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# INFLUENCE OF SULPHUR FERTILIZER ON YIELD AND MICRONUTRIENT UPTAKE IN SUNFLOWER

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**ABSTRACT:** Field experiments were conducted during rabi seasons of 1995-96, 1996-97 and 1997-98 in the Grey Terrace soil (Albaquept) of Gazipur to see the effect of different levels of S application on the yield and micronutrients (Cu and Zn) uptake in sunflower (cv. Kironi). The effect of S on seed yield was significant. The highest yield was recorded with the application of 80 kg S/ha which was statistically identical with 60 kg S/ha. Micronutrients (Cu and Zn) uptake by plant were also significantly influenced by the added S up to 60 kg/ha at all the growth stages. Plants grown without S had the lowest seed yield and the lowest nutrient uptake.

**Key words:** Sunflower, S fertilizer, Micronutrient uptake

## INTRODUCTION

Sunflower (*Helianthus annuus* L) is relatively a new oilseed crop in Bangladesh. It contains high quality of edible oil (40-45%) and 20% protein. The crop can be grown both in rabi (winter) and kharif (summer) seasons. Sunflower is a potentially remunerative oilseed crop because of its wide adaptability and photo-insensitive nature. However, the yield of sunflower is low for many reasons, of which depletion of soil fertility is a major one. Sunflower, in general, has a high S requirement for the better seed formation and development of oil storage organs (Singh and Sahu, 1986; Aulakh *et al.*, 1980). Saraf (1988) also reported that S fertilizer applications not only increase seed or grain yield of crops but also enhances their superior nutritional and marked quality.

Mobilization of nutrient element takes place within the plant during the life cycle. The extent of mobilization of the element, however, depends on the availability of the elements in the plant and demand of photosynthesis. Application of S fertilizer enhanced the uptake of Cu, Fe and Mn by sunflower crops (Gangadhara *et al.*, 1990). Crops also differ in their pattern of dry matter accumulation and nutrient uptake (Nagaraj and Kumar, 1986). The available information on such aspects is meager vis-a-vis our condition and hence this study was taken up to see the effect of S on yield and uptake of Cu and Zn by sunflower.

## MATERIALS AND METHODS

Field trials were conducted for three consecutive years (1995-96, 1996-97 and 1997-98) at the Bangladesh Agricultural Research Institute farm, Gazipur. The experimental soil was clay loam with pH 6.0, organic matter 1.06%, total N 0.035%, available P 0.02 ppm, exchangeable K 0.14 meq/100 g soil, available S 10.5 ppm and available Cu 0.7 ppm and Zn 0.2 ppm. The total rainfall during the crop season (November to March) was 88.4 mm in 1995-96, 61.0 mm in 1996-97 and 116.8 mm in 1997-98.

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Seven levels of S viz. 0, 20, 40, 60, 80, 100 and 120 kg S/ha were used as treatment variables. The experiment was laid out in a randomized complete block design and the treatments were replicated four times. The unit plot size was 5m x 3m. Every plot was fertilized with $N_{120}P_{90}K_{80}Zn_5B_2$ kg/ha as urea for N, TSP for P, MP for K, ZnO for Zn and Soluber for B. Sulphur is applied in the form of gypsum. The whole amount of TSP, MP, gypsum, zinc oxide, soluber and half of urea were applied as basal dose. Seed of sunflower (cv. Kironi) were sown in the first week of November every year. The remaining urea was applied in two splits at 25 and 45 days after emergence (DAE). Three irrigations were made at 25, 45 and 75 DAE. Weeding and mulching were done as and when required.

Five plants were randomly collected from each plot and separated into leaf, petiole, stem and head at vegetative (35-40 DAE), reproductive (75-80 DAE) and at maturity (110-115 DAE) stages to determine nutrient uptake. The Cu and Zn contents were determined by atomic absorption spectrophotometer (Hunter, 1984).

The crop was harvested at 110-115 DAE when the head turned yellow brown in colour. The heads were cut from the plants and dried on the threshing floor for about 6-7 days. The seeds of plants from each plot were then recorded individually and adjusted to 8% moisture content. Data on yield and nutrient uptake were subjected to analysis of variance. Duncan's New Multiple Range Test (DMRT) was used for mean separation (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

