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Abstract
The experiment was conducted to assess yield and economics of ginger (Zingiber officinale Rosc.) cultivation under Soppinabetta ecosystem of Karnataka. The experiment was laid out in a randomized block design (RBD) fashion with 16 treatments replicated twice. The investigation indicated that the Humnabad Local was the most promising genotype in terms of yield and economics. It has recorded highest yield per plant (560.20g), yield per plot (8.08kg) and fresh rhizome yield per hectare (21.55 ton) which was on par with IISR-Mahima. Genotype Humnabad Local also recorded maximum dry recovery (27.35%) which was on par with IISR- Mahima (25.10%), Rio-de-Janeiro (24.80%) and Karkala Local (24.03%). Highest cost-benefit ratio was recorded in genotype Humnabad Local (Rs.4.918) and the least cost-benefit ratio was recorded in genotype Jorhat-1 (Rs.2.407). Higher cost-benefit ratio is attributed to the increase in fresh rhizome yield of the genotype.

Keywords: ginger, evaluation, yield, cost-benefit ratio.

Introduction
The rhizome of ginger (Zingiber officinale Rosc.) is one of the most widely used spice of the family Zingiberaceae. India is the largest ginger producing country in the world and is cultivated in most of the Indian states. In India, it is grown in an area of 1.65 lakh hectares with an annual production of 1.81 lakh MT with productivity of 6.57 MT per hectare [1]. Many varieties of ginger are available in India which are region specific, varying in plant habit, yield and quality parameters. The performance of ginger grown in Soppinabetta ecosystem of Utara Kannada district of Karnataka has shown an immense potential for its commercial cultivation in large area. However, the information on varieties suitable to this region is scanty and no systematic efforts were made to evaluate the improved ginger cultivars for their suitability to this region and economics of cultivation. Hence, the present investigation was under taken to identify a suitable variety or varieties with better benefit cost ratio for Utara Kannada and surrounding regions of costal and south India for commercial cultivation at college of Horticulture Sirsi, Uttara Kannada district of Karnataka.

Material and methods
The field experiment was carried out at the farm field of College of Horticulture, Sirsi, Karnataka during 2014-2015. The College of Horticulture, Sirsi is located at 14.26° North latitude and 74.5° East longitudes at an altitude of 619 meters above mean sea level. It receives an annual average rainfall of 2353 mm. The mean maximum temperature is 35.10° C (May) and mean minimum temperature is 15.50° C (January) and the relative humidity ranges from 64 to 93.80 per cent. The experiment conducted in a red sandy loam soil with moderate fertility level having pH5.67. The trials were laid out in randomized block design (RBD) with two replications using sixteen genotypes of ginger namely IISR-Mahima, IISR-Varada, IISR-Rajatha, Suravi, Suprabha, Himagiri, Rio-de-Janeiro, Suruchi, Himachal, Karkal Local, Humnabad Local, Jorhat-1, Jorhat-2, Bidar-1, Bidar-2 and Shikaripura Local were selected for the study. Raised bed of 3 m length and 1m width and 15 cm height was prepared. The ginger rhizomes were planted with a spacing of 30 cm × 20 cm. The land was applied with FYM (farm yard manure) at 25 tonnes per hectare, vermicom post at 2 tonnes per hectare and

~ 91 ~
recommended dose of P and K (50:50 kg P and K/ha) at the
time of land preparation. Recommended N (100 kg/ha) was
applied in split doses, 50 percent of the N was applied one
month after the planting and remaining 50 percent of the N
was applied one month after the first application. Cultivation
practices were followed as per recommended package of
practices [2]. The crop was harvested when leaves started
withering by digging out the rhizomes after drying up of
leaves which indicated complete maturity. Harvested
rhizomes were cleaned to remove adhering soil and sticking
roots. Five randomly chosen plants in each replication of each
entry were labeled and used for recording the observations
viz., fresh yield per plant (g), fresh rhizome yield per plot
(kg), fresh rhizome yield per hectare (t), dry ginger recovery
(%) and dry ginger yield per hectare (t). The dry ginger
recovery was measured by soaking known quantity of fresh
rhizomes in water for 6 hours and adhering scales were
removed, and the rhizomes were dried until constant weight
was obtained and expressed in percentage by using the
following formula.

