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Influence of foliar application of micronutrient mixture on micronutrient uptake by the safflower

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Abstract
A field experiment on "response of safflower (*Carthamus tinctorius* L.) to foliar application of micronutrient mixture" was conducted during *Rabi* 2018, at MARS farm, Raichur. Experiment was laid out in Randomized complete block design with three replications and nine treatments. Results revealed that foliar application of Grade-I multi micronutrient mixture (Fe-2%, Zn-3%, Mn-1% and B-0.5%) at 30 and 50 days after sowing @ 10 ml/litre and soil application of RDF (75:75:40 and 80 kg ha^{-1} of NPK and gypsum, respectively) along with zinc sulphate @ 6 kg ha^{-1} has recorded higher uptake of micro-nutrients *viz.*, iron (629.21 g ha^{-1}), zinc (331.29 g ha^{-1}), manganese (113.32 g ha^{-1}), copper (103.34 g ha^{-1}) and boron (122.74 g ha^{-1}) and it was on par with the treatment receiving RDF(75:75:40 and 80 kg ha^{-1} of NPK and gypsum, respectively) and along with foliar application of Grade-I micronutrient mixture @ 10 ml/litre and was superior to other treatments. From these results it can be concluded that foliar spray of Grade-I multi micronutrient mixture @ 10 ml /litre is feasible.

Keywords: Safflower, foliar application, micronutrient mixture, uptake

Introduction
Safflower (*Carthamus tinctorius* L.) is an important oilseed crop in the world and ranks third next to groundnut and soybean in crop production. Safflower belongs to family Compositae or Asteraceae. The increasing cost of fertilizer nutrients have led to search for alternative practices of managing the fertilizer nutrients more judiciously, efficiently and in balance proportions. Such approach would reduce the depletion of macro and micronutrients from soil. Among the nutrients, macro-nutrients have been given the priority and little attention has been given the priority and little attention has been paid towards micronutrients. In the absence of micronutrients, plant shows physiological disorder which eventually lead to low crop yield and fair quality

The micronutrients requirement by crop for normal growth and yield are less compared to that of the macronutrients. Nevertheless, each of the micronutrients Zn, Fe, B, Cu, Mn, Mo and Ni meet the requirements for essentiality criteria in plants and despite the small amounts needed by crops to complete their life cycles, their deficiencies greatly influences the growth and yield attributes of many crops.

Foliar fertilization with micronutrients is one of the most important methods of application of fertilizers for quick remedy for deficiency in both normal and problematic soils in agriculture practice with the aim of increasing the concentration of mineral nutrition in grain and enhancing their use efficiency (Wojtkowaik *et al*., 2015) [13]. Foliar application of nutrients facilitates their easy and quick absorption by penetrating the stomata or leaf cuticle and entering the cells. The spraying of micronutrients has led to improving the growth and increased macro and micronutrient uptake (Bameri *et al*., 2012) [3]. Hence, foliar application could be an advantage for crop growth and yield.

Materials and Methods
A field study was carried out during *Rabi* 2018 at MARS farm Raichur on "Response of safflower (*Carthamus tinctorius* L.) to foliar application of micronutrient mixture". The experiment was conducted in completely randomized block design having nine treatments are replicated thrice. The FYM (Farm Yard Manure) was applied to all the treatment plots before

one week of sowing. The treatment details are T1: RDF (NPK @ 75:75:40 and Gypsum @80 kg ha-1); T2 : T1 + ZnSO4 @ 6 kg ha-1 soil application ; T3 : T1 + Foliar spray of Grade-I micronutrient mixture @ 2.5 ml / litre of water ; T4 : T1 + Foliar spray of Grade-I micronutrient mixture @ 5 ml / litre of water ; T5 : T1 + Foliar spray of Grade-I micronutrient mixture @ 10 ml / litre of water ; T6 : T2 + Foliar spray of Grade-I micronutrient mixture @ 2.5 ml / litre of water ; T7 : T2 + Foliar spray of Grade-I micronutrient mixture @ 5 ml / litre of water ; T8 : T2 + Foliar spray of Grade-I micronutrient mixture @ 10 ml / litre of water ; T9 : Absolute control. The Grade-I micronutrient mixture was sprayed at 30 and 50 days after sowing (DAS).

