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EFFECT OF DIFFERENT SOURCES AND LEVELS OF SULPHUR ON GROWTH AND NUTRIENT UPTAKE OF IRRIGATED SUMMER GROUNDNUT (*ARACHIS HYPOAGEA* L.) CV. VRI-2 FOR LOAMY SOILS

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Abstract

Field investigation was carried out during (April- July) the year of 2017 to study the effect of different sources and levels of sulphur on the growth, nutrient uptake of irrigated summer groundnut grown in loamy soil. The experiment was laid out in randomized block design and replicated thrice. The experiment comprised of nine treatments with different sulphur sources and levels and the treatment details are T_1 – Control (RDF), T_2 – RDF + 20 kg Sulphur ha^{-1} through Ammonium Sulphate,T_3 - RDF + 20 kg Sulphur ha^{-1} through Single Super Phosphate, T_4 – RDF + 20 kg Sulphur ha^{-1} through Gypsum, T_5 - RDF + 20 kg Sulphur ha^{-1} through Elemental Sulphur, T_6 - RDF + 40 kg Sulphur ha^{-1} through Ammonium Sulphate, T_7 - RDF + 40 kg Sulphur ha^{-1} through Single Super Phosphate, T_8 - RDF + 40 kg Sulphur ha^{-1} through Gypsum, T_9 – RDF + 40 kg Sulphur ha^{-1} through Elemental Sulphur. The results of the experiments revealed that application of RDF + 40 kg sulphur ha^{-1} through Gypsum (T_8) had a positive influence on supply of nutrients and growth promoting substances and eventually increased the growth attributes *viz.*,, Plant height, LAI, DMP and number of nodules per plant and also nutrient uptake *viz.*,, N,P,K and S of groundnut.

Key words : Groundnut, Gypsum, Nodule, nutrient uptake, Oilseed and Sulphur.

Introduction

Groundnut (*Arachis hypogaea* L.) is "King of Oilseeds" belongs to the family Leguminosae. It is the world's largest source of edible oil, ranks 13th among the food crops as well as the 4th most important oilseed crop of the world (Ramanathan, 2001). It ranks first among oilseed crops in India contributing 33% of world's production and 40% of the area. Groundnut is the prominent and premier oilseed crop of India mainly cultivated for human consumption and animal feed. Seeds contain high oil content 50%, 25-30% protein, 20% carbohydrates and 5% fiber and ash (Fageria *et al.*, 1997). They are rich sources of vitamin A, B, E and some members of B_2 group. Groundnut has a very high calorific value of 349 per 100 gram.

Groundnut being an oilseed crop requires secondary nutrient and micronutrient which are a crucial component for growth and production. Therefore supply of nutrients in an judicious and balanced manner with appropriate time and proper source are in needs for the present situation. Sulphur is increasingly being recognised as the fourth major nutrient after nitrogen, phosphorus and potassium (Tandon and Messick, 2002). It is the master nutrient for oilseed production as each unit of sulphur fertilizer generates 3-5 units of edible oil. In oilseeds sulphur plays a vital role in the development of seed and improving the quality (Naser *et al.*, 2013). Sulphur helps in the synthesis of cystein, methionine, chlorophyll, vitamins (B, biotin and thiamine), metabolism of carbohydrates, oil content, protein content and also associated with growth and metabolism, especially by its effect on the proteolytic enzymes (Najar *et al.*, 2011). Sulphur deficiency was observed in different states of India. Eighty eight out of four hundred odd districts were identified as sulphur deficient with varying degrees (Tandon, 1986). Sulphur deficiency have been reported

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in 70 countries worldwide of which India is one of the agriculturally important country with very little data on soil sulphur status. It has been found that 80 per cent of the samples obtained from 15 benchmark clay soil in Cuddalore district were found to be S deficient (Balasubramanian *et al.*, 1990). The gap between sulphur supply and demand is widen with the targeted higher food production under intensive farming practises covering use of high yielding, high responsive crop varieties supplied with inadequate organic manure, when fertilized with high grade sulphur free N and P fertilizers.

Materials and Methods

A field study was conducted during April-July of 2017 with an objective to study the effect of sulphur nutrition on the growth and nutrient uptake of irrigated summer groundnut (*Arachis hypogea* L.) cv. VRI-2 in loamy soils (isohyperthermic typic haplustalf of Vadapudupet series). The experimental site is situated at 11.66'N latitude, 79.53' E longitude with an altitude of 26 m above mean sea level.. The weather of experimental site is moderately warm with hot summer months. The maximum mean temperature ranges from 32.8 to 40.5 with a mean of 30.5 while the mean minimum temperature ranges from 21.76 to 28.76 with a mean of 26. The highest relative humidity is 89 % and the lowest being 69 % with a mean of 65%. The textural class of experimental soil was sandy loam with 13.2% of clay, 5.1% silt and 81.38% of sand in the surface (0-15cm) soil.

