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Effect of sources and levels of sulphur on nutrient composition of *kharif* groundnut and soil properties

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Abstract

A field experiment was laid out at the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat during the *kharif* season of 2025 to find out the effect of different sources and levels of sulphur on nutrient composition of *kharif* groundnut and soil properties. The experiment was laid out in a Randomized Block Design with three replications. The results revealed that the application of 40 kg S/ha through sulphur coated urea recorded significantly higher groundnut yield, S content and N, P, K and S uptake in kernel and haulm, and was remained at par with the application of 40 kg S/ha through all other sources i.e., gypsum, bentonite sulphur, potassium thiosulphate, ammonium sulphate and sulphur coated urea. Available nitrogen and sulphur in soil were increased significantly with the application of 40 kg S/ha through sulphur coated urea followed by the application of 40 kg S/ha through gypsum, bentonite sulphur, potassium thiosulphate, ammonium sulphate as well as sulphur coated urea.

Keywords: Sulphur, sources, levels, content, uptake, soil, groundnut

1. Introduction

Groundnut is a most important oilseed and legume crop, commonly referred as 'Poor man's almond'. Its kernels are rich in edible oil (40-45%) and easily digestible protein content (about 25%). As it produces oil and protein rich kernels, contains root nodules that fixes atmospheric nitrogen, it requires optimum nutrient availability. Generally in India, farmers consider N, P and K fertilizers for nutrient management in any crop. Therefore in these soils, a sulphur deficiency is increasingly being reported due to intensive cultivation, reduced application of organic manure and intensive application of sulphur-deficient fertilizers such as urea, DAP (Di-Ammonium Phosphate) and MOP (Muriate of Potash). All these operations have led to sudden S deficiencies in nearly 180 districts which affects the yield and quality of over 40 crops such as groundnut (Tandon, 1991, and Singh and Shivay, 2019) ^[11, 10]. This sulphur deficiency may results into poor yield and quality of leguminous crops.

Sulphur (S) is firmly placed as the fourth major plant nutrient following nitrogen (N), phosphorus (P) and potassium (K). It plays an important role in the biosynthesis of major amino acids such as cysteine and methionine and is a necessary component of oil formation in oilseed crops. Sulphur is also a component of most coenzymes involved in physiological processes such as photosynthesis, respiration and symbiotic nitrogen fixation in legume-Rhizobium symbiosis (Tandon and Messick, 2002; Singh, 1999) ^[13, 9]. Sulphur enhances protein and oil yields, nodulation and chlorophyll content and prevents chlorosis (Tewatia *et al.*, 2006) ^[14]. It also improves the uptake of other macro and micronutrients and helps maintain soil pH balance, thereby enhancing overall soil nutrient availability and plant health (Patel *et al.*, 2020) ^[7]. Among the various sources available, gypsum, bentonite sulphur, potassium thiosulphate, ammonium sulphate and sulphur coated urea differ in their solubility and rate of sulphur release, which in turn influences their use efficiency in improving yield and quality of groundnut as well as soil nutrient status. Keeping this in view, the present investigation was undertaken to study the effect of different sources and levels of sulphur on the nutrient composition of *kharif* groundnut and soil properties.

2. Materials and Methods

A field experiment was conducted during the *kharif* season of 2025 at Plot No. 12, Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat. The region has a semi-arid subtropical climate with an average annual rainfall of about 800-900 mm, mostly received from the south-west monsoon between mid-June and mid-September. The experimental soil was loamy sand in texture, slightly alkaline in reaction, low in organic carbon, available nitrogen and sulphur, medium in available phosphorus and potassium.

