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EFFECT OF SULPHUR FERTILIZATION ON GROWTH, YIELD AND NUTRIENT UPTAKE OF SUNFLOWER IN NORTH CAUVERY DELTAIC REGION

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ABSTRACT

Aim: The present investigation was carried out to evaluate the response and fix an optimize source and levels of S for sunflower production.

Materials and Methods: Field experiments were conducted in the Experimental Farm of the Department of Agronomy, Annamalai University, Annamalai Nagar during March - June and June - September 2014 in RBD to study the response of sunflower (*Helianthus annuus* L.) var. K-1 to different sources and levels of sulphur (Elemental sulphur, Gypsum and Pyrite for their growth, yield attributes, and yield.

Result: Among the different treatments Elemental Sulphur @ 45 kg ha^{-1} along with RDF (40:20:20 kg ha^{-1}) had a positive effect on growth, yield attributes, yield and nutrient uptake in sunflower for I and II crops. The lowest values of growth, yield attributes and yield were recorded by 0 kg S ha^{-1} along with RDF.

Conclusion: Application of sulphur especially through Elemental sulphur @ 45 kg ha^{-1} along with RDF (40:20:20 kg ha^{-1}) is a fitting practice for augmenting sunflower yields in clay loam regions of Cuddalore district sunflower farmers.

Key Words: Sulphur Levels, Growth, Yield, Sunflower, Nutrient uptake

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops containing high quality edible oil. It is easy to cultivate and grown in different conditions and soils [Kaya MD and Kolsarici O (2011)]. Sunflower oil has excellent nutritional properties, and has a relatively high concentration of linoleic acid [Seiler GJ (2007)]. Oilseeds and their derivatives vegetable oil and meal are in demand globally, and there is a need to identify and quantify the key issues for their production by different stakeholders to develop and support actions that will ensure a viable future of such crops (Muhammad Farhan et al., 2013). In oil seeds sulphur plays a vital role in the development of seed and improving the quality (Naser et al., 2012). Sulphur is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium (Tandon and messick, 2002). Sulphur plays a predominant role in improving the grain quality of sunflower crop and also the use efficiency of nitrogen and phosphorus. 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 protolytic 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 70 countries worldwide, of which India is one, Tamilnadu is one of the agriculturally important states with very little data on soil sulphur status. It has been found that 80 percent of the samples obtained from 15 bench mark clay soil in Cuddalore district were reported to be 'S' deficient (Balasubramanian *et al.,*1990). Consequently, the yield of oilseed crops, especially sunflower, is severely affected due to S deficiency. Response of crops to other nutrients also becomes less and less because of the marginally low level of S in these soils. In addition, the disproportionately greater use of nitrogen (N) and

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P in comparison to S has widened the N–S and P–S ratios (Manickam and Vijayachandran, 1985). Hence the present investigation was carried out to evaluate the response and fix an optimize levels of S for sunflower production.

MATERIALS AND METHODS

In order to study the different sources of sulphur at varying levels on the quantitative and qualitative characters of sunflower. The experiment was conducted at Annamalainagar experimental farm, Tamilnadu, India during March to June and June to September on 2014. The experimental site of the study is geographically located at 11^{0} 24'N latitude, 79 ^{0} 44'E longitude and an altitude of +5.79 m of above mean sea level. Soil was analysed for their physical and chemical properties. A composite soil sample was collected at a depth of 0-30 cm. It was air dried, crushed, and tested for physical and chemical properties. The soil was clay loam in texture with soil reaction of (pH 7.7), electrical conductivity 0.49 dS m^{-1}, organic matter (0.96%), low available nitrogen (256.5kg.ha^{-1}), available phosphorus (20.6 Kg ha^{-1}), and low available sulphur (17.8 kg.ha^{-1}). The experimental design was carried out in a randomized block design with arrangement of treatments in three replications. Experimental plots consist of three sulphur sources (Elemental sulphur, Gypsum and iron pyrite), levels (15, 30, 45 kg.ha^{-1}) and control i.e., recommended N, P and K (40:20:20 kg. ha $^{-1}$) alone. The plots were prepared with dimension of 5 m × 3 m and seeds of variety K1 were sown with a spacing of 30×30 cm. At 4-5 leaf stage plants were thinned to appropriate density. Weeds were controlled manually at 5-leaf stage, stem elongation and flowering stage to maintain a uniform plant population. Irrigation were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. The crop was completely harvested at physiological maturity stage and their biometric observations such as seed number.cap^{-1}, 1000 seed weight, seed yield, biological yield and oil yield were recorded. Oil percentage was calculated using a commercial Nuclear Magnetic Resonance Spectrometer (NMRS) method. Oil yield was obtained by following formula:

