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EFFECT OF DIFFERENT LEVELS OF SECONDARY AND MICRONUTRIENTS ON THE PHENOTYPIC ENHANCEMENT OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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Abstract

An attempt was made to study the effect of S as a secondary nutrient (Soil) and Zn and B as micronutrients (foliar) application on the phenotypic enhancement of hybrid sunflower, at Ayan Athur village, Ariyalur district (TN) during the summer seasons of 2016 and 2017. The experiments were laid out in Randomized Block Design (RBD) with three replications. The growth components of sunflower *viz*., plant height, leaf area index, dry matter production, LAD and growth analysis parameters such as CGR, RGR, NAR and chlorophyll content were favourably influenced by foliar application of 0.5% Zn on bud initiation stage and seed formation stage and B @ 0.3% on bud initiation stage and ray floret formation stage along with S @ 40 kg ha^{-1} and RDF as a soil application. The RDF alone (T_1) recorded the lowest values with the above growth attributes. Among the treatments, foliar application of Zn @ 0.5% and B @ 0.3% along with S @ 40 kg ha^{-1} and RDF (T_9) recorded the highest percentage of growth components in both the seasons of crop period.

Key words: Boron, Chlorophyll content, DAP, Foliar spray, micronutrients, sulphur and Zinc.

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops grown worldwide containing high-quality edible oil. It is a hardy crop, combines with high yielding potential and great adaptation capacity to any adverse condition. Its high synthetic capacity and harvest index allows this crop to be productive in a broad range of environments (Agele, 2003). Oilseeds and their derivatives of vegetable oil and meal are in demand globally and there is a need to identify and quantify the key issues for their production by different stakeholders to develop and support actions that will ensure a viable future of such crops (Muhammad Farhan *et al*., 2013). Nowadays, the consumption of edible oil is increasing whereas, the production of the same is declining due to mismanagement practices of nutrient application in India. The increased demand for food grain production has led to intensive cultivation which paves continuous depletion of soil micronutrient fertility. As a result, there is steady fall of nutrient use efficiency and that is partly attributed due to the increased incidences of deficiencies of zinc and boron in many parts of the country (Singh and Goswami, 2014). For optimal growth and development, 16 essential elements are required by the crop plants. Apart from the major nutrients, sulphur is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium (Tandon and Messick, 2002).

Sulphur plays a predominant role in improving the grain quality of sunflower crop and also the use efficiency of nitrogen and phosphorus. In oilseeds, sulphur plays a vital role in the development of seed and improving quality (Naser *et al*., 2012). Sulphur deficiency has been reported 70 countries worldwide, of which India is one, Tamilnadu is one of the agriculturally important states with very little data on soil sulphur status. It has been found that 80 percent of the samples obtained from 15 benchmark clay soil in Cuddalore district were reported to be ‘S’ deficient (Balasubramanian *et al.,* 1990). Hence the present investigation was carried out to evaluate the appropriate source of sulphur and its response and optimize the levels of S to enhance the oil content and oil yield in sunflower.

Micronutrients such as zinc, boron and iron often act as co-factors in enzyme synthesis and actively participate in redox reactions, besides having several other vital functions in plants. Micronutrients are involved in the key physiological processes of photosynthesis and respiration (Marchner, 1995). Among the micronutrients zinc actively involved as both functional and structural component in the synthesis of several enzymes (Hemantaranjan, 1996) and its deficiency leads to many aberrations in reproductive organs of plants, which leads to lower productivity (Neena and Chitrlekha, 2001). Boron is functionally associated with one or more of the processes of calcium utilization, cell division, flowering and fruiting, carbohydrate and nitrogen metabolism, disease resistance, water relations and catalyst for certain reactions (Sprague, 1951).

Iron is functionally accompanied by an increment of root size especially in soil with high pH and sandy loam in nature leads to the betterment of crop growth. Indian soils are mostly low. medium and high in nitrogen, phosphorus and potassium respectively. But with micronutrient concern, most of the Indian states are deficient particularly the state of Tamil Nadu ranks 4th in Zn (58.4%) and Fe (17%) deficiency whereas 5th rank in B (21%) of samples in deficiency (GOI, 2015). Though the required quantity of micronutrients is low, the application of these nutrients through foliar fertilization is a prominent one due to rapid translocation of these nutrients to leaf and seed is superior to soil application (Neumann, 1982). Foliar nutrients usually penetrate the leaf cuticle or stomata and enter the cells facilitating the easy entry of nutrients. Hence an attempt was made to study the effect of micronutrients through foliar application along with primary and secondary nutrients on the phenotypic enhancement of sunflower.