**Seed yield:** The seed yield/ha of sunflower varied significantly due to S application in all years (Fig. 1). The yield varied from 2.06 to 3.14 t/ha in 1995-96, 1.94 to 3.26 t/ha in 1996-97 and 1.80 to 3.68 t/ha in 1997-98. The highest seed yield was obtained with 80 kg S/ha application and beyond this dose yield declined. However, seed yield due to 60 to 80 kg S/ha was not significantly different from each other. The yield advantage for S application @ 60-80 kg/ha on an average was 52%, 68% and 104% higher over the control (without S) in 1995-96, 1996-97 and 1997-98, respectively. The soil test value showed that the experimental field was deficient in S. So, the application of S to this soil regulated in the higher S uptake by plants which ultimately helped increased formation of reproductive structure for sink strength and increased production of assimilates. Samui and Bandopadhyay (1997) reported that application of 40-60 kg S/ha through gypsum significantly increased the seed yield in Indian mustard. Sreemannarayana and Raju (1994) observed that sunflower responded to S fertilization and the application of 60 kg/ha gave significantly more seed yield. Tripathi (1992) also reported similar results in sunflower. Further increase in dose of S fertilizer significantly reduced the seed yield (Fig. 1). The negative response of higher doses of S indicated an imbalance of S with other nutrients in the plants. Plants grown without S had the lowest seed yield of sunflower in all the years. These results suggested that S deficiency had an adverse effect in terms of poor growth and low yield of sunflower. The regression analysis showed a quadratic relationship between seed yield and S application (Fig. 2). The value of $R^2$ indicates that 82% of total variation in seed yield could be accounted for by the quadratic function of the S levels. From the estimated relationship, it can be expected that seed yield would increase with the application of S up to a certain limit (i.e. 60 kg/ha).