\[
\text{Percentage of dry ginger recovery} = \left( \frac{\text{Weight of dried ginger}}{\text{Weight of fresh ginger}} \right) \times 100
\]

The harvest index was calculated on dry weight basis by
dividing weight of rhizome per clump with total weight of
biomass produced per clump, as for the formula given by
Donald (1962) [3] and expressed in percentage.

\[
\text{HI(%) = } \left( \frac{\text{Economic yield (g/plant)}}{\text{Biological yield (g/plant)}} \right) \times 100
\]

Duration from the date of planting to the date when more than
sixty percent of the clumps in a treatment showed withering
and drying of foliage was accounted to days taken for
maturity and expressed in days. Based on number of days
taken for maturity, crop duration was classified as short
duration varieties (100–120 days), medium duration
(120–140 days) and long duration (160 days plus).
The data collected were subjected to statistical analysis. For
determination of standard error of mean (S.Em±) and critical
difference (C.D) between the treatment means at 5% level of
significance, the statistical table formulated by Panse and
Sukhatme [4] was referred.

Economics of cultivation is calculated by calculating total
cost of cultivation, total income and net income. Total cost of
cultivation was calculated for cost of fertilizers, manures,
plant protection chemicals, labour, land rental value and
wages for all the cultural practices pertained during the
experimental year and expressed (Rs/ha). Total income
(Rs/ha) was computed by multiplying total fresh weight of
rhizome per hectare and average price prevailed in the market.
Net income is worked out by subtracting total cost of
cultivation from total income. Finally Benefit to Cost ratio
was worked out to know the feasibility of economics of
cultivation. It was computed by dividing the gross income
from the total cost of cultivation i.e.

\[
\text{Benefit Cost ratio} = \frac{\text{Gross income}}{\text{Total cost of cultivation}}
\]

