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Performance of Sunflower (*Helianthus annuus* L.) under Different Sources and Levels of Sulfur Nutrition

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ABSTRACT

A field experiment was carried out during summer seasons of four consective years of 2011 to 2014 to evaluate the performanc of sunflower (*Helianthus annuus* L.) under different sources and levels of sulhur nutrition. The farm is located at an altitude of 5 m with the geographical location of 22^{o}33 N latitude and 89^{o}4 E longitude. The soil of the experimental farm was silty clay loam in texture with pH 7.2, EC 1.43 dS/m, organic carbon (0.43%) and sulfur 63 ppm. The experimental site is sub-tropical humid climate with an average rainfall ranging between 1430 mm to 1760 mm and mean minimum, maximum temperature of 10 to 42^{o}C respectively. The available , N P_2O_5 and K_2O found were 403.8, 34.5 and 639.63 Kg/ha, respectively. The experiment was laid out in Randomized Block Design with 11 treatment replicated thrice. The different treatment of sunflower were T_1 Control (no sulfur) T_2 : 20 kg sulfur/ha through ammonium sulfhate, T_3 : 20 kg sulfur/ha through single super phosphate, T_4 : 20 kg sulfur/ha gypsum, T_5 : 20 kg sulfur/ha through elemental sulfur, T_6 : 20 kg sulfur/ha through facto-phos (20:20:0:13), T_7 : 40 kg sulfur/ha through ammonium sulfate, T_8 : 40 kg sulfur/ha through single super phosphate,T_9 : 40 kg sulfur/ha through gypsum, T_{10} : 40 kg sulfur/ha through elemental sulfur T_{11} : 40 kg sulfur/ha through facto-phos (20:20:0: 13). A general dose of N, P and K was @ 80 kg, 40 and 40 kg/ha as urea, single super phosphate and muriate of potash respectively. Various sources of sulfur were ammonium sulfate (24%S), single super. phosphate (12%S), gypsum (15%S), elemental sulfur (85%S) and facto-phos (20 : 20 : 0 : 13). The experimental data revealed thatmaximum plant height, head diameter (15.04 cm) and 100 seed wight was recorded with T_{11} treatment i.e. 40 kg S/ha applied as facto-phos (20 : 20 : 0 : 13). Maximum seed and oil yields wre observed using 40 kg sulfur/ha through ammonium sulfate T_7 and T_{10} respectively but the effect was found not significant. Sulfur @ 40 kg /ha throughtal sulfur and facto-phos (20 : 20 : 0 : 13) producted 15.8 and 11.24% higher oil yield than that of control. The highest net return and return per rupee invested was obtained at T_{11} and T_1 respectively. The experimental data showed that rhere are no significant effect of levels and sources of sulfur on performance of sunflower in Sundarban areas of South 24 Parganas of West Bengal.

Keywords Sunflower, Sulfur, Source, Yields, Economics.

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INTRODUCTION

Sunflower (*Helianthus annuus* L.) used an ornamental plant in India, has become an important source of edible oil in recent times. Globally, sunflower ranks second to soybean among annual field crops grown for edible oil. Its short duration and photo-insensitivity, suits well for cultivation in rainy season. The quantity of sunflower oil represents about 15% of total world production of major vegetable oils. Sunflower oil has excellent nutritional oproperties and has a relatively high concentration of linoleic acid (Seiler 2007). Oil seeds and their derivatives vegetable oil and meal are in demand globally and there is a need to identify and quantify the key issue for their production by different staketholders to develop and support actions that will ensure a viable future of such crops (Muhammad Farham et al 2013) Sunflower seeds are one of the most nutritions and healthy foods. Our country is facing acute shortage of edible oils mainly because of heavy demand due to population pressure, raised standard of living and high drmand from oil consuming industries.

