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Research Article

Outcome of Sulphur and Zinc on Yield Attributes of Hybrid Sunflower in an Alfisol of Tamiraparani Tract

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ABSTRACT

In India, oil seed production is not available to meet domestic requirements. India has been facing a recurring shortage of edible oils for many years. Presently, about 23% of sunflower oil being consumed in India has to be imported. To improve our country sunflower production by proper fertilizer management and used sunflower hybrids in the production. This research was conducted to study the yield, seed quality and economics of hybrid sunflower variety CO_2 on alfisol of tambirabarani tract using a randomized complete block design replicated thrice with eight treatments in 2016-2017.

The experiment consisted of eight treatments *viz.* T_1-control, T_2-60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1}, T_3-60:90:60 kg of NPK ha^{-1}+S at 12.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray, T_4-60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray, T_5-60:90:60 kg of NPK ha^{-1}+S at 37.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray, T_6-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 12.5 kg ha^{-1}+S at 0.2% foliar spray, T_7-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1}+S at 0.2% foliar spray and T_8-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray. Application of RDF as 60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1} (T_2) produced significantly seed yield (2101 kg ha^{-1}), stover yield (6523 kg ha^{-1}), maximum oil content (40.4%), protein content (11.8%), net return (82,159 ha^{-1}) and B:C ratio. However, 60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray (T_8) registered highest seed and stover yield, net return and B:C ratio. Hence, the above study concluded that application of recommended dose of fertilizer as 60:90:60 kg of NPK ha^{-1} with S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1} is found to be the best for getting optimum yield and maximum benefit cost ratio for sunflower in an alfisol of Tambiraparani tract.

Keywords: Alfisol; Economics; $ZnSO_4$; $CaSO_4$; Hybrid sunflower; Seed yield

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the second most important oil seed crop after groundnut in India. In India, sunflower is cultivated in the area of 4.87 lakh ha and the production of 2.96 lakh tons with the productivity of 1325 kg ha^{-1} (DAC, GoI, 2017). In Tamil Nadu the production is 11,554 tones from the area of 8720 hectares with the productivity of 1325 kg ha^{-1} (DES, 2016). Even though the sunflower crop has the yield potential of around 2.3 to 2.5 tones ha^{-1} under favourable conditions but average productivity level in India is only 0.6 tones ha^{-1} due to imbalanced fertilization [1].

Inadequate and imbalanced nutrient supply is the reason for low productivity of sunflower. Absence of sulphur and zinc, the crop shows nutritional disorders which eventually lead to low yield with poor quality of seed and oil in sunflower. The recently released high yielding hybrid varieties remove more nutrients from the soil, so proper management of nutrient is essential for sustainable production. Though there are several studies on sulphur and zinc nutrition on sunflower in different parts of

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Tamil Nadu. Hence, the present investigation was under taken to study the yield and economics of hybrid sunflower variety CO2 on alfisol of Tambiraparani tract [2,3].

MATERIALS AND METHODS

A field experiment was conducted at agricultural college and research institute, Killikulam, Thoothukudi during Rabi season between November-February on 2015-16 to 2016-17. The soil of experimental field was sandy clay loam in texture, nearly neutral in reaction (pH 6.7), low in organic carbon (0.48%), low in available nitrogen (234 kg ha^{-1}), medium in available phosphorus (18.0 kg ha^{-1}) and high in available potassium (258 kg ha^{-1}). The available sulphur and zinc were low with the values of 7.56 mg kg^{-1} and 1.03 mg kg^{-1}. The cation exchange capacity of the soil was 22 cmol (p^{+})/kg. The bulk density of the soil was (1.36 Mg/m^3). The soil was taxonomically grouped as Rhodustalfs [4].

The experiment consisted of eight treatments *viz.* T_1-control, T_2-60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1}, T_3-60:90:60 kg of NPK ha^{-1}+S at 12.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray, T_4-60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray, T_5-60:90:60 kg of NPK ha^{-1}+S at 37.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray, T_6-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 12.5 kg ha^{-1}+S at 0.2% foliar spray, T_7-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1}+S at 0.2% foliar spray and T_8-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray was carried out in Randomized Block Design (RBD) with three replication. The hybrid sunflower var. CO_2 was taken as test crop. Sowing of sunflower was done during first week of November with the spacing of 60 cm × 30 cm [5].

The cultivation practices were followed as per the guidance of crop production guide of Tamil Nadu agricultural university (CPG, 2015). The fertilizer sources used were urea for N (46% N), single super phosphate for P (16% water soluble P_2O_5), muriate of potash for K (60% of K_2O), gypsum (19% of SO_4) and zinc sulphate (21% of Zn) [6]. Growth and yield attributes were recorded as per standard procedures. Five representative samples of each plot were collected and observations of seed yield, hundred seeds weight and dry matter production were statistically analysed. Two-way Analysis of Variance (ANOVA) was performed for trait for seasons and the combined (pooled) over seasons after testing error variance homogeneity was carried out according to the procedure outlined by Gomez and Gomez statistical package. Significance difference between the treatments were compared with the critical difference at (± 5%) probability by LSD [7].

RESULTS AND DISCUSSION

Yield

Application of sulphur and zinc at different levels and methods with the recommended dose of NPK in hybrid sunflower significantly enhanced the seed and stover yield of hybrid sunflower compared to control. The application of RDF+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1} produced the maximum seed and Stover yield (2101 and 6523 kg ha^{-1}, respectively) which was significantly higher to the tune of 115 and 66% over control [8]. The second best treatment was RDF+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray which also recorded the seed and Stover yield (1980 and 5813 kg ha^{-1}, respectively), whereas lowest yield of seed and Stover (975 and 3923 kg ha^{-1}, respectively) was noticed with no application of fertilizer (control). The increase in seed and stover yields might be due to increased growth and yield attributes. This might be due to adequate and steadily supply of all nutrients to plants at all stages of crop growth. This corroborates the earlier report of Singh et al., and Eslami et al [9].

