Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 15 Issue 9 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Efficacy of Foliar Nutrition on Vegetative and Reproductive Growth of Sunflower (*Helianthus Annuus* L.)

By Tegegnework Gebremedhin, Shanwad U. K, Wubayehu Gebremedhin & A. Anantha Rama

Debre Markos University, Ethiopia

Abstract- The study showed the significant efficacy of foliar application of macro and micronutrients along with the soil test crop responses on all the parameters of sunflower (*Helianthus annuus* L.) Among nine treatments under study, treatment T_9 (STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%) recorded maximum height of plants (191.7cm), number of leaves per plant (22.17), leaf area (17.32 dm^2), stem girth (9.97 cm), minimum days to flowering (54), head diameter (28.14 cm) and total dry matter accumulation (108.07 g $plant^{-1}$) followed by the treatment T_3: STCR approach (Yield target: 25 q/ha) and T_8: Soil test based NPK (STL) + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%. The stem girth (9.97 cm) was found maximum in T_9 followed by the treatment T_3. Maximum gross returns (Rs. 65,257 ha^{-1}), net returns (Rs. 42,105 ha^{-1}) and B: C ratio (2.82) was found with T_9 (STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%).

Keywords: sunflower nutrition, STCR, STL, foliar.

GJSFR-D Classification : FOR Code: 309999p

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Efficacy of Foliar Nutrition on Vegetative and Reproductive Growth of Sunflower (*Helianthus Annuus* L.)

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I. Introduction

Sunflower (*Helianthus annuus L.*) is grown in different agro climatic zones of the world, differing in soil nutrient status. The use of foliar fertilizing in agriculture has been a popular practice with farmers since the 1950s, when it was learned that foliar fertilization was effective and economic. Its purpose is not to replace soil fertilization, but rather to supplement plant nutrient needs during short and/or critical growth stages. Foliar feeding is intended to delay natural senescence processes shortly after the end of reproductive growth stages. Recent research has shown that a small amount of nutrients, particularly Zn, Fe, B and Mn applied by foliar spraying increases significantly the yield of crops (Sarkar *et al.*, 2007; Wissuwa *et al.*, 2008, Asad *et al.*, 2002). Also, foliar nutrition is an option when nutrient deficiencies cannot be corrected by applications of nutrients to the soil (Sarkar *et al.*, 2007; Cakmak, 2008). It is likely therefore, in open-field conditions, where the factors that influence the uptake of the nutrients are very changeable, foliar fertilization can get considerable importance. Among the micronutrients, Zn and Fe nutrition can affect the susceptibility of plants to drought stress (Sultana *et al.*, 2001; Cakmak, 2008).The highest rate of Boron foliar fertilization resulted in leaf burn but had no other evident detrimental effect on plant growth. Under B-deficient conditions, Boron foliar application increased the vegetative and reproductive dry mass of plants. Iron plays essential roles in the metabolism of chlorophylls. External application of Fe increased photosynthesis, net assimilation and relative growth in seawater-stressed rice (Sultana *et al.*, 2001). This is especially true for soils of high pH where equilibrium conditions favour the oxida- absorption of plant-available Fe^{+2} to unavailable Fe^{+3}. Plant yield on many soils is, therefore, limited by poor Fe availability, rather than a low Fe content in the soil (Ahmad, B. and Garib, M., 2010).

Foliar feeding of nutrients has become an established procedure to increase yield and improve the quality of crop products (Romemheld, 1999). This procedure improves nutrient utilization and lower environmental pollution through reducing the amount of fertilizers added to soil. Foliar feeding of nutrients may actually promote root absorption of the same nutrient or other nutrients through improving root growth and increasing nutrients uptake (Saqib *et al.*, 2006). Foliar application of nutrients is in advance more significance in fertilization of various field and floricultural crops, in many countries. The advantages of foliar fertilizers were more noticeable under growing conditions restricting the incorporation of nutrients from the soil (Verma, 2003).Foliar fertilization method may also be a good substitute to the predictable soil application to avoid the loss of fertilizers by leaching and thereby minimizing the ground water pollution (Tomimori *et al.*, 1995). Zinc plays an important role in the production of biomass (Cakmak, 2008). It may be required for chlorophyll production, pollen function, fertilization. The purpose of this study is to understand the effect of foliar fertilization of micro nutrients along with the different basal fertilizer application on the vegetative and reproductive growth of sunflower.

