with 50 kg S ha^{-1}.

Keywords: Sulphur

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the important edible oilseed and high-value cash crop, especially in tropical and subtropical regions of the world. Groundnut is the world's fourth most important source of edible oil (44-56%), third-most valuable source of high-quality vegetable protein (22-30%), carbohydrates (20%) also containing significant amount of essential fatty acids, vitamins and minerals required for human nutrition (Ojiewo *et al*., 2020) [12]. Globally, groundnut is cultivated in 120 countries across 327 lakh hectares with a total global production of 539 lakh tonnes (FAOSTAT, 2021) [6].

Groundnut is also an important food and oilseed crop in India, cultivated across a wide range of agro-climatic conditions. It is mostly grown (83% of total groundnut area) under rainfed conditions during the monsoon season (June/July to October/November), and the remaining 17% is grown under irrigated conditions in the post-monsoon (October-March) season (Kadiyala *et al.*, 2021) [10]. Globally, India ranks first in groundnut cultivation with an acreage of 54.2 lakh hectares and stands second in the production statistics with 101 lakh tonnes of production, with an average productivity of 1863 kg/ha (AICRPG, 2023) [1]. Groundnut cultivation in the country is mainly concentrated in the states of Gujarat, Rajasthan, Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka, and Madhya Pradesh (AICRPG, 2023) [1].

Groundnut is the principal oilseed crop during the *Kharif* season in the state of Rajasthan, where its cultivation is concentrated in districts of Bikaner, Sikar, Churu, Jodhpur, Jaipur, Ganganagar, Hanumangarh, Chittorgarh and Nagaur. It was grown over 7.78 lakh ha in the state with a production of 17.53 lakh tonnes and an average productivity of 2256 kg/ha (AICRPG, 2023) [1].

Sulphur is now recognised as fourth major plant nutrient following nitrogen, phosphorus and potassium. It is also considered an essential component of balanced fertilisation and nutrition, especially for oilseed crops in general and groundnut in particular. Sulphur is an essential nutrient that plays a vital role in determining both the yield and oil content of oilseed crops. It supports higher productivity by enhancing photosynthesis, facilitating protein synthesis and promoting better root development. Sulphur is one of the essential plant nutrients widely recognised for its important and specific role in the synthesis of sulphur-containing amino acids such as methionine (20%) and cysteine (27%) as well as in the production of proteins, chlorophyll and oil in groundnut (Zenda *et al.*, 2021) [16].

Materials and methods

A field experiment entitled "Effect of Sulphur Management on Growth and Yield of Groundnut (*Arachis hypogea* L.)"was conducted at Agronomy farm, Vivekananda Global University, Jaipurduring *Kharif* seasons of the years 2024-25.The experiment was laid out at Agronomy Farm, Vevakananda Global University, Jaipur during *Kharif* seasons of 2024. Jaipur is situated at 26^0 5" North latitude and 75^0 28" East longitudes at an altitude of 427 meters above mean sea level. In Rajasthan, this region falls under Agro-climatic zone-IIIA (Semi-Arid Eastern Plains).The climate of this region is a typically semi-arid, characterized by extremes of temperature during both summers and winters. The average annual rainfall of this tract varies from 450 mm to 500 mm most of which is received during the period of July to September. There is hardly any rain during winter. As the climate affects the growth, yield and quality of agricultural product, it is necessary to present climatic variables in this chapter. The data revealed that *crop* season witnessed a rainfall of 396 mm. The mean daily maximum and minimum temperatures during the growing season of groundnut fluctuated between 28.2 to 37.9 ^{0}C and 14.6 to 26.2^{0}C, respectively. Similarly, mean daily relative humidity ranged between 41 to 91 per cent. The average sunshine hours per day ranged between 5.0 to 9.8.

Results

The data on plant height ofgroundnut recorded at 30 DAS, 60DAS and at harvestasinfluenced by differentsources andlevels ofsulphurare presentedin Table 1. The revealed that plant height of groundnut at 30 DAS was not significantly influenced due to different sources and levels of sulphur. Application of 60 kg S ha^{-1} (T_7) recorded significantly the highest plant height at 60 DAS (39.51 cm) and at harvest (49.87 cm) which were found statisticallyatparwithtreatmentsT_7(60kgSha^{-1}),T_6(50kgSha^{-1}) and T_5 (40 kg S ha^{-1}).

