Effect of foliar application of urea, zinc sulphate and borax on flowering, fruiting and yield of acid lime (Citrus aurantifolia Swingle) vari. Kagzi lime under Malwa Plateau conditions

Alka Yadav, Jyoti Kanwar, Rajiv Dubey and Megha Upadhyay

Abstract
Field experiments were conducted during 2016-2017 at K.N.K. College of Horticulture, Mandsaur, Madhya Pradesh to study the effect of urea, zinc sulphate and borax on flowering, fruiting and yield of acid lime. The result revealed that foliar spray of urea 1.5% + borax 0.6% + ZnSO₄ 0.5% was found to be the best for maximum increase in plant-height (0.32 m), plant spread in north-south (0.37 m), plant spread in east-west (0.33 m), number of flower per plant (1977.33), fruit set (63.28%), number of fruit per plant (985.00) and reduced fruit drop (36.14%) which ultimately increased the yield of fruit per plant (45.40 kg) compared to other treatments.

Keywords: foliar application, fruiting, acid lime

Introduction
Acid lime is the third important citrus fruit crop in India next to mandarins and sweet oranges. In India, acid lime is grown in a variety of agro-climates comprising from the northern plains and central highlands having hot semi-arid eco-region with black and red soils. Acid lime flowers throughout the years in three distinct seasons known as “bahar” viz, Ambe, Mrig and Hasta bahar. Due to the continuous flowering and heavy crop load on trees, the size of the fruits remains usually very small. Qualitative characters also get affected, resulting into harvest of poor quality and unmarketable fruits. Micronutrients play a vital role in plants and foliar spray of micronutrient is more successful than soil application. Among the various factors responsible for poor yield and declining health in citrus, deficiency of micronutrients is considered to be the major one (Edward raja, 2009) [7]. Micronutrient can tremendously boost Kagzi lime flowering and fruiting quality (Venu et al., 2014) [16]. Foliar application of the nutrients is obviously an ideal way of evading the problems of nutrient availability. This method is highly helpful for the correction of trace element deficiencies to restore disrupted nutrient supply and to overcome stress factors limiting their availability. Keeping the above facts in mind, a field experiment was conducted at the Instructional cum Research Fruit Orchard Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (M.P.)

Materials and Methods
Field experiment was conducted during 2016-2017 at the Instructional cum Research Fruit Orchard Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (M.P.) to study the effect of urea, zinc sulphate and borax on flowering, fruiting and yield of acid lime on black soils with pH 7.5, O.C (0.94 %), available N (533 kg ha⁻¹), available P (14.9 kg ha⁻¹) and available K (533 kg ha⁻¹). The experiment was laid out in randomized block design with thirteen treatments viz., control, urea (0.5%), urea (1.0%), urea (1.5%), Borax (0.4%), Borax (0.5%), Borax (0.6%), ZnSO₄ (0.3%), ZnSO₄ (0.4%), ZnSO₄ (0.5%), urea (0.5%) + borax (0.4%), ZnSO₄ (0.3%), urea (1.0%) + borax (0.5%), ZnSO₄ (0.4%) and urea (1.5%) + borax (0.6%), ZnSO₄ (0.5%) and replicated three times. Twelve years old uniform trees of acid lime (Citrus aurantifolia Swingle) were selected for the study. The recommended management practices were followed uniformly for all the treatments studied.

Results and Discussion
Growth parameters
The data of growth parameters like plant-height increment, plant spread in E-W and N-S direction, leaf area (cm²) due to the effect of foliar application of urea, zinc sulphate and borax
significantly influenced over the control (Table 1). When applied singly without combination, urea (1.5%) exhibited significantly higher plant height increment (0.24 m), higher plant spread in E-W and N-S direction (0.26 m and 0.30 m, respectively) and leaf area (36.83 cm²) over all the single treatments. Different level of urea, borax and ZnSO₄ when spray in combinations, higher combination i.e. Urea (1.5%) + Borax (0.6%) + ZnSO₄ (0.5%) significantly increased plant-height (0.32 m), plant spread in E-W and N-S direction (0.33 m and 0.37 m, respectively) and leaf area (39.97 cm²) which is followed by the treatment receiving Urea (1.0%) + Borax (0.5%) + ZnSO₄. The beneficial effect of nitrogen in increasing the tree growth might be due to the fact that absorbed nitrogen combined with carbohydrates synthesis leads to the formation of nitrogenous compound such as protein, nucleic acids, nucleotides, enzymes and co-enzymes to build up new tissues (Rathore and Chandra, 2003) [12]. Folia application of nitrogen alone and combination with zinc sulphate (0.5%) increased vegetative growth of acid lime trees with respect to plant-height, spread in north to south and east to west directions (Rathore and Chandra, 2003) [12]. The reason for increase in growth due to boron is involved in the carbohydrate metabolism; it directly affects plant growth and indirectly influences the photosynthetic rate (Cakmak and Romheld, 1977) [14] and increases the phenolic compounds which regulate polar auxin transport, the increased auxin activity results in increased tissue growth and development (Gurjar et al., 2015) [8].

