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Effect of foliar spray of micronutrients on growth attributes of Nagpur mandarin (*Citrus reticulata* Blanco.)

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Abstract
A field experiment entitled ‘‘Effect of foliar spray of nutrients on yield and quality of Nagpur mandarin (*Citrus reticulata* Blanco.)’’ was conducted during the year 2018-19, at the Fruit Instructional Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar. The experiment consisted of different treatments of nutrients including macro and micro-nutrients and was laid out in Randomized Block Design. Amongst different treatments application, treatment T_{27} ($FeSO_4$ 0.25% + K_2SO_4 1.0%) foliar application was found significantly superior over other treatments in terms of growth parameters such as plant height and canopy volume. Whereas, foliar application of T_{22} ($FeSO_4$ 0.25% + $CuSO_4$ 0.25%) treatment was found significantly superior over other treatments in terms of N-S plant spread. Overall, T_{27} treatment exhibited better growth except plant spread.

Keywords: Mandarin, potassium sulphate, micro-nutrients, growth

Introduction
Nagpur mandarin (*Citrus reticulata* Blanco.) belongs to family Rutaceae. It having shizolysigenic oil gland and particular aroma indicating flavour of particular citrus species. It is considered to be one of the most important cultivated species among citrus and is being commercially grown in specific region of the country like Nagpur mandarin in Central India, Khasi mandarin in North Eastern regions and Coorg mandarin in Southern regions (Vikee *et al.*, 2018). Though, it is grown in every state, certain pockets have emerged as the leading producers. Nagpur mandarin is chiefly grown in Satpura hills (Vidarbha region) of Central India, hilly slopes of Darjeeling (West Bengal), Coorg (Karnataka) and Jhalawar (Rajasthan). In Jhalawar district of Rajasthan state, it is the major fruit crop highly acclimated under vertisols. Jhalawar district receives annual rainfall of 950 mm and black vertisols with enriched calcium carbonate is highly suitable for Nagpur mandarin cultivation. In South India, Wynad, Nilgiri, Palaney and Shevroy hills are major mandarin growing belts, while hills of North eastern states particularly Meghalaya (Khasi, Dusha, Garo, Jaintia), Mizoram, Tripura, Sikkim and Arunachal Pradesh have predominance of mandarins under forest belts.
Nagpur Mandarin is one of the finest varieties in term of sugars acid blend possessing tangy taste and very popular in India as well as in world. Its fruit is big, sub-globose, weigh 110-125g, rind medium thick, peel fairly loosely adherent, surface is also relatively smooth but dominant sometimes with expression of root stock characteristics. In a single fruit there are 10-11 segments and there are 1-2 seeds per segment. The colour of peel is pale orange and fruits have mild flavour, excellent quality, juicy pulp TSS 10-12^0 Brix, and acidity in the range 0.50-0.70 per cent. Fully mature tree bears 125 kg fruits.
The total production of mandarin in India is 51.01 lakh tonnes from an area of 4.28 lakh hectares with the productivity of 14.84 MT/ha (Anonymous, 2018). In Rajasthan state, the acreage of Nagpur mandarin is around 23,900 ha area and the production is 4.7 lac tonnes.
Plant nutrients are categorized as macro and micro nutrients. Besides, nitrogen, phosphorous and potassium are also required in large amounts, however micro nutrients specially zinc, iron, copper and manganese are required in small amounts. Citrus is considered highly nutrient responsive crop and site-specific nutrient management involving combination of macro and micro nutrients is must to solve nutrient deficiencies as well as to improve nutritional quality of mandarin.
In Nagpur mandarin, the role of nutrients especially potassium in enhancement of fruit quality

is well known. Potassium is one of the key elements which plays an important role in determining yield and quality. Nutritional K-sprays are required to increase fruit yield as well quality attributes specially juice recovery percentage and ascorbic acid content. Potassium is needed for enzyme activation, cell division, photosynthesis, photosynthates transport and osmo-regulations (Marques *et al*., 2018). Potassium is responsible for many important internal and external fruit characteristics including fruit size, rind thickness and colour (Mongi and Obreza, 2003).

