Nutrient management study in sweet orange 
\textit{(Citrus sinensis} L) cv. mosambi

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Abstract
Effect of micronutrients on growth, yield and quality parameters of sweet orange was studied at Experimental field of department of Horticulture, Collage of Agriculture, RVSKVV, Gwalior (M.P.). Foliar application of 4g CuSO$_4$ (Copper sulphate)+ 2g FeSO$_4$ (Ferrous sulphate), + 2g Borax+ 4g ZnSO$_4$ (Zinc sulphate) + 4g MgSO$_4$ (Magnesium sulphate) + 10g lime per liter water during the mid of March and 1$^{st}$ week of July with 600 N + 500 P+300 K g/tree on sweet orange gave maximum Yield per tree (41.03 kg), Number of fruits/tree (248), Fruit weight (167 g), Fruit length (11.8 cm), Fruit diameter (21.8 cm) and good quality fruits Juice (56.08 %) (Titratable Acidity (0.78%), Ascorbic acid (58.04 mg/100ml) with Total Soluble Solids (11.6 °Brix). Therefore, application of this dose of micronutrient combination will improve yield and fruit quality in sweet orange of these micronutrients as a result of which the orchardist will be economically benefited.

Keywords: sweet orange, micronutrients, quality, ascorbic acid, fruit weight

Introduction
Citrus fruits hold an important place in the economy of the country and these fruits form the third largest fruit industry NHB database (2016) [10]. These fruits are a fair source of vitamin C and their daily consumption protects mankind from scurvy, a disease commonly associated with inadequate availability of vitamin C in the dietary foods. Citrus fruits are cultivated in India in four different zones i.e. central India (Madhya Pradesh, Maharashtra and Gujarat), southern India (Andhra Pradesh and Karnataka), north-western India (Punjab, Rajasthan, Haryana and western UP) and north-eastern India (Meghalaya, Assam and Sikkim). These zones have different leading cultivar(s) that occupies a place of prominence in the respective area (Etebu and Nwauzoma (2014) [5]. Citrus occupies an important place in the fruit industry, but yield levels of citrus orchards are still very low Srivastava and Singh (2009) [15]. Out of many factors, poor nutrient status of the soil as well as malnutrition is considered to be the major factors responsible for citrus decline and low yield. Nutrient refers to all those compounds, which are required by the plant as a source of body building material and for the energy, without which, it will not be able to complete its life cycle (Ibrahim, et al., 2011) [7]. Fertilizer is one of the major inputs accounting for nearly one-third of the cost of cultivation and its production consumes a lot of energy used in agriculture. Consequent to the global energy crisis, efficient and judicious use of the fertilizers is imperative not only for obtaining more yields per unit area on a sustainable basis, but also to conserve the energy and to avoid the problem of environment quality (Sarwry et al. (2012) [14]. The new thinking about the soil management technologies needed for the continuous enhancement of the productivity, sustainability of land, arresting the process of land degradation, accelerating the process of land degradation, accelerating the rate of reclamations and restoration of the productivity of lands which have degraded in the past (Khehra and Bal, 2014) [9]. Therefore, it is a holistic approach, where we first know what exactly is required by the plant for an optimum level of production in what different forms these nutrients should be applied in soil and at what different timings in the best possible method; and how best these forms should be integrated to obtain highest productive efficiency on the economically acceptable limits in an environment friendly manner.