Zinc increased tree height and leaf size in the treated trees might be due to the active synthesis of tryptophane in the presence of zinc, the precursor of auxin, which in turn causes an increase in the rate of chlorophyll synthesis which ultimately accelerates the photosynthetic activity consequently it increased tissue growth and development (Rawat et al., 2010) [13]. Similar results were found by Sajid et al., 2010 [13]. The minimum values of growth parameters were found with control.

Reproductive parameters

Reproductive parameters such as number of flowers per plant, fruit set and fruit retention percentage had significantly increased and fruit drop percent is decreased (Table 1). Maximum number of flowers, fruit set, and minimum fruit drop were reported with the application of foliar spray of urea 1.5% + borax 0.6% + ZnSO₄ 0.5% which was significantly superior than all over treatment. The result indicates that the number of flowers per plant was significantly increased due to different levels of urea. The urea has helped in more fruit retention per shoot, which resulted in increasing number of fruits per plant (Symal et al., 2008) [14]. Similar results were found by Dudi et al., 2004 [6]. The cumulative effect of nitrogen on photosynthetic as well metabolic activities has helped to increase the fruit size and fruit weight and thereby increase the fruit yield (Jat and Kacha 2014) [9]. Similar results are also found by Labanauskas et al., 1963 [10]. The significant increase in yield by boron application may be accredited to the positive effect of boron on increasing the rates of carbohydrates, cell wall development and RNA metabolism which enhance profuse flowering and fruit setting per shoot resulting increase in yield per plant (Bhatt et al., 2012) [3]. The results in line with Rawat et al., 2010 [13]. Zinc play important role in auxin synthesis and boron in translocation of start to fruit resulted into better photosynthesis, greater accumulation of starch in fruits. Balance of auxin in plant regulates the fruit drop or retention in plants, which altered the control of fruit drop and increased the total number of fruit per plant (Venu et al., 2014) [16]. Similar results is obtained by Banik et al., 1997) [1].

Table 1: Reproductive parameters such as number of flowers per plant, fruit set and fruit retention percentage had significantly increased and fruit drop percent is decreased

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant-height increment (m)</th>
<th>Plant-spread increment (m)</th>
<th>Leaf area (cm²)</th>
<th>No. of flowers/ plant</th>
<th>Fruit set (%)</th>
<th>Fruit drop (%)</th>
<th>Fruit yield (kg/ plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Water spray)</td>
<td>0.13</td>
<td>0.14</td>
<td>0.15</td>
<td>24.94</td>
<td>1160.00</td>
<td>40.80</td>
<td>765.00</td>
</tr>
<tr>
<td>Urea (0.5 %)</td>
<td>0.18</td>
<td>0.19</td>
<td>0.24</td>
<td>30.30</td>
<td>1315.33</td>
<td>45.17</td>
<td>855.00</td>
</tr>
<tr>
<td>Urea (1.0%)</td>
<td>0.22</td>
<td>0.24</td>
<td>0.26</td>
<td>34.00</td>
<td>1396.33</td>
<td>48.65</td>
<td>880.33</td>
</tr>
<tr>
<td>Urea (1.5%)</td>
<td>0.24</td>
<td>0.26</td>
<td>0.30</td>
<td>36.83</td>
<td>1467.67</td>
<td>47.91</td>
<td>890.00</td>
</tr>
<tr>
<td>Borax (0.4%)</td>
<td>0.16</td>
<td>0.16</td>
<td>0.17</td>
<td>27.00</td>
<td>1533.44</td>
<td>57.10</td>
<td>866.67</td>
</tr>
<tr>
<td>Borax (0.5%)</td>
<td>0.18</td>
<td>0.18</td>
<td>0.19</td>
<td>0.28</td>
<td>0.50</td>
<td>0.33</td>
<td>0.23</td>
</tr>
</tbody>
</table>

### References