The surface soil posses pH 5.2, Electrical conductivity 0.14 and the available N, P, K and S *viz.,*, 63, 19, 110 and 6 kg/ha respectively. The experiments were laid in RBD, comprising 9 treatments with three replications. T_1 – Control (RDF), T_2 – RDF + 20 kg Sulphur ha^{-1} through Ammonium Sulphate,T_3 - RDF + 20 kg Sulphur ha^{-1} through Single Super Phosphate, T_4 – RDF + 20 kg Sulphur ha^{-1} through Gypsum, T_5 - RDF + 20 kg Sulphur ha^{-1} through Elemental Sulphur, T_6 - RDF + 40 kg Sulphur ha^{-1} through Ammonium Sulphate, T_7 - RDF + 40 kg Sulphur ha^{-1} through Single Super Phosphate, T_8 - RDF + 40 kg Sulphur ha^{-1} through Gypsum, T_9 – RDF + 40 kg Sulphur ha^{-1} through Elemental Sulphur.

Crop management

The experimental field was thoroughly ploughed and brought in to a fine tilth. Laying of plots and allocation of treatments were carried out according to the treatment schedule which were randomized. Channels were laid to facilitate irrigation of plots individually. The groundnut cv. VRI 2 seeds were treated with Rhizobium. The seeds were sown by dibbling method at a depth of 4 to 5 cm by adopting a spacing of 30 cm × 10 cm. The fertilizer recommendation for groundnut is 17:34:54 kg of N, P_2O_5 and K_2O ha^{-1} respectively. Nitrogen was applied as urea (46 per cent N), phosphorous as single super phosphate (16 per cent P_2O_5) and potassium as murate of potash (60 per cent K_2O) half dose of N and half dose of K_2O were applied on 20 DAS only on the controlled plot. All the other treatments were supplemented through respective sulphur sources with appropriate levels along with RDF. Five plants from each plot were chosen by simple random sampling method and were tagged. These tagged plants were used for recording all biometric observations at different stages of crop growth.

Statistical Analysis

The data recorded were statistically analysed and whenever the results were found significant, the critical differences were arrived at 5 per cent level and drawn statistical calculations (Panse and Sukhatme, 1978).

Results and Discussion

Growth components

The nutrition through different sources and levels of sulphur recorded a remarkable influence in various growth parameters of groundnut *viz.*, Plant height, LAI, DMP and number of nodules per plant during the summer season for the year of 2017 are presented in fig. 1.

The application of RDF + 40 kg sulphur ha^{-1} through Gypsum (T_8) recorded increased plant height, LAI, DMP, number of nodules $plant^{-1}$ at all the stages of crop growth. Application of RDF + 40 kg sulphur ha^{-1} through Gypsum (T_8) recorded the higher values of plant height (44 and 67.4 cm), LAI (5.9 and 4.2), DMP (4216 and 6035 kg ha^{-1}) and number of nodules $plant^{-1}$ (44.9 and 60.9) at 60 DAS and at harvest during summer season for the year of 2017. This was followed by (T_7) RDF + 40 kg sulphur ha^{-1} through single super phosphate recorded the higher values of growth attributes *Viz.,*, plant height (41.1 and 62.9 cm), LAI (5.5 and 3.9), DMP (3847 and 5667 kg ha^{-1}) and number of nodules $plant^{-1}$ (41.9 and 56.4) at 60 DAS and harvest. The lowest growth attributes were observed under T_1 (RDF + No sulphur).

Crop Nutrient uptake (N,P,K and S)

The nutrition through different sources and levels of sulphur recorded a remarkable influence on nutrient N,P,K and S uptake during the summer season for the year of 2017 are presented in table 1.

The application of RDF + 40 kg sulphur ha^{-1} through Gypsum (T_8) recorded increased N, P, K and S nutrient uptake at harvest stage of crop growth. Application of RDF + 40 kg sulphur ha^{-1} through Gypsum (T_8) recorded the higher uptake values of 101.43, 23.45, 74.50 and 16.14

kg ha^{-1} of N, P, K and S at harvest during summer season for the year of 2017. This was followed by (T_7) RDF + 40 kg sulphur ha^{-1} through single super phosphate recorded the higher uptake values of 94.44, 20.97, 68.88 and 14.76 kg ha^{-1}. The lowest nutrient uptake were observed under T_1 (RDF + No sulphur).