Table 1: Effect of Sulphur Management onplantheight of groundnut

Treatments	Plantheight(cm)		
	30 DAS	60 DAS	Atharvest
T_1 - 0 kg S ha^{-1}(Control)	16.04	37.54	39.70
T_1 -10 kg S ha^{-1}	16.41	38.11	41.20
T_1 -20 kg S ha^{-1}	16.61	38.31	42.30
T_1 -30 kg S ha^{-1}	16.70	38.7	43.45
T_5 -40 kg S ha^{-1}	17.06	38.95	44.57
T_6 -50 kg S ha^{-1}	17.02	39.34	46.80
T_7 -60 kg S ha^{-1}	17.10	39.51	49.87
SEm±	0.33	0.62	1.73
CDat5%	1.00	1.87	5.24

Dry matter accumulation

The maximum dry matter accumulation 30, 60 and at harvest (21.90,181.20 and 264.14 g/plant) was recorded due totheapplicationof60kgsulphurha^{-1}anditwasstatisticallysignificant as compared with all the levels of sulphur. The increase in levels of sulphur from 0 to 60 Kg ha^{-1} resulted in a significant increase in the dry matter accumulation of groundnut g/plant from 21.90 and 264.14. Thedry matter accumulation increased progressively with increasing levels of sulphur from 0 to 60 Kg ha^{-1}. The results showed that there was concomitant increase in dry matter accumulation with an increase in levels of sulphur Table 2).

Table 2: Effect of Sulphur Management ondry matter accumulation of groundnut

Treatments	Dry matter accumulation (g/plant)		
	30 DAS	60 DAS	Atharvest
T_1 - 0 kg S ha^{-1}(Control)	19.78	131.10	231.56
T_1 -10 kg S ha^{-1}	20.66	141.43	240.40
T_1 -20 kg S ha^{-1}	20.89	150.20	245.54
T_1 -30 kg S ha^{-1}	21.11	155.42	249.20
T_5 -40 kg S ha^{-1}	21.62	166.20	255.47
T_6 -50 kg S ha^{-1}	21.82	179.20	261.21
T_7 -60 kg S ha^{-1}	21.90	181.20	264.14
SEm±	0.89	6.87	10.52
CDat5%	2.69	20.84	31.89

Number of pods plant^{-1}

The highest number ofpods plant^{-1} (12.95) was recorded due to the applicationofsulphur @ 60 kg ha^{-1}and it was significantlysuperior over 10, 20 and 30 kg sulphur ha^{-1} and control treatments. The control treatment showed the lowest pod yield (6.38) as compared with other levels of sulphur.

Table 3: Effect of Sulphur Management onnumber of pods per plant of groundnut

Treatments	Number of pods plant^{-1}	Number of seeds pod^{-1}	Test weight (g)
T_1 - 0 kg S ha^{-1}(Control)	6.38	1.30	26.81
T_1 -10 kg S ha^{-1}	8.13	1.40	27.61
T_1 -20 kg S ha^{-1}	10.50	1.45	28.1
T_1 -30 kg S ha^{-1}	11.00	1.65	29.82
T_5 -40 kg S ha^{-1}	12.25	1.65	30.39
T_6 -50 kg S ha^{-1}	12.65	1.80	31.08
T_7 -60 kg S ha^{-1}	12.95	2.00	31.22
SEm±	0.50	0.07	0.43
CDat5%	1.52	0.21	1.30

Number of seeds pod^{-1}

An assessment of data (Table 3) revealed that different sources and levels of sulphur manifested their significant influence on number of seeds per pods. The maximum number of seeds per pods (2.00) were observed due to the treatment T_7(60 kg S ha^{-1}) and this treatment showed statistical par with treatments T_6 (50 kg S ha^{-1}), T_5 (40 kg S ha^{-1}) and T_4 (30 kg S ha^{-1}). Whereas, significantly the lowest number of seeds per pods (1.30) was treatment T_1 (0 kg S ha^{-1}).

Pod yield (kg ha^{-1})

The resultsshowed that the highest pod yield (1930 kgplant^{-1}) ofgroundnut was observed dueto the application ofsulphur @60KgS ha^{-1}. It was followed by 40 and 50 Kg S ha^{-1} (1850 and 1910 kg ha^{-1} respectively). They were at par to eachother.The control treatment showed the lowest pod yield (1520 kg ha^{-1}) as comparedwith other levels ofsulphur (Table 3).

Test weight (g)

An assessment of data (Table 3) revealed that different sources and levels of sulphur manifested their significant influence on 100 seed test weight. The maximum test weight (31.22) were observed due to the treatment T_7(60 kg S ha^{-1}) and this treatment showed statistical par with treatments T_6 (50 kg S ha^{-1}), T_5 (40 kg S ha^{-1}) and T_4 (30 kg S ha^{-1}). Whereas, significantly the lowest seed weight (26.81) was treatment T_1 (0 kg S ha^{-1}).

yield attributes

The resultsshowed that the highest pod yield (1930 kgplant^{-1}) ofgroundnut was observed dueto the application ofsulphur @60KgS ha^{-1}. It was followed by 40 and 50 Kg S ha^{-1} (1850 and 1910 kg ha^{-1} respectively). They were at par to eachother.The control treatment showed the lowest pod yield (1520 kg ha^{-1}) as comparedwith other levels ofsulphur (Table 4).

The haulm yield of groundnut was significantly increased with increase in levels of sulphur. The highest haulm yield (5405 kg ha^{-1}) was observed due to the application of 60 Kg S ha^{-1} and it was significantly superior over rest of the treatments. However, the lowest haulm yield (3226 kg ha^{-1}) was recorded by without application of sulphur to the groundnut crop.