Seed quality parameters

The quality parameters such as oil content, oil yield, protein content and protein yield of seeds of hybrid sunflower were also significantly influenced by S and Zn with recommended NPK (Table 1). Among the treatments, 60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1} (T_2) recorded the highest oil content and yield (40.4% and 849 kg ha^{-1}, respectively). The treatment with 60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray (T_8) recorded the next best oil content and yield (39.8% and 788 kg ha^{-1}, respectively) and recommended dose of fertilizer as 60:90:60 kg of NPK ha^{-1}+S at 37.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray (T5) (39.3% and 744 kg ha^{-1}, respectively). These three treatments were on par to each other. This increase in oil content and yield might be due to efficient fatty acid synthesis with sulphur application. It seems that soil application of S and Zn is more beneficial to oil biosynthesis. Similar findings were also reported by Upadhyay and Pable et al [10].

Table 1: Effect of sulphur and zinc on seed quality parameters of hybrid sunflower (Pooled mean of 2015-2016 to 20162017).

Treatments	Oil content (%)	Protein content (%)	Oil yield (kg ha^{-1})	Protein yield (kg ha^{-1})
T_1-Control	33.7	7.6	329	74
T_2-60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1}	40.4	11.8	849	247
T_3-60:90:60 kg of NPK ha^{-1}+S at 12.5 kg	36	8.4	616	143

ha^{-1}+$ZnSO_4$ at 0.5% foliar spray				
T_4-60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray	37.2	9.7	670	174
T_5-60:90:60 kg of NPK ha^{-1}+S at 37.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray	39.3	10.1	744	192
T_6-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 12.5 kg ha^{-1}+S at 0.2% foliar spray	36.5	9.3	641	163
T_7-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1}+S at 0.2% foliar spray	37.5	9.9	680	179
T_8-60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray	39.8	10.9	788	217
SEd	0.72	0.18	13.89	3.46
CD (P=0.05)	1.56	0.39	29.8	7.42

Note: RDF: Recommended Dose of Fertilizer for hybrid sunflower (60:90:60 kg of NPK ha^{-1})

The trend was similar to that of oil content and yield. Application of 60:90:60 kg of NPK ha^{-1}+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1} (T_2) recorded the highest crude protein content and yield (11.8% and 247 kg ha^{-1}, respectively). The treatment with 60:90:60 kg of NPK ha^{-1}+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray (T_8) recorded the next best crude protein content and yield (10.9% and 217 kg ha^{-1}, respectively) followed by 60:90:60 kg of NPK ha^{-1}+S at 37.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray (T_5) for 10.1% and 192 kg ha^{-1}, respectively. The lowest crude oil and protein content (33.7% and 7.6%) was observed which recorded the lowest yield of oil and protein (329 and 74, kg ha^{-1}, respectively) in control. The increase in protein content and yield with sulphur application is due to involvement of sulphur directly in protein metabolism. Sulphur application with recommended NPK responded well in synthesis of sulphur containing amino acid, led to protein content in seed. This might due to increase in soil which facilitated more nutrient mobility to plant. Similar findings were reported by Kalaiyarasan et al., and Singh and Mann [11].

Economics

The application of RDF+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1} fetched significantly higher net returns (82,159 ha^{-1}) and benefit: Cost ratio (3.39) over the rest of treatments (Table 2). The additional net return was to the tune of 53,181 ha^{-1} due to application of RDF+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1} over control. The second best treatment was RDF+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray which fetched a net returns of 77,093 ha^{-1} and benefit: Cost ratio of 3.28. This might be due to achieved higher productivity as well as lower cost of cultivation owing to increased economic returns in hybrid sunflower. These results are in close conformity with the findings of Reddy Bhemanna [12].

Table 2: Effect of sulphur and zinc on yield and economics of hybrid sunflower (Pooled mean of 2015-16 to 201617).

Treatment	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
T_1-Control	975	3923	29,982	28,978	1.96
T_2-RDF+S at 25 kg ha^{-1}+$ZnSO_4$ at 25 kg ha^{-1}	2101	6523	34,347	82,159	3.39

T_3-RDF+S at 12.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray	1712	5102	31,024	66,734	3.15
T_4-RDF+S at 25 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray	1801	5531	31,197	70,367	3.25
T_5-RDF+S at 37.5 kg ha^{-1}+$ZnSO_4$ at 0.5% foliar spray	1892	5601	32,520	73,713	3.26
T_6-RDF+$ZnSO_4$ at 12.5 kg ha^{-1}+S at 0.2% foliar spray	1757	5385	32,385	68,637	3.11
T_7-RDF+$ZnSO_4$ at 25 kg ha^{-1}+S at 0.2% foliar spray	1813	5588	34,005	70,856	3.08
T_8-RDF+$ZnSO_4$ at 37.5 kg ha^{-1}+S at 0.2% foliar spray	1980	5813	33,679	77,093	3.28
SEd	43.16	125.61	-	-	-
CD (P=0.05)	92.58	269.44	-	-	-

CONCLUSION

It was concluded that soil application of RDF+S at 25 kg ha^{-1} +$ZnSO_4$ at 25 kg ha^{-1} not only improves the hybrid sunflower productivity and net profit but soil fertility status was also improved due to the combined application of sulphur and zinc. Sulphur and zinc application both in soil and foliar spray not only proves most beneficial but economic for hybrid sunflower productivity in alfisols of Tamil Nadu.

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