Results and Discussion

The data on yield attributes are presented in table 1. There
was a significant difference among the genotypes for all the
yield attributes. The genotype Humnabad Local recorded the
highest yield per plant (360.20g) which was on par with Cv.
IISR- Mahima (325.40 g) and the lowest yield per plant was
recorded in the genotype Jorhat-1 (180.50g). Per plant
rhizome yield varied from 152 g per plant to 201.00 g per plant
among ten ginger cultivars grown under West Bengal
condition was also reported [5]. The fresh rhizome yield per
plot differed significantly among the genotypes. The genotype
Humnabad Local recorded the highest yield (8.08 kg) which
was on par with Cv. IISR- Mahima (7.14 kg) and Bidar-1
(7.10 kg) whereas, lowest yield was in the genotype Jorhat-1
(3.96 kg). The genotype Humnabad Local recorded the
highest yield per hectare (21.55 ton), which was on par with
IISR- Mahima (19.45 ton) and the lowest yield per hectare
was recorded in the genotype Jorhat-1 (10.55ton). Variation
in yield among different cultivators under different growing
condition also reported by Chongtham et al. (2013) [5] under
Southern West Bengal condition. Where, cultivar Goruba
than recorded highest rhizome yield per hectare (18.27 ton)
followed by Sambuk local (14.74 ton). Curing is an important
post-harvest operation in dry ginger preparation, which
involves treating rhizomes in limewater and drying to get
finished product. The ultimate cured yield depends on the
maturity of the crop and fiber content. Significant variation in
curing percentage was observed among the varieties under
present study. The genotype Humnabad Local recorded the
maximum dry recovery (27.35%) and dry rhizome yield (5.89
t/ha) which was on par with the genotype IISR- Mahima
(25.10%) and (4.78/ha) and the lowest was recorded in the
genotype Jorhat-1 (17.17%) and (1.81t/ha). Such variation in
curing percentage from 26.90% (Suprabha) to 33.48%
(Sambuk local) also reported in ginger under Southern West
Bengal condition [5]. The genotype Humnabad Local recorded
the higher harvest index (0.56) which was at par with IISR-
Mahima (0.54), Karkala Local (0.54), Shikaripura Local
(0.54), Suprabha (0.53), Suravi (0.53) and IISR- Rajatha
(0.52) and least was recorded in the genotype Jorhat-1 (0.46). The
performance of genotypes revealed the inherent capacity of
the genotypes evaluated in similar conditions. In the present
investigation, crop duration varied significantly among
different genotypes (198 to 240 days) from planting to upo
harvest. The variation is attributed due to differential maturity
and growth habit of the genotypes. The genotype Karkala
Local recorded higher crop duration (240 days), Humnabad
Local (233 days), Himagiri (230 days) Rio-de-Janiero (230
days), Bidar-1 (230 days) and Bidar-2 (230 days) were on par
with each other taking more number of days to mature, while
genotype IISR- Rajatha (198 days), IISR- Varada and IISR-
Mahima (200 days), genotype Jorhat-1 (215 days), and
Himachal (218 days) took less number of days to harvest.
The duration of the total growing season has an
enormous influence on the seasonal crop water need. Based
on the maturity the genotypes IISR-Rajatha, IISR-Mahima,
IISR-Varada, Jorhat-1 and Jorhat-2, are found to be of short
duration type (196-215 days), while genotypes, viz.,
Humnabad Local, Shikaripura Local, Himagiri, Suravi, Bidar-
2, Karkala Local were found to be medium duration types
(225-240 days). Such variation in crop duration was also
recorded and confined by Hrideek et al. (2006) [6] at higher
elevation of Western Ghats and [7] under Muzzaffarpur
condition in turmeric. The higher fresh rhizome yield in the
genotypes Humnabad Local is attributed to the growth parameters like plant height,
number of leaves per plant and number of tillers per plant and the
study indicated that the local genotype also have the
potential to perform better by following standard package of
practices.
Benefit Cost ratio is an important and ultimate parameter which decides the optimum level of input to be used in production of any crop. In the present study, the cost benefit ratio for different genotypes was worked out and represented in Table 2. Maximum cost-benefit ratio was obtained in genotype Humnabad Local (Rs. 4.918), followed by the genotype IISR- Mahima (Rs.4.438). The least cost-benefit ratio was recorded in genotype Jorhat-1 (Rs. 2.407) higher cost-benefit ratio is attributed to the increase in fresh rhizome yield of the genotype. These results are in agreement with findings of [8], [9] and [10] in Turmeric.

Table 1: Yield attributes and crop duration in different ginger genotypes under Soppinabetta ecosystem

