HELIA, **19**, Nr. 25, p.p. 141-148, (1996) UDC 631.416.3:633.854.78

SULPHATE ACQUISITION BY SUNFLOWER FROM ROOT MEDIUM SUPPLIED WITH VARIOUS SOURCES OF SULPHUR

Badr-uz-Zaman*, M. Salim, B.H. Niazi and Rahmatullah

Plant Nutrition, Land Resources Research Institute, National Agricultural Research Centre, Park Road, Islamabad, Pakistan

Received: June 30, 1996
Accepted: December 16, 1996

SUMMARY

Four sulphur sources i.e., ammonium sulphate, potassium sulphate, calcium sulphate, and ferrous sulphate, each at 0.5 mM of SO_4 in root medium were used to grow sunflower under controlled conditions. Five harvests with the time interval of 0, 6, 24, 48, and 168 hours were taken. Root and shoot growth was proportional to the time irrespectively of the sources. Significant relationships (r=0.99) were shown by fresh weight and dry matter yield (DMY) with respect to the harvest time irrespectively of the sources. Ammonium sulphate and ferrous sulphate shared a positive relationship with SO_4 uptake (r=0.85) in root. After 48 hours, the various sources showed distinct contribution for root DMY.

Key words: Sunflower, sulphur utilization, sulphur sources.

INTRODUCTION

Sulphur as a plant nutrient has special significance for sunflower. Oilseed crops generally require higher amounts of sulphur for their growth as compared with other crops (Singh and Singh, 1978; Aulakh and Pasricha, 1988; Nabi et al., 1989). Roots absorb most of their sulphur from the soil as SO_4^{-2} (Bardsley, 1960).

Absorption of SO_4^{-2} ions is an active process. Mostly the production of oilseed crop is dependent upon their sulphur relation. Some S containing compounds like methionine and cysteine are integral part of the structure and function of many enzymes (Torchinsky, 1981).

For sulphur application to soils, various sources may be used. In calcareous soils, acidic fertilizers are preferred. Sulphur changes to SO_4^{-2} which is taken up by plant roots. Like N and P, the efficiency of SO_4^{-2} utilization by plants from the