Author α ρ: Department of Plant Sciences, Debre Markos University, Ethiopia.
Author σ ω: Department of Agronomy, UAS, Raichur, India.
Author ¥: EIAR, Pawe Agricultural Research Center, Ethiopia.
Author §: Department of Agricultural microbiology, UAS, GKVK, Bangalore, India. e-mail: tegegne90@gmail.com

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II. Material and Methods

a) Description of the site

The experiment was conducted on the research farm of Main Agricultural Research Station of North Eastern Dry Zone (Zone-2) of Karnataka, Raichur, India at 16° 15' N latitude and 77° 20' E longitude with an altitude of 389 meters above mean sea level during 2013 growing seasons. Site of study has cold winter and very hot summer. The yearly average precipitation 50-years long term period) which is mostly occurred during the spring months is 681.2 mm. The mean annual average maximum and minimum temperature was 33 and 21.5°C respectively.

b) Soil sampling and analysis

Prior to the beginning of experiment, soil samples were taken in order to determine the physical and chemical properties. A composite soil samples were collected at a depth of 0-30 cm. It was air dried, crushed, and tested for physical and chemical properties. The research field had a clay loam soil. Details of soil properties are shown in (Table 1).

Table 1 : Physical and chemical properties of the soil used in the study (0-30 cm)

Textural class	Clay loam
Soil PH	7.69
Ec (dsm-1)	0.36
CEC (c mol (p+) kg-1)	48.2
Organic carbon (%)	0.62
N (kg ha-1)	234.28
P2O5 (kg ha-1)	39.78
K2O (kg ha-1)	405.02
Mn (ppm)	11.9
Fe (ppm)	3.94
Zn (ppm)	0.26
CU (ppm)	1.01

c) Field preparation and Treatment allocation

After plough in fall and two disks in summer, the land was flatted by leveler and then plots were prepared. The experimental design was laid out in a Randomized Complete Block Design with three replications. The treatments involved were, T_1 - Recommended NPK as per POP (90:90:60 N P K kg ha^{-1}), T_2 - Soil test based NPK (STL method), T_3 - STCR approach (Yield target: 25 q/ha), T_4 - Foliar spray of nutrients NPK (19:19:19 @ 1% spray at 15, 30, 45 and 60 DAS) + Zn (0.5%) and Fe (0.5%) sprays at 30, 45 and 60 DAS + B (0.2%) sprays at 50% flowering, T_5 - T_1 + T_4, T_6 - 75% Recommended NPK + T_4, T_7 - 50% Recommended NPK + T_4, T_8 - T_2 + T_4, T_9 - T_3 + T_4 where in RDF: Recommended Dose of fertilizers and STCR: Soil Test Crop Responses.

The net plots had 4.8 m length and 4.8 m width consisted of 8 rows, 0.6 m apart between all plots, 1 m distance was kept to eliminate all influence of lateral water movement. NPK (19:19:19) was applied @ 5 kg ha^{-1}, Zn and Fe were applied in the form of ZnSO4 and FeSO4 @ 2.5 kg ha^{-1} and finally Boron was applied @ 1 kg ha^{-1} as foliar application to the treatment details. According to results of soil analysis 102.5:90:60 N: P_2O_5:K_2O kg ha^{-1}, 96:165:57: N, P_2O_5, K_2O kg ha^{-1} and for RDF 90:90:60 kg ha^{-1} Basal dose of fertilizer for T_2, T_3 and T_1 respectively was used. All of diammonium phosphate (DAP) and one third of urea were distributed in plots and mixed with surface soil before seed sowing. Rest of urea was used at 30 DAS.

III. Result and Discussions

a) Growth Parameters

The data revealed that the efficiency of foliar application of both macro and micro nutrient fertilizers along with different basal fertilizer application methods affected growth parameter like plant height, number of leaves, leaf area and stem girth of Sunflower as shown in (Table 2). Significant difference in the plant height, number of leaves, leaf area and stem girth was recorded due to application of foliar nutrition long with of soil test crop response basal fertilizer application. The treatment T_9 recorded the maximum plant height (191.7cm), number of leaves per plant (22.17), and leaf area (17.32 dm^2) followed by T_3 (185cm), (21.17) and (16.76 dm^2) and T_8 (182.67 cm), (18.62) and (16.77 dm^2) of plant height, number of leaves and leaf area , respectively and the maximum stem girth was on T_9 (9.97 cm) followed by T_3 (9.26 cm) which differed significantly from each other as well from other treatments.

The higher plant height might be attributed to increased efficiency in nutrient availability resulting in prolonged greenness and larger leaf surface as indicated by the result at all the growth stages. Similar results were reported by Elnaz *et al*. (2010). The Plant height due to the enhancement of auxine biosynthesis and synergetic relation between iron and nitrogen the significantly lower growth parameter was noticed on the treatment T_4 (solely foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%) because providing only foliar nutrition might not have fulfilled the crop demand. The better performance of sunflower with the increased nourishment of soil test crop response along with foliar spray of micro nutrient may be due to the greater availability of nutrients and Foliar fertilization is theoretically more immediate and target- oriented than soil fertilization since nutrients can be directly delivered to plant tissues during critical stages of plant growth (Fernández and Brown, 2013). The present findings are in consonance with that of Ramachandrappa and Najappa (2005). The result were identified by Kassab (2005) confirmed the significant effect of micronutrients in growth parameters including yield in mung bean plants by foliar application.