The multi micronutrient mixtures (Grade-I) was prepared as per Karnataka State Department of Agriculture recommendations (Fe: 2.0%, Mn: 1.0%, Zn: 3.0% and B: 0.5%). This mixture was prepared in the laboratory by using iron sulphate, manganese sulphate, zinc sulphate and boric acid by adding 99.56 g, 30.77 g, 131.93 g and 28.59 g respectively in a distilled water and the solution was cleared by adding 1.2 per cent of citric acid and pH was adjusted by using 1M potassium hydroxide and made up to one litre with distilled water. The prepared mixture was preserved by adding a pinch of sodium benzoate. This mixture was sprayed according to dosage mentioned in treatment details during morning hours at 30 and 50 days after sowing. The initial properties of the soil are presented in Table 1.

Plant sample was collected at harvest stage of safflower from each plot and uptake of micro-nutrients were estimated. Uptake (Kg ha^{-1}) was calculated by multiplying its per cent concentration with seed, stover yield respectively. Boron in plants was estimated through Azomethane-H method and the colour developed was measured using spectrophotometer at 650 nm (Berger and Trough, 1939) [5]. The content of Zn, Cu, Fe and Mn were estimated by using Atomic Absorption Spectrophotometer (AAS) as explained by Jackson (1973) [9]. The digested material was directly fed to Atomic Absorption Spectrophotometer (AAS) with suitable dilutions wherever necessary and concentration of these elements was recorded in mg kg^{-1}.

Results and Discussion

Effect of foliar application of Grade-I micronutrient mixture on uptake of micro-nutrients by seeds and stover of safflower

Iron The data on the uptake of iron by safflower seed, stover and total at harvest significantly influenced by application of foliar application of Grade-I micronutrient mixture and results are presented in Table 2.

Uptake by seed

Significantly higher iron uptake by seed was recorded in the treatment T_8 which received RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (300.57 g ha^{-1}) compared to all other treatments and it was on par with the treatment T_5 which received RDF+ Foliar spray of Grade-1 @ 10 ml / litre of water (290.32 g ha^{-1}). However, significantly lower uptake of 105.42 g ha^{-1} was recorded in the treatment T_9 (control).

Uptake by stover

Iron uptake by stover of safflower differed significantly. Application of RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) was recorded significantly higher nitrogen uptake by stover (328.63 g ha^{-1}). It was on par with the treatment T_5 which received RDF + Foliar spray of Grade-1 @ 10 ml / litre of water (320.08 g ha^{-1}) and followed by treatment T_7: RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 5 ml / litre of water (318.53 g ha^{-1}). However, significantly lower iron uptake by stover was noticed in the treatment T_9 which is absolute control (154.37 g ha^{-1}).

Total uptake of iron by safflower crop

Total uptake of iron by safflower was significantly higher of 629.21 g ha^{-1} was recorded in the treatment RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water applied at 30 DAS and 50 DAS (T_8). It was on par with the treatment T_5 which received RDF + Foliar spray of Grade-1 @ 10 ml / litre of water (610.40 g ha^{-1}). However, significantly lower iron uptake by safflower was recorded in the treatment T_9: absolute control (259.79 g ha^{-1}).

The high uptake of iron noticed in treatment receiving RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) as showed in Fig. 1.This may be complimented to application of FYM which chelated the iron in soil and made easier availability to plant and also due to absorption of iron from foliar application of micronutrient mixture which contained Fe. Similar results were reported by Basavaraj and Uppar, (2008) [4] in groundnut and Samadhiya (2017) [12] in safflower.