Among essential nutrients, zinc (Zn) after nitrogen (N) is undoubtedly the most widely reported deficient nutrient in citrus orchards. In citrus, the role of zinc is performed both in term of growth and yield potential. Low level of zinc reduces fruit number per tree and reduces fruit quality. Zinc plays an important role as a co-factor of number enzymes and also involved in the production of growth regulation and chloroplast development. Foliar application of zinc is most effective in controlling zinc deficiency (rosette formation) and improvement of vegetative growth attributes, fruit morphological attributes and internal fruit quality attributes like total soluble solid and ascorbic acid content. Zinc also plays an important role in reducing pre harvest fruit drop (Mongi and Obreza, 2003).

Iron plays an important role in citrus production. It acts as a catalyst in oxidation reduction reactions. It is also involved in respiration, photosynthesis and the reduction of nitrate and sulphate. It is also a co-factor in many enzymes. Iron deficiency is common in calcareous soils. Jhalawar soil contains a high concentration of calcium carbonate and has an average pH of about 8.3. These soils may contain appreciable amounts of iron, but it exists in a form that is slightly available to plants, Iron deficiency in Nagpur mandarin plants can be induced by high phosphorus or accumulation of copper in the soil.

The most obvious effect of iron deficiency is lime induced chlorosis *i.e.* "iron chlorosis". Young leaves manifest itself into light yellow to white colour of leaves and the veins greener than remaining portion of the leaf. Canopy volume decreases and fruit set as well as mandarin yield are reduced. In severe cases, the entire tree is affected. Trees suffer from iron deficiency in calcareous soil with high pH values. Under such conditions, iron required to form chlorophyll becomes unavailable to the plant (Mongi and Obreza, 2003).

Copper plays an important role in photosynthesis, carboxylation efficiency, pollen viability, fruit set, respiration and water use efficiency. Copper deficiency is known as 'die back', 'ammoniation' and 'exanthema'. These names are synchronously synthesized from dying back of the twigs, frequent association with excess application of nitrogen and exudates on the surface of the twigs and fruits. The first symptoms of copper deficiency are formation of unusually vigorous, large, dark green foliage with a "bowing up" of the midrib. Twigs are unusually vigorous, long, angular, soft, frequently "S" shaped and somewhat drooping type. As deficiency become severe, the twig starts to die, some of the weak twigs will bear very small, yellowish green leaves that drop quickly, leaving the entire twig defoliated. The symptoms of copper deficiencies are most pronounced in orange. Brown stained area of hardened gum on the fruit rind may precede the appearance of leaf and twig symptoms (Mongi and Obreza, 2009).

Insufficient application of micro-nutrients and macro-nutrients to mandarin trees results in extreme depletion of macronutrients and micronutrients and multiple nutrient deficiencies may appear. Since mineral nutrients are major factor in maximizing quality and yield of citrus fruits. Citrus especially Nagpur mandarin is highly nutrient responsive crop both in terms of macro and micro nutrients, therefore, present investigation was being undertaken on Nagpur mandarin plants at Fruit Instructional Farm of College of Horticulture and Forestry, Jhalawar to study the foliar effect of potassium, zinc, iron and copper alone and in combination among these nutrients for fruit quality and yield enhancement of mandarin.

Materials And Methods

The experimental entitled ''Effect of foliar spray of nutrients on yield and quality of Nagpur mandarin (*Citrus reticulata* Blanco.)'' was conducted during the year 2018-19, at the Fruit Instructional Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar. The solutions of 0.25% $ZnSO_4$, 0.5% $ZnSO_4$, 0.25% $CuSO_4$ and 0.5% $CuSO_4$ were prepared by diluting 25 g $ZnSO_4$, 50 g $ZnSO_4$, 25 g $CuSO_4$ and 50 g $CuSO_4$ in 10 liter of water for two mandarin plants and solutions were used after neutralizing with overnight soaking in lime to avoid leaf scorching and to increase absorption. Foliar application of potassium sulphate and micro-nutrients treatments were done with battery operated hand Knapsac sprayer at gravel stage during first week of May and at marvel stage during first week of July in eleven year old Nagpur mandarin tree.

The solution of 0.50% K_2SO_4 and 1.0% K_2SO_4 were prepared by diluting 50 g K_2SO_4 and 100 g K_2SO_4 in 10 liter of water for two mandarin plants.

