Guava (Psidium guajava L.) is one of the most important fruit crops of tropical and sub-tropical regions of India. It can be grown satisfactorily on marginal soils with minimum care and is also called as ‘Apple of the Tropics’. It is largely grown in warmer tropical countries of the world. It is a rich source of ascorbic acid in human diet, content of which is three to five times more than that in fresh orange juice. In India, guava occupies an area of 228.5 (000) hectares and production of 2.71 million tones. Chhattisgarh has covered an area of 15.6 (000) hectares with an annual production of 121300 metric tonnes. The recent concept of integrated nutrient supply involving organic, inorganic and biofertilizers has developed to meet the growing need for nutrients under intensive cultivation. In integrated plant nutrition supply system, the basic goal is to maintain or possibly improve the soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of the benefits from all possible sources of plant nutrients in an integrated manner. Guava is very hardy to soil and agro-climatic conditions and gives good response to manuring in terms of increasing fruit production and quality. Fertilizer experiments conducted in India showed that guava has given good response to balanced use of inorganic fertilizers along with organic manures. It is reported that application of organics and chemical fertilizers not only increased the yield, but also improved the fruit quality in guava.

MATERIALS AND METHODS

A field experiment was carried out during 2013-14 using Mrig bahar crop of guava at Horticulture Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) to study the effect of integrated application of chemical fertilizers, organics and biofertilizers on growth, yield and quality of guava Psidium guajava (L.). The experiment was laid out in Randomized Block Design (RBD) with four replications and twelve treatments. Results revealed significant differences amongst various growth attributes, fruit yield and quality of guava due to chemical fertilizers, organic manures and biofertilizers. The application of 75% RDF + Cowdung Slurry produced the highest tree height, trunk girth, tree canopy spread, length of shoot (92.18 cm), diameter of shoot (1.01 cm), fruit length (9.80 cm), fruit diameter (9.54 cm), fruit volume (257.50 cm), number of fruits per tree (250.57) and the highest yield (14.31 tha-1). The application of 75% RDF + Vermiwash 10 litre/tree and 75% RDF + Azospirillum + PSB was equally good for producing higher yield. Ascorbic acid, TSS, reducing, non-reducing, total sugars were maximum under 75% RDF + Cowdung slurry 10 litre/tree.
using measuring tape and average was calculated. Five shoots were randomly selected from each tree. The lengths of shoots were measured and average was worked out and recorded as length of shoot. The data was recorded at the commencement and at the end of the experiment. and diameters of these shoots were measured by vernier callipers and average was worked out and recorded as diameter of shoot.

The length of five fruits of each treatment was measured from stalk to stylar end with the help of vernier callipers and after computing mean, it was recorded as average length of fruit in centimetre. The diameter of five randomly selected fruits were measured, perpendicular to the length at the maximum width with the help of vernier callipers and average was worked out. The volume of fruit was determined by the help of water displacement method using measuring cylinder. The numbers of fruits per tree were recorded at each harvest and total number was calculated at last harvesting by summation of values of all pickings. The yield per hectare was calculated by multiplying the value of yield/tree (kg) by total number of tree/hectare and dividing the result by 1000. Total soluble solids was recorded by hand refractometer (0-32 °Brix) by taking a drop of juice from fruit pulp on the prism of the refractometer and observing it against the light, the reading was recorded as total soluble solids in °Brix. The ascorbic acid was determined by titrating a known weight of sample with 2,6 dichlorophenol - indophenol dye using metaphosphoric acid as a stabilizing agent. Sugars were determined by the method of Lane and Eynon as described by Ranganna⁴.