Materials and Methods
Experimental design and fertilizers
The experiment was conducted on 8 year old sweet orange orchards at Experimental field of department of Horticulture, Collage of Agriculture, RVSKVV, Gwalior (M.P.) during 2017. Sixty four trees were selected for this purpose. Sixteen treatments with four replications were applied. A basal dose of 600 N + 200 P+300 K g/tree was applied. Foliar application of
micronutrients, 4g CuSO4 (Copper sulfate) + 2g FeSO4 (Ferrous sulfate), + 2g Borax+ 4g ZnSO4 (Zinc sulfate) + 4g MgSO4 (Magnesium Sulphate) + 10g lime per liter water during the mid of March and 1st week of July with RDF 600 N + 200 P+300 K g/tree only the treatment combination of phosphorus (400, 500 and 600) was changed in dose. The various treatments used in the study include: T0 - Water spray + 600:200:300 (RDF of NPK g /tree), T1 - 600:400:300 (N:P:K g/tree), T2 - 600:600:300 (N:P:K g/tree), T3 - 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water + RDF of N:P:K g/tree, T4 - 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water + RDF of N:P:K g/tree, T5 - 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water + RDF of N:P:K g/tree, T6 - 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water + RDF of N:P:K g/tree, T7 - 600:400:300 (N:P:K g/tree), T8 - 600:500:300 (N:P:K g/tree), T9 - 600:600:300 (N:P:K g/tree) + 4g CuSO4+2g Borax+4g ZnSO4+4g MgSO+ 10g lime per liter water + RDF of N:P:K g/tree, T10 - 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water + RDF of N:P:K g/tree, T11 - 600:500:300 (N:P:K g/tree) + 4g CuSO4+2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T12 - 600:600:300 (N:P:K g/tree) + 4g CuSO4+2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T13 - 600:400:300 (N:P:K g/tree) + 4g CuSO4+2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T14 - 600:500:300 (N:P:K g/tree) + 4g CuSO4+2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T15 - 600:600:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T16 - 600:500:300 (N:P:K g/tree) + 4g CuSO4+2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T17 - 600:600:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T18 - 600:400:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T19 - 600:500:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water, T20 - 600:600:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water. The average fruit weight (167g) was recorded at November and December months in the year. The average number of fruits per plant, yield, TSS, Juice content, and acidity were analysed for the study period and mean values were presented. The study was revealed that fruit yield and quality were significantly influenced by the different phosphorus and micronutrients treatments Gill et al. (2005) [6]. The highest number of fruits per plants (248 fruits/plant) and fruit yield (41.03 kg/tree) was in T2 in 600:500:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water followed by T12, 600:500:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water (Juice 55.25%, TSS 10.75 o Brix, acidity 0.81% and Vitamin C 56.55 mg/100ml). The similar results were observed by Abd-Allah (2006) [2] in Washington Navel orange and Yaseen and Ahmad (2010) [19] in Kinnow. The present findings are also reported by Vijay et al. (2016) [16] in sweet orange.

The application of phosphorus with soil application and micronutrients through foliar spray had a positive effect on the yield as well as fruit quality of the sweet orange during 2017. The sweet orange fruits were harvested during November and December months in the year. The average number of fruits per plant, yield, TSS, Juice content, and acidity were analysed for the study period and mean values were presented. The study was revealed that fruit yield and quality were significantly influenced by the different phosphorus and micronutrients treatments Gill et al. (2005) [6]. The highest number of fruits per plants (248 fruits/plant) and fruit yield (41.03 kg/tree) was in T2 in 600:500:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water followed by T12, 600:500:300 (N:P:K g/tree) + 4g CuSO4 + 2g FeSO4 + 2g Borax + 4g ZnSO4 + 4g MgSO+ 10g lime per liter water (Juice 55.25%, TSS 10.75 o Brix, acidity 0.81% and Vitamin C 56.55 mg/100ml). The similar results were observed by Abd-Allah (2006) [2] in Washington Navel orange and Yaseen and Ahmad (2010) [19] in Kinnow. The present findings are also reported by Vijay et al. (2016) [16] in sweet orange.

### Table 1: Effect of micronutrients on yield and quality parameters of sweet orange cv. Mosambi

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fruit weight (g)</th>
<th>Fruit length (cm)</th>
<th>Fruit diameter (cm)</th>
<th>Number of fruits/tree</th>
<th>Yield per tree (kg)</th>
<th>Juice acidity (°Brix)</th>
<th>Total Soluble Solids %</th>
<th>Juice (%)</th>
<th>Vitamin C mg/100ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>147</td>
<td>08.6</td>
<td>19.5</td>
<td>142</td>
<td>20.87</td>
<td>1.09</td>
<td>47.37</td>
<td>46.33</td>
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<tr>
<td>T1</td>
<td>152</td>
<td>09.5</td>
<td>20.0</td>
<td>190</td>
<td>34.97</td>
<td>0.86</td>
<td>53.52</td>
<td>52.01</td>
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</tr>
<tr>
<td>T2</td>
<td>159</td>
<td>10.6</td>
<td>20.7</td>
<td>214</td>
<td>37.11</td>
<td>0.82</td>
<td>54.77</td>
<td>54.42</td>
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</tr>
<tr>
<td>T3</td>
<td>164</td>
<td>11.2</td>
<td>21.5</td>
<td>215</td>
<td>33.34</td>
<td>0.90</td>
<td>52.02</td>
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</tr>
<tr>
<td>T4</td>
<td>148</td>
<td>08.8</td>
<td>19.7</td>
<td>168</td>
<td>22.07</td>
<td>0.97</td>
<td>52.78</td>
<td>51.91</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

In view of the experimental results obtained during the present investigation, the treatment T₁₂ 600:500:300 (N:P:K g/tree) + 4g CuSO₄+2g FeSO₄ + 2g Borax + 4g ZnSO₄ + 4gMgSO₄ + 10g lime per liter water was found to be the best in terms of maximum highest number of fruits per tree (248), highest number of fruits (248 fruits/plant) and fruit yield (41.03 kg/tree) as a result of which the orchardist will be economically benefited. Hence, these treatment combinations are recommended particularly in northern area of Gwalior, Madhya Pradesh.

References