Table 1: The treatments combinations were

Sr. No.	Treatment notation	Treatment contents
1	T_1	Control
2	T_2	$ZnSO_4$ (0.25%)
3	T_3	$ZnSO_4$ (0.50%)
4	T_4	$FeSO_4$ (0.25%)
5	T_5	$FeSO_4$ (0.50%)
6	T_6	$CuSO_4$ (0.25%)
7	T_7	$CuSO_4$ (0.50%)
8	T_8	K_2SO_4 (0.50%)
9	T_9	K_2SO_4 (1.0%)
10	T_{10}	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.25%)
11	T_{11}	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.50%)
12	T_{12}	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.25%)
13	T_{13}	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.50%)
14	T_{14}	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.25%)
15	T_{15}	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.50%)
16	T_{16}	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.25%)
17	T_{17}	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.50%)
18	T_{18}	$ZnSO_4$ (0.25%) + K_2SO_4 (0.50%)
19	T_{19}	$ZnSO_4$ (0.25%) + K_2SO_4 (1.0%)
20	T_{20}	$ZnSO_4$ (0.50%) + K_2SO_4 (0.50%)
21	T_{21}	$ZnSO_4$ (0.50%) + K_2SO_4 (1.0%)
22	T_{22}	$FeSO_4$ (0.25%) + $CuSO_4$ (0.25%)
23	T_{23}	$FeSO_4$ (0.25%) + $CuSO_4$ (0.50%)
24	T_{24}	$FeSO_4$ (0.50%) + $CuSO_4$ (0.25%)
25	T_{25}	$FeSO_4$ (0.50%) + $CuSO_4$ (0.50%)
26	T_{26}	$FeSO_4$ (0.25%) + K_2SO_4 (0.50%)
27	T_{27}	$FeSO_4$ (0.25%) + K_2SO_4 (1.0%)
28	T_{28}	$FeSO_4$ (0.50%) + K_2SO_4 (0.50%)
29	T_{29}	$FeSO_4$ (0.50%) + K_2SO_4 (1.0%)
30	T_{30}	$CuSO_4$ (0.25%) + K_2SO_4 (0.50%)
31	T_{31}	$CuSO_4$ (0.25%) + K_2SO_4 (1.0%)
32	T_{32}	$CuSO_4$ (0.50%) + K_2SO_4 (0.50%)
33	T_{33}	$CuSO_4$ (0.50%) + K_2SO_4 (1.0%)

The experiment was laid down in randomized block design with three replications. Mandarin fruit tree growth parameters such as plant height (m) East – West plant (m) spread. North-South tree spread (m) and canopy volume (m^3) were recorded two months after first spray (first week of May, 2018) and two months after second spray (first week of July, 2018). The data generated during the experimentation were subjected to statistically analysed by Panse and Sukhatme (1954).

The present investigations were undertaken at Fruit Instructional Farm, College of Horticulture and Forestry, Jhalawar on eleven old plants of Nagpur mandarin planted at spacing of 6 X 6 meter under square system of planting. The total number of plants included in the experiment was 99. All the mandarin plants were selected on the basis of desired uniformity in growth and vigour and bearer. All the treatments were applied in first week of May, 2018 and first week of July, 2018.

Effect of foliar spray of nutrients on changes in growth parameters

Plant height (m)

The augmentation in plant height of Nagpur mandarin trees in response to foliar application of nutrients measured in September, 2018 over base values are presented in table 2.

The results presented in table 2 indicated that maximum per cent increase of plant height with value (28.45%) was obtained in T_{27} treatment consisting ($FeSO_4$ @ 0.25% + K_2SO_4 @ 1.0%) and T_{27} treatment exhibited at par performance with T_{23}, T_{25}, T_{16} and T_{14} treatments. However, T_{27}treatment was found statistically significant higher over T_8, T_{19}, T_{32}, T_{11}, T_{15}, T_{21}, T_{18}, T_{31}, T_{30}, T_{12}, T_{17}, T_{33}, T_{11}, T_9, T_4, T_{10}, T_7, T_6, T_5, T_{26}, T_{22}, T_2, T_{29}, T_{13}, T_{24}, $T_3$and T_1 treatments. Likewise, the minimum per cent increase in plant height of (16.35%) was measured in T_1 treatment and it was found at par with T_2, T_3, T_5, T_6, T_7, T_{13}, T_{20}, T_{22}, T_{24}, T_{26}, T_{28} and T_{29} treatments.

East-West plant spread (m)

The response of foliar application of nutrients on per cent increase of E-W plant spread in Nagpur mandarin tree during September, 2018 is exhibited in table 3.