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b) Reproductive Parameters

The data revealed that the efficiency of foliar application of Nutrients along with different basal fertilizer application methods affected various flowering and flower head parameters as shown in (Table 3). The treatment, T_9 (STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%), T3 (STCR approach), T8: (Soil test based NPK + Foliar spray of NPK @ 1% + ZnSO4 @ 0.5% + FeSO4 @ 0.5% and B @ 0.2%) and T_2 (Soil test based NPK) were noticed early flowering ranges between (54 and 55 DAS) as compared to all other treatments. The treatment T_9 recorded the maximum flower head diameter (28.14 cm), followed by T_3 (26.53 cm) and T_8 (25.47 cm) which differed significantly from each other as well from other treatments. This may be due to considerably higher and balanced levels of fertilizer application. These results are in line with the work of Osman *et al*. (1980) and Akram (1989) who reported that nitrogen alone or in combination with phosphorous and potash increased head diameter over the control. Wang *et al.,* (2003) observed that boron plays an essential role in pollen germination and pollen tube growth in *Picea meyeri*.

Table 2 : Effect of foliar nutrition along with different basal fertilizer application methods on different vegetative growth parameters of sunflower

Treatments		Plant height (cm)	Number of leaves	Leaf area (dm^2)	Stem girth (cm)
T_1	RDF (control)	174.4	15.83	15.4	8.17
T_2	Soil test based NPK (STL method)	180.34	17.78	15.5	8.84
T_3	STCR approach (Yield target: 25 q/ha)	185	21.17	16.76	9.26
T_4	Foliar spray of NPK + $ZnSO_4$ + $FeSO_4$ and B	165	11.53	11.73	7.43
T_5	T_1 + T_4	174.67	16.41	15.43	8.35
T_6	75% RDF + T_4	171	15.74	15.11	7.95
T_7	50% RDF + T_4	167	14.96	14.58	7.6
T_8	T_2 + T_4	182.67	18.62	16.77	8.93
T_9	T_3 + T_4	191.7	22.17	17.32	9.97
	S.Em±	2.8	1.18	0.47	0.32
	C.D. at 5%	8.4	3.56	1.42	0.96

Table 3 : Effect of foliar nutrition along with different basal fertilizer application methods on the total dry matter accumulation and reproductive parameters of sunflower

Treatments		Days to 50% flowering	Head diameter (cm)	Total dry matter accumulation (g plant-1)
T_1	RDF (control)	56	22.27	95.9
T_2	Soil test based NPK (STL method)	55	24.17	98.4
T_3	STCR approach (Yield target: 25 q/ha)	54	26.53	103.27
T_4	Foliar spray of NPK + $ZnSO_4$ + $FeSO_4$ and B	58	19.03	86.89
T_5	T_1 + T_4	56	23.27	97.07
T_6	75% RDF + T_4	57	20.33	94.63
T_7	50% RDF + T_4	57	19.43	91.73
T_8	T_2 + T_4	54	25.47	101.6
T_9	T_3 + T_4	54	28.14	108.07
	S.Em±	0.5	1.12	1.74
	C.D. at 5%	1.6	3.38	5.23

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c) Total Dry matter Accumulation in sunflower

The data revealed that the efficiency of foliar nutrition along with different basal fertilizer application methods affected the total dry matter production and its accumulation (Table 3).

The treatment T_9 recorded the maximum total dry matter accumulation (108.07 g plant^{-1}), followed by T_3 (103.27 g plant^{-1}) which differed significantly from each other as well from other treatments. Significantly lower total dry matter accumulation (86.89 g plant^{-1}) was recorded with T4 (foliar spray of NPK @ 1% + ZnSO4 @ 0.5% + FeSO4 @ 0.5% and B @ 0.2%). The increased total dry matter accumulation may be attributed to greater accumulation of photosynthates by vegetative parts in the plants having micronutrient application. Similar results were also reported by Thiyageshwari and Ramanathan (2001) in tomato, Movahedi-Dehnavi *et al.* (2009) and (Mohammad, G., *et al*., 2012) which they indicated the Positive effect of micronutrient elements on biological yield of safflower. The application of micronutrients favoured the accumulation of even macronutrients due to their role in activation of enzymes, involved in metabolic processes.

IV. Conclusion

On the basis of present study, it is concluded that the application of STCR approach + Foliar spray of NPK @ 1% + $ZnSO_4$ @ 0.5% + $FeSO_4$ @ 0.5% and B @ 0.2%) resulted in maximum plant height, number of leaves per plant, leaf area, stem girth, flower head and early days to 50% flowering. Therefore we can conclude that plant which received foliar nutrition along with different basal soil test crop response fertilizer application to nutrient exhaustive crops like sunflower show significant results as compared to those other treatments. Micro nutrients uptake are controlled by the two major factors, availability of these elements in the soil and the ability of plants to acquire them. Application methods of micronutrients are very important to attain the best absorption. Sometimes response of the plants is different to application methods of fertilizers, for example in calcareous soil Fe and Zn are not available for plants, under such situations, foliar application is a useful method for best use of nutrients in plants like sunflower crop.

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