* Scientific Officer, LRRI, NARC, Islamabad, Fax No. 92-51-1240909

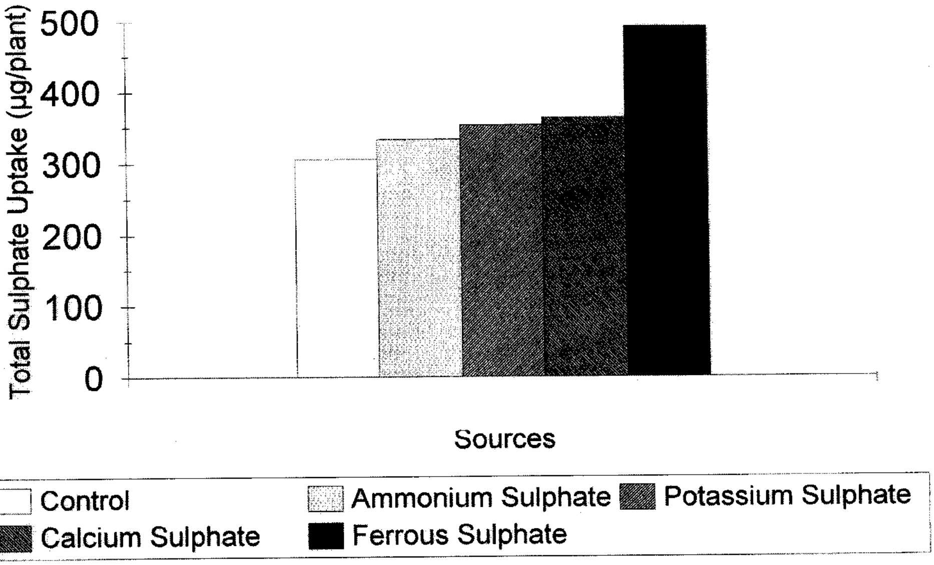

Figure 1. Response of sunflower to different sources of sulphur

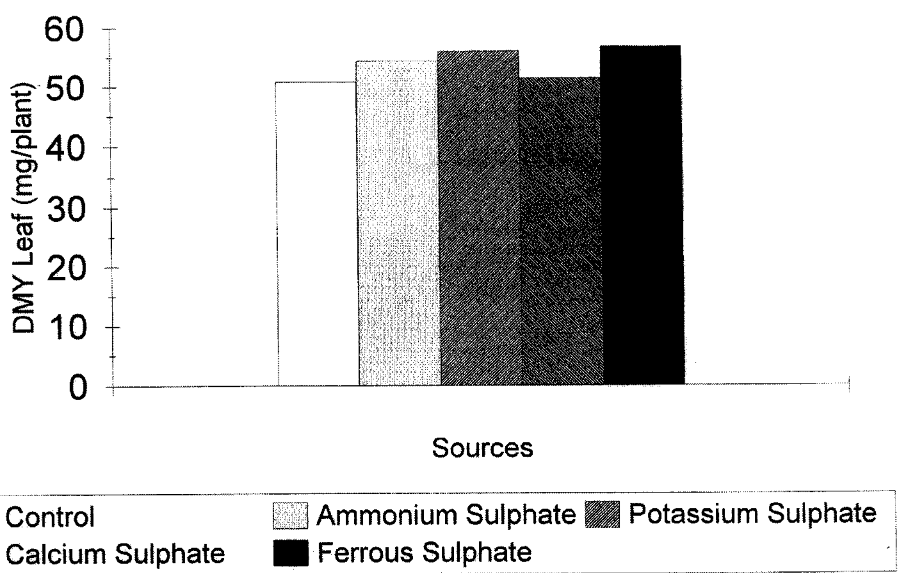

Figure 2. Growth of sunflower leaf to sulphate when applied from various sources

root medium containing various sulphur sources may be variable (Badr et al., 1994; Kaiser and Lewis, 1991). The preferential utilization of a nutrient by plant may effect its growth through maturity. Therefore, a study was conducted in solution culture to compare the SO_4^{-2} uptake efficiency of sunflower from the root medium containing a uniform SO_4^{-2} level maintained by various sources.

MATERIALS AND METHOD

Sunflower (*Helianthus annuus* L. NK-265) was grown in aerated solution in a controlled climate chamber having 16 hour light with illumination of 450 µmol m^{-2} s^{-1} at shoot level and a temperature of 30 ± 2°C. The nutrient solution had the following concentrations.

Ion	Concentration	Source
Ca	4 mM	Ca $(NO_3)_2.4H_20$
Mg	1 mM	Mg $(NO_3)_2.6H_20$
P	6 mM	KH_2P0_4
N	8 mM	$Ca(NO_3)_2.4H_2O$ and $Mg(NO_3)_2.6H_2O$
B	20 µM	H_3B0_3
Mn	2 µM	$MnCl_2$
Zn	2 µM	$ZnCl_2$
Fe	20 µM	Fe-EDTA
Mo	0.5 µM	H_2MoO_4
Cu	2 µM	$Cu(CH_3C00)_2.H_20$

The pH of solution was adjusted to 5.5 ± 2 with KOH or HCl. The SO_4^{-2}, sources were $(NH_4)_2$ SO_4, K_2SO_4, $CaSO_4.2H_2O$, and $FeSO_4$ $.7H_2O$. The treatments were imposed in triplicate. The pots were arranged in a randomized block design. Initially the seedlings were grown in a nutrient solution without SO_4^{-2}. Five centimeter plants were supplied with SO_4^{-2} from different sources. During the growth, the harvest intervals were 0, 6, 24, 48, and 168 hours. After each harvest fresh weight of the vegetative parts was recorded. After drying the root and the shoot at 68 ± 2°C, these were digested in boiling 1N HNO_3 and 0.5N $HClO_4$ mixture (Salim, 1989, modified). In the digest, SO_4^{-2} was determined as given by Verma et al., (1977). The data was analyzed statistically for treatment significance and least significant difference (LSD) was used for mean separation (Gomez and Gomez, 1976).