The data presented in table 3 revealed that maximum per cent increase of E-W plant spread with value (10.76%) was measured in T_9 treatment consisting (K_2SO_4 @ 1.0%) and it was observed at par with rest of the treatments except control. The result revealed non-significant difference among all the treatments in augmentation of E-W plant spread measured during September, 2018 over base values.

North-South plant spread (m)

The enhancement in plant spread (N-S) of Nagpur mandarin trees during September, 2018 in response to foliar application of nutrients are presented in table 4.

The Perusal of data in table 4 revealed maximum per cent increase in North-South plant spread of (12.52%) was estimated in T_{22} treatment consisting ($FeSO_4$ @ 0.25% + $CuSO_4$ @ 0.25%) and T_{22} was observed at par with T_{21}, T_{20}, T_5, T_{30}, T_{32}, T_{24}, T_{24}, T_{26} and T_{31} treatments however, T_{22} treatment was found significantly superior and higher as compared with T_{11}, T_{14}, T_{15}, T_4, T_6, T_7, T_{18}, T_{23}, T_{25}, T_{28}, T_{12}, T_{29}, T_{27}, T_{33}, T_{13}, T_{18}, T_{17}, T_8, T_{19}, T_{16}, T_3, T_2, T_1 and T_9 treatments. Similarly, the minimum per cent increase in N-S plant spread of (8.89%) was measured in T_2 treatment consisting ($ZnSO_4$ @ 0.25%).

Canopy volume (m^3)

The augmentation in canopy volume (m^3) of Nagpur mandarin during September, 2018 from base value in response to foliar application of various treatments of nutrients are exhibited in table 5.

The data presented in table 5 revealed that maximum per cent increase (33.84%) was recorded in T_{27} treatment consisting ($FeSO_4$ @ 0.25% + K_2SO_4 @ 1.0%) and it was observed at with T_{23}, T_{25}, T_{14}, T_{21}, and T_{16} treatments, however, T_{27} treatment was found statistically significant and superior as compared with rest of the treatments. Likewise, minimum per cent increase of (22.24%) was recorded in T_1 treatment consisting (control).

Table 2: Effect of foliar spray of nutrients on plant height in Nagpur mandarin

Plant Height (m)				
Sr. No.	**Treatments**	**Base value (m)**	**Two months after first spray July, 2018 (m)**	**Two months after second spray September, 2018 (m)**
1	Control	3.03	3.06 (5.38%)	3.29 (16.35%)
2	$ZnSO_4$ (0.25%)	3.28	3.31 (5.48%)	3.68 (20.38%)
3	$ZnSO_4$ (0.50%)	3.88	3.91 (5.05%)	4.30 (19.2%)
4	$FeSO_4$ (0.25%)	3.07	3.10 (5.36%)	3.49 (21.74%)
5	$FeSO_4$ (0.50%)	3.47	3.50 (5.34%)	3.90 (20.52%)
6	$CuSO_4$ (0.25%)	3.43	3.46 (5.37%)	3.86 (20.91%)
7	$CuSO_4$ (0.50%)	3.47	3.50 (5.61%)	3.91 (20.03%)
8	K_2SO_4 (0.50%)	3.29	3.32 (5.48%)	3.80 (23.10%)
9	K_2SO_4 (1.0%)	3.61	3.64 (5.22%)	4.11 (21.74%)
10	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.25%)	3.36	3.39 (5.43%)	3.82 (21.71%)
11	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.50%)	3.12	3.16 (5.83%)	3.58 (21.82%)
12	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.25%)	3.40	3.43 (5.40%)	3.88 (22.04%)
13	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.50%)	3.75	3.78 (5.14%)	4.17 (19.48%)
14	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.25%)	3.06	3.10 (5.90%)	3.55 (23.40%)
15	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.50%)	3.27	3.30 (5.49%)	3.76 (22.66%)
16	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.25%)	3.06	3.09 (5.74%)	3.55 (23.79%)
17	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.50%)	3.42	3.46 (6.60%)	3.89 (21.89%)
18	$ZnSO_4$ (0.25%) + K_2SO_4 (0.50%)	3.32	3.35 (5.46%)	3.79 (22.25%)
19	$ZnSO_4$ (0.25%) + K_2SO_4 (1.0%)	3.35	3.38 (5.43%)	3.86 (23.07%)
20	$ZnSO_4$ (0.50%) + K_2SO_4 (0.50%)	3.36	3.39 (5.43%)	3.63 (19.4%)