Oil yield = Oil percentage × seed yield /100.

Chlorophyll Assay

The total chlorophyll content of leaves was determined by using 80 % acetone extraction suggested by Arnon (1949). About 250 mg of fresh leaf material from each plot was taken and crushed thoroughly with 80% acetone. A homogeneous paste was made and filtered through Whatman No.1 filter paper, made up the volume with 80 % acetone 25 ml. Since the extract is subjected to evaporation and photo oxidation. The optical activity or density of chlorophyll 'a' and 'b' recorded at 645 nm and 663 nm wave length respectively and chlorophyll a and b were calculated using the formula.

Chlorophyll a = 20.2 × O.D value at 645 nm × 100 /1000 mg.g^{-1}

Chlorophyll b = 8.02 × O.D value at 663 nm × 100 /1000 mg.g^{-1}

Total chlorophyll content = chlorophyll a + chlorophyll b.

Biometric observations were obtained by selecting five representative sample plants from each plot at random the growth characters (plant height, number of leaves, leaf area index and DMP) yield components (Capitulum diameter, number of seeds.$capitulum^{-1}$, number of filled seeds and seed yield in the experiments were recorded at 30 (vegetative stage), 45 (flowering stage) DAS and at harvest. Post harvest soil samples were taken from each treatment at 0-15 cm depth and the samples were dried and passed through a 2mm sieve and available N, P, K and S obtained by using appropriate methods.

STATISTICAL ANALYSIS

The experimental data were statistically analysed as suggested by Gomez and Gomez (1976). For significant results the critical difference was worked out at 5 per cent level.

RESULTS

Growth attributes

Statistically analysed results showed that the effect of different sources and levels of sulphur application significantly influenced all experiment traits except 1000 seed weight. Among the different levels of sulphur, the highest plant height (144.80 cm and 146.73 cm) was noticed with application of elemental sulphur @ 45 kg ha^{-1} along with RDF (40:20:20 kg ha^{-1}) at harvest which was followed by gypsum and iron pyrite in two seasons. Application of sulphur significantly increases the plant height in sunflower (Intodia and Tomar, 1997). Similar results have been reported by Zeiny *et al*., (1998) and Legha and Gajendra Giri (1999). The similar trend was recorded in LAI (4.26 and 4.49) at flowering stage, DMP (4027.00 and 4134.00 kg ha^{-1}) at harvest stage, CGR (16.02 and 16.09), RGR (0.0762 and 0.0765) at flowering stage and total chlorophyll content (1.642) in both the seasons. The lowest values for growth attributes were recorded in the plots which received 0 kg S ha^{-1} in both seasons.

Yield Attributes

Sulphur levels and sources significantly influenced the yield components and yield in both the crops. Among the different sources and levels of suphur through elemental sulphur

@ 45 kg ha^{-1} along with RDF (40:20:20 kg ha^{-1}) obtained maximum capitulum diameter (16.92 cm and 17.22 cm), number of filled seeds $capitulum^{-1}$ (695.00 and 705.00), seed yield 1060.00 and 1072.00 kg ha^{-1}), oil content (38.53% and 38.51%) and crude protein content (16.35% and 16.39%) followed by gypsum and iron pyrite in both seasons.