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Genotypes</th>
<th>Fresh rhizome yield (g/plant)</th>
<th>Fresh rhizome yield (kg/plot)</th>
<th>Fresh rhizome yield (t/ha)</th>
<th>Dry rhizome yield (t/ha)</th>
<th>Recovery (%)</th>
<th>Harvest index</th>
<th>Number of days to harvest</th>
<th>Crop duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Suprabha</td>
<td>222.60</td>
<td>6.82</td>
<td>18.18</td>
<td>3.80</td>
<td>20.88</td>
<td>0.53</td>
<td>225.00</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>IISR-Mahima</td>
<td>325.40</td>
<td>7.14</td>
<td>19.45</td>
<td>4.78</td>
<td>25.10</td>
<td>0.54</td>
<td>200.00</td>
<td>Short</td>
</tr>
<tr>
<td>3</td>
<td>Karkala Local</td>
<td>309.00</td>
<td>4.58</td>
<td>12.20</td>
<td>2.93</td>
<td>24.03</td>
<td>0.54</td>
<td>240.00</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>Humnabad Local</td>
<td>360.20</td>
<td>8.08</td>
<td>21.55</td>
<td>5.89</td>
<td>27.35</td>
<td>0.56</td>
<td>233.00</td>
<td>Medium</td>
</tr>
<tr>
<td>5</td>
<td>Himagiri</td>
<td>208.50</td>
<td>4.34</td>
<td>11.58</td>
<td>2.36</td>
<td>20.40</td>
<td>0.48</td>
<td>230.00</td>
<td>Medium</td>
</tr>
<tr>
<td>6</td>
<td>IISR-Varada</td>
<td>259.10</td>
<td>6.90</td>
<td>18.40</td>
<td>4.06</td>
<td>22.09</td>
<td>0.43</td>
<td>200.00</td>
<td>Short</td>
</tr>
<tr>
<td>7</td>
<td>Suravi</td>
<td>298.20</td>
<td>6.50</td>
<td>17.33</td>
<td>3.90</td>
<td>22.51</td>
<td>0.53</td>
<td>228.00</td>
<td>Medium</td>
</tr>
<tr>
<td>8</td>
<td>Shikaripura Local</td>
<td>309.00</td>
<td>6.90</td>
<td>18.40</td>
<td>4.16</td>
<td>22.59</td>
<td>0.54</td>
<td>228.00</td>
<td>Medium</td>
</tr>
<tr>
<td>9</td>
<td>Suruchi</td>
<td>309.00</td>
<td>7.00</td>
<td>18.67</td>
<td>3.57</td>
<td>19.15</td>
<td>0.45</td>
<td>222.00</td>
<td>Medium</td>
</tr>
<tr>
<td>10</td>
<td>Jorhat-1</td>
<td>180.50</td>
<td>3.96</td>
<td>10.55</td>
<td>1.81</td>
<td>17.17</td>
<td>0.44</td>
<td>215.00</td>
<td>Short</td>
</tr>
<tr>
<td>11</td>
<td>Himachal</td>
<td>244.95</td>
<td>6.95</td>
<td>18.53</td>
<td>3.95</td>
<td>21.32</td>
<td>0.48</td>
<td>218.00</td>
<td>Short</td>
</tr>
<tr>
<td>12</td>
<td>Rio-de-Janeiro</td>
<td>199.70</td>
<td>7.01</td>
<td>18.70</td>
<td>4.64</td>
<td>24.80</td>
<td>0.50</td>
<td>230.00</td>
<td>Medium</td>
</tr>
<tr>
<td>13</td>
<td>IISR-Rajatha</td>
<td>251.85</td>
<td>6.97</td>
<td>18.58</td>
<td>3.73</td>
<td>20.07</td>
<td>0.52</td>
<td>198.00</td>
<td>Short</td>
</tr>
<tr>
<td>14</td>
<td>Bidar-1</td>
<td>290.70</td>
<td>7.10</td>
<td>18.94</td>
<td>3.51</td>
<td>18.54</td>
<td>0.49</td>
<td>230.00</td>
<td>Medium</td>
</tr>
<tr>
<td>15</td>
<td>Jorhat-2</td>
<td>268.70</td>
<td>6.78</td>
<td>18.09</td>
<td>3.70</td>
<td>20.46</td>
<td>0.46</td>
<td>215.00</td>
<td>Short</td>
</tr>
<tr>
<td>16</td>
<td>Bidar-2</td>
<td>317.50</td>
<td>7.00</td>
<td>18.69</td>
<td>3.80</td>
<td>20.35</td>
<td>0.50</td>
<td>230.00</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Table 2: Economics for different ginger genotypes grown under Soppinabetta ecosystem (for one hectare area)