21	$ZnSO_4$ (0.50%) + K_2SO_4 (1.0%)	3.35	3.39 (6.28%)	3.84 (22.48%)
22	$FeSO_4$ (0.25%) + $CuSO_4$ (0.25%)	3.44	3.47 (5.35%)	3.87 (20.42%)
23	$FeSO_4$ (0.25%) + $CuSO_4$ (0.50%)	3.17	3.20 (5.77%)	3.75 (25.33%)
24	$FeSO_4$ (0.50%) + $CuSO_4$ (0.25%)	3.73	3.80 (7.21%)	4.09 (17.02%)
25	$FeSO_4$ (0.50%) + $CuSO_4$ (0.50%)	3.39	3.42 (5.44%)	4.00 (25.22%)
26	$FeSO_4$ (0.25%) + K_2SO_4 (0.50%)	3.47	3.54 (7.61%)	3.91 (20.44%)
27	$FeSO_4$ (0.25%) + K_2SO_4 (1.0%)	3.04	3.07 (5.72%)	3.73 (28.45%)
28	$FeSO_4$ (0.50%) + K_2SO_4 (0.50%)	3.35	3.39 (5.72%)	3.73 (19.05%)
29	$FeSO_4$ (0.50%) + K_2SO_4 (1.0%)	3.66	3.69 (4.88%)	4.09 (20.17%)
30	$CuSO_4$ (0.25%) + K_2SO_4 (0.50%)	3.41	3.44 (5.39%)	3.89 (22.10%)
31	$CuSO_4$ (0.25%) + K_2SO_4 (1.0%)	3.41	3.45 (5.68%)	3.90 (22.22%)
32	$CuSO_4$ (0.50%) + K_2SO_4 (0.50%)	3.31	3.35 (5.73%)	3.80 (22.68%)
33	$CuSO_4$ (0.50%) + K_2SO_4 (1.0%)	3.29	3.32 5.77%)	3.74 (21.89%)
S.Em+		0.15	0.15 (0.63%)	0.16 (1.87%)
CD at 5%		0.43	0.43 (1.79%)	0.44 (5.30%)

*Figures in parenthesis indicate Arc Sin Transformed Value

Table 3: Effect of foliar spray of nutrients on E-W plant spread in Nagpur mandarin