RESULT AND DISCUSSION

Effect on tree growth: Results revealed that significant differences amongst various tree growth attributes of guava due to chemical fertilizers, organics and biofertilizers (Table-1). The significantly maximum tree height (5.27 m), trunk girth (86.83 cm), North-South spread (7.34 m), East-West spread (7.04 m), length of shoot (92.18 cm) and diameter of shoot (86.83 cm), number of fruits per tree (250.57) and fruit yield (14.31tha⁻¹) were found in treatment T⁴. The maximum fruit length was observed under 75% RDF + Cowdung slurry was probably due to better utilization of nutrients within the plant as well as translocation of more nitrogen to the apical part of plant body. Similar results were also been reported by earlier workers⁸,⁹ in papaya crop. These favourable effects on quality improvement in the treatment of combined application of organic and inorganic fertilizers may be due to the result of better vegetative growth of the treated plants which resulted in production of higher quantities of photosynthates such as starch and carbohydrates and their translocation to the fruits, thus increasing the length, diameter and volume of fruits. Earlier workers have also reported the quality improvement in terms of physical attributes of fruits¹⁰.

The production of more number of fruits in the treatments of combined application of inorganic fertilizers with cowdung slurry at different levels could be a result of the improvement in soil physical, biological and chemical properties which in turn, provided required nutrition for the conversion of flowers to fruits.
### Table 1. Effect of integrated application of chemical fertilizers, organics and Biofertilizers on tree growth of guava

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tree height (m)</th>
<th>Trunk girth (cm)</th>
<th>Tree canopy spread (m)</th>
<th>Length of shoot (cm)</th>
<th>Diameter of shoot (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>N-S</td>
<td>E-W</td>
<td></td>
</tr>
<tr>
<td>T₀</td>
<td>3.52</td>
<td>61.49</td>
<td>5.25</td>
<td>5.10</td>
<td>74.04</td>
</tr>
<tr>
<td>T₁</td>
<td>4.27</td>
<td>68.04</td>
<td>5.85</td>
<td>5.75</td>
<td>81.73</td>
</tr>
<tr>
<td>T₂</td>
<td>5.27</td>
<td>86.83</td>
<td>7.34</td>
<td>7.04</td>
<td>92.18</td>
</tr>
<tr>
<td>T₃</td>
<td>4.83</td>
<td>78.10</td>
<td>6.74</td>
<td>6.63</td>
<td>89.09</td>
</tr>
<tr>
<td>T₄</td>
<td>4.62</td>
<td>71.85</td>
<td>5.96</td>
<td>5.91</td>
<td>82.67</td>
</tr>
<tr>
<td>T₅</td>
<td>3.88</td>
<td>66.96</td>
<td>5.69</td>
<td>5.59</td>
<td>81.61</td>
</tr>
<tr>
<td>T₆</td>
<td>4.67</td>
<td>73.99</td>
<td>6.16</td>
<td>6.25</td>
<td>83.85</td>
</tr>
<tr>
<td>T₇</td>
<td>3.86</td>
<td>63.14</td>
<td>5.45</td>
<td>5.51</td>
<td>75.43</td>
</tr>
<tr>
<td>T₈</td>
<td>4.86</td>
<td>83.10</td>
<td>7.17</td>
<td>6.93</td>
<td>90.44</td>
</tr>
<tr>
<td>T₉</td>
<td>4.75</td>
<td>76.51</td>
<td>6.55</td>
<td>6.49</td>
<td>87.22</td>
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<tr>
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<td>4.85</td>
<td>82.97</td>
<td>6.94</td>
<td>6.85</td>
<td>90.42</td>
</tr>
<tr>
<td>T₁¹</td>
<td>4.74</td>
<td>74.91</td>
<td>6.33</td>
<td>6.36</td>
<td>85.75</td>
</tr>
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<td>SEmt</td>
<td>0.11</td>
<td>1.34</td>
<td>0.18</td>
<td>0.16</td>
<td>0.01</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>0.33</td>
<td>3.86</td>
<td>0.52</td>
<td>0.46</td>
<td>0.04</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>Control (Without nutrient application)</td>
</tr>
<tr>
<td>T₁</td>
<td>100% RDF (600:300:300 gm NPK/tree)</td>
</tr>
<tr>
<td>T₂</td>
<td>75% RDF + Cow dung slurry (10 litre/tree)</td>
</tr>
<tr>
<td>T₃</td>
<td>50% RDF + Cow dung slurry (10 litre/tree)</td>
</tr>
<tr>
<td>T₄</td>
<td>75% RDF + Vermi wash (10 litre/tree)</td>
</tr>
<tr>
<td>T₅</td>
<td>50% RDF + Vermi wash (10 litre/tree)</td>
</tr>
<tr>
<td>T₆</td>
<td>75% RDF + Azospirillum (100 gm/tree)</td>
</tr>
<tr>
<td>T₇</td>
<td>50% RDF + Azospirillum + PSB</td>
</tr>
<tr>
<td>T₈</td>
<td>50% RDF + Azospirillum + PSB</td>
</tr>
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</table>