Crop Nutrient Uptake

The crop nutrient uptake increased with in levels of sulphur application and the values were significant between the sources, Elemental sulphur @ 45 kg ha^{-1} along with RDF (40:20:20 kg ha^{-1}) recorded highest uptake (82.16 and 85.80, 14.94 and14.97, 113.63 and 113.80 and 11.68 and 12.00 kg ha^{-1}) followed by gypsum and iron pyrite of N, P, K and S respectively in both seasons and among the sources. Yadav and Singh (1970) opined that the synergistic relationship of S with N, P, K, Ca and Mg in plants and hence increment in S levels in soil increase the uptake of nutrients by the crop. Among all sources tried, Elemental sulphur resulted in the highest nutrient uptake at all levels.

DISCUSSION

In present series of study the increase in growth attributes might be due to more synthesis of amino acids, increase in chlorophyll content in growing region and improving the photosynthetic activity, ultimately enhancing cell division resulted in an increment in plant height, higher LAI and DMP. This was evidenced through the studies of Intodia and Tomar (1997) and Raja et al. (2007).

Sulphur application resulted in significance increase in LAI, chlorophyll pigments, CGR, RGR, capitulum diameter and 100 seed weight. Obviously these have jointly contributed and increased the yield potential of the crop as reflected by the higher seed yield. Such a response to increasing levels of 'S' might be ascribed to adequate supply of nutrients resulted in high production of photosynthates and their translocation to sink (Tomar *et al.,* 1997). Further the properties of elemental sulphur reveal that when it is applied to the soil, absorbs moisture and disintegrates into fine and coarse particles. The finer particles oxidise rapidly and coarser particles slowly which might have supplied sufficient sulphur to the soil pool throughout the growth period of sunflower and resulted in higher seed yield than other sources like gypsum and iron pyrite respectively. Apart from that application of sulphur helps in conversion of carbohydrates into oil. In fatty acid synthesis, acetyl co-A is converted into malonyl co-A. In this conversion an enzyme thiokinase is involved, the activity of which depends upon sulphur supply. Moreover, acetyl co-A itself contains sulphur and sulphadryl group (Sreemannarayana *et al*., 1998). The results in line with the earlier findings of Ajabsingh Yadav and Harishankar (1980), Tripathi and Sharma (1995) and Tamak *et al* ., (1997). Crude protein content was increased with the increment of sulphur levels. Sulphur nutrition provides disulphide group of cross linking of two polypeptide chains in protein formation (Allway and Thompson, 1996). Similar findings were reported by Yadav and Singh (1970), Das et al., (1994) and Jadav and Shelke (1994).

In the present study a synergistic effect of sulphur on phosphorus was recorded. This might be due to solubalization of phosphorus by sulphur. Jaggi and Dixit (1996) reported, all sorts of interactions viz., positive, neutral and negative between phosphorus and sulphur. The increase in S uptake with increasing rates of sulphur seems to be associated with increased availability of S from applied sulphur with a concomitant increase in crop yield. Decrease in S content of the mature crop might be attributed to the translocation of the absorbed S to the growing part, especially to seed (Tandon, 1990). The higher uptake of sulphur in seeds indicated its requirement in the synthesis of lipids and proteins for qualitative improvement in sunflower (Narender Reddy et al., 1996).

CONCLUSION

In the light of the above study, it may be concluded that application of sulphur especially through Elemental sulphur @ 45 $kg.ha^{-1}$ combined with RDF (40:20:20 kg ha^{-1}) is a fitting practice for augmenting sunflower yields in clay loam regions of Cuddalore district sunflower farmers.

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REFERENCES

1. Ajab Singh Yadav and Harishankar 1980, Effect of nitrogen, sulphur and boron fertilization on oil and protein content and their quality parameter in sunflower seeds, Oilseeds journal, 10: 58 – 68.
2. Allway, F. O. and J. F Thompson 1996, Sulphur in nutrition of plants and animals. Soil Sci., 101: 204-207.
3. Arnon, D. I. 1949, Copper enzyme in isolated chloroplasts, polyphenol oxidase in *Beta vulagaris* Pl. Physiol., 24: 1-15.
4. Balasubramanian, p., Babu, M., Arivazhagan, K. and B.Ragupathy 1990, Influence of soil parameters on the forms of