1				
Sr. No.	**Treatments**	**Base value (m)**	**Two months after first spray July, 2018 (m)**	**Two months after second spray September, 2018 (m)**
1	Control	2.25	2.28 (6.96%)	2.32 (8.09%)
2	$ZnSO_4$ (0.25%)	2.18	2.21 (7.09%)	2.25 (10.18%)
3	$ZnSO_4$ (0.50%)	2.23	2.26 (7.01%)	2.30 (10.31%)
4	$FeSO_4$ (0.25%)	2.17	2.20 (7.10%)	2.24 (10.27%)
5	$FeSO_4$ (0.50%)	2.25	2.28 (6.97%)	2.32 (10.26%)
6	$CuSO_4$ (0.25%)	2.24	2.27 (6.99%)	2.31 (9.90%)
7	$CuSO_4$ (0.50%)	2.20	2.24 (7.05%)	2.27 (10.17%)
8	K_2SO_4 (0.50%)	2.19	2.26 (9.39%)	2.27 (10.29%)
9	K_2SO_4 (1.0%)	2.24	2.27 (6.99%)	2.31(10.76%)
10	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.25%)	2.21	2.25 (7.04%)	2.28 (9.90%)
11	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.50%)	2.24	2.27 (6.99%)	2.31 (10.22%)
12	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.25%)	2.26	2.30 (6.95%)	2.33 (10.41%)
13	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.50%)	2.28	2.31 (6.93%)	2.35 (19.86%)
14	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.25%)	2.20	2.24 (7.04%)	2.27 (10.11%)
15	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.50%)	2.23	2.26 (7.01%)	2.30 (10.48%)
16	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.25%)	2.25	2.29 (6.96%)	2.32 (9.95%)
17	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.50%)	2.27	2.30 (6.94%)	2.34 (10.11%)
18	$ZnSO_4$ (0.25%) + K_2SO_4 (0.50%)	2.42	2.46 (6.72%)	2.49 (10.25%)
19	$ZnSO_4$ (0.25%) + K_2SO_4 (1.0%)	2.44	2.47 (6.72%)	2.51(9.76%)
20	$ZnSO_4$ (0.50%) + K_2SO_4 (0.50%)	2.39	2.42 (6.78%)	2.46 (9.54%)
21	$ZnSO_4$ (0.50%) + K_2SO_4 (1.0%)	2.31	2.35 (6.87%)	2.38 (9.89%)
22	$FeSO_4$ (0.25%) + $CuSO_4$ (0.25%)	2.31	2.35 (6.87%)	2.38 (9.98%)
23	$FeSO_4$ (0.25%) + $CuSO_4$ (0.50%)	2.33	2.36 (6.85%)	2.40 (9.98%)
24	$FeSO_4$ (0.50%) + $CuSO_4$ (0.25%)	2.35	2.38 (7.16%)	2.42 (10.43%)
25	$FeSO_4$ (0.50%) + $CuSO_4$ (0.50%)	2.37	2.46 (10.24%)	2.43 (9.34%)
26	$FeSO_4$ (0.25%) + K_2SO_4 (0.50%)	2.36	2.39 (6.81%)	2.43 (9.89%)
27	$FeSO_4$ (0.25%) + K_2SO_4 (1.0%)	2.37	2.41 (6.79%)	2.44 (9.9%)
28	$FeSO_4$ (0.50%) + K_2SO_4 (0.50%)	2.38	2.41 (6.78%)	2.45 (9.89%)
29	$FeSO_4$ (0.50%) + K_2SO_4 (1.0%)	2.40	2.43 (6.74%)	2.47 (9.84%)
30	$CuSO_4$ (0.25%) + K_2SO_4 (0.50%)	2.25	2.28 (6.97%)	2.32 (10.05%)
31	$CuSO_4$ (0.25%) + K_2SO_4 (1.0%)	2.26	2.29 (6.95%)	2.33 (10.15%)
32	$CuSO_4$ (0.50%) + K_2SO_4 (0.50%)	2.29	2.31 (6.17%)	2.35 (9.56%)
33	$CuSO_4$ (0.50%) + K_2SO_4 (1.0%)	2.29	2.33 (6.9%)	2.36 (10.04%)
S.Em+		0.02	0.02 (0.8%)	N.S
CD at 5%		0.05	0.06 (2.26%)	N.S

*Figures in parenthesis indicate Arc Sin Transformed Values

Table 4: Effect of foliar spray of nutrients on N-S plant spread in Nagpur mandarin

North-South plant spread (m)				
Sr. No.	**Treatments**	**Base value (m)**	**Two months after first spray July, 2018 (m)**	**Two months after second spray September, 2018 (m)**
1	Control	2.77	2.81(6.44%)	2.84 (9.28%)
2	$ZnSO_4$ (0.25%)	2.75	2.78 (5.84%)	2.82 (8.89%)
3	$ZnSO_4$ (0.50%)	2.76	2.79 (5.93%)	2.83 (8.90%)
4	$FeSO_4$ (0.25%)	2.72	2.78 (8.77%)	2.82 (11.04%)