Zinc

The data on the uptake of zinc by safflower seed, stover and total at harvest significantly influenced by application of foliar application of Grade-I micronutrient mixture and results are presented in the Table 3.

Uptake by seed

Significantly higher zinc uptake by seed was recorded in the treatment T_8 which received RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (183.46 g ha^{-1}) as compared to all other treatments and it was on par with the treatment T_5: RDF+ Foliar spray of Grade-1 @ 10 ml / litre of water (178.51 g ha^{-1}). However, significantly lower uptake of 52.69 g ha^{-1} was recorded in the treatment T_9 (control).

Uptake by stover

Zinc uptake by stover of safflower differed significantly. Application of RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) was recorded significantly higher zinc uptake by stover (147.83 g ha^{-1}). It was on par with the treatment T_5 which received RDF + Foliar spray of Grade-1 @ 10 ml / litre of water (142.06 g ha^{-1}). However, significantly lower zinc uptake by stover was noticed in the treatment T_9 which is absolute control (41.81 g ha^{-1}).

Total uptake of zinc by safflower crop

Total uptake of zinc by safflower was significantly higher of 331.29 g ha^{-} was recorded in RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8). It was on par with the treatment T_5 which received RDF+ Foliar spray of Grade-1 @ 10 ml / litre of water (320.57 g ha^{-1}). However, significantly lower zinc uptake by safflower was recorded in the treatment T_9: absolute control (94.50 g ha^{-1}).

The high uptake of zinc recorded in treatment receiving RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) as showed in Fig. 1.This might be due to Zn spray and soil application improved the root growth and

prevented nutritional disorders and consequently caused increase the uptake of Zn and also due to interaction effect of Zn and Fe. Combined application of Zn through soil and foliage at grand growth stages led to increased availability in soil which increased absorption by above ground parts of sunflower and also due to higher biomass in respective treatment. Results are in conformity with Ravi *et al*. (2008) [11], Ebrahimian and Ahmad (2011) [6] and Raghavendra *et al*. (2013) [10].

Manganese

The data on the uptake of manganese by safflower seed, stover and total at harvest was significantly influenced by application of foliar application of Grade-I micronutrient mixture and results are presented in Table 4.

Uptake by seed

Significantly higher manganese uptake by seed was recorded in the treatment T_8 which received RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water applied at 30 DAS and 50 DAS (47.33 g ha^{-1}) and it is superior to all other treatments. However, significantly lower uptake of 10.96 g ha^{-1} was recorded in the treatment T_9: control.

Uptake by stover

Manganese uptake by stover of safflower differed significantly. Application of RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) was recorded significantly higher manganese uptake by stover (65.88 g ha^{-1}). However, significantly lower manganese uptake by stover was noticed in the treatment T_9 which is absolute control (22.65 g ha^{-1}).

Total uptake of manganese by safflower crop

Total uptake of manganese by safflower was significantly higher of 113.22 g ha^{-1} was recorded in RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8). However, significantly lower manganese uptake by safflower was recorded in the treatment T_9 which is absolute control (33.61 g ha^{-1}).

The highest uptake of manganese is recorded in treatment receiving RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) as showed in Fig. 1. This may be attributed to direct absorption from foliage, higher soil contents and higher dry matter accumulation. These results are in conformity with Babaeian *et al*. (2011) [2].

Copper

The data on the uptake of copper by safflower seed, stover and total at harvest was significantly influenced by application of foliar application of Grade-I micronutrient mixture and results are presented in Table 5.

Uptake by seed

Significantly higher copper uptake by seed was recorded in the treatment T_8 which received RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (43.35 g ha^{-1}) as compared to all other treatments and it was on par with the treatment T_5 which received RDF+ Foliar spray of Grade-1 @ 10 ml / litre of water (41.84 g ha^{-1}).

However, significantly lower uptake of 10.93 g ha^{-1} was recorded in the treatment T_9 (control).