Discussion

Effect of different sources and levels of sulphur on growth components

The increase in LAI and DMP may be due to better crop growth as evidenced by taller plants (Fig.1). The observed improvement might be due to an early and plentiful availability of sulphur leading to better nutritional environment in the root zone for growth and development. Besides that, the increase in growth attributes might be due to more synthesis of amino acids, increase in chlorophyll content in growing region and improving the

Table 1: Effect of different sources and levels of sulphur on the nutrient uptake of irrigated summer groundnut.

Treatments	Nutrient Uptake Kg ha^{-1}			
	N	P	K	S
T_1 – Control (RDF + No Sulphur)	52.68	9.35	32.75	7.11
T_2 - RDF + 20 kg Sulphur ha^{-1} through Ammonium Sulphate	77.14	15.32	53.71	11.59
T_3 - RDF + 20 kg Sulphur ha^{-1} through Single Super Phosphate	59.94	11.15	38.88	8.14
T_4 – RDF + 20 kg Sulphur ha^{-1} through Gypsum	67.33	12.85	44.20	9.43
T_5 - RDF + 40 kg Sulphur ha^{-1} through Elemental Sulphur	69.99	13.79	48.18	10.24
T_6 - RDF + 40 kg Sulphur ha^{-1} through Ammonium Sulphate	87.43	18.99	62.98	13.24
T_7 – RDF + 40 kg Sulphur ha^{-1} through Single super phosphate	94.44	20.97	68.88	14.76
T_8 - RDF + 40 kg Sulphur ha^{-1} through Gypsum	101.43	23.45	74.50	16.14
T_9 – RDF + 40 kg Sulphur ha^{-1} through Elemental Sulphur	84.22	17.64	59.14	12.88
S.E(m)	3.11	0.65	2.18	0.47
CD (P=0.05)	6.6	1.38	4.62	0.99