sulphur in benchmark soils of Chidambaram Taluk, Tamilnadu, Proc. U.A.S. FACT seminar on sulphur, Bangalore.
5. Das, S. K. Ahmed, A. Tripathi, S. K., R. P. Singh 1994. Effect of soil water Conservation practices and sulphur fertilization on seed yield and quality of sunflower on eroded type of Ustochrept. J. Indian Soc. Soil Sci., 42: 491-493.
6. Gomez A. A., R. A. Gomez 1976, Statistical procedure for agricultural research with emphasis on rice. IRRI. Los Banos Philippines.
7. Intodia, S. K., O. P. Tomar 1997, Effect of sulphur application on growth and yield of sunflower, Indian J. Agrl. Sci., 67(1): 46 – 47.
8. Jadav, T.W., D. K. Shelke, 1994. Effect of levels and timing of sulphur application on seed yield and oil content, Res. Bull. Marathwada Agic. Univ., 18(1): 38–40.
9. Jaggi, R. C., S.P. Dixit, 1996, Sulphur efficiency in presence of other nutrients, Intensive Agric., 5: 13–14.
10. Kaya MD, Kolsarici O (2011) Seed yield and oil content of some sunflower (*Helianthus annuus* L.) hybrids irrigated at different growth stages. Afr. J. Biotechnol 10: 4591-4595.
11. Legha, P. K., Gajendra Giri 1999. Influence of nitrogen and sulphur on growth, yield and oil content of sunflower grown in spring season, Indian J. Agron., 44 (2): 408–412.
12. Manickam, T. S., and P. K. Vijayachandran (eds.) 1985, Proc. of the National Seminar on Sulphur in Agriculture. Tamilnadu Agricultural University, Coimbatorc, India 188 pp.
13. Muhammad Farhan Sarwar, Muhammad Haroon Sarwar, Muhammad Sarwar,Niaz Ahmad Qadriand Safia Moghal.2013. The role of oilseeds nutrition in human health: A critical review. Journal of Cereals and Oilseeds, 4(8), 97-100.
14. Najar, G. R., Singh, S. R., Akthar, F. Hakeem, S. A. 2011. Influence of sulphur levels on yield, uptake and quality of soybean (*Glycine max*) under temperate conditions of Kashmir valley. Indian Journal of Agricultural Sciences 81 (4): 340-3.
15. Narender Reddy, S., Gopal Singh, B. and R. Uma Reddy. 1993. Response of phosphorus and sulphur fertilization in sunflower. J. Res. APAU, 21: 235–236.
16. Naser, A. Anjum , Sarvajeet, S. Gill, Shahid Umar, Igbal Ahmed, Armando C. Duarte. and Eduarda Pereira 2012. Improving growth and productivity of *Oliferous brassica* under changing environment. Significance of nitrogen and sulphur nutrient and underlying mechanisms, The Scientific world Journal, 12.
17. Raja A., Omar Hattab, K., Gurusawmy, L., Vembu, G., Suganya, K. S., 2007, Sulphur application on growth, yield and quality of sesame varieties. Int. J. Agric. Res. 2, 599-606.
18. Seiler GJ (2007) Wild annual *Helianthus anomalus* and *H. deserticola* for improving oil content and quality in sunflower. Ind. Crops Prod 25: 95-100.
19. Sreemannarayna, B., Srinivasa Raju, A. and G. Mrinalini 1998, Effect of N and S application on yield and quality of sunflower, Madras Agric. J., 85(3, 4): 204-206.
20. Tamak, J. C. Sharma, H. C. and K. P. Singh 1997, Effect of phosphorus, sulphur and boron on seed yield and quality of sunflower (*Helianthus annuus* L). Ind. J. Agron., 42: 173–176.
21. Tandon, H. L. S. 1986, Sulphur research and development in Indian agriculture, Fert. News, 31 (9): 9–16.
22. Tandon, H. L. S. 1990, Fertilizer recommendation for oilseed crops: A guide book. Fertilizer and consultation organization, New Delhi.
23. Tandon, H. L. S. and Messick, D. L. 2002. *Practical sulphur guide*. The Sulphur Institute, Washington, D. C.
24. Tomar, H. P. S., Singh, H.P. and K.S. Dadhwali 1997, Effect of irrigation, nitrogen and phosphorus on growth and yield of spring sunflower. Ind. J. Agron., 42: 169-172.
25. Tripathi, A., N. l. Sharma 1995. Effect of gypsum and pyrite on yield and quality of mustard in salt affected soils of western Uttar Pradesh, J. Indian Soc. Soil Sci., 45(2):290-291.
26. Yadav, R. and S. Singh, 1970, Effect of gypsum on the chemical competition, nutrient uptake and yield of groundnut, J. Ind. Soc. Soil Sci., 18: 183–186.
27. Zeiny, H. A., Saade, A.O.M., Thalooth, A. T. and G. Garab. 1998. Physiological responses of peanuts grown under saline conditions as affected by spraying with vapor guard and $MnSo_4$ under gypsum application. Photsynthesis: mechanisms and effects, Vol. 4. Proceeding of the XIth International congress on photosynthesis, 2633–2636.