Materials and Methods

Study area

To study the effect of Zn, Fe and B as micro nutrients along with different levels of sulphur on the phenotypic enhancement of sunflower, the experiment was conducted at Ayan Athur village, Ariyalur district, Tamilnadu, India during Feb. to Apr. on 2016 and 2017. The experimental site of the study details furnished in table.1 Soil was analysed for their physical and chemical properties. A composite soil sample was collected at a depth of 0-30 cm. It was air dried, crushed and tested for physical and chemical properties. The soil was sandy clay loam in texture with soil reaction of (pH 7.6), electrical conductivity 0.69 dS m^{-1}, organic matter (0.72%), low available nitrogen (152.7 $kg.ha^{-1}$), available phosphorus (17.4 Kg ha^{-1}), low available sulphur (17.2 $kg.ha^{-1}$), low available Zn (0.72 mg/kg) and low available B (0.56 mg/kg). The experimental design was carried out in a randomized block design with nine treatments and replicated thrice. The experimental treatments as follows: T_1- RDF alone, T_2- RDF+ S @ 20 kg ha^{-1}, T_3- RDF+ S @ 20 kg ha^{-1}+ Zn @ 0.25% as foliar spray, T_4- RDF + S @ 20 kg ha^{-1}+ B @ 0.15% as foliar spray, T_5- RDF + S @ 20 kg ha^{-1}+ Zn @0.25% and B @ 0.15% as foliar spray, T_6- RDF + S @ 40 kg ha^{-1}, T_7- RDF + S @ 40 kg ha^{-1}+ Zn @ 0.5% as foliar spray, T_8- RDF + S @ 40 kg ha^{-1} + B @ 0.3% as foliar spray, T_9- RDF + S @ 40 kg ha^{-1}+ Zn @ 0.5%and B @ 0.3% as foliar spray. Experimental plots consist of two levels of sulphur (20 and 40 kg ha^{-1}) as soil application, Zn (0.25 and 0.5%) and B (0.15 and 0.3%) as foliar application and control *i.e.*, recommended N, P and K (60:90:60 kg. ha^{-1}) alone as soil application.

Crop management Practices

The land was thoroughly ploughed with a tractor-drawn implement with a criss-cross manner and levelled properly. The plots were prepared with the dimension of 8m × 5m and seeds of hybrid sunflower Sunbred-275 were sown with a spacing of 60×30 cm. For fertilization, the RDF treatment 100% of P through DAP and S through elemental sulphur, 50% of N through urea and K

Fig. 1: Geographical location of the Experimental site.

through MOP was applied basally as a soil application. Remaining 50% of N and K applied at the pre-flowering stage. Treatments possessing micro nutrients *viz*., Zn supplemented through zinc chloride @ 0.25 and 0.5% as a foliar application at bud initiation stage and seed formation stage and B through boric acid @ 0.15 and 0.3% as a foliar application at bud initiation stage and ray floret formation stage respectively. Tween-twenty as surfactant used @ 0.5cc/L added to enhance the persistence capacity of spray solution on the leaf during the spray. At 4-5 leaf stage plants were thinned to appropriate density. Irrigation was given uniformly and regularly to all plots as per the requirement to prevent the crop from water stress at any stage. The crop biometric observations of growth attributes such as plant height, LAI, LAD, DMP and also growth indices of CGR, RGR and chlorophyll content were recorded during the study.

Chlorophyll Assay

The total chlorophyll content of leaves was determined by using 80% acetone extraction suggested by Arnon, (1949). About 250 mg of fresh leaf material from each plot was taken and crushed thoroughly with 80% acetone. A homogeneous paste was made and filtered through Whatman No.1 filter paper, made up the volume with 80% acetone 25 ml. Since the extract is subjected to evaporation and photo-oxidation. The optical activity or density of chlorophyll 'a' and 'b' recorded at 645 nm and 663 nm wavelength respectively and chlorophyll a and b were calculated using the formula.