The experiment was laid out in a Randomized Block Design (RBD) with three replications. It comprised eleven treatments as follows: T₁: Control (RDF); T₂: 20 kg S/ha through gypsum; T₃: 40 kg S/ha through gypsum; T₄: 20 kg S/ha through bentonite sulphur; T₅: 40 kg S/ha through bentonite sulphur; T₆: 20 kg S/ha through potassium thiosulphate; T₇: 40 kg S/ha through potassium thiosulphate; T₈: 20 kg S/ha through ammonium sulphate; T₉: 40 kg S/ha through ammonium sulphate; T₁₀: 20 kg S/ha through sulphur coated urea; and T₁₁: 40 kg S/ha through sulphur coated urea. All plots received a uniform recommended dose of fertilizer (RDF) of 12.5:25:00 kg NPK/ha, with 50% nitrogen applied as basal and the remaining dose was applied as top dressing at 30 DAS (except treatments T₈ to T₁₁). Groundnut variety GG 34 was used at a seed rate of 120 kg/ha. The plant samples were analyzed for their N, P, K and S content (Jackson, 1973 and Tandon, 1993)^[2, 12] and their uptake was measured based on nutrient content and yield after harvest of groundnut and expressed in kg/ha. The protein in kernel was calculated by multiplying using factor 6.25. After harvest of groundnut, soil samples were analyzed for pH, EC, Available N, P₂O₅, K₂O and S using standard procedures. The experimental data were statistically analysed as per the method given by Panse and Sukhatme (1985)^[5].

3. Results and Discussion

3.1 Kernel and haulm yield

The data regarding kernel and haulm yield of groundnut was significantly influenced by sources and levels of sulphur as given in Table 1. The treatment T₁₁ (40 kg S/ha through sulphur coated urea) recorded significantly higher kernel (1637 kg/ha) and haulm (3490 kg/ha) yield over other treatments but was remained at par with T₃, T₅, T₇ and T₉. The increase in yield under higher sulphur levels could be ascribed to improved vegetative growth, increased nodulation and better partitioning of photosynthates towards reproductive organs. These findings are in close accordance with those reported by Giri *et al.* (2014)^[3] and Pawan *et al.* (2024)^[8].

3.2 Nutrient content in kernel and haulm

The experimental data given in Table 1 showed that the different sources and levels of sulphur significantly influenced the sulphur content in kernel and haulm of *kharif* groundnut. The N, P and K content were not influenced significantly by these treatments. Among the different treatments, treatment T₁₁ (40 kg S/ha through sulphur coated urea) recorded significantly higher sulphur content in kernel

(0.435%) and haulm (0.350%), which was remained at par with the treatments T₃, T₅, T₇ and T₉. An increase in sulphur concentration in kernels may be due to increased sulphate availability in soil, improved nutrient uptake and efficient translocation of sulphur from vegetative tissues to developing seeds. Similar observations were reported by Manaf *et al.* (2017)^[4].

3.3 Nutrient uptake by kernel and haulm

The different sources and levels of sulphur produced a significant effect on nutrient uptake by kernel and haulm of groundnut (Table 2). The treatment T₁₁ (40 kg S/ha through sulphur coated urea) gave significantly maximum N uptake by kernel (57.54 kg/ha) than other treatments except treatments T₂, T₃, T₅, T₇ and T₉. Whereas, significantly maximum uptake of P, K and S (10.02, 13.62 and 7.12 kg/ha, respectively) by kernel was recorded with the treatment of 40 kg S/ha through sulphur coated urea (T₁₁) and was found to be at par with the treatments T₃, T₅, T₇ and T₉.

In case of nutrient uptake by haulm, the treatment of application of 40 kg S/ha through sulphur coated urea (T₁₁) recorded significantly maximum uptake of nitrogen (55.81 kg/ha), phosphorus (14.70 kg/ha), potassium (40.09 kg/ha) and sulphur (12.15 kg/ha) by haulm as compared to other treatments but was remained at par with the treatments T₃, T₅, T₇ and T₉. The increase in sulphur uptake with applied higher level of sulphur may be attributed to better sulphur availability in the root zone, improved assimilation processes and enhanced enzymatic and protein synthesis activities within the plant system. These results are also concurrent with the findings of Patel *et al.* (2018)^[6].