Table 1: Effect of sources and levels of Sulphur on Growth attributes

Treatment	Plant height In cm at harvest		LAI at flowering		DMP in Kg at harvest		Total Chlorophyll content at flowering	
	2014	2015	2014	2015	2014	2015	2014	2015
To- Recommended dose of Fertilizer alone (RDF)	123.20	124.10	3.12	3.16	2967.00	2972.00	-	1.132
T_1- Elemental Sulphur@15 kgha^{-1} + RDF	130.60	133.68	3.45	3.54	3497.00	3358.10	-	1.463
T_2- Elemental Sulphur@30 kgha^{-1} + RDF	140.46	142.85	3.84	3.87	3882.00	3618.90	-	1.560
T_3- Elemental Sulphur@45 kgha^{-1} + RDF	144.80	146.73	4.26	4.29	4027.00	4134.00	-	1.642
T_4- Gypsum @ 15kg ha^{-1} + RDF	127.80	129.21	3.34	3.44	3374.00	3226.00	-	1.411
T_5- Gypsum @ 30kg ha^{-1} + RDF	138.83	139.71	3.75	3.70	3646.00	3486.00	-	1.516
T_6- Gypsum @ 45kg ha^{-1} + RDF	143.20	143.29	4.15	4.18	3903.69	3909.00	-	1.583
T_7- Pyrite @ 15 Kg ha^{-1}+ RDF	125.30	126.44	3.22	3.28	3144.65	3098.65	-	1.365
T_8- Pyrite @ 30 Kg ha^{-1}+ RDF	136.90	136.34	3.46	3.54	3348.66	3336.65	-	1.468
T_9- Pyrite @ 45 Kg ha^{-1}+ RDF	141.20	140.82	3.97	4.04	3583.87	3776.00	-	1.541
$S.E_M$	**0.82**	**1.65**	**0.039**	**0.050**	**59.23**	**60.42**	-	**0.006**
CD (p = 0.05)	**1.74**	**2.30**	**0.078**	**0.100**	**118.61**	**120.84**	-	**0.013**