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Genotypes</th>
<th>Cost of cultivation (₹/ha)</th>
<th>Yield (ton ha$^{-1}$)</th>
<th>Gross return (₹ ha$^{-1}$)</th>
<th>Net return (₹ ha$^{-1}$)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>B</td>
<td>C=A x market price</td>
<td>D = C - A</td>
<td>E = C/A</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Suprabha</td>
<td>241020.45</td>
<td>18.18</td>
<td>9999900.00</td>
<td>758879.55</td>
<td>4.149</td>
</tr>
<tr>
<td>2</td>
<td>IISR-Mahima</td>
<td>241020.45</td>
<td>19.45</td>
<td>1069750.00</td>
<td>828729.55</td>
<td>4.438</td>
</tr>
<tr>
<td>3</td>
<td>Karkala local</td>
<td>241020.45</td>
<td>12.20</td>
<td>671000.00</td>
<td>429979.55</td>
<td>2.784</td>
</tr>
<tr>
<td>4</td>
<td>Humnabad local</td>
<td>241020.45</td>
<td>21.55</td>
<td>1185250.00</td>
<td>944229.55</td>
<td>4.918</td>
</tr>
<tr>
<td>5</td>
<td>Himagiri</td>
<td>241020.45</td>
<td>11.58</td>
<td>636900.00</td>
<td>395879.55</td>
<td>2.643</td>
</tr>
<tr>
<td>6</td>
<td>IISR-Varada</td>
<td>241020.45</td>
<td>18.40</td>
<td>1012000.00</td>
<td>770979.55</td>
<td>4.199</td>
</tr>
<tr>
<td>7</td>
<td>Suravi</td>
<td>241020.45</td>
<td>17.33</td>
<td>953150.00</td>
<td>712129.55</td>
<td>3.955</td>
</tr>
<tr>
<td>8</td>
<td>Shikaripura local</td>
<td>241020.45</td>
<td>18.40</td>
<td>1012000.00</td>
<td>770979.55</td>
<td>4.199</td>
</tr>
<tr>
<td>9</td>
<td>Suruchi</td>
<td>241020.45</td>
<td>18.67</td>
<td>1026850.00</td>
<td>785829.55</td>
<td>3.456</td>
</tr>
<tr>
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<td>Jorhat-1</td>
<td>241020.45</td>
<td>10.55</td>
<td>580250.00</td>
<td>339229.55</td>
<td>2.407</td>
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<tr>
<td>11</td>
<td>Himachal</td>
<td>241020.45</td>
<td>18.53</td>
<td>1019150.00</td>
<td>778129.55</td>
<td>4.228</td>
</tr>
<tr>
<td>12</td>
<td>Rio-de-Janeiro</td>
<td>241020.45</td>
<td>18.70</td>
<td>1028500.00</td>
<td>787479.55</td>
<td>4.267</td>
</tr>
<tr>
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<td>IISR-Rajatha</td>
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<td>18.58</td>
<td>1021900.00</td>
<td>780879.55</td>
<td>4.240</td>
</tr>
<tr>
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<td>Bidar-1</td>
<td>241020.45</td>
<td>18.94</td>
<td>1041700.00</td>
<td>800679.55</td>
<td>3.432</td>
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<td>15</td>
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<td>241020.45</td>
<td>18.09</td>
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<td>753929.55</td>
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<td>Bidar-2</td>
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<td>18.69</td>
<td>1027950.00</td>
<td>786929.55</td>
<td>4.265</td>
</tr>
</tbody>
</table>

Market price of fresh ginger as on April 2015, ₹ 55 per kg of fresh rhizome.

Conclusion
Among the different genotypes evaluated, the genotype Humnabad Local yielded highest yield per plant, per plot and yield per hectare and also the genotype Humnabad Local exhibited better benefit cost ratio as compared to all other genotypes. Hence, it can be recommended for commercial cultivation in Uttara Kannada area of Karnataka and adjoining states of southern India.

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