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Effect of Soil and Foliar Application of Zinc on Yield and Quality of Nagpur Mandarin

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Abstract **– Nagpur mandarin (*Citrus reticulata* Blanco) is well-known citrus cultivar in India. Nagpur mandarin occupies a considerable importance particularly in Vidarbha region of M.S. In recent years, it has been observed that orange gardens are declined. Deficiency of micronutrient elements has been reported as one of the major causes of citrus decline in India. The present investigation was undertaken to study the effect of soil and foliar application of zinc on soil properties yield and quality of Nagpur mandarin at Regional Fruit Research Station, (Dr. P.D.K.V., Akola) Katol, Dist. Nagpur. Six different treatments (five tree units in each treatment) in four replications were laid out in randomized block design. The experimental soil had pH 7.65, low in available N, P and high in available K and deficient in Zn. The treatments consisting of recommended dose of fertilizer, RDF+$ZnSO_4$@50g/tree, RDF+ $ZnSO_4$ @100g/tree, RDF+ $ZnSO_4$ @150g/tree, RDF+ 0.5 % $ZnSO_4$ foliar spray/ tree (1 spray), RDF+ 0.5 % $ZnSO_4$ foliar spray/tree (2 spray). Results indicated that soil and foliar application of micronutrient significantly enhanced the yield and quality parameters of Nagpur mandarin.**

Keywords **– Nagpur Mandarin, Micro-Nutrients, Foliar Application, Fruit Quality and TSS/Acidity Ratio.**

I. INTRODUCTION

Orange is grown across the world in 41.96 lakh ha area with 684.75 lakh tonnes production according to FAO, 2009. Brazil is the world leader in orange production (176.18 lakh tonnes) contributing to 25.73 % of world production followed by the US at 12.09 % (82.81 lakh tonnes). India is the third largest producer of orange in the world at 7.60 % (52.01 lakh tonnes). On commercial basis India ranks 64th in productivity, which is very low as compared to the US, Indonesia, Turkey and other countries. Maharashtra is the leading orange (Mandarin) producing State with 8.27 lakh tonnes (2009-10). Madhya Pradesh, Assam, Rajasthan, Mizoram, Meghalaya, Nagaland and Karnataka have also contributed in orange production, (Anon., 2011).

The genus Citrus is economically very important and is known for its juice and pulp throughout the world. C*itrus reticulata* Blanco is one of the most important fruit crop of India, is generally known as Nagpur mandarin. It is belongs to the family Rutaceae. Mandarin is rich in vitamin C, A, B and phosphorus. It is consumed fresh or in the form of juice, jam, squash and syrup. It is the main source of peel oil, citric acid and cosmetics which have international market value. More than sixteen essential elements requires for the normal growth and production of citrus. Deficiency of' micronutrients occur at various stages of growth and developments of citrus plants. Micronutrients play very important role, yet they are very effective in regulating plant growth. The foliar application of micronutrients increases the photosynthetic compounds inside the plant tissue which ultimately reduces the leaf drop and give strength for their persistency compare to soil application (Suresh *et al*., 2018). The nutrient deficiency disturbs the production of plant growth regulators which ultimately control size, color and premature fruit drop. Different workers have suggested that application of suitable combination of plant growth regulators and macro and micro-nutrients for the control of excessive fruit drop and

improvement of the yield and quality of citrus fruits (Doberman and Fairhurst, 2000; Saleem *et al.*, 2005). The nutrients are being exploited for their applications in other fruit crops also (Gaur *et al*., 2014; Gurjar *et al*., 2015). The nutrition constitutes an important component of successful and healthy citrus cultivation. An inadequate nutrition leads to the improper growth and reduced productivity of the citrus trees. The mineral nutrients are composed of major (N, P and K) and Ca, Mg and S are the secondary nutrients, most of them are supplied to the trees along with the primary nutrients through the synthetic fertilizers (Singh and Khan, 2012).