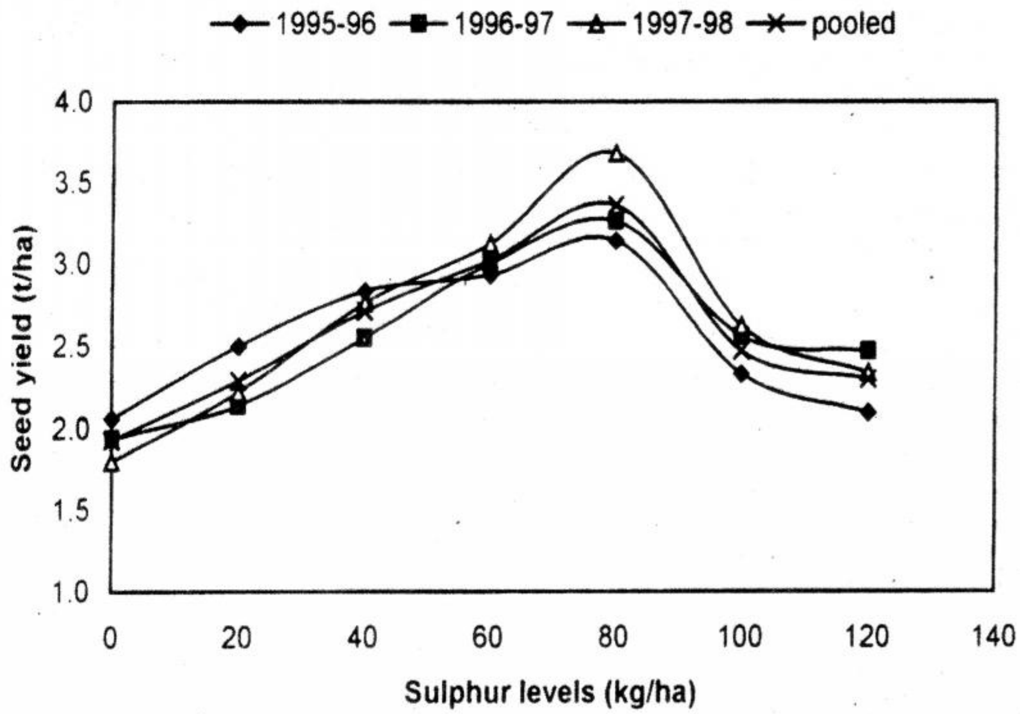


Fig. 1. Yield of sunflower as influenced by sulphur fertilization during 1995-98

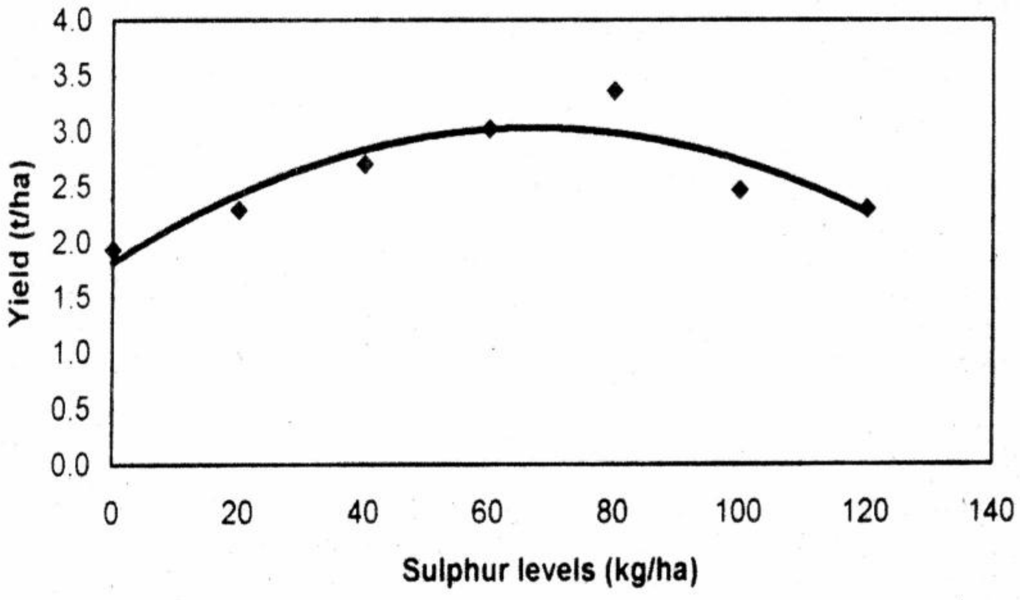


Fig. 2. Functional relationship between seed yield and sulphur levels

**Nutrient uptake:** The uptake of micronutrients (Cu and Zn) by different components of sunflower as recorded over three years were almost similar, hence three years results have been pooled. The uptake of a nutrient element by the plant was taken as the dry matter multiplied by the content of a given nutrient. However, the effect of S on Cu and Zn uptake by sunflower plant was found positive and significant up to certain level of S application at all the growth stages of the crop (Tables 1-2). The Cu accumulation was low at vegetative stage but increased with plant age reaching its maximum at maturity stage (Table 1). The mean total uptake of 0.28 kg/ha at vegetative stage increased to 3.64 kg/ha at maturity. The variations in the total uptake were largely a function in the dry matter content. The Cu uptake by leaf and petiole increased up to reproductive stages and then it decreased irrespective of S levels. The results revealed that there was much less remobilization of Cu from other plant parts to the head or seed. Similar result was observed by Gangadhara *et al.* (1990) in sunflower that the Cu uptake by seed or head was lower compared to leaf, petiole and stem. Remobilization of Cu by plant parts started from reproductive stage and continued to maturity. The Cu uptake in stem also increased throughout the growing season due to its increased rate of dry matter accumulation. The maximum uptake of Cu by different components was found in 80 kg S/ha which was closely followed by 60 kg S/ha irrespective of growth stages and thereafter it tended to decrease. Significantly the lowest Cu uptake was apparent by different plant parts of sunflower with 0 kg S/ha in all growth stages. This variation was mostly governed by accumulation of dry matter. Generally, the Cu uptake by heads was significantly higher than the other plant parts regardless of treatments.

The influence of S on Zn uptake by sunflower at different growth stages was significant (Table 2). The mean total uptake of Zn was about 0.38 kg/ha at vegetative. 2.75 kg/ha at reproductive and 4.62 kg/ha at maturity stages. However, the trend of Zn uptake was quite different irrespective of growth stages. There is a definite increasing trend in Zn uptake up to 80 kg S/ha, being followed by 60 kg S/ha and the trend was similar in all the stages. In comparison with different plant parts, the leaf displayed the highest Zn uptake during the whole growth period regardless of treatments. Higher content of Zn was the probable reason for higher Zn uptake by the foliage. On the contrary, uptake of Zn by head including seed increased sharply from reproductive to maturity stages irrespective of treatments due to its increased concentration together with increased dry matter Sinha *et al.* (1995) reported that Zn uptake by grain in linseed increased significantly by S application. Generally, the untreated plants removed the lowest amount of Zn across the growth cycle. This result indicated that S requirement by sunflower plant per unit area is quite high to sustain its better growth and high yield potential.

The results indicate that the dry matter synthesis and accumulation of nutrients were interrelated. Reproductive to seed filling period was more important for dry matter and nutrient accumulation. Uptake of Cu and Zn by sunflower plant at different growth stages were the highest between 60-80 kg S/ha. Hence, there is a need of S application in soils low in available S to boost crop yields and increase nutrient uptake by crop.