3.4 Soil properties

Application of different sources and levels of sulphur had not significant influence on pH, EC, organic carbon, available phosphorus and potassium in soil after harvest of groundnut (Table 3). But the available nitrogen and sulphur in soil was significantly influenced by the application of sulphur. The treatment receiving 40 kg S/ha through sulphur coated urea (T₁₁) gave significantly maximum available nitrogen (212 kg/ha) and sulphur (10.98 mg/kg) in soil than other treatments, but was remained at par with the treatments T₃, T₅, T₇ and T₉. The treatments receiving higher levels of sulphur (40 kg S/ha) generally maintained greater residual nitrogen availability compared to their respective lower levels. This improvement in soil available nitrogen may be attributed to enhanced mineralization processes, better nutrient transformation and favorable soil conditions created by adequate sulphur supply. Whereas the increase in available sulphur may be ascribed to direct addition of sulphur through different fertilizers and its gradual oxidation into sulphate form, thereby enhancing its availability in soil. Slow and sustained nutrient release from sulphur-coated urea, bentonite sulphur and other sulphur-containing fertilizers also aided in maintaining greater residual sulphur status after crop harvest. These observations are in close conformity with the findings of Giri *et al.* (2014)^[3] and Dileep *et al.* (2021)^[1].

Table 1: Effect of sources and levels of sulphur on yield, nutrient content in kernel and haulm of *khari* groundnut

Treatments	Kernel yield (kg/ha)	Haulm yield (kg/ha)	Nutrient content in kernel				Nutrient content in haulm			
			N (%)	P (%)	K (%)	S (%)	N (%)	P (%)	K (%)	S (%)
T ₁ : (Control) (RDF)	1267	2806	3.25	0.531	0.752	0.354	1.40	0.375	0.97	0.312
T ₂ : (20 kg S/ha through gypsum)	1365	3047	3.36	0.557	0.787	0.385	1.47	0.394	1.03	0.322
T ₃ : (40 kg S/ha through gypsum)	1596	3413	3.50	0.606	0.829	0.429	1.58	0.416	1.13	0.343
T ₄ : (20 kg S/ha through bentonite sulphur)	1323	2994	3.33	0.552	0.777	0.377	1.46	0.388	1.00	0.319
T ₅ : (40 kg S/ha through bentonite sulphur)	1532	3365	3.45	0.600	0.821	0.420	1.55	0.409	1.10	0.340
T ₆ : (20 kg S/ha through potassium thiosulphate)	1357	3001	3.34	0.559	0.798	0.380	1.46	0.394	1.06	0.320
T ₇ : (40 kg S/ha through potassium thiosulphate)	1569	3389	3.47	0.606	0.836	0.426	1.58	0.412	1.16	0.341
T ₈ : (20 kg S/ha through ammonium sulphate)	1349	3052	3.37	0.554	0.784	0.381	1.48	0.390	1.03	0.321
T ₉ : (40 kg S/ha through ammonium sulphate)	1588	3441	3.52	0.601	0.827	0.429	1.59	0.410	1.11	0.343
T ₁₀ : (20 kg S/ha through sulphur coated urea)	1382	3061	3.37	0.567	0.793	0.386	1.50	0.396	1.04	0.323
T ₁₁ : (40 kg S/ha through sulphur coated urea)	1637	3490	3.53	0.612	0.832	0.435	1.60	0.422	1.15	0.350
SEm	83	142	0.14	0.020	0.025	0.016	0.06	0.014	0.05	0.008
CD@5%	246	420	NS	NS	NS	0.047	NS	NS	NS	0.025
CV%	9.96	7.73	7.19	5.86	5.46	6.93	6.40	5.85	7.73	4.42

Table 2: Effect of sources and levels of sulphur on nutrient uptake by kernel and haulm of *khari* groundnut