5	$FeSO_4$ (0.50%)	2.73	2.80 (9.19%)	2.84 (11.38%)
6	$CuSO_4$ (0.25%)	2.72	2.78 (8.73%)	2.82 (11.02%)
7	$CuSO_4$ (0.50%)	2.72	2.78 (8.68%)	2.82 (10.99%)
8	K_2SO_4 (0.50%)	2.72	2.78 (8.35%)	2.81 (9.9%)
9	K_2SO_4 (1.0%)	2.74	2.77 (6.00%)	2.81 (8.96%)
10	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.25%)	2.77	2.83 (8.69%)	2.87 (10.94%)
11	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.50%)	2.78	2.85 (8.88%)	2.88 (11.09%)
12	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.25%)	2.78	2.84 (8.43%)	2.88 (10.73%)
13	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.50%)	2.80	2.86 (8.04%)	2.89(10.47%)
14	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.25%)	2.77	2.84 (8.85%)	2.87 (11.08%)
15	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.50%)	2.78	2.85 (8.84%)	2.88 (11.05%)
16	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.25%)	2.80	2.84 (6.99%)	2.88 (9.59%)
17	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.50%)	2.81	2.86 (7.64%)	2.90 (10.00%)
18	$ZnSO_4$ (0.25%) + K_2SO_4 (0.50%)	2.81	2.87 (8.63%)	2.90 (10.23%)
19	$ZnSO_4$ (0.25%) + K_2SO_4 (1.0%)	2.82	2.87 (7.89%)	2.90 (9.84%)
20	$ZnSO_4$ (0.50%) + K_2SO_4 (0.50%)	2.81	2.88(8.54%)	2.92 (11.38%)
21	$ZnSO_4$ (0.50%) + K_2SO_4 (1.0%)	2.81	2.88 (8.81%)	2.93 (11.90%)
22	$FeSO_4$ (0.25%) + $CuSO_4$ (0.25%)	2.73	2.79 (8.73%)	2.86 (12.52%)
23	$FeSO_4$ (0.25%) + $CuSO_4$ (0.50%)	2.74	2.80 (8.48%)	2.84 (10.08%)
24	$FeSO_4$ (0.50%) + $CuSO_4$ (0.25%)	2.74	2.81 (9.07%)	2.85 (11.28%)
25	$FeSO_4$ (0.50%) + $CuSO_4$ (0.50%)	2.76	2.82 (8.45%)	2.86 (10.76%)
26	$FeSO_4$ (0.25%) + K_2SO_4 (0.50%)	2.74	2.81 (8.96%)	2.84 (11.18%)
27	$FeSO_4$ (0.25%) + K_2SO_4 (1.0%)	2.76	2.82 (8.18%)	2.85 (10.55%)
28	$FeSO_4$ (0.50%) + K_2SO_4 (0.50%)	2.77	2.83 (8.44%)	2.87 (10.74%)
29	$FeSO_4$ (0.50%) + K_2SO_4 (1.0%)	2.78	2.84 (8.40%)	2.88 (10.71%)
30	$CuSO_4$ (0.25%) + K_2SO_4 (0.50%)	2.75	2.82 (9.18%)	2.86 (11.35%)
31	$CuSO_4$ (0.25%) + K_2SO_4 (1.0%)	2.76	2.83 (8.93%)	2.86 (11.14%)
32	$CuSO_4$ (0.50%) + K_2SO_4 (0.50%)	2.77	2.84 (9.15%)	2.88 (11.31%)
33	$CuSO_4$ (0.50%) + K_2SO_4 (1.0%)	2.79	2.85 (8.14%)	2.89 (10.49%)
S.Em+		0.008	0.015 (0.48%)	0.011 (0.49%)
CD at 5%		0.023	0.024 (1.36%)	0.026 (1.39%)

