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

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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) [3]. 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 T8 which received RDF + ZnSO4 @ 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 T9 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 T9 (control).

Uptake by stover
Iron uptake by stover of safflower differed significantly. Application of RDF + ZnSO4 @ 6 kg ha⁻¹ + Foliar spray of Grade-1 @ 10 ml / litre of water (T9) was recorded significantly higher nitrogen uptake by stover (328.63 g ha⁻¹). It was on par with the treatment T9 which received RDF + Foliar spray of Grade-1 @ 10 ml / litre of water (320.08 g ha⁻¹) and followed by treatment T7: RDF + ZnSO4 @ 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 T9 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 + ZnSO4 @ 6 kg ha⁻¹ + Foliar spray of Grade-1 @ 10 ml / litre of water applied at 30 DAS and 50 DAS (T9). It was on par with the treatment T9 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 T9; absolute control (259.79 g ha⁻¹).

The high uptake of iron noticed in treatment receiving RDF + ZnSO4 @ 6 kg ha⁻¹ + Foliar spray of Grade-1 @ 10 ml / litre of water 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 T8 which received RDF + ZnSO4 @ 6 kg ha⁻¹ + Foliar spray of Grade-1 @ 10 ml / litre of water (183.46 g ha⁻¹) compared to all other treatments and it was on par with the treatment T9: 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 T9 (control).

Uptake by stover
Zinc uptake by stover of safflower differed significantly. Application of RDF + ZnSO4 @ 6 kg ha⁻¹ + Foliar spray of Grade-1 @ 10 ml / litre of water (T9) was recorded significantly higher zinc uptake by stover (147.83 g ha⁻¹). It was on par with the treatment T9 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 T9 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⁻¹ was recorded in the treatment RDF + ZnSO4 @ 6 kg ha⁻¹ + 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 T9; absolute control (94.50 g ha⁻¹).

The high uptake of zinc recorded in treatment receiving RDF + ZnSO4 @ 6 kg ha⁻¹ + Foliar spray of Grade-1 @ 10 ml / litre of water (320.57 g ha⁻¹) and followed by treatment T7: RDF + ZnSO4 @ 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 T9 which is absolute control (154.37 g ha⁻¹).
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 to higher biomass in respective treatment. Results are in conformity with Ravi et al. (2008) [11], Ebrahimian and Ahmad (2011) [10] 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-1 micronutrient mixture and results are presented in Table 4.

Uptake by seed
Significantly higher manganese uptake by seed was recorded in the treatment T8 which received RDF + ZnSO4 @ 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 T9 which is absolute control (22.65 g ha\(^{-1}\)).

Uptake by stover
Manganese uptake by stover of safflower differed significantly. Application of RDF + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8) 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 T9 which is absolute control (11.17 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 + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8). However, significantly lower manganese uptake by safflower was recorded in the treatment T9 which is absolute control (33.61 g ha\(^{-1}\)).

The highest uptake of manganese is recorded in treatment receiving RDF + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8) 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) [3].

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-1 micronutrient mixture and results are presented in Table 5.

Uptake by seed
Significantly higher copper uptake by seed was recorded in the treatment T8 which received RDF + ZnSO4 @ 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 T9 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 T9 (control).

Uptake by stover
Copper uptake by stover of safflower differed significantly. Application of RDF + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8) was recorded significantly higher copper uptake by stover (59.99 g ha\(^{-1}\)). It was on par with the treatment T3 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 T9 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 + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water applied at 30 DAS and 50 DAS (99.04 g ha\(^{-1}\)). However, significantly lower copper uptake by stover was recorded in the treatment T9 receiving absolute control (35.03 g ha\(^{-1}\)).

The highest uptake of copper is noticed in treatment receiving RDF + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8) 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-1 micronutrient mixture and results are presented in Table 6.

Uptake by seed
Significantly higher boron uptake by seed was recorded in the treatment T8 which received RDF + ZnSO4 @ 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 T5: 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 T9 which is absolute control (37.31 g ha\(^{-1}\)).

Uptake by stover
Boron uptake by stover of safflower differed significantly. Application of RDF + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8) was recorded significantly higher boron uptake by stover (74.91 g ha\(^{-1}\)). It was on par with the treatment T3 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 T9 which is absolute control (26.47 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 + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8) and it was on par with the treatment T3 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 T9: absolute control (48.48 g ha\(^{-1}\)).

The highest uptake of boron is noticed in treatment receiving RDF + ZnSO4 @ 6 kg ha\(^{-1}\) + Foliar spray of Grade-1 @ 10 ml / litre of water (T8) as showed in Fig. 1. These results are further supported by the findings of Ishaq, (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\(_2\)O\(_5\))     | 28.68  |
| Potassium (K\(_2\)O)            | 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\(^{-1}\)) |
|---------------------------------------------------------------------------|----------------------|
| T\(_1\): RDF (75:75:40 NPK kg ha\(^{-1}\) and gypsum @ 80 kg ha\(^{-1}\)) |                      |
| T\(_2\): T\(_1\) + ZnSO\(_4\) @ 6 kg ha\(^{-1}\)                         | 172.33               |
| T\(_3\): T\(_1\) + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 224.44               |
| T\(_4\): T\(_1\) + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 234.53               |
| T\(_5\): T\(_1\) + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 290.32               |
| T\(_6\): T\(_2\) + Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 259.22               |
| T\(_7\): T\(_2\) + Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 278.98               |
| T\(_8\): T\(_2\) + Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 300.57               |
| T\(_9\): Absolute control                                                | 105.42               |
| S.Em. ±                                                                   | 7.39                 |
| C.D. @ 5%                                                                 | 20.36                |
Table 3: Effect of foliar application of micronutrient mixture on zinc uptake by safflower