Chlorophyll a = 20.2 × O.D value at 645 nm × 100 / 1000 $mg.g^{-1}$

Chlorophyll b = 8.02 × O.D value at 663 nm × 100 / 1000 $mg.g^{-1}$

Total chlorophyll content = chlorophyll a+chlorophyll b.

Statistical Analysis

The experimental data were statistically analysed as suggested by Gomez and Gomez, (1976). For significant results, the critical difference was worked out at 5 percent level.

Results and Discussion

Effect of S and micronutrients (Zn and B) on the growth components of sunflower

Statistically analyzed results presented in table 1 revealed that the effect of different levels of the sulphur application combines with micronutrients had a positive influence on all growth attributes *viz*., plant height, LAI,

Table 1: Characteristics of the study area.

Site	Characteristics
District	Ariyalur (Ayan Athur)
Latitude and Longitude	11°23'N and 79°29'E
Agro-climatic zone	West Cauvery deltaic zone (TN-4)
Mean Sea Level	+26.0 mts
South East Monsoon	375 mm
North East Monsoon	585 mm
Summer rain	83 mm
Winter rain	29 mm
Major soils	Deep and very deep black soil, deep and very deep Red soil, moderately loam and misc. soil
Major crops grown	Rice, Sugarcane, Cotton, Maize, Groundnut, sorghum, Gingelly, sunflower and vegetables

Table 2: Effect of secondary and micronutrients on growth components of sunflower.

Treatments	Crop I				Crop I			
	Plant height in cm	LAI @ Flow	LAD	DMP @ Harvest	Plant height in cm	LAI @ Flow	LAD	DMP @ Harvest
T_1- RDF alone as soil application	138.2	5.2	42.0	4750.0	130.4	5.0	41.6	4688.7
T_2- RDF+ S @ 20 kg ha^{-1}as soil application	143.7	5.4	42.8	5100.4	135.2	5.3	42.3	5058.0
T_3- RDF+ S @ 20 kg ha^{-1}+ Zn @ 0.25% as foliar spray	146.0	5.5	44.0	5375.2	138.6	5.4	43.1	5294.5
T_4- RDF + S @ 20 kg ha^{-1}+ B @ 0.15% as foliar spray	147.5	5.6	44.3	5489.0	140.0	5.5	43.9	5401.0
T_5- RDF + S @ 20 kg ha^{-1}+ Zn @ 0.25 % and B @ 0.15% as foliar spray	151.0	5.8	46.0	6001.7	145.9	5.9	46.1	5598.2
T_6- RDF + S @ 40 kg ha^{-1}as soil application	157.2	6.1	48.2	6324.2	151.8	6.1	47.9	5846.0
T_7- RDF + S @ 40 kg ha^{-1}+ Zn @ 0.5% as foliar spray	164.1	6.4	50.9	6691.0	159.0	6.2	49.5	6130.8
T_8- RDF + S @ 40 kg ha^{-1} + B @ 0.3% as foliar spray	166.2	6.5	51.8	6812.8	162.1	6.3	50.1	6211.3
T_9- RDF + S @ 40 kg ha^{-1}+ Zn @ 0.5% and B @ 0.3% as foliar spray	172.3	6.9	53.5	7130.4	168.4	6.6	51.9	6725.0
S.E(m)	**2.3**	**0.05**	**0.59**	**66.72**	**2.42**	**0.06**	**0.64**	**69.8**
C.D (P=0.05)	**4.87**	**0.11**	**1.25**	**141.4**	**5.13**	**0.13**	**1.36**	**147.9**

Table 3: Effect of secondary and micro nutrients on the growth analysis components of sunflower.

