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Mahesh Namdev Shingare
M.Sc. Scholar, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Renuka Bhakher
M.Sc. Scholar, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Rashmi Vishwajna
M.Sc. Scholar, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Mahesh Namdev Shingare
M.Sc. Scholar, Department of Agronomy, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Influence of sulphur and iron on growth and yield of groundnut

Mahesh Namdev Shingare, Renuka Bhakher and Rashmi Vishwajna

Abstract
At the Department of Agronomy, SHUATS, Prayagraj (U.P), a field experiment was carried out during Kharif 2022. The experiment was set up using a Randomized Block Design, with each of the ten treatments being reproduced three times. The result showed that growth parameters *viz.* no. of nodule/plant (49.17) was recorded significantly maximum with the application of Sulphur 60 kg ha^{-1} + FeSO4 (0.75%) and in between 40-60 DAS, Crop Growth Rate (1.94 g/m^2/day), no. of pods $plant^{-1}$ (27), seed index (36.95 g) and halum yield (3.42 t/ha) were recorded significant maximum with the application of Sulphur at 60 kg ha^{-1} and $FeSO_4$ (1%). Highest Harvest index (43.38%) were observed with the application of Sulphur 60 kg ha^{-1} and FeSO4 (0.5%) were found non-significant.

Keywords: Groundnut, sulphur, iron, CGR, RGR

1. Introduction
One of the primary legume crops in tropical and semiarid countries, the groundnut or peanut is a significant source of vegetable protein and edible oil. Protein makes up 25–36% of groundnut kernels and 47–53% of the oil. A self-pollinating plant, groundnut produces flowers above ground, and following fertilization, pegs travel toward the soil, where they mature into seed pods that are buried beneath the soil. Although it is also grown as an irrigated crop, groundnut is generally grown as a rainfed crop. It is a versatile crop with great nutritional value that produces food, oil, and has good fodder for cattle in the form of its leaf or haulm. About 48.32% of it is oil, followed by 22-25% protein, 20% carbohydrates, 5% fibre and ash, and vitamins B and E. In addition to being the highest plant source of thiamine, it is also the largest source of niacin, which is scarce in grains. The Greek words arachis, which refers to the legume, and hypogaea, which indicates below ground, are combined to form the name *Arachis hypogaea* L.

As the fourth key nutrient, sulphur is crucial for the nutrition of oil-seed crops and contains the amino acids cystine, cysteine, and methionine (Gangadhara *et al*. 1990) [3]. The creation of disulphide bonds between polypeptide chains is one of sulphur's primary roles in proteins or polypeptides. When it comes to the stabilization and conformation of proteins, disulphide bonds are extremely important. Sulphur treatment enhanced groundnut's intake of numerous macro and micronutrients. (Patel *et al*. 2018) [7]. It also affects the synthesis of vitamins (thiamine, biotin), as well as the coenzyme-A metabolism of proteins, carbohydrates, and lipids. Proteins include sulphur, which is also essential for the creation of oil.

Foliar application of micronutrients is more advantageous than soil application because the application rate of the nutrient is relatively lower and nutrient absorption is higher. In addition, foliar treatment is always a suitable substitute when roots are unable to supply vital nutrients.

Among its many important functions in the growth and development of plants, iron enhances the effectiveness of photosystems and helps plants produce chlorophyll. It is an essential part of several enzymes. Iron is also involved in the oxidation process that releases energy from sugars and starches as well as the reactions that convert nitrate into ammonium in plants. It is crucial for the metabolism of nucleic acids. (Havlin *et al*., 2014) [5]. Although cereal crops only need a tiny quantity of Fe for good growth and life cycle completion, it is crucial. According to Fernando *et al*. (2009) [2], iron foliar treatments are typically based on Fechelates or Fe-salt solutions and are absorbed through the cuticle or stomata.

2. Materials and Methods
The experiment was carried out at the Crop Research Farm, Department of Agronomy, Sam

Higginbottom University of Agriculture, Technology, and Sciences during the kharif season of 2022. Three replications and 10 treatments were used in the experiment's Randomised Block Design. Different rates of Sulphur levels *viz.*, 20, 40, 60 kg/ha with three $FeSO_4$ levels *viz.*, 0.5, 0.75, 1% and recommended doses of fertilizer are Nitrogen @20 kg/ha, Phosphorus @40 kg/ha and potassium @20 kg/ha. Seeds are sown at a spacing of 30 cm×10 cm according to a seed rate of 90 kg/ha. Urea, SSP, and MOP were chosen as the N, P, and K fertiliser sources, respectively. Data were calculated and analysed using the statistical technique of Gomez and Gomez (1984) [4].

Treatment combinations

T_1: Sulphur 20 kg ha^{-1} + $FeSO_4$ 0.5%, T_2: Sulphur 20 kg ha^{-1} + $FeSO_4$ 0.75%, T_3: Sulphur 20 kg ha^{-1} + $FeSO_4$ 1%, T_4: Sulphur 40 kg ha^{-1} + $FeSO_4$ 0.5%, T_5: Sulphur 40 kg ha^{-1} + FeSO4 0.75%, T_6: Sulphur 40 kg ha^{-1} + $FeSO_4$ 0.1%, T_7: Sulphur 60 kg ha^{-1} + FeSO4 0.5%, T_8: Sulphur 60 kg ha^{-1} + FeSO4 0.75%, T_9: Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.1%, T_{10}: Control RDF.

3. Results and Discussions

1. No. Of nodule plant^{-1}

At 80 DAS, significantly higher no. of nodule plant^{-1} (49.17) was observed in T_8 (Sulphur 60 kg ha^{-1} + FeSO4 0.75%). However, T_9 (Sulphur 60 kg ha^{-1}+ $FeSO_4$ 1%) which was statistically at par with T_8 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.75%). It might be increased nodulation, root development, and nitrogen fixation are results of sulphur treatment. Similarly, reported by Solaimalai *et al.* (2020) [9].