In oil seed crops sulfur plays a predominant role in the development of seed and improving the quality (Naser et al 2012)). Sulfur is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium (Tandon and Messick 2002). Hence it is generally considered as “quality nutrient”. It plays a vital role in improving the grain quality of sunflower crop and also the use efficiency of nitrogen and phosphorus. Sulfur 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). However, S. deficient soils are widely distributed around the world. Consequently, the yield of oil seed crops, espectially sunflower, is severely affected due to its deficiency. The deficiency symptoms are more often observed in crops at early stages of growth, because sulfur can be easily leached from the surface soil (Hitsuda et al 2005). But, research findings related to sulfur nutrition on sunflower in this sundarban regions are very limited or very rare. 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 of sulfur at varying levels on the quantitative and qualitative characters of sunflower the field expriment was conducted during summer seasons of 2011, 2012, 2013 and 2014 at Experimental Research farm of Ramkrishna Ashram, Nimpith, South 24 Parganas (Sundarban) West Bengal to study the performance of sunflower (*Helianthus annuus* L,) under different sources and levels of sulfur nutrition. The experimental site of the study is located at 22°33 N latitude, 89°4 E longitude and an altitude of 5 m above the mean sea level. Soil was analyzed for their physical and chemical properties. The soil of the study area was silty clay loam in texture with pH 7.2, EC 1.43 dS/m, 0.43% organic carbon and sulfur 63 ppm. The experimental site was sub-tropical humid climate with an average rain fall ranging between 1430 mm to 1760 mm and means maximum, minimum temperature of 10 to 42°C respectively. The available N, P_2O_5 and K_2O of the study plot were 403.8, 34.5 and 639.63 kg/ha, respectively. The experiment was laid out with three replications in Randomized Block desgin wit eleven treatments. The different treatments of sulfur onsunflower were T_1: Control (no sulfur), T_2 : 20 kg sulfur/ha through ammonium sulfate, T_3 : 20 kg sulfur/ha htrough single super phosphate, T_4 : 20 kg sulfur/ha through gypsum, T_5 : 20 kg sulfur/ha through elemental sulfur, T_6 : 20 kg sulfur/ha through factophos (20 : 20 : 0 : 13), T_7 : 40 kg sulfur/ha through ammonium sulfate, T_8 : 40 kg sulfur/ha through single super phosphate, T_9: 40 kg sulfur/ ha through gypsum, T_{10} : 40 sulfur/ha through elemental sulfur, T_{11} : 40 kg sulfur/ha through factophos (20 : 20 : 0: 13). The recommended dose of notrogen, phosphorus and potassium were applied at the rate of 80 : 40 : 40 kg N, P_2O_5 and K_2O per hectare in the form of urea, super phosphate and muriate of potash and sulfur as per treatments. The sources of sulfur were ammonium sulfate (24%S), single super phosphate (12%S), gypsum (15%S), ele mentalsulfur (85% S) and facto-phos (20: 20 : 0 : 13). At basal, half of urea, full dose of super phosphate and muriate of potash were applied and one-fourth urea applied on 1st irrigation i. e. 30 DAS and another one fouth dose at 2nd irrigation i.e. 55 DAS respectively. The crop was sown on January 24, 20, 22 and 20 and harvested on April 28, May 03, April 29 and 22 in 2011, 2012, 2013 and 2014 respectively. Sunflower variety grown as test crop was DRSH-1. Irrigation were given uniformly and regularly to all plots as per requirement so as to prevent the crop from water stress at any stage. As per pactices all the cultural practices were followed. The crop was completely harvested at physiological maturity stage and their biometric observations such as plant height,100 seed weight, seed yield, oil content and oil yield were recorded. The ecoomic analysis was done basted on prevailing market price of inputs used and output obtained from each treatment. The experimental data were statistically analyzed as suggested by Gomez and Gomez (1976). For significant results the critical difference was worked out at 5% level.

RESULTS AND DISCUSSION

Among various Sulfur treatments, 40 kg facto-phos (20 : 20 : 0 : 13) attained the highest plant height(135 cm) of sunflowr followed by 40 kg elemental sulfur (Table 1). The incrase in plant height 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. These results arein conformity with the findings of Raja et al. (2007). The lowest plant height was recorded under 40 kg A/S (123 cm) treatment though the effect was found not significant. Again, aulfur regulates the metaolic and enzymatic processes including photosynthesis and respiration. These results in the similar trend with those of reported by Poomurugesan and Poonkodi (2008). Among the yield contributing character head diameter was significantly influenced by sulfur application. Application of 40 kg facto-phos (20 : 20 : 0 :13) recorded the hightes head diameter (15.04 cm) and the lowest one from 40 kg A/S. Sufur dose of 40kg / ha as facto-phos (20 : 20 : 0 : 13), elemental sulfur and single super phosphate treated plot showed highest seed index value (6.3 g/100 seed) and the lowest value was recorded by ammonium sulfate source of sulfur either 20 kg S/ha or 40 kg S/ha (5.9 cm).

