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# Response of Sunflower (*Helianthus annuus L.*) to the Foliar Fertilization of Micronutrients under no Till Condition in Rice Fallows

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**ABSTRACT**

A field experiment was conducted at Regional Agricultural Research Station, Warangal to find out the response of sunflower to the foliar spraying of micronutrients under zero tillage in rice fallows during *rabi* 2007-08 and 2008-09 on clay loam soil. The results revealed that combined foliar spraying of $ZnSO_4$, $FeSO_4$, Biozinc and Borax along with the recommended NPK significantly improved the yield attributes and seed yield of sunflower (1262 and 1100 kg $ha^{-1}$ respectively) over recommended NPK alone (828 and 780 kg $ha^{-1}$ respectively), during 2007-08 and 2008-09. When sprayed individually, Biozinc or Borax only could influence the yields of sunflower than other micronutrients i.e., $ZnSO_4$ or $FeSO_4$. Approximately, the seed yield of sunflower was increased by 47% by combined foliar spraying of $ZnSO_4$, $FeSO_4$, Biozinc and Borax twice at 30 and 50 days after sowing with an improvement of Rs. 8378/- and 5710/- $ha^{-1}$, respectively in net returns over recommended NPK alone.

**Key words :** Biozinc and Borax, $FeSO_4$, No till condition (zero tillage), Sunflower.

Sunflower (*Helianthus annuus* L.), due to its short duration, photo-insensitivity and wide adaptability to different agro-climatic regions and soil types, holds a great promise to increase the oilseed production in India. It can be grown at any time of the year and can serve as an ideal catch crop during the period when the land is otherwise fallow. Sunflower can play an important role in meeting out the shortage of edible oils, which is a chronic problem in the country. In the event of shortage of water for the post rainy season (*rabi)* rice crop, sunflower offers good scope for increasing the croping intensity even under no till ( zero tillage) condition. In many field experiments it was identified as a best crop next only to maize with no tillage in rice fallows. Apart from major and secondary nutrients, sunflower also needs micronutrients in required quantities. Especially, boron is an essential element for sunflower, playing many important roles like flowering, pollen germination and seed setting (Shekhawat and Shivay, 2008). Majority of the rice growing soils have become saline due to various reasons. Availability of nutrients to the crop plants especially micronutrients in saline soils is limited, which may be aggravated when the mean temperatures are low during the post rainy season. Salinity exerts adverse effects on plants including osmotic effects, ion toxicity and nutritional imbalance resulting in reduced growth and yield (Akram *et al.,* 2007). In such soils, foliar nutrition is a better choice. Foliar spraying of the micronutrients at critical growth stages supply the required micronutrients instantaneously leading to improved yields by alleviating the hidden hunger. Particularly the boron requirement of many plants during reproductive growth is reputedly much higher than during vegetative growth (Asad *et al.,* 2003). Keeping in view of above aspects, the present study was conducted to find out the response of sunflower to the foliar spraying of micronutrients under no till condition at Regional Agricultural Research Station, Warangal.

## MATERIAL AND METHODS

A field experiment was conducted during *rabi* 2007-08 and 2008-09 at Regional Agricultural Research Station, Warangal which is situated at an altitude of 268.5 m above mean sea level on 79.28$^0$E longitude and 17.58$^0$N latitude. The soil was clay loam with a pH of 8.4, organic carbon of 0.3%, available N as 253 kg $ha^{-1}$, available $P_2O_5$ as 28.6 kg $ha^{-1}$ and available $K_2O$ as 392 kg $ha^{-1}$ and electrical conductivity (EC) as 0.12 d $Sm^{-1}$. The micronutrient contents of the soil were 0.6 mg $kg^{-1}$ B, 8 mg $kg^{-1}$ Fe and 1 mg $kg^{-1}$ Zn. The experiment was laid out in Randomized Block Design replicated thrice.