Uptake by stover

Copper uptake by stover of safflower differed significantly. Application of RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) was recorded significantly higher copper uptake by stover (59.99 g ha^{-1}). It was on par with the treatment T_5 which received RDF + Foliar spray of Grade-1 @ 10 ml / litre of water (57.20 g ha^{-1}). However, significantly lower copper uptake by stover was noticed in the treatment T_9 which is absolute control (24.10 g ha^{-1}).

Total uptake of copper by safflower crop

Significantly higher total uptake of copper with 103.34 g ha^{-1} by safflower was recorded in RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water applied at 30 DAS and 50 DAS (T_8) and it was on par with the treatment T_5 which received RDF + Foliar spray of Grade-1 @ 10 ml / litre of water (99.04 g ha^{-1}). However, significantly lower copper uptake by safflower was recorded in the treatment T_9 receiving absolute control (35.03 g ha^{-1}).

The highest uptake of copper is noticed in treatment receiving RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) as showed in Fig. 1. This is mainly due to increased biomass which is a result of balanced and sufficient nutrient supply through soil. Guruprasad *et al*. (2009) [7] reported the similar results in groundnut.

Boron

The data on the uptake of boron by safflower seed, stover and total at harvest was significantly influenced by application of foliar application of Grade-I micronutrient mixture and results are presented in Table 6.

Uptake by seed

Significantly higher boron uptake by seed was recorded in the treatment T_8 which received RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (47.82 g ha^{-1}) as compared to all other treatments and it was on par with the treatment T_5: RDF+ Foliar spray of Grade-1 @ 10 ml / litre of water (46.16 g ha^{-1}). However, significantly lower uptake of 11.17 g ha^{-1} was recorded in the treatment control (T_9).

Uptake by stover

Boron uptake by stover of safflower differed significantly. Application of RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) was recorded significantly higher boron uptake by stover (74.91 g ha^{-1}). It was on par with the treatment T_5 which received RDF + Foliar spray of Grade-1 @ 10 ml / litre of water (73.10 g ha^{-1}). However, significantly lower boron uptake by stover was noticed in the treatment T_9 which is absolute control (37.31 g ha^{-1}).

Total uptake of boron by safflower crop

Significantly higher total uptake of boron with 122.74 g ha^{-1} by safflower was recorded in RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) and it was on par with the treatment T_5 which received RDF+ Foliar spray of Grade-1 @ 10 ml / litre of water (119.26 g ha^{-1}). However, significantly lower boron uptake by safflower was recorded in the treatment T_9: absolute control (48.48 g ha^{-1}).

The highest uptake of boron is noticed in treatment receiving RDF + $ZnSO_4$ @ 6 kg ha^{-1} + Foliar spray of Grade-1 @ 10 ml / litre of water (T_8) as showed in Fig. 1. These results are further supported by the findings of Ishag, (1992) [8] and Abd El-Hady, (2007) [1], who mentioned that foliar application of micronutrients led to an increase in concentrations of macro and micronutrients in peanuts seeds and this is mainly due to

the vital physiological roles in plant cells which promote the uptake of plant nutrients. The higher uptake was due to increased growth components, total dry matter production, yield and yield components.