The highest seed yield of sunflower was obtained from 40 kg A/S (1840 kg/ha) treated plot but the plot treated with 20 kg S registered the lowest seed yield (1717 kg/ha) (Table 2). Better partitioning of photosynthates to the plant could be the reason for these improvements. Application of higher level of sulfur did not show significant increase in oil content and oil yield. The result on oil content revealed that 20 kg S

Table 1. Effect of sulfur on plant height, head diametr and 100 seed weight of sunflower (pooled data of four years).

Treatments	Plant height (cm)	Head diameter (cm)	100 seed weight (g)
Control	127	13.44	6.0
20 kg S through A/S	125	13.26	5.9
20 kg S through SSP	124	13.34	6.2
20 kg S through gypsum	126	13.93	6.1
20 kg S through elemental S	128	13.75	6.1
10 kg S through facto-phos (20 : 20 : 0 : 13)	129	13.69	6.2
40 kg S through A/S	123	13.16	5.9
40 kg S through SSP	127	13.83	6.3
40 kg S through gypsum	129	13.41	6.0
40 kg S through elemental S	132	13.48	6.3
40 kg S through facto-phos (20 : 20 : 0 :13)	135	15.04	6.3
SEm (±)	2.72	0.34	0.17
CD at 5%	NS	0.98	NS
CV%	4.27	4.97	5.62

Table 2. Effect of sulfur on seed yield, oil content and oil yield of sunflower (pooled data of four years).

Treatments	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)
Control	1718	34.64	595.12
20 kg S through A/S	1777	34.56	614.13
20 kg S through SSP	1728	34.78	601.00
20 kg S through Gypsum	1734	34.47	597.71
20 kg S through elemetal S	1717	35.02	601.29
20 kg S through facto-phos (20 : 20 : 0 : 13)	1725	35.44	611.34
40 kg S through A/S	1840	34.93	642.71
40 kg S through SSP	1803	34.09	614.64
40 kg S through Gypsum	1791	34.57	619.15
40 kg S through elemental S	1830	34.71	635.19
40 kg S through facto-phos (20 : 20 :0 ;13)	1828	33.21	607.08
SEm (±)	91.72	11.94	51.12
CD at 5%	NS	NS	NS
CV%	4.67	4.20	4.25

through either elemental sulfur or facto-phos (20 : 20 0 :13) showed highest oil content (35.02 and 35.44%) and lowest one was recorded by 40 kg S as facto-phos (20 : 20 : 0 : 13) (33.21%) oil content. The oil yield of sunflower was also not showed any definite influence of sulfur application and 40 kg sulfur as A/S treated plot attained highest oil yield (642.71 kg/ha) whereas, the lowest yield was registered by control plot (595.12 kg/ha) might be due to inherent S content of the soil Sundarban areas of West Bengal.

The economics study of sunflower cultivation data (Table 3) revealed that 40 kg sulfur per hectare applied as facto-phos (20 : 20 : 0 : 13) registered the highest gross return (Rs 49,594) and net return (Rs 26,897). Similarly, the highest benefit-cost ratio (1.19) was recorded under control plot as well as 40 kg S through facto-phos whereas the lowest value was found at 20 kg S through elemental sulfur (1.06) probably due lower return of this treatment.

Table 3. Effect of sulfur on economics of sunflower cultivation (pooled data of four years).

Treatments	Total cost of cultivation (Rs/ha)	Gross return Rs/ha)	Net return (Rs/ha)	B : C ratio
Control	20882	45770	24888	1.19
20 kg S through A/S	21885	47112	25227	1.15
20 kg S through SSP	21723	46334	24611	1.13
20 kg S through Gypsum	21735	46126	24391	1.12
20 kg S through elemental S	22083	45537	23454	1.06
20 kg S through facto-phos (20 ;20: 0:13)	21793	46735	24942	1.14
40 kg s through A/S	22514	48562	26048	1.16
40 kg S through SSP	22095	47785	25690	1.16
40 kg S through Gypsum	22360	47398	25038	1.12
40 kg S through elemental S	23118	48725	25607	1.11
40 kg S through facto-phos (20:20:0:13)	22697	49594	26897	1.19
SEm (±)	148.56	590.08	476.31	0.079
CD at 5%	427.85	1699.4	1371.77	NS
CV%	1.00	7.37	9.19	3.51

CONCLUSION

In the light of the above study, it may be concluded that application of sulfur from different sources and levels has no significant effect in augmenting sunflower yields in silty clay loam soil of Sundarban regions of South 24 Parganas District of West Bengal. Further research is required to develop strategies which could be most economic and ecologically sound method of nutrition approach for increasing seed and oil yield of sunflower.

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