Treatments	Nutrient uptake by kernel				Nutrient uptake by haulm			
	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)
T ₁ : (Control) (RDF)	40.87	6.68	9.52	4.50	39.44	10.55	27.08	8.73
T ₂ : (20 kg S/ha through gypsum)	46.39	7.64	10.72	5.22	44.55	11.98	31.45	9.80
T ₃ : (40 kg S/ha through gypsum)	55.94	9.70	13.24	6.85	53.98	14.19	38.52	11.70
T ₄ : (20 kg S/ha through bentonite sulphur)	44.08	7.29	10.29	4.99	43.69	11.57	29.80	9.55
T ₅ : (40 kg S/ha through bentonite sulphur)	52.97	9.18	12.53	6.42	52.10	13.80	37.15	11.46
T ₆ : (20 kg S/ha through potassium thiosulphate)	45.46	7.60	10.84	5.17	43.90	11.84	31.87	9.62
T ₇ : (40 kg S/ha through potassium thiosulphate)	54.54	9.51	13.12	6.68	53.61	14.00	39.18	11.61
T ₈ : (20 kg S/ha through ammonium sulphate)	45.33	7.47	10.59	5.14	45.08	11.87	31.48	9.80
T ₉ : (40 kg S/ha through ammonium sulphate)	55.83	9.58	13.12	6.83	54.88	14.13	38.50	11.82
T ₁₀ : (20 kg S/ha through sulphur coated urea)	46.53	7.81	10.97	5.33	45.61	12.14	32.16	9.90
T ₁₁ : (40 kg S/ha through sulphur coated urea)	57.54	10.02	13.62	7.12	55.81	14.70	40.09	12.15
SEm	3.80	0.57	0.76	0.40	2.29	0.74	2.21	0.56
CD@5%	11.19	1.69	2.24	1.18	6.75	2.19	6.51	1.65
CV%	13.26	11.81	11.23	11.83	8.19	10.05	11.15	9.16

Table 3: Effect of sources and levels of sulphur on soil properties after harvest of *khari* groundnut

Treatments	pH	EC (dS/m)	OC (%)	Available N (kg/ha)	Available P ₂ O ₅ (kg/ha)	Available K ₂ O (kg/ha)	Available S (mg/kg)
T ₁ : (Control) (RDF)	7.85	0.192	0.416	188	37.16	252	7.96
T ₂ : (20 kg S/ha through gypsum)	7.82	0.188	0.425	192	38.40	257	9.54
T ₃ : (40 kg S/ha through gypsum)	7.79	0.184	0.429	209	40.79	262	10.63
T ₄ : (20 kg S/ha through bentonite sulphur)	7.85	0.191	0.422	190	37.93	255	9.42
T ₅ : (40 kg S/ha through bentonite sulphur)	7.84	0.193	0.425	204	39.97	261	10.45
T ₆ : (20 kg S/ha through potassium thiosulphate)	7.81	0.193	0.424	192	38.46	260	9.50
T ₇ : (40 kg S/ha through potassium thiosulphate)	7.79	0.197	0.427	207	40.63	267	10.58
T ₈ : (20 kg S/ha through ammonium sulphate)	7.84	0.195	0.422	192	37.95	256	9.58
T ₉ : (40 kg S/ha through ammonium sulphate)	7.78	0.198	0.427	210	40.06	262	10.70
T ₁₀ : (20 kg S/ha through sulphur coated urea)	7.83	0.189	0.424	194	38.66	257	9.69
T ₁₁ : (40 kg S/ha through sulphur coated urea)	7.81	0.187	0.427	212	40.89	263	10.98
SEm	0.20	0.007	0.019	5.75	1.56	5.12	0.41
CD@5%	NS	NS	NS	17	NS	NS	1.21
CV%	4.50	6.49	7.90	5.00	6.91	3.42	7.20

4. Conclusion

From the result it was found that the application of 40 kg S/ha through all the sources of sulphur studied *i.e.*, sulphur coated urea, gypsum, potassium thiosulphate, bentonite sulphur and ammonium sulphate significantly increased the kernel and haulm yield, S content, N, P, K and S uptake by kernel and haulm of *khari* groundnut and available N and S in soil. The comparatively superior performance of sulphur-coated urea and ammonium sulphate may be attributed partly to the higher nitrogen input associated with these sulphur sources. But without extra N, gypsum, potassium thiosulphate and bentonite sulphur are considered more

appropriate sulphur sources as they gave similar result. So, it can be concluded that application of S through gypsum, potassium thiosulphate and bentonite sulphur found beneficial for improving groundnut yield, S content and N, P, K and S uptake by groundnut and available N and S in soil.

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