Table 1. Influence of foliar fertilization of micronutrients on growth and yield attributes of sunflower

| Treatments | Plant height (cm) | | Seed weight / plant (g) | | Chaffy seeds/Head | | Filled seeds /Head | | 100 – Seed weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2007-08 | 2008-09 | 2007-08 | 2008-09 | 2007-08 | 2008-09 | 2007-08 | 2008-09 | 2007-08 | 2008-09 |
| $T_1$ | 82.0 | 80.0 | 25.45 | 24.62 | 98 | 106 | 732 | 710 | 3.63 | 3.52 |
| $T_2$ | 72.5 | 70.0 | 21.70 | 20.83 | 124 | 131 | 708 | 692 | 3.55 | 3.44 |
| $T_3$ | 83.0 | 81.5 | 25.94 | 25.12 | 90 | 97 | 787 | 774 | 3.78 | 3.65 |
| $T_4$ | 86.4 | 85.0 | 27.89 | 27.00 | 85 | 93 | 811 | 801 | 3.92 | 3.80 |
| $T_5$ | 95.3 | 93.7 | 30.18 | 29.84 | 76 | 84 | 890 | 876 | 4.11 | 4.00 |
| $T_6$ | 99.8 | 98.0 | 35.06 | 34.60 | 71 | 87 | 918 | 903 | 4.19 | 4.14 |
| $T_7$ | 103.5 | 101.5 | 37.68 | 36.92 | 45 | 53 | 941 | 929 | 4.31 | 4.20 |
| SEm± | 8.7 | 8.6 | 4.11 | 4.28 | 17 | 10 | 70 | 38 | 0.24 | 0.24 |
| CD (P=0.05) | 26.8 | 25.9 | 12.66 | 12.90 | 52 | 31 | 214 | 116 | 0.74 | 0.75 |

**There were seven treatments comprising:**

$T_1$: Recommended dose of NPK (RDF) (75, 60 and 30 kg N $P_2O_5$ $K_2O$ $ha^{-1}$)
$T_2$: Foliar spraying of 0.2% $ZnSO_4$ + 0.3% $FeSO_4$ + 0.2% Biozinc + 0.15% Borax at 30 and 50 days after sowing (DAS)
$T_3$: RDF + foliar spraying of 0.3% $FeSO_4$ at 50 DAS
$T_4$: RDF + foliar spraying of 0.2% $ZnSO_4$ at 50 DAS
$T_5$: RDF + foliar spraying of 0.15% Borax at 50 DAS
$T_6$: RDF + foliar spraying of 0.2% Biozinc at 50 DAS
$T_7$: RDF + foliar spraying of 0.2% $ZnSO_4$ + 0.3% $FeSO_4$ + 0.2% Biozinc + 0.15% Borax at 30 and 50 DAS

Sunflower hybrid "PHS-Sunbest-99" was sown on 29-11-2007 and 05-12-2008 under zero tillage after *kharif* rice and harvested on 10-03-2008 and 17-03-2009, respectively during the study period. The mean monthly maximum temperature ranged from 30.6 – 35.2$^0$C and 30.3 – 35.8$^0$C, respectively while the mean monthly minimum temperature ranged from 15.5 – 22.0$^0$C and 16.4 – 22.4$^0$C, respectively during 2007-08 and 2008-09. A total of 22.9 mm of rainfall was received over four rainy days in the crop period during 2007-08 and no rainfall occurred during 2008-09. The calculated quantity of N, $P_2O_5$ and $K_2O$ in the form Urea, DAP and Muriate of Potash, respectively were applied as per the treatments. The recommended dose of NPK (100% RDF) for *rabi* sunflower was 75, 60 and 30 kg N $P_2O_5$ $K_2O$ $ha^{-1}$ in Andhra Pradesh. Full dose of $P_2O_5$ and half dose of $K_2O$ were applied as pocketing near seedling at 15 DAS. Nitrogen was applied in 2 splits i.e., at 25 and 45 days after sowing. Remaining half dose of $K_2O$ was applied along with first split of N at 25 days after sowing as pocketing near seedling. While applying fertilizers as top dressing, required moisture was ensured in the soil by giving light irrigation. Foliar spraying of the micronutrients was done as per the treatments. Bio zinc (Bio available Zinc) is a Zinc gluconate with 12 per cent organic zinc on dry weight basis in gluconate form along with bio-available sulphur. It is a natural derivative from glucose fermentation. All the other recommended package of practices was followed.