*****Figures in parenthesis indicate Arc Sin Transformed Values

Table 5: Effect of foliar spray of nutrients on Canopy Volume in Nagpur mandarin

Canopy volume (m^3)				
Sr. No.	**Treatments**	**Base value (m^3)**	**Two months after first spray July, 2018 (m^3)**	**Two months after second spray September, 2018 (m^3)**
1	Control	39.94	41.44 (11.10%)	45.87 (22.24%)
2	$ZnSO_4$ (0.25%)	41.69	43.16 (10.80%)	49.41 (25.43%)
3	$ZnSO_4$ (0.50%)	50.54	52.22 (10.55%)	59.06 (24.34%)
4	$FeSO_4$ (0.25%)	38.59	40.87 (12.20%)	46.90 (27.92%)
5	$FeSO_4$ (0.50%)	45.07	47.37 (13.04%)	54.27 (26.85%)
6	$CuSO_4$ (0.25%)	44.15	46.47 (12.69%)	53.25 (26.99%)
7	$CuSO_4$ (0.50%)	44.00	46.00 (12.80%)	53.44 (27.14%)
8	K_2SO_4 (0.50%)	41.79	43.42 (14.02%)	51.20 (26.85%)
9	K_2SO_4 (1.0%)	48.00	50.04 10.64%)	56.30 (26.60%)
10	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.25%)	43.74	45.86 (12.70%)	53.08 (27.68%)
11	$ZnSO_4$ (0.25%) + $FeSO_4$ (0.50%)	41.17	43.24 (13.06%)	50.46 (28.34%)
12	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.25%)	45.31	47.41(12.45%)	55.12 (27.81%)
13	$ZnSO_4$ (0.50%) + $FeSO_4$ (0.50%)	50.75	52.96 (12.05%)	60.04 (25.40%)
14	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.25%)	39.15	45.07 (13.13%)	49.20 (29.32%)
15	$ZnSO_4$ (0.25%) + $CuSO_4$ (0.50%)	42.97	45.11 (12.89%)	52.83 (28.61%)
16	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.25%)	40.84	42.52 (11.64%)	50.27 (28.84%)
17	$ZnSO_4$ (0.50%) + $CuSO_4$ (0.50%)	46.52	48.07 (12.54%)	52.56 (27.31%)
18	$ZnSO_4$ (0.25%) + K_2SO_4 (0.50%)	47.56	49.78 (12.47%)	57.78 (27.58%)
19	$ZnSO_4$ (0.25%) + K_2SO_4 (1.0%)	48.58	50.42 (11.89%)	58.72 (28.12%)
20	$ZnSO_4$ (0.50%) + K_2SO_4 (0.50%)	48.05	49.91 (12.43%)	54.69 (22.80%)
21	$ZnSO_4$ (0.50%) + K_2SO_4 (1.0%)	46.13	48.73 (13.23%)	56.46 (28.85%)
22	$FeSO_4$ (0.25%) + $CuSO_4$ (0.25%)	45.87	48.06 (12.61%)	56.56 (27.53%)
23	$FeSO_4$ (0.25%) + $CuSO_4$ (0.50%)	42.51	44.69 (12.42%)	52.43 (30.88%)
24	$FeSO_4$ (0.50%) + $CuSO_4$ (0.25%)	50.89	53.68 (14.32%)	61.82 (24.36%)
25	$FeSO_4$ (0.50%) + $CuSO_4$ (0.50%)	46.45	48.63 (14.92%)	56.59 (30.46%)
26	$FeSO_4$ (0.25%) + K_2SO_4 (0.50%)	47.31	50.12 (14.10%)	58.10 (26.63%)
27	$FeSO_4$ (0.25%) + K_2SO_4 (1.0%)	41.91	43.82 (12.33%)	51.67 (33.84%)
28	$FeSO_4$ (0.50%) + K_2SO_4 (0.50%)	46.50	49.17 (12.51%)	57.61 (25.18%)
29	$FeSO_4$ (0.50%) + K_2SO_4 (1.0%)	51.44	53.68 (12.09%)	61.39 (26.07%)
30	$CuSO_4$ (0.25%) + K_2SO_4 (0.50%)	44.61	50.21 (13.04%)	53.44 (28.24%)

31	$CuSO_4$ (0.25%) + K_2SO_4 (1.0%)	45.03	50.64 (12.98%)	55.03 (28.22%)
32	$CuSO_4$ (0.50%) + K_2SO_4 (0.50%)	44.71	46.54 (12.78%)	52.25 (28.48%)
33	$CuSO_4$ (0.50%) + K_2SO_4 (1.0%)	44.52	46.57 (12.40%)	53.96 (27.58%)
S.Em+		2.07	2.34 (0.78%)	2.32 (1.80%)
CD at 5%		5.84	6.60 (2.20%)	6.54 (5.10%)

*Figures in parenthesis indicate Arc Sin Transformed Values

Conclusion

On the basis of results obtained from the field experiment, It may be concluded that the foliar spray of different micro-nutrients and potassium sulphate influenced the growth of mandarin tree (*Citrus reticulata* Blanco.) specially under Agro-climatic zone-V of Rajasthan i.e. in (Jhalawar condition). Among the different treatments, T_{27} ($FeSO_4$ @ 0.25% + K_2SO_4 @ 1.0%), was found significantly superior over treatment T_1 in respect to plant height, and canopy volume whereas, N-S south plant spread under T_{22} ($FeSO_4$ @ 0.25% + CuSO4 @ 0.25%) was found significantly superior over other treatment while application of treatment T_9 (K_2SO_4 @ 1.0%) was found non-significant in respect to E-W plant spread. The plant growth characters *viz*. plant height, canopy volume and North-South plant spread increased significantly under T_{27}, and T_{22} treatment over other treatments except N-S plant spread. Based on the present investigations, it may be concluded that during May, 2018 and July, 2018, foliar sprays of zinc sulphate and potassium sulphate in T_{21} ($FeSO_4$ @ 0.25% + K_2SO_4 @ 1.0%) in Nagpur mandarin at bearing stage during first week of May, 2018 and first week of July, 2018, improved the growth attributes of Nagpur mandarin. However, these results are only indicative based on eight months experimentation and requires further confirmation before any recommendations are made.

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Conflict of Interest

Author has no conflict of interest of any type.

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