| Treatment | Zinc (g ha⁻¹) |
|-----------|---------------|
|           | Seed | Stover | Total |
| T₁: RDF (75:75:40 NPK kg ha⁻¹ and gypsum @ 80 kg ha⁻¹) | 123.77 | 79.98 | 203.75 |
| T₂: T₁+ ZnSO₄ @ 6 kg ha⁻¹ | 142.49 | 100.80 | 243.30 |
| T₃: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 140.97 | 102.28 | 243.24 |
| T₄: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 152.02 | 109.72 | 261.74 |
| T₅: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 178.51 | 142.06 | 320.57 |
| T₆: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 158.43 | 117.70 | 276.93 |
| T₇: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 167.93 | 130.19 | 298.12 |
| T₈: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 183.46 | 147.83 | 331.29 |
| T₉: Absolute control | 52.69 | 41.81 | 94.50 |
| S.Em. ± | 2.66 | 3.07 | 4.44 |
| C.D. @ 5% | 7.97 | 9.20 | 13.22 |

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

| Treatment | Manganese (g ha⁻¹) |
|-----------|-----------------|
|           | Seed | Stover | Total |
| T₁: RDF (75:75:40 NPK kg ha⁻¹ and gypsum @ 80 kg ha⁻¹) | 26.02 | 44.25 | 70.28 |
| T₂: T₁+ ZnSO₄ @ 6 kg ha⁻¹ | 30.83 | 50.13 | 80.96 |
| T₃: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 32.19 | 52.21 | 84.40 |
| T₄: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 35.59 | 53.69 | 89.28 |
| T₅: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 44.12 | 59.45 | 103.57 |
| T₆: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 37.96 | 59.38 | 97.34 |
| T₇: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 41.35 | 61.96 | 103.31 |
| T₈: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 47.33 | 65.88 | 113.22 |
| T₉: 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 |
| T₁: RDF (75:75:40 NPK kg ha⁻¹ and gypsum @ 80 kg ha⁻¹) | 25.00 | 43.05 | 68.05 |
| T₂: T₁+ ZnSO₄ @ 6 kg ha⁻¹ | 29.38 | 46.86 | 76.25 |
| T₃: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 29.32 | 46.91 | 76.23 |
| T₄: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 32.60 | 49.44 | 82.04 |
| T₅: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 41.84 | 57.20 | 99.04 |
| T₆: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 34.09 | 52.06 | 86.15 |
| T₇: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 39.27 | 54.42 | 93.70 |
| T₈: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 43.38 | 59.99 | 103.34 |
| T₉: Absolute control | 10.93 | 24.10 | 35.03 |
| S.Em. ± | 0.74 | 1.10 | 1.84 |
| C.D. @ 5% | 2.21 | 3.30 | 5.51 |

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

| Treatment | Boron (g ha⁻¹) |
|-----------|---------------|
|           | Seed | Stover | Total |
| T₁: RDF (75:75:40 NPK kg ha⁻¹ and gypsum @ 80 kg ha⁻¹) | 26.79 | 62.81 | 89.60 |
| T₂: T₁+ ZnSO₄ @ 6 kg ha⁻¹ | 29.44 | 69.09 | 98.53 |
| T₃: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 33.17 | 69.05 | 102.22 |
| T₄: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 37.65 | 70.48 | 108.13 |
| T₅: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 46.16 | 73.10 | 119.26 |
| T₆: T₁+ Foliar spray of Grade-1 @ 2.5 ml / litre of water at 30 DAS and 50 DAS | 39.98 | 71.52 | 111.50 |
| T₇: T₁+ Foliar spray of Grade-1 @ 5 ml / litre of water at 30 DAS and 50 DAS | 43.60 | 73.09 | 116.68 |
| T₈: T₁+ Foliar spray of Grade-1 @ 10 ml / litre of water at 30 DAS and 50 DAS | 47.82 | 74.91 | 122.74 |
| T₉: Absolute control | 11.17 | 37.31 | 48.48 |
| S.Em. ± | 0.87 | 1.25 | 1.96 |
| C.D. @ 5% | 2.61 | 3.74 | 5.35 |

Conclusion

Micronutrients uptake were significantly differed with various treatments and highest uptake was observed with the application of RDF + ZnSO₄ @ 6 kg ha⁻¹ soil application+ foliar spray of Grade-1 micronutrient mixture @ 10 ml / litre (T₈). It was on par with T₂: 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 + ZnSO₄ @ 6 kg ha⁻¹ soil application+ foliar spray of Grade-1 micronutrient mixture @ 10 ml / litre (T₈) compared to RDF and control.
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