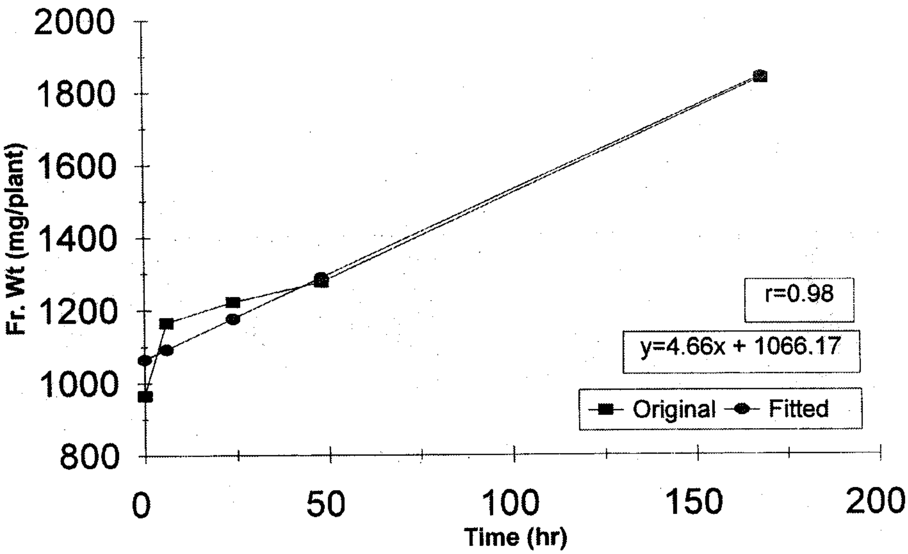

Figure 3. Growth of sunflower as a function of time.

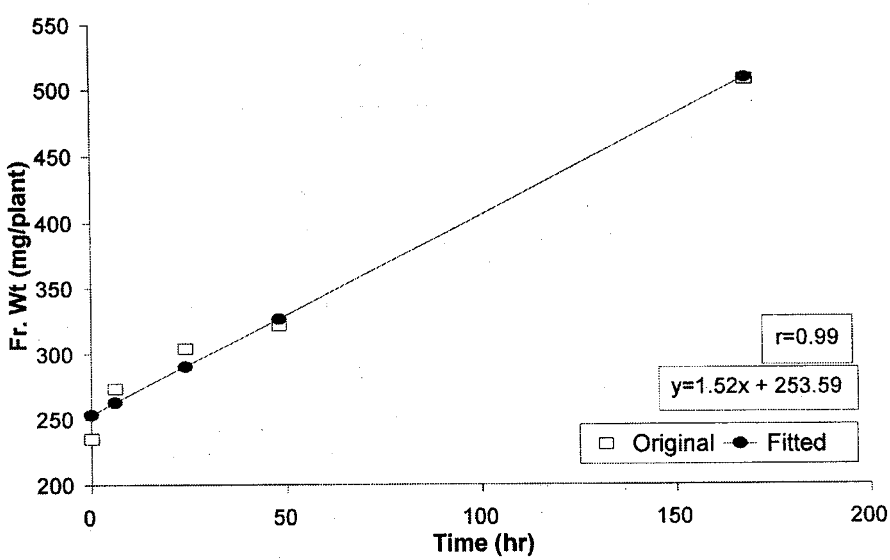

Figure 4. Growth of sunflower root as a function of time.

RESULTS AND DISCUSSION

Sulphate ion dependent metabolic sites are a function of its sources as well as time period in sunflower. The concentration of sulphur in root and shoot system was significantly ($P<0.01$) different among the various S sources (Table 1). It has been reported that the root hair region is the major site of SO_4^{-2} entry into plant (Cacco et al., 1980). The SO_4^{-2} concentration in root was the highest from calcium sulphate source and in shoots S concentration was maximum with ferrous source. Maximum concentration of S found in roots and shoots was 36.67 and 45.24 percent higher than the controls, respectively. Earlier it has been observed that sulphur-containing fertilizers, either with nitrogen or potassium, resulted in higher sulphur concentrations in oilseed plants (Salim and Rahmatullah, 1987). The application of sulphur from various sources increased dry matter yield (DMY) which conforms with Falatah and Shawab (1990).