Table 2. Influence of foliar fertilization of micronutrients on yield and net returns of sunflower

| Treatments | Head diameter (cm) | | Seed yield (kg ha$^{-1}$) | | Net returns (Rs ha$^{-1}$) | |
|---|---|---|---|---|---|---|
| | 2007-08 | 2008-09 | 2007-08 | 2008-09 | 2007-08 | 2008-09 |
| $T_1$ | 11.4 | 11.1 | 828 | 780 | 7216 | 5770 |
| $T_2$ | 10.0 | 9.8 | 730 | 624 | 6390 | 3746 |
| $T_3$ | 11.9 | 11.7 | 952 | 845 | 9619 | 6843 |
| $T_4$ | 12.3 | 12.1 | 1005 | 882 | 10860 | 7713 |
| $T_5$ | 13.0 | 12.8 | 1208 | 936 | 15356 | 8904 |
| $T_6$ | 13.6 | 13.4 | 1066 | 949 | 12077 | 9029 |
| $T_7$ | 14.1 | 13.8 | 1262 | 1100 | 15594 | 11480 |
| SEm± | 0.88 | 0.41 | 132 | 40 | - | - |
| CD (P=0.05) | 2.77 | 1.27 | 406 | 122 | - | - |

Price (Rs kg$^{-1}$): 22.0 (2007-08); 21.5 (2008-09)

## RESULTS AND DISCUSSION

### Plant height (cm) and Seed weight (g) plant$^{-1}$

Foliar application of micronutrients like $ZnSO_4$, $FeSO_4$, Biozinc and Borax either alone or in combination along with the recommended dose of NPK ($T_3$, $T_4$, $T_5$, $T_6$ and $T_7$) did not influence the height of sunflower over RDF ($T_1$) alone during both the years of study (Table 1). Further, foliar spraying of $ZnSO_4$, $FeSO_4$, Biozinc and Borax at 30 and 50 days after sowing ($T_2$) registered on par plant height (cm) with that of individual foliar spraying of either $FeSO_4$, $ZnSO_4$ or Borax along with the RDF ($T_3$, $T_4$ and $T_5$) and RDF alone ($T_1$). Similar trend was observed with respect to seed weight (g)/plant as well (Table 1).

### Number of filled seeds head$^{-1}$

During 2007-08, individual or combined foliar spraying of $FeSO_4$. $ZnSO_4$, Biozinc and Borax along with RDF ($T_3$, $T_4$, $T_5$, $T_6$, and $T_7$) and RDF alone ($T_1$) were found to be significantly superior to the combined foliar spraying of $FeSO_4$. $ZnSO_4$, Biozinc and Borax without RDF ($T_2$) and they were at par among themselves.

However, during 2008-09, combined foliar spraying of $FeSO_4$, $ZnSO_4$, Biozinc and Borax along with the RDF ($T_7$) registered significantly more number of filled seeds head$^{-1}$ (929) compared to RDF alone ($T_1$) (710), foliar spraying of the above nutrients alone without RDF ($T_2$) (692), foliar spraying of $FeSO_4$ along with RDF ($T_3$) (774) or $ZnSO_4$ along with RDF ($T_4$) (801), foliar spraying of Borax ($T_5$) (876) or Biozinc ($T_6$) (903) spraying at 50 days after sowing along with RDF ($T_7$) (Table 1).

### Number of chaffy seeds head$^{-1}$

Chaffyness was significantly reduced with combined application of $FeSO_4$, $ZnSO_4$, Biozinc and Borax ($T_7$) along with RDF with 45 seeds head$^{-1}$ compared to the separate application of RDF ($T_1$) (98) and foliar spraying of micronutrients ($T_2$) (124) (Table 1). However, all the treatments wherein foliar spraying of micronutrients was taken up i.e., $T_3$, $T_4$, $T_5$, $T_6$, and $T_7$ were statistically at par with respect to chaffyness in sunflower during 2007-08.

During 2008-09 also, less number of chaffy seeds/head was recorded in $T_7$ compared to all other treatments except $T_5$ where Borax was sprayed along with RDF. More number of chaffy seeds was observed with foliar application of micronutrients without RDF ($T_2$) followed by RDF alone ($T_1$).

### 100-Seed weight (g)

The test weight (g) was not influenced by the foliar spraying of micronutrients either individually or in combination along with RDF ($T_3$, $T_4$, $T_5$, $T_6$, and $T_7$) compared to RDF alone ($T_1$) during both the years of study (Table 1). However, significant improvement in test weight was observed with the combination of RDF and foliar spraying of micronutrients ($T_7$) compared to the foliar spraying of micronutrients alone without RDF ($T_2$).