The biological yield of groundnut was significantly increased with increase in levels of sulphur. The highest biological yield (5335 kg ha^{-1}) was observed due to the application of 60 Kg S ha^{-1} and it was significantly superior over rest of the treatments.

The harvest index of groundnut was non significantly with increase in levels of sulphur

Table 4: Effect of Sulphur Management onpod, haulm, biological yield and harvest index of groundnut

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
T_1 - 0 kg S ha^{-1}	1520	3226.00	4746.00	32.03
T_1 -10 kg S ha^{-1}	1620	3256.00	4876.00	33.22
T_1 -20 kg S ha^{-1}	1720	3288.00	5008.00	34.35
T_1 -30 kg S ha^{-1}	1740	3312.80	5052.80	34.44
T_5 -40 kg S ha^{-1}	1765	3324.30	5089.30	34.68
T_6 -50 kg S ha^{-1}	1795	3371.65	5166.65	34.74
T_7 -60 kg S ha^{-1}	1820	3405.00	5225.00	34.83
SEm±	72	137.40	209.75	1.42
CDat5%	220	416.70	636.10	NS

Discussion

However, it is at par with 50 Kg sulphur ha^{-1}. Similar observation was found by Misra (2003). He observed that the highestseed 1930 Kg ha^{-1} and haulm 3405 Kg ha^{-1} yield of mustard with the application of S at the rate of 60 Kg ha^{-1} which were 26.97 per cent higher in comparison to control respectively. The reason for higher growth with split application might be the fact that early application ensures better early root growth and nodulation by supplying calcium and sulphur when root hairs are forming, while the later application synchronizes calcium and sulphur availability with high metabolic demand during flowering and pod development stages which ultimately led to higher dry matter accumulation and a higher number of branches, CGR, RGR and nodulation. Further, split application of gypsum also helps in minimising nutrient losses through leaching and ensures continuous nutrient supply throughout the crop life cycle. Overall, both the levels and scheduling of gypsum application play a critical role in optimizing growth dynamics and enhancing the physiological efficiency of the groundnut crop. These results are consistent with the observations reported by Bhattacharya *et al.* (1997) [4].

Sangale and Sonar (2004) [13] also observed that the application of increasing levels of S up to30Kgha^{-1}increased soybeanseed yields over control. Each higher level ofS up to30 Kg ha^{-1}(i.e.10, 20and 30 Kg S ha^{-1}) increasedsoybeanseed yields over the lower level. The highest soybean yield of 25.1 q ha^{-1} was observed at 30 Kg S ha^{-1}. Tageldin and Salama (1987) [15] observed that the pod yield of groundnut was significantly increased by sulphur treatment than control. The greatest response recorded at or below 50 Kg ha^{-1} applied at sowing.

The significantly higher number ofpods/plant, number of seeds/pod, weight, haulm yield, biological yield and root biomass were recorded with application of 60 kg S/ha over 50 kg S/ha and control. The pod yield, kernel yield, harvest index and sound mature kernel of groundnut increased significantly with successive increase in level of gypsum from 0 to 60 kg/ha (Table 4.6). The significantly higher pod yield, kernel yield, harvest index and sound mature kernel of groundnut were recorded with application of 600 kg gypsum/ha over 400, 200 kg gypsum/ha and control.

Awlad *et al*. (2003) [2] concluded that the dry matter yield of groundnut at different growth stages were significantly affected with the increasing levels of S and Zn application. Similar observation was recorded by Baviskar *et al.* (1968) [3]. He concluded that the significantly higher straw yield (40.32 q ha^{-1}) was observed over control and 15 Kg S ha^{-1}. Giri *et al.* (2005) [8] also reported similar results that the dry matter production due to 20, 40 and 60 Kg S ha^{-1} was at par with each other, they were significantly superior over zero Kg S ha^{-1}. Kale and Adsule (2009) [11] also observed that the application of sulphur resulted significant increase in dry matter yield of sunflower upto 30 mg S Kg^{-1} soil in all the soils over control. Groundnut possesses a distinctive trait among leguminous crops, as its pods develop underground. Unlike most crops where developing fruits primarily receive nutrients from the shoot system via transpirational pull through the xylem, calcium behaves differently in groundnut. It tends to accumulate in the leaf tissues as calcium oxalate and is inefficiently translocated to the developing pods. As a result, groundnut pods depend on the direct absorption of calcium from the soil surrounding them rather than from aboveground tissues (Dutta *et al.*, 2004) [5]. This highlights the importance of soil application of calcium, particularly during critical reproductive stages such as flowering and pegging. Ensuring calcium availability in the pod zone at the right time facilitates peg penetration, promotes pod set, and supports the development of healthy, fully formed pods (Jena *et al*., 2006) [9].

Conclusion

The application of sulphur @ 60 kg ha^{-1} recorded significantly higher value of seed and haulm yield**,** dry pod yield, number of pods and number seeds per pod ascomparedwithallsulphurtreatments. However,drymatter accumulation and yield and number of seeds per pods were at par with 50 kg S ha^{-1}.

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