Table 1: Growth and sulphate content of shoot and root of sunflower grown in solution culture containing 0.5 mM SO_4^{-2} supplied from various sources.

Sources	Dry matter yield mg/plant		Sulphate conc. (%)		Shoot/Root	F.wt/DMY	F.wt/DMY
	Shoot	Root	Shoot	Root	(DMY)	(Shoot)	(Root)
Control	64.78	16.23 a	0.42 c	0.30 c	4.11 ± 0.20	21.35 ± 0.87	21.36 ± 0.86
Ammonium sulphate	67.40	14.0 c	0.47 bc	0.35 abc	4.75 ± 0.11	23.12 ± 0.52	23.12 ± 0.52
Potassium sulphate	69.20	15.92 ab	0.47 bc	0.34 bc	4.50 ± 0.26	21.36 ± 1.08	21.36 ± 1.08
Calcium sulphate	64.18	14.12 bc	0.50 b	0.41 a	4.55 ± 0.10	22.48 ± 0.51	22.48 ± 0.51
Ferrous sulphate	69.30	15.94 ab	0.61a	0.40 ab	4.38 ± 0.07	20.12 ± 0.48	20.11 ± 0.48
		*	**	***			

Significant difference ($P<0.05$) were found in roots DMY. Shoot dry matter yield produced by various S sources differed non-significantly. Comparing the control, 16% higher shoot/root in DMY was credited to the application of $(NH_4)_2SO_4$. Added NH_4^+ has been shown to appreciably enhance the uptake of SO_4^{-2} (Kirkby, 1968; Haynes & Goh, 1978). Fresh weight/DMY shows that water content in shoots and roots were highest where $(NH_4)_2SO_4$ was applied. The ascending order with other sources was $FeSO_4.7H_2O< K_2SO_4<CaSO_4.2H_2O$. The total sulphate uptake was significantly high comparing various sources ($P<0.01$). Among these, the sunflower responded highest of ferrous sources (Figure 1). For DMY of leaf, various sulphur sources contributed significantly ($P<0.05$). Here also, $FeSO_4.7H_2O$ contributed the highest (Figure 2). The fresh weight of shoot and root displayed a significant relationship with time intervals ($r=0.99$, $P<0.01$; Figures 3 & 4). It can be held that per unit increase in time period is responsible for three times growth in shoots than in roots.

CONCLUSIONS

This study shows that at early growth stages of sunflower the root system is selective to source for SO_4^{-2}. Its uptake is a function of metabolic activities of a particular vegetative part and SO_4^{-2} attachment with a specific cation.

REFERENCE

Aulakh, M.S and Pasricha, N.S., 1988. Sulphur fertilization for oilseeds for yield and quality. In : Proc. Sulphur Indian Agri., ps ii/3 (1-4), New Delhi.

Badr-uz-Zaman, Salim, M., Rahmatullah and Zia, M., 1994. Utilization of phosphorus and sulphur by maize from various organic and inorganic sources. Proc. of the Fifth Nat. Cong. of Soil Sci. of Pakistan Soils: Problem and Management, held at NWFP Agri. Univ. Peshawar, 23-25 Oct. 1994.

Bardsley, C.E., 1960. Absorption of sulphur from organic and inorganic sources by bush beans. Agron. J., 52: 485-486.

Cacco, G., Ferrari, G. and Wani, M.S., 1980. Pattern of sulphate uptake during root elongation in maize: its correlation with productivity. Physiol. Plant., 48 : 375-378.

Falatah, A. and Schwab, A.P., 1990. Plant available iron and zinc in a calcareous soil as affected by addition of sulphur and micronutrient fertilizer. J. Fert. Issues., 7(2), 35-40.