**Table 1. Influence of S application on Cu uptake (kg/ha) by sunflower at different growth stages (average of 3 years)**

| S levels | Vegetative stage | | | | | Reproductive stage | | | | | Maturity stage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (kg/ha) | Leaf | Petiole | Stem | Bud | Total | Leaf | Petiole | Stem | Head | Total | Leaf | Petiole | Stem | Head | Total |
| 0 | 0.05 b | 0.01 | 0.05 d | -- | 0.11 | 0.15 e | 0.08 c | 0.33 d | 0.29 g | 0.85 | 0.12 e | 0.04 c | 0.32 e | 1.49 c | 1.97 |
| 20 | 0.08 b | 0.01 | 0.08 cd | 0.03 b | 0.20 | 0.22 d | 0.15 d | 0.57 c | 0.66 d | 1.60 | 0.20 d | 0.09 c | 0.49 d | 2.07 d | 2.85 |
| 40 | 0.10 b | 0.01 | 0.14 ab | 0.03 b | 0.28 | 0.47 c | 0.28 b | 0.56 c | 0.93 c | 2.24 | 0.30 bc | 0.17 b | 0.69 b | 2.83 b | 3.99 |
| 60 | 0.16 a | 0.02 | 0.17 ab | 0.06 ab | 0.41 | 0.52 b | 0.31 a | 0.75 b | 1.12 b | 2.70 | 0.41 a | 0.21 ab | 0.72 a | 3.49 a | 4.83 |
| 80 | 0.16 a | 0.02 | 0.20 a | 0.07 a | 0.45 | 0.61 a | 0.31 a | 0.85 a | 1.40 a | 3.17 | 0.45 a | 0.23 a | 0.76 a | 3.58 a | 5.02 |
| 100 | 0.07 b | 0.01 | 0.14 b | 0.07 a | 0.29 | 0.38 cd | 0.25 b | 0.70 b | 0.53 c | 1.86 | 0.32 b | 0.19 b | 0.57 c | 2.45 c | 3.53 |
| 120 | 0.06 b | 0.01 | 0.10 c | 0.04 b | 0.21 | 0.29 d | 0.20 c | 0.52 c | 0.38 f | 1.39 | 0.20 d | 0.15b | 0.49 d | 2.44 c | 3.28 |
| CV(%) | 4.3 | 2.8 | 3.7 | 4.0 | -- | 5.4 | 4.0 | 4.2 | 5.7 | -- | 3.3 | 4.4 | 5.2 | 7.2 | -- |

**Table 2. Influence of S application on Zn uptake (kg/ha) by sunflower at different growth stages (average of 3 years)**

| S levels | Vegetative stage | | | | | Reproductive stage | | | | | Maturity stage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (kg/ha) | Leaf | Petiole | Stem | Bud | Total | Leaf | Petiole | Stem | Head | Total | Leaf | Petiole | Stem | Head | Total |
| 0 | 0.06 c | 0.01 | 0.05 d | -- | 0.12 | 0.24 e | 0.05 d | 0.25 e | 0.49 e | 1.03 | 0.40 d | 0.04 d | 0.35 d | 1.45 e | 2.24 |
| 20 | 0.08 bc | 0.01 | 0.13 bc | 0.04 b | 0.26 | 0.31 e | 0.11 c | 0.80 c | 0.98 c | 2.20 | 0.60 c | 0.08 c | 0.65 c | 2.41 d | 3.74 |
| 40 | 0.13 ab | 0.01 | 0.21 b | 0.04 b | 0.39 | 0.53 d | 0.20 b | 0.92 b | 1.11 b | 2.76 | 0.80 b | 0.16 b | 0.69 c | 3.23 b | 4.88 |
| 60 | 0.18 a | 0.02 | 0.28 b | 0.09 a | 0.57 | 0.74 b | 0.25 b | 1.13 a | 1.80 a | 3.92 | 1.12 a | 0.20 b | 0.90 b | 3.97 a | 6.19 |
| 80 | 0.18 a | 0.03 | 0.29 a | 0.11 a | 0.61 | 0.92 a | 0.37 a | 1.18 a | 1.87 a | 4.34 | 1.23 a | 0.32 a | 1.14 a | 4.02 a | 6.71 |
| 100 | 0.11 bc | 0.01 | 0.19 b | 0.10 a | 0.41 | 0.67 c | 0.23 b | 0.79 c | 1.07 b | 2.76 | 0.77 b | 0.18 b | 0.76 c | 2.95 c | 4.66 |
| 120 | 0.09 bc | 0.01 | 0.12 cd | 0.06 b | 0.28 | 0.58 d | 0.14 c | 0.70 d | 0.80 d | 2.22 | 0.70 b | 0.10 c | 0.65 c | 2.44 d | 3.89 |
| CV(%) | 3.0 | 2.0 | 4.1 | 2.9 | -- | 4.8 | 3.2 | 5.4 | 5.0 | -- | 6.6 | 4.0 | 5.3 | 7.3 | -- |

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