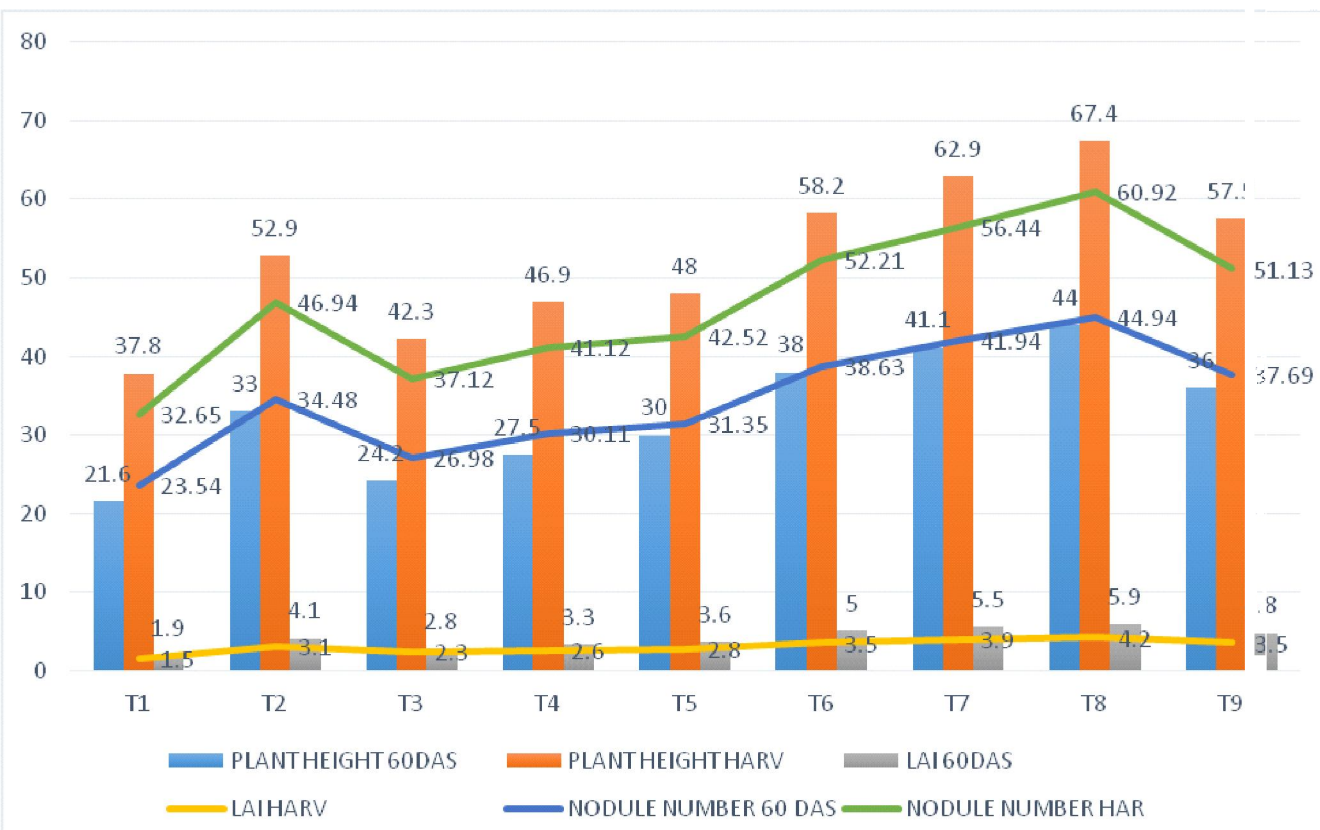

Fig.1: Effect of different sources and levels of sulphur on the growth components of irrigated summer groundnut.

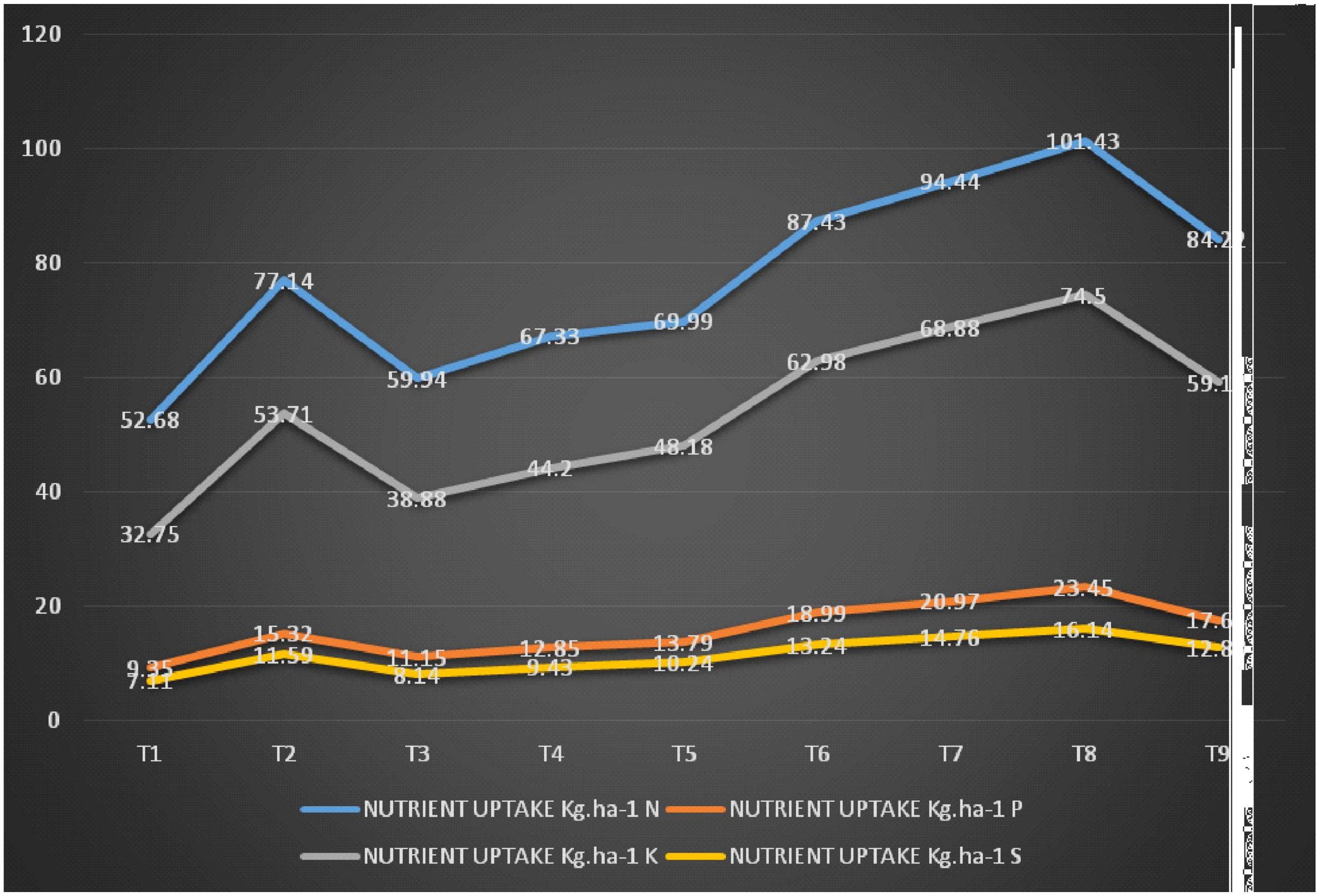

Fig. 2: Effect of different sources and levels of sulphur on the nutrient uptake of irrigated summer groundnut.