### Table 2. Effect of integrated application of chemical fertilizers, organics and biofertilizers on fruit growth attributes and yield of guava

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fruit length (cm)</th>
<th>Diameter of fruit (cm)</th>
<th>Volume of fruit (cc)</th>
<th>Number of fruits per tree</th>
<th>Fruit yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>5.98</td>
<td>6.22</td>
<td>143.25</td>
<td>175.72</td>
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<tr>
<td>T₁</td>
<td>7.44</td>
<td>7.92</td>
<td>183.00</td>
<td>215.78</td>
<td>8.33</td>
</tr>
<tr>
<td>T₂</td>
<td>9.80</td>
<td>9.54</td>
<td>257.50</td>
<td>250.57</td>
<td>14.31</td>
</tr>
<tr>
<td>T₃</td>
<td>8.72</td>
<td>9.00</td>
<td>242.75</td>
<td>234.47</td>
<td>11.43</td>
</tr>
<tr>
<td>T₄</td>
<td>7.87</td>
<td>8.23</td>
<td>189.75</td>
<td>216.59</td>
<td>9.14</td>
</tr>
<tr>
<td>T₅</td>
<td>6.57</td>
<td>7.51</td>
<td>175.50</td>
<td>203.75</td>
<td>7.72</td>
</tr>
<tr>
<td>T₆</td>
<td>8.01</td>
<td>8.50</td>
<td>212.00</td>
<td>226.58</td>
<td>9.84</td>
</tr>
<tr>
<td>T₇</td>
<td>6.21</td>
<td>6.70</td>
<td>168.50</td>
<td>200.55</td>
<td>6.94</td>
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<tr>
<td>T₈</td>
<td>9.60</td>
<td>9.26</td>
<td>253.25</td>
<td>240.41</td>
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</tr>
<tr>
<td>T₉</td>
<td>8.54</td>
<td>8.96</td>
<td>229.75</td>
<td>239.65</td>
<td>10.94</td>
</tr>
<tr>
<td>T₁₀</td>
<td>9.10</td>
<td>9.15</td>
<td>245.25</td>
<td>238.46</td>
<td>12.42</td>
</tr>
<tr>
<td>T₁¹</td>
<td>8.24</td>
<td>8.75</td>
<td>224.00</td>
<td>229.18</td>
<td>10.33</td>
</tr>
<tr>
<td>SEmt</td>
<td>0.40</td>
<td>0.99</td>
<td>0.05</td>
<td>6.76</td>
<td>0.28</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>1.17</td>
<td>2.27</td>
<td>10.82</td>
<td>19.54</td>
<td>0.83</td>
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</table>
Table-3. Effect of integrated application of chemical fertilizers, organics and biofertilizers on quality of guava.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total soluble solids (0 Brix)</th>
<th>Ascorbic acid (mg/100 gm pulp)</th>
<th>Reducing sugar (%)</th>
<th>Non-reducing sugar (%)</th>
<th>Total sugar (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>11.95</td>
<td>193.29</td>
<td>3.90</td>
<td>4.62</td>
<td>8.52</td>
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<tr>
<td>T1</td>
<td>12.92</td>
<td>208.57</td>
<td>4.40</td>
<td>5.20</td>
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</tr>
<tr>
<td>T2</td>
<td>14.80</td>
<td>236.60</td>
<td>5.30</td>
<td>5.47</td>
<td>10.50</td>
</tr>
<tr>
<td>T3</td>
<td>14.35</td>
<td>224.48</td>
<td>5.10</td>
<td>5.31</td>
<td>10.30</td>
</tr>
<tr>
<td>T4</td>
<td>13.48</td>
<td>212.24</td>
<td>4.60</td>
<td>5.22</td>
<td>9.77</td>
</tr>
<tr>
<td>T5</td>
<td>12.60</td>
<td>205.13</td>
<td>4.20</td>
<td>5.05</td>
<td>9.45</td>
</tr>
<tr>
<td>T6</td>
<td>13.58</td>
<td>215.87</td>
<td>4.70</td>
<td>5.23</td>
<td>10.02</td>
</tr>
<tr>
<td>T7</td>
<td>12.46</td>
<td>203.10</td>
<td>4.00</td>
<td>4.82</td>
<td>8.82</td>
</tr>
<tr>
<td>T8</td>
<td>14.75</td>
<td>233.46</td>
<td>5.21</td>
<td>5.33</td>
<td>10.40</td>
</tr>
<tr>
<td>T9</td>
<td>14.12</td>
<td>221.26</td>
<td>5.00</td>
<td>5.20</td>
<td>10.20</td>
</tr>
<tr>
<td>T10</td>
<td>14.50</td>
<td>227.03</td>
<td>5.17</td>
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<td>10.36</td>
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<tr>
<td>T11</td>
<td>13.90</td>
<td>216.35</td>
<td>4.90</td>
<td>5.26</td>
<td>10.22</td>
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<tr>
<td>SEMt</td>
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<td>1.38</td>
<td>0.11</td>
<td>0.13</td>
<td>0.20</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>1.03</td>
<td>3.98</td>
<td>0.33</td>
<td>0.39</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Figure-1. Showing effect of integrated application of chemical fertilizers, organics and biofertilizers on fruit growth attributes and yield of guava.
resulting in higher fruit set and ultimately increased the number of fruits per tree\textsuperscript{11}. The maximum yield in the combined application of organic and inorganic fertilizers is a result of the interaction between them which helped in increasing the soil nutrient availability and their uptake by the plants that resulted in better vegetative growth in terms of shoot length and number of leaves which have produced the higher quantum of carbohydrates needed for the development of the fruits thereby, increasing the number, size and weight of fruits which ultimately leads towards getting higher yield in these treatments. The results on similar lines were also reported by earlier workers\textsuperscript{12, 13}.