2. Crop growth rate (g $m^{-2}day^{-1}$)

In between 40-60 DAS, significant and higher crop growth rate (1.94 g m^{-2} day^{-1}) was observed in T_9 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 1%). However, T_8 (Sulphur at 60 kg/ha + $FeSO_4$ 0.75%), T_7 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.5%) and T_6 (Sulphur at 40 kg ha^{-1} + $FeSO_4$ 1%) which was statistically at par with T_9 (Sulphur60 kg ha^{-1} + $FeSO_4$ 1%). It might be due to the application of Sulphur plays a role in plant metabolism, which may boost photosynthesis. Similar results were observed by Sisodiya *et al.* (2016) [8].

3. Number of pods plant^{-1}

Significant and higher number of pods/plant (27) was recorded in T_9 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 1%). However, T8(Sulphur at 60 kg ha^{-1} + $FeSO_4$ 0.75%), T_7 (Sulphur at 60 kg ha^{-1} + $FeSO_4$ 0.75%) which is statistically at par with T_9 (Sulphur at 60 kg ha^{-1} + $FeSO_4$ 1%). It might be due to higher Sulphur treatment doses were better for root development, cell multiplication, elongation, and expansion in the plant body, which eventually boosted the seed production. Kundu *et al.* (2010) [6].

4. Seed index (g)

At harvest, higher seed index (36.65g) was observed in T_9 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 1%). However, T_8 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.75%), T_7 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.75%) which was statistically at par with T9(Sulphur 60 kg ha^{-1} + $FeSO_4$ 1%). It might be due to applying a larger dose of sulphur improved root development, cell multiplication, cell elongation, and cell expansion in the plant body, which eventually boosted the seed production reported by Dutta and Patra *et al.* (2005) [1].

5. Halum yield (t ha^{-1})

At harvest significantly higher haulm yield (3.42t ha^{-1}) was observed in T_9 (Sulphur at 60 kg ha^{-1} + $FeSO_4$ 1%). However, T_8 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.75%), T_5(Sulphur 40 kg ha^{-1} + $FeSO_4$ 0.75%) and T_7 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.5%) which was statistically at par with T9(Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.75%).

6. Harvest index (%)

At harvest, highest harvest index (43.38%) was observed in T_7 (Sulphur 60 kg ha^{-1} + $FeSO_4$ 0.5%) though the data was non-significant.

Table 1: Response of sulphur and iron on growth attributes of groundnut

S. N.	Treatment combinations	No. of nodule/plant	Crop Growth Rate (g/m^2/day)
1.	Sulphur at 20 kg ha^{-1} + $FeSO_4$ 0.5%	40.67	1.28
2.	Sulphur at 20 kg ha^{-1} + $FeSO_4$ 0.75%	42.33	0.85
3.	Sulphur at 20 kg ha^{-1} + $FeSO_4$ 1.0%	41.17	1.62
4.	Sulphur at 40 kg ha^{-1} + $FeSO_4$ 0.5%	41.83	1.22
5.	Sulphur at 40 kg ha^{-1} + $FeSO_4$ 0.75%	44.57	1.33
6.	Sulphur at 40 kg ha^{-1} + $FeSO_4$ 1.0%	44.00	1.65
7.	Sulphur at 60 kg ha^{-1} + $FeSO_4$ 0.5%	44.67	1.67
8.	Sulphur at 60 kg ha^{-1} + $FeSO_4$ 0.75%	49.17	1.93
9.	Sulphur at 60 kg ha^{-1} + $FeSO_4$ 1.0%	46.50	1.94
10.	Control (RDF20:40:20 NPK kg ha^{-1})	40.33	1.34
	F test	S	S
	S.Em(±)	1.29	0.21
	C.D. (P=0.05	3.83	0.62

Table 2: Response of sulphur and iron on yield attributes of groundnut

S.N.	Treatment Combinations	No. of pods/plant	Seed index (g)	Kernel Yield (t/ha)	Harvest Index (%)
1.	Sulphur at 20 kg ha^{-1} + $FeSO_4$ 0.5%	18.50	33.00	2.67	37.48
2.	Sulphur at 20 kg ha^{-1} + $FeSO_4$ 0.75%	20.33	32.71	2.70	40.74
3.	Sulphur at 20 kg ha^{-1} + $FeSO_4$ 1.0%	20.50	33.11	2.72	40.21
4.	Sulphur at 40 kg ha^{-1} + $FeSO_4$ 0.5%	22.33	33.59	2.92	43.14
5.	Sulphur at 40 kg ha^{-1} + $FeSO_4$ 0.75%	23.00	34.12	3.20	38.45
6.	Sulphur at 40 kg ha^{-1} + $FeSO_4$ 1.0%	22.50	34.78	2.99	41.30
7.	Sulphur at 60 kg ha^{-1} + $FeSO_4$ 0.5%	24.67	36.58	3.18	43.38
8.	Sulphur at 60 kg ha^{-1} + $FeSO_4$ 0.75%	25.83	36.74	3.38	39.52
9.	Sulphur at 60 kg ha^{-1} + $FeSO_4$ 1.0%	27.00	36.95	3.42	41.58
10.	Control (RDF20:40:20 NPK kg ha^{-1})	17.17	32.02	2.23	35.96
	F test	S	S	S	NS
	S.Em(±)	1.24	1.0	0.22	4.81
	C.D. (P=0.05)	3.69	2.95	0.65	-

4. Conclusion
From the study, it can be concluded that sulphur and iron combination shows positive effect on groundnut. Thus increase the yield as well morphological characters.

5. Conflict of interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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