photosynthetic activity, ultimately enhancing cell division resulted in an increment in plant height, higher LAI and DMP (Ravikumar *et al.,* 2016). As sulphur is one of the secondary essential plant nutrients required for growth. Therefore, overall growth with the application of sulphur in deficient soil of the experimental site could be ascribed to its pivotal role in several physiological and biochemical processes which are of vital importance for development of the plants. Sulphur in the form of sulphate is involved in various metabolic and enzymatic activities of plants. Further, sulphur also plays a vital role in chlorophyll formation as it consititutes succinyl Co-A which is involved in synthesis of chlorophyll (Pirson, 1955). It engages in activation of a number of enzymes participating in dark reaction of photosynthesis via improvement in general and their activation at cellular level by promoting greater photosynthesis and merismetic activity seemed to have stimulated vegetative growth of crops in terms of dry matter accumulation, number and weight of nodules per plant significantly. These results were in line with the findings of Sriramachandrasekharan (2004) and Vaiyapuri *et al*., (2004). This is due to lesser values for growth attributing characters. Similar results were also reported by Singh *et al*., (2017) in groundnut.

Effect of different sources and levels of sulphur on nutrient uptake

The effect of different sources of sulphur influenced the N, P, K and S uptake (Fig. 2). Among the treatments tried, T_8 (40 kg sulphur ha^{-1} through gypsum) registered the higher amount of N, P, K and S uptake by the groundnut crop respectively. The positive influence of sulphur fertilization on nutrient concentration in crop seems to be due to improved nutritional environment both in rhizosphere and the plant system which led to greater translocation of N, P and S to reproductive parts which ultimately increased the concentration of these nutrients in pods and haulm. The increased availability of nutrients in root zone coupled with increased metabolic activity at cellular level might have increased the uptake of nutrients and their accumulation in various plant parts. Higher accumulation of nutrients in vegetative plant parts concomitant with improved metabolism led to greater translocation of these nutrients to the reproductive parts of the crop.

The significant increase in N concentration in plants due to sulphur may be attributed to higher in sulphur concentration which in turn might have stimulated protein synthesis (Charliers and Carpentiers, 1956). Sulphur and nitrogen are said to increase the uptake and concentration of each other in groundnut. Both are supposed to be synergistic as reported by Mishra (1996). Higher uptake of N, P and S is the cumulative effect of higher nutrient concentration and increased pod and haulm yields due to application of sulphur. Several workers have also reported increased N, P and S concentrations and uptake due to S application (Jat and Ahlawat, 2009 and Kader and Mona, 2013). This might be due to S application through Gypsum which the increased the uptake of N, P, K and S and ultimately more utilization of these nutrients, which in turn enhanced their concentration and uptake (Bhagat *et al.,* 2003).

Phosphorous uptake was increased by sulphur application. Jaggi and Dixit (1996) reported, all sort of interaction *viz.,* positive, neutral and negative between phosphorous and sulphur. In the present investigation a synergistic effect of sulphur on phosphorous was recorded. This might be due to the solubilisation of phosphorous by sulphur. Similar result was reported by Randhawa and Arora (1997). Increased availability of potassium due to sulphur application through Gypsum enhanced its uptake also findings of Lal *et al.,* (1997) and Sakal *et al*., (1999) confirm this result.

Sulphur uptake was also enhanced due to addition through various sources. Among the various sources gypsum is the best source. The increase in S uptake might be due to increased availability of S from the applied sulphur with a concomitant increase in crop yield. Least uptake of N, P, K and S was observed in T_1 – RDF + No sulphur. The results are in conformity with the findings of Thorat *et al*., (2003) and Nagesh Yadav *et al*., (2017).

Conclusion

From the above experimental results, it may be concluded that application of 40 kg sulphur ha^{-1} through Gypsum along with RDF had a positive influence on growth parameters and nutrient uptake which paves way for enhancing the productivity of irrigated summer groundnut in sandy loam soils of isohyperthermic typic haplustalf in Vadapudupet series.

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