Nabi, G., Salim, M., and Rahmatullah, 1989. Growth and sulphur relations of mustard on a sandy loam soil supplied with three sulphur sources. Pak. J. Agri. Sci., 26(4): 460-465.

Gomez, K.A. and Gomez, A.A., 1976. Statistical procedures for agricultural research. John Wiley and Sons. Inc., N.Y.

Haynes, R.J. and Goh, K.M., 1978. Ammonium and nitrate nutrition of plants. Biol. Rev., 53: 465-510.

Kaiser, J.J. and Lewis, O.A.M., 1991. The influence of nutrient source on the growth and productivity of sunflower (*Helianthus annuus* var. Dwarf Sungold). South-African J. Bot., 57(1): 6-9.

Kirkby, E.A., 1968. Influence of ammonium and nitrate nutrition on the cation-anion balance and nitrogen carbohydrate metabolism of white mustard plants grown in dilute nutrient solutions. Soil Sci., 105: 133-141.

Salim, M. and Rahmatullah, 1987. Evaluation of sulphur status and potential for its application in Pakistan soils. Proc. Symp. Fert. Sulphur Requirements and Sources in Developing Countries of Asia and Pacific, pp. 49 -56. Bangkok, 26-30 Jan. 1987.

Salim. M., 1989. Effect of NaCl and KCl salinity on growth and ionic relations of red kidney beans (*Phaseolus vulgaris* L.) J. Agron. and Crop Sci., 163, 338-344.

Singh, M. and Singh, N., 1978. Effect of sulphur on the quality of raya (*Brassica juncea*). J. Ind. Soc. Soil Sci., 28: 203-207.

Torchinsky, Y.M., 1981. Sulphur in proteins. Pergamon Press, Elmford, NY.

Verma, B.C., Swaminathan, K.S. and Sud. K.C., 1977. An improved turbidimetric method for sulphur determination in plants and soils., Talanta, 24: 49-50.

ADQUISICION DE SULFATO POR UN MEDIO RADICULAR SUPLEMENTADO CON VARIAS FUENTES DE AZUFRE

RESUMEN

Cuatro fuentes de azufre, sulfato amónico, sulfato de potasio, sulfato de calcio y sulfato ferroso, cada uno 0.5 mm de soy en el medio radicular fueron usados para crecer girasol bajo condiciones controladas. Cinco recolecciones con un intervalo de tiempo de 0, 6, 24, 48 y 168 horas fueron tomadas. El crecimiento de la raiz y el tallo fué proporcional el tiempo independientemente de las fuentes. Una relación significativa (r=0.99) fué mostrada para cada frasco y materia seca (DMY) en relación al tiempo a recolección independientemente de las fuentes. El sulfato amónico y sulfato ferroso compartieron una relación positiva con la absorción de sulfato (r=0.83) por la raiz. Despues de 48 horas las diversas fuentes mostraron una distinta contribución para la DMY de la raiz.

PRÉLÉVEMENT DU SULFATE PAR LE TOURNESOL, DANS UN MILLEU D'ENRACINEMENT ENRICHI PAR DIVERSES SOURCES DE SOUFRE

RÉSUMÉ

Quatre sources le sulfate d'ammonium, sulfate de potassium, sulfate de calcium, et sulfate ferreux, chacun à la dose de 0.5 mM de SO_4 dans une milleu d'enracinement ont été utilisés pour faire croître le tournesol en conditions contrôlées. Cinq récoltes à des intervalles de temps de 0, 6, 24, 48 et 168 heures ont été réalisées. La croissance des racines et de la partie aérienne était proportionnelle à la durée indépendamment des sources de soufre. Des relations significatives (r=0.99) sont montrées pour le poids frais et la production de matiére séche (DMY) en relation avec la date de récolte, quelle que soit la source. Le sulfate d'ammonium et le sulfate ferreux présentent une relation positive avec l'absorption de SO_4 dans la racine (r=0.85). Aprés 48 heures, les diverses sources ont montré des contributions différentes pour la production de matiére séche (DMY) des racines.