Treatments	Crop I				Crop II			
	CGR g/m2 /day	RGR g/g /day	NAR g/m2	Total Chlor-ophyll mg/g	CGR g/m2 /day	RGR g/g /day	NAR g/m2	Total Chlor-ophyll mg/g
T_1- RDF alone as soil application	13.9	0.053	11.3	1.464	13.6	0.049	11.2	1.446
T_2- RDF+ S @ 20 kg ha^{-1}as soil application	14.4	0.056	11.9	1.490	14.1	0.053	11.9	1.470
T_3- RDF+ S @ 20 kg ha^{-1}+ Zn @ 0.25% as foliar spray	14.8	0.058	12.2	1.521	14.5	0.056	12.3	1.487
T_4- RDF + S @ 20 kg ha^{-1}+ B @ 0.15% as foliar spray	15.3	0.061	12.4	1.539	15.0	0.057	12.3	1.520
T_5- RDF + S @ 20 kg ha^{-1}+ Zn @0.25% and B @ 0.15% as foliar spray	15.6	0.064	13.0	1.574	15.4	0.060	12.1	1.531
T_6- RDF + S @ 40 kg ha^{-1}as soil application	16.2	0.066	13.1	1.593	15.9	0.062	12.2	1.564
T_7- RDF + S @ 40 kg ha^{-1}+ Zn @ 0.5% as foliar spray	16.4	0.069	13.2	1.645	16.1	0.065	12.4	1.590
T_8- RDF + S @ 40 kg ha^{-1} + B @ 0.3% as foliar spray	16.5	0.070	13.2	1.651	16.2	0.067	12.4	1.602
T_9- RDF + S @ 40 kg ha^{-1}+ Zn @ 0.5% and B @ 0.3% as foliar spray	16.9	0.075	13.3	1.687	16.6	0.071	12.9	1.615
S.E(m)	**0.012**	**0.001**	**0.12**	**0.005**	**0.010**	**0.001**	**0.09**	**0.004**
C.D (P=0.05)	**0.025**	**0.002**	**0.25**	**0.011**	**0.021**	**0.002**	**0.19**	**0.008**

DMP and LAD and growth analysis *viz*., CGR, RGR and chlorophyll content in both the crop period. Among the different levels of sulphur, the highest plant height (172.3 cm and 168.4 cm), LAI (6.9 and 6.6), DMP (7130.4 and 6725.0 kg ha^{-1}), LAD (53.5 and 51.9 days), CGR (16.9 and 16.6), RGR (0.075 and 0.071), NAR (13.3 and 12.9 g day^{-1}) and total chlorophyll content (1.687 and 1.615 mg g^{-1}) were recorded with the application of elemental sulphur @ 40 kg ha^{-1} along with RDF (60:90:60 kg ha^{-1}) and micronutrients both Zn @ 0.5% and B @ 0.3% as foliar spray which was significantly followed by S with B @ 0.3% foliar spray with consistent pace in both the crop period over 20 and 0 kg S ha^{-1} with Zn @ 0.25% and B @ 0.15%.

This might be due to more synthesis of amino acids, increase in chlorophyll content in a growing region and improving the photosynthetic activity, ultimately enhancing cell division resulted in an increment in plant height, higher LAI and DMP. This was evidenced through the studies of Raja *et al*., (2007). Furthermore, this beneficial effect might be due to the interaction effect of sulphur, zinc and boron and their unanimous role in the synthesis of IAA, metabolism of auxin and formation of chlorophyll synthesis (Ravi *et al*., 2008). Similar results are corroborating the findings of Rathore and Tomar, (1990). Addition of boron increased growth parameters due to its contribution to cell wall formation and the deficient plants remain stunted and do not reach a maximum height at the same time boron supply reduces the lignifications, hence, histologically, the plant cell continues to grow, especially at the tips with elongation of epicotyls and hypocotyls (Yu and Bell, 1998) and also the interaction effect between boron and sulphur significantly and synergistically influenced the dry matter and seed yields of both mustard and sunflower, which were observed the highest at 60 mg kg^{-1} of S in conjunction with 2 mg kg^{-1} of boron (Karthikeyan and Shukla, 2008).

Conclusion

In the light of the above facts, it may be concluded that application of sulphur @ 40 kg ha^{-1} basally as soil application along with RDF and micronutrients such as Zn @ 0.5% and B @ 0.3% at bud initiation stage, seed formation stage (Zn) and bud initiation, ray floret formation stage (B) as foliar application enhances all the growth parameters of sunflower in sandy clay loam soils of Ariyalur district.

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