The micronutrients on the other hand though are required in small amount but play a great role in plant metabolism (Katyal, 2004; Kazi *et al.,* 2012). These are involved in the synthesis of many compounds essential for plant growth and productivity and are the activators for various enzymes. For instance, Zn is involved in the biosynthesis of Tryptophan, a precursor of naturally occurring auxin, indole acetic acid (IAA) (Swietlik, 2002). The response of fertilization in improving the growth, yield and quality of different citrus fruits is well recognized (Ghosh, 1990; Kumar *et al.*1993; Ram *et al*., 1997 and Shukla *et al*., 2000). Huchche *et al.* (1998) also reported that application of chemical fertilizers along with organic soil amendments increased mandarin yield in India. Soil nutritional status and leaf analyses in recent years have been widely used to identify nutritional problems, to detect deficiency of nutrient and to measure the response to the applied plant nutrients (Srivastava and Singh, 2003; Srivastava *et al.* 2017). It is considered fairly good index to measure the fertilizer need of citrus plants (Srivastava and Singh, 2005). Nutritional deficiencies especially of the micronutrient have been observed based on visual observation or leaf analysis in different orchards (Srivastava and Singh, 2004). The present investigation has been undertaken to study the effect of soil and foliar application of zinc on soil properties yield and quality of Nagpur mandarin.

II. Material and Methods

The present investigation was undertaken to study the effect of soil and foliar application of zinc on soil properties yield and quality of Nagpur mandarin at Regional Fruit Research Station, (Dr. P.D.K.V., Akola) Katol, Dist. Nagpur during 2013-14. Six different treatments (five tree units in each treatment) in four replications were laid out in randomized block design. The experimental soil had pH 7.65, low in available N, P and high in available K. the treatments consisting of T1 - Recommended dose of fertilizer (RDF), T2- RDF + $ZnSO_4$@50g/ tree, T3-RDF + $ZnSO_4$@100g/ tree, T4- RDF + $ZnSO_4$@150g/ tree, T5- RDF + 0.5% $ZnSO_4$ foliar spray/ tree (1 spray: pea size fruits stages), T6- RDF + 0.5% $ZnSO_4$ foliar spray/tree (2 spray: flowering and on pea size fruits stages).

The micronutrient was applied as foliar sprays in the evening hours with the help of foot sprayer. The required quantities of micronutrients were dissolved in water separately and then pH of these nutrient solutions was adjusted by lime and sprayed in flowering and on pea size fruits stages. The water spray was done on the tree under control treatment. The soil application $ZnSO_4$ was done at the time of application of recommended dose of fertilizers (RDF) (1100g N + 380g P_2O_5/ tree was common for all the treatments and applied through Urea and Single super phosphate in addition with 30 kg FYM/ tree).

Seven months old leaves were collected in the third week of September from non – bearing terminals of current season growth. The leaf samples were processed following the method of Chapmann (1964) and digested in a diacid mixture of nitric acid and perchloric acid (5: 1). The plant extracts were analyzed for Zinc, Iron and Manganese with the help of Atomic Absorption Spectrophotometer. The fruit yield was recorded in the

second week of January.

Eight years old uniformly grown trees spaced at 6 x 6 m were selected for the present study. Plants were kept under uniform orchard management practices during the study, where all the cultural practices were carried out as per package of practices. The observations were recorded on number of fruits per plant, fruit diameter (cm), fruit weight (g) and fruit yield (kg/plant) and biochemical properties of fruits.