**Effect on quality of guava:** The significantly maximum total soluble solid percentage was observed in treatment T\textsubscript{2} (14.80 °Brix), the ascorbic acid percentage was significantly maximum under the treatment T\textsubscript{2} (236.60 mg/100 g pulp), that significantly maximum reducing sugar percentage was recorded under the treatment T\textsubscript{2} (5.30 %), maximum non-reducing sugar percentage was observed in treatment T\textsubscript{2} (5.47 %), significantly maximum total sugar percentage was recorded under the treatment T\textsubscript{2} (10.50 %). These results are in agreement with earlier findings\textsuperscript{14}. The increase in TSS might be due to accumulation of sugars and other soluble components from hydrolysis of protein and oxidation of ascorbic acid\textsuperscript{15}. Enhancement in ascorbic acid might be ascribed due to optimum availability of nutrients in T\textsubscript{2}. The results are in close conformity with the report of earlier workers\textsuperscript{16} in guava. Due to the balanced absorption of macro and micro nutrients which have exerted regulatory role as an important constituent of endogenous factors in affecting the quality of the fruits. The carbohydrate reserves of the roots and stems are drawn upon heavily which might have resulted in higher sugar contents in fruits as has also been reported by earlier workers\textsuperscript{17}.

**ACKNOWLEDGEMENT**

The first author expresses his heartfelt gratitude to Dr. S.N. Dikshit, Head, Department of Horticulture, IGKV, Raipur (C.G.) for his constant guidance and intellectual input throughout the study period.

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