Table 2: Effect of sources and levels of Sulphur on Yield attributes and yield

Treatment	Capitulum diameter in cm		Number of filled seeds capitulum^{-1}		100 seed weight in gm		Seed yield in kg ha^{-1}	
	2014	2015	2014	2015	2014	2015	2014	2015
To- Recommended dose of Fertilizer alone (RDF)	12.74	13.33	538.00	549.00	4.424	4.441	810.00	825.00
T_1- Elemental Sulphur@15 kgha^{-1} + RDF	14.75	15.07	634.00	642.00	4.435	4.458	926.00	942.00
T_2- Elemental Sulphur@30 kgha^{-1} + RDF	15.90	16.00	655.00	667.00	4.445	4.486	965.00	979.00
T_3- Elemental Sulphur@45 kgha^{-1} + RDF	16.92	17.22	695.00	705.00	4.506	4.511	1060.00	1072.00
T_4- Gypsum @ 15kg ha^{-1} + RDF	14.14	14.52	612.00	624.00	4.432	4.454	888.00	904.00
T_5- Gypsum @ 30kg ha^{-1} + RDF	15.47	15.80	642.00	650.00	4.441	4.482	928.00	943.00
T_6- Gypsum @ 45kg ha^{-1} + RDF	16.33	16.73	680.00	690.00	4.487	4.499	1006.00	1021.00
T_7- Pyrite @ 15 Kg ha^{-1}+ RDF	13.48	13.89	582.00	592.00	4.428	4.449	855.00	863.00
T_8- Pyrite @ 30 Kg ha^{-1}+ RDF	14.92	14.60	639.00	649.00	4.438	4.479	890.00	905.00
T_9- Pyrite @ 45 Kg ha^{-1}+ RDF	15.74	16.12	658.66	668.66	4.482	4.489	969.00	983.00
$S.E_M$	**0.29**	**0.26**	**0.56**	**0.54**	**0.001**	**0.001**	**17.51**	**18.03**
CD (p = 0.05)	**0.59**	**0.53**	**1.13**	**1.08**	**0.003**	**0.002**	**35.02**	**36.06**

Table 3: Effect of sources and levels of Sulphur on Growth analysis and quality parameters

Treatment	CGR at Flowering stage g.m^{-2} day^{-1}		RGR at Flowering stage g.gm^{-1}day^{-1}		Oil content in %		Crude protein %	
	2014	2015	2014	2015	2014	2015	2014	2015
To- Recommended dose of Fertilizer alone (RDF)	12.36	12.39	0.0472	0.0471	37.04 (37.48)	37.11 (37.53)	15.0 2 (22.80)	15.09 (22.85)
T_1- Elemental Sulphur@15 kgha^{-1} + RDF	13.58	13.60	0.0526	0.0527	37.16 (37.55)	37.38 (37.69)	15.50 (23.18)	15.54 (23.21)
T_2- Elemental Sulphur@30 kgha^{-1} + RDF	14.50	14.64	0.0632	0.0636	37.93 (38.01)	37.46 (37.73)	16.00 (23.57)	15.89 (23.49)
T_3- Elemental Sulphur@45 kgha^{-1} + RDF	16.02	16.09	0.0762	0.0765	38.54 (38.37)	38.51 (38.35)	16.35 (23.85)	16.39 (23.88)
T_4- Gypsum @ 15kg ha^{-1} + RDF	13.20	13.30	0.0519	0.0523	37.12 (37.53)	37.31 (37.64)	15.23 (22.97)	15.36 (23.07)
T_5- Gypsum @ 30kg ha^{-1} + RDF	14.34	14.38	0.0625	0.0628	37.82 (37.95)	37.19 (37.57)	15.81 (23.42)	15.84 (23.45)
T_6- Gypsum @ 45kg ha^{-1} + RDF	15.96	16.03	0.0731	0.0735	38.32 (38.24)	38.57 (38.27)	16.23 (23.75)	16.27 (23.78)
T_7- Pyrite @ 15 Kg ha^{-1}+ RDF	12.60	12.68	0.0509	0.0513	37.07 (37.50)	37.18 (37.57)	15.12 (22.95)	15.16 (22.91)
T_8- Pyrite @ 30 Kg ha^{-1}+ RDF	13.64	13.70	0.0608	0.0612	37.59 (37.81)	37.33 (37.66)	15.62 (23.27)	15.69 (23.33)
T_9- Pyrite @ 45 Kg ha^{-1}+ RDF	15.24	15.87	0.0716	0.0718	38.14 (38.13)	38.11 (38.12)	16.14 (23.68)	16.18 (23.71)
$S.E_M$	**0.013**	**0.011**	**0.001**	**0.0003**	**0.012**	**0.018**	**0.038**	**0.044**
CD (p = 0.05)	**0.027**	**0.0224**	**0.002**	**0.0006**	**0.024**	**0.036**	**0.076**	**0.088**