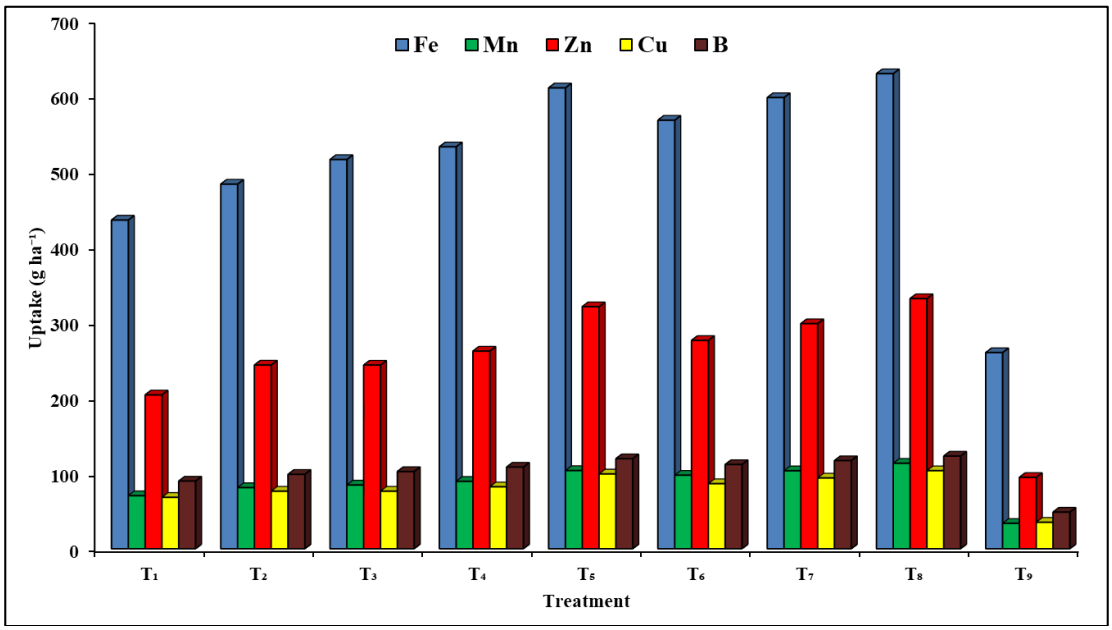

Fig 1: Effect of foliar application of micronutrient mixture on uptake of micro nutrients (g ha^{-1}) by safflower

Table 1: Initial soil physical and chemical properties of the experimental site

Particulars	Value
I. Physical properties	
Bulk density (Mg m^{-3})	1.39
Particle size distribution (%)	
Sand (%)	22.75
Silt (%)	22.35
Clay (%)	50.90
Textural class	Clay loam
II. Chemical properties	
Soil pH (1:2.5)	7.72
Electrical conductivity (1:2.5) dSm^{-1}	0.25
Organic carbon (g kg^{-1})	4.60
Available nutrients (kg ha^{-1})	
Nitrogen (N)	263.42
Phosphorus (P_2O_5)	28.68
Potassium (K_2O)	401.00
Sulphur (S)	13.30
Exchangeable calcium (Cmol (p^+) kg^{-1})	17.50
Exchangeable magnesium (Cmol (p^+) kg^{-1})	4.00
DTPA extractable micronutrients (mg kg^{-1})	
Iron	1.27
Zinc	0.57
Manganese	7.27
Copper	1.87
Hot water soluble boron	1.10

Table 2: Effect of foliar application of micronutrient mixture on iron uptake by safflower

Treatment	Iron (g ha^{-1})		
	Seed	Stover	Total
T_1: RDF (75:75:40 NPK kg ha^{-1} and gypsum @ 80 kg ha^{-1})	172.33	262.97	435.30
T_2: T_1+ $ZnSO_4$ @ 6 kg ha^{-1}	194.89	288.01	482.90
T_3: T_1 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	224.44	291.07	515.52
T_4: T_1 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	234.53	297.80	532.33
T_5: T_1 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	290.32	320.08	610.40
T_6: T_2 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	259.22	308.39	567.61
T_7: T_2 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	278.98	318.53	597.52
T_8: T_2 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	300.57	328.63	629.21
T_9: Absolute control	105.42	154.37	259.79
S.Em. ±	6.79	4.53	8.63
C.D. @ 5%	20.36	13.58	25.86

Table 3: Effect of foliar application of micronutrient mixture on zinc uptake by safflower