### Head diameter (cm)

The head diameter (cm) was not influenced by the additional foliar spraying of individual or combined micronutrients ($T_3$, $T_4$, $T_5$, $T_6$, and $T_7$)

compared to the application of RDF alone during 2007-08 (Table 2). However, significantly bigger heads were observed with the foliar spraying of all the micronutrients in the study along with RDF ($T_7$) (14.1 cm) compared to the foliar spraying of micronutrients without RDF ($T_2$) (10.0 cm) (Table 2). Similarly, bigger heads with more diameter were found with the application of RDF + foliar spraying of $FeSO_4$, $ZnSO_4$, Biozinc and Borax ($T_7$) (13.8) compared to RDF alone ($T_1$) (11.1); foliar spraying of micronutrients alone ($T_2$) (9.8); RDF + $FeSO_4$ ($T_3$) (11.7) and RDF + $ZnSO_4$ ($T_4$) but was at par with other two treatments where Borax ($T_5$) or Biozinc (T6) was sprayed along with the RDF during 2008-09 as well.

**Seed yield (kg ha$^{-1}$)**

Foliar spraying of $FeSO_4$, $ZnSO_4$, Biozinc and Borax at 30 and 50 days after sowing along with RDF ($T_7$) (1262 kg ha$^{-1}$) increased the seed yield of sunflower significantly compared to RDF alone ($T_1$) with 828 kg ha$^{-1}$ or foliar spraying of the above nutrients without RDF ($T_2$) (730 kg ha$^{-1}$) during 2007-08 (Table 2). But foliar spraying of any one of the micronutrients along with RDF ($T_3$, $T_4$, $T_5$ & $T_6$) could not improve the seed yield significantly over RDF alone ($T_1$). However during 2008-09, the seed yield of sunflower was significantly higher in $T_7$ with 1100 kg ha$^{-1}$ over all the treatmental combinations including the RDF. Foliar spraying of Borax ($T_5$) or Biozinc ($T_6$) also registered significant increase in the yields of sunflower compared to RDF alone.

The yield of any crop is the final product of various yield attributing characters. The improvement in these characters even though less, contributed for the increase in seed yields of sunflower due to the combined foliar spraying of micronutrients. Better partitioning of photosynthates from source to sink might have led to higher yield attributes, which finally resulted in higher seed yield of sunflower. Yu *et al.,* (2002) found that Boron removal from the plant growth medium alters the cell wall structure, with a transitory decrease in elasticity modulus, followed by a secondary hardening and reduction in the incidence of plasma membrane bound reductase activity for better translocation to sink, reducing the total seed yield. Positive response to the foliar spraying of boron was reported in sunflower by Asad *et al.,* (2003) and Brighenti and Castro (2008) and in alfalfa by Dordas (2006).

Zn and Fe play important role in the synthesis of chlorophyll, hormones, DNA, enzymatic processes, photosynthesis and translocation of carbohydrates. Increased yield of cluster bean due to foliar application of Zn and Fe were found by Sharma *et al.,* (2004). Similarly improved yields of sunflower due to foliar spraying of Zn on a saline calcareous soil were reported by Mirzapour and Khoshgoftar (2006). Application of Zn and B through foliar application was reported to increase the yields of groundnut compared to soil application (Shankar *et al*., 2003). Srijaya *et al., (*2008) found improved yields of rice with the soil as well as foliar spraying of Biozinc along with the recommended NPK.

**Net Returns (Rs. ha$^{-1}$)**

An improvement of Rs. 8378/- and Rs. 5710/- , respectively ha$^{-1}$ in net returns was found with the combined foliar spraying of $ZnSO_4$, $FeSO_4$, Biozinc and Borax at 30 and 50 days after sowing + RDF during 2007-08 and 2008-09 (Table 2). It was followed by the spraying of Borax at 50 days after sowing + RDF with an increase of Rs. 8140/- and Rs. 3134/-, respectively in the net returns ha$^{-1}$. Spraying of Biozinc at 50 days after sowing along with the RDF could register an increase of Rs. 4861/- and Rs. 3259/- in the net returns ha$^{-1}$ over the application of RDF alone during the period of study.

In essence, combined foliar spraying of $ZnSO_4$, $FeSO_4$, Biozinc and Borax along with the recommended NPK significantly increased the seed yields of sunflower by an average of 47% under no till condition in rice fallows with an improvement of net returns up to Rs. 8378/- ha$^{-1}$.

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