III. Result and Discussion

The observations were recorded on number of fruits per plant, fruit weight (g) and fruit yield (kg/plant) was presented in Table 1. Significantly maximum number of Fruits per tree was recorded in T3 (RDF+$ZnSO_4$ @ 100 g /tree) and found at par with T4 (RDF + $ZnSO_4$ @ 150 g /tree) and T6 (RDF + 0.5% $ZnSO_4$ foliar spray/ tree (2 Spray)). Significantly maximum Fruit weight and Fruit yield were recorded in T4 (RDF + $ZnSO_4$ @ 150 g/ tree) and found at par with T3 (RDF + $ZnSO_4$ @ 100 g/ tree). Lowest fruit yield was recorded in T1 i.e., control (RDF). Tariq *et al.,* (2007) observed that application leads to more number of fruits in sweet orange and yield were increased significantly. Fruit quantity parameters like number of fruits per tree, weight of fruits per tree and productivity was influenced by use of micronutrients. Kazi *et al*., (2012) reported in two years trial (2007 & 2008) NPK bulk recommended dose + multi micronutrient through soil showed significantly superior values of number of fruits per tree (554 & 553), weight of fruit per tree (132.90 and 143.80 Kg and productivity per hector (36.18 and 39.83 t/ha). Saraswathi *et al.* 1998, also observed that supplementation of essential microelements significantly increased the number of fruits per plant in mandarin orange. Shrivastava *et al.* (1981) reported that plants sprayed with Cu, Mn, and Zn gave significantly higher fruit yield than the untreated controlled plant. Foliar application of Zinc sulphate upto 0.6 per cent has earlier reported to improve fruit yield and quality in Kinnow mandarin by Razzaq *et al*. (2013).

Table 1. Effect of different treatments on yield of Nagpur mandarin.

Treatment	No. of Fruits/tree	Fruit Weight (g)	Fruit yield /tree (Kg)
T1: Control (RDF)	324.81	138.05	44.85
T2: RDF+$ZnSO_4$ @ 50 g /tree	365.64	153.98	56.31
T3: RDF+$ZnSO_4$ @ 100 g /tree	378.21	163.20	61.73
T4: RDF+$ZnSO_4$ @ 150 g /tree	374.25	170.76	63.91
T5: RDF+0.5% $ZnSO_4$ foliar spray/tree(1 Spray)	369.25	158.71	58.58
T6: RDF+0.5% $ZnSO_4$ foliar spray/tree (2 Spray)	373.92	161.90	60.54
SE (m)±	2.29	2.75	1.09
CD at 5%	6.92	8.29	3.29

The observations were recorded on Fruit diameter (cm) and Juice percentage was presented in Table 2. Significantly maximum fruit diameter was recorded in T4 (RDF + $ZnSO_4$ @ 150 g/ tree) and was found at par with T3 (RDF + $ZnSO_4$ @ 100 g/ tree) and T6 (RDF + 0.5% $ZnSO_4$ foliar spray/ tree (2 Spray)). Lowest in T1 i.e. control (RDF). Maximum Juice percentage was recorded in T4 (RDF + $ZnSO_4$ @ 150 g/ tree) and was found at par with T3 (RDF + $ZnSO_4$ @ 100 g/ tree). Lowest in T1 i.e. control (RDF). Increased in fruit girth observed continuously in two years 2007 & 2008 (Kazi *et al;* 2012). Razzaq *et al.* (2013) and Ullah *et al.* (2012) were

noticed an increase in fruit size of sweet orange and mandarin with the foliar application of zinc or boron. Gurjar and Rana (2014) reported that the increase in fruit weight might be due to increased photosynthesis with potassium application, which led to accumulation of more carbohydrates. Similar increase in juice content with micronutrients has earlier been reported by Rama and Bose (2000). The findings are in agreement with Ingle *et al.* (2002) in acid lime.

Table 2. Effect of different treatments on fruit diameter and juice % of Nagpur mandarin fruit.