Treatment	Zinc (g ha^{-1})		
	Seed	Stover	Total
T_1: RDF (75:75:40 NPK kg ha^{-1} and gypsum @ 80 kg ha^{-1})	123.77	79.98	203.75
T_2: T_1+ $ZnSO_4$ @ 6 kg ha^{-1}	142.49	100.80	243.30
T_3: T_1 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	140.97	102.28	243.24
T_4: T_1 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	152.02	109.72	261.74
T_5: T_1 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	178.51	142.06	320.57
T_6: T_2 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	158.43	117.50	275.93
T_7: T_2 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	167.93	130.19	298.12
T_8: T_2 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	183.46	147.83	331.29
T_9: Absolute control	52.69	41.81	94.50
S.Em. ±	2.66	3.07	4.44
C.D. @ 5%	7.97	9.20	13.32

Table 4: Effect of foliar application of micronutrient mixture on manganese uptake by safflower

Treatment	Manganese (g ha^{-1})		
	Seed	Stover	Total
T_1: RDF (75:75:40 NPK kg ha^{-1} and gypsum @ 80 kg ha^{-1})	26.02	44.25	70.28
T_2: T_1+ $ZnSO_4$ @ 6 kg ha^{-1}	30.83	50.13	80.96
T_3: T_1 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	32.19	52.21	84.40
T_4: T_1 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	35.59	53.69	89.28
T_5: T_1 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	44.12	59.45	103.57
T_6: T_2 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	37.96	59.38	97.35
T_7: T_2 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	41.35	61.96	103.31
T_8: T_2 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	47.33	65.88	113.22
T_9: Absolute control	10.96	22.65	33.61
S.Em. ±	0.80	1.00	1.63
C.D. @ 5%	2.40	3.01	4.89

Table 5: Effect of foliar application of micronutrient mixture on copper uptake by safflower

Treatment	Copper (g ha^{-1})		
	Seed	Stover	Total
T_1: RDF (75:75:40 NPK kg ha^{-1} and gypsum @ 80 kg ha^{-1})	25.00	43.05	68.05
T_2: T_1+ $ZnSO_4$ @ 6 kg ha^{-1}	29.38	46.86	76.25
T_3: T_1 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	29.32	46.91	76.23
T_4: T_1 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	32.60	49.44	82.04
T_5: T_1 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	41.84	57.20	99.04
T_6: T_2 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	34.09	52.06	86.15
T_7: T_2 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	39.27	54.42	93.70
T_8: T_2 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	43.35	59.99	103.34
T_9: Absolute control	10.93	24.10	35.03
S.Em. ±	0.74	1.10	1.56
C.D. @ 5%	2.21	3.30	4.67

Table 6: Effect of foliar application of micronutrient mixture on boron uptake by safflower

Treatment	Boron (g ha^{-1})		
	Seed	Stover	Total
T_1: RDF (75:75:40 NPK kg ha^{-1} and gypsum @ 80 kg ha^{-1})	26.79	62.81	89.60
T_2: T_1+ $ZnSO_4$ @ 6 kg ha^{-1}	29.44	69.09	98.53
T_3: T_1 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	33.17	69.05	102.22
T_4: T_1 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	37.65	70.48	108.13
T_5: T_1 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	46.16	73.10	119.26
T_6: T_2 + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS	39.98	71.52	111.50
T_7: T_2 + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS	43.60	73.09	116.68
T_8: T_2 + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS	47.82	74.91	122.74
T_9: Absolute control	11.17	37.31	48.48
S.Em. ±	0.87	1.25	1.96
C.D. @ 5%	2.61	3.74	5.89

Conclusion

Micronutrients uptake were significantly differed with various treatments and highest uptake was observed with the application of RDF + $ZnSO_4$ @ 6 kg ha^{-1} soil application+ foliar spray of Grade-1 micronutrient mixture @ 10 ml / litre (T_8). It was on par with T_5: RDF + foliar spray of Grade-1 micronutrient mixture @ 10 ml / litre. From this study it can be concluded that to get higher yield, higher uptake, it is advised to follow the application of RDF + $ZnSO_4$ @ 6 kg ha^{-1} soil application+ foliar spray of Grade-1 micronutrient mixture @ 10 ml / litre (T_8compared to RDF and control.

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