Treatment	Fruit diameter (cm)	Juice (%)
T1: Control (RDF)	5.51	50.20
T2: RDF+$ZnSO_4$ @ 50 g /tree	6.02	53.07
T3: RDF+$ZnSO_4$ @ 100 g /tree	6.20	54.56
T4: RDF+$ZnSO_4$ @ 150 g /tree	6.30	56.65
T5: RDF+0.5% $ZnSO_4$ foliar spray/tree(1 Spray)	5.89	51.77
T6: RDF+0.5% $ZnSO_4$ foliar spray/tree (2 Spray)	6.09	52.85
SE (m)±	0.07	1.10
CD at 5%	0.21	3.32

The data in respect of biochemical parameters of Nagpur mandarin fruit was found to be significant (Table 3). Maximum reducing sugar percentage was recorded in T4 (RDF + $ZnSO_4$ @ 150 g/ tree) and was found at par with T3 (RDF + $ZnSO_4$ @ 100 g/ tree) and T6 (RDF + 0.5% $ZnSO_4$ foliar spray/ tree (2 Spray)). The TSS % was recorded maximum in T4 (RDF + $ZnSO_4$ @ 150 g/ tree) and was found at par with T3 (RDF + $ZnSO_4$ @ 100 g/ tree) while, lowest TSS % was recorded in T1 i.e. control (RDF).

However lowest acidity percentage was recorded in treatments T4 (RDF + $ZnSO_4$ @ 150 g/ tree) and highest in control (T1). Significantly lowest acidity percentage was recorded in all the treatments over control and these treatments were found at par with each other. The TSS/ acidity ratio was recorded maximum in treatment T4 (RDF + $ZnSO_4$ @ 150 g/ tree) and was found at par with T3 (RDF + $ZnSO_4$ @ 100 g/ tree) and T6 (RDF + 0.5% $ZnSO_4$ foliar spray/ tree (2 Spray)). Kazi *et al* (2012) reported that reducing and non reducing sugar maximum with application of NPK bulk recommended dose + multi micronutrient. The reduction in acidity content might be due to its in-verse relation with fruit size as reported by Dixit *et al*. (1977). Kazi *et al.* (2012) also observed that minimum acidity found with application of NPK bulk RDF + multi micronutrient. The acidity decreases in micronutrient applied plant's fruit juice might be due to their utilization in respiration and rapid metabolic transformation of organic acids in to sugars (Brahamachari *et al*, 1997) Similar result were reported by Patil and Hiwarale (2004) in acid lime. Ghosh and Basra (2000) reported that highest TSS in sweet orange with foliar application of $ZnSO_4$ + Borax. Kazi et al. 2012 reported that TSS ranged from 9.0 to 10.3 ^{0}Bx showed maximum with NPK + micronutrient.

Table 3. Effect of different treatments on biochemical parameters of Nagpur mandarin fruit.

Treatment	Reducing sugar (%)	TSS (%)	Acidity (%)	TSS/Acidity ratio
T1: Control (RDF)	4.49	8.87	0.71	12.54
T2: RDF+$ZnSO_4$ @ 50 g /tree	5.07	9.10	0.67	13.60

Treatment	Reducing sugar (%)	TSS (%)	Acidity (%)	TSS/Acidity ratio
T3: RDF+$ZnSO_4$ @ 100 g /tree	5.21	9.29	0.67	13.93
T4: RDF+$ZnSO_4$ @ 150 g /tree	5.28	9.36	0.66	14.19
T5: RDF+0.5% $ZnSO_4$ foliar spray/tree (1 Spray)	4.99	9.01	0.68	13.35
T6: RDF+0.5% $ZnSO_4$ foliar spray/tree (2 Spray)	5.13	9.23	0.67	13.73
SE (m)±	0.05	0.04	0.01	0.20
CD at 5%	0.16	0.10	0.03	0.58

IV. CONCLUSION

Zinc nutrient play an important role in growth, fruit set, fruit retention and development and cause efficient yield and quality improvement. Based on the results obtained from the present investigations, it was observed that soil and foliar application of Zn-micronutrient in combination with recommended dose of fertilizers enhanced the yield attributes and higher profit gain by correcting Zn- deficiency.

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