Growth and Harvestable Maturity of Red Amaranth at Different Sowing Dates

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Abstract: A study was conducted to optimize the time of sowing and stage of harvest of red amaranth during winter season to obtain higher yield without loss of palatability. It was observed that in November sowing, highest palatability (1.59) was achieved when harvested at 15 DAS. Harvesting at 20 days after sowing (DAS) was found to be suitable for November sowing considering economic yield as well as palatability. In December sowing had moderate palatability with leaf-stem ratio 1.38. On the other hand, in January sowing when harvested at 30 DAS expressed acceptable leaf-stem ratio (1.71). Therefore, considering yield and optimum palatability, harvesting of the crop should be done at 25 DAS in December sowing and 30 DAS in January sowing.

Key words: Red amaranth, growth, harvestable maturity, palatability

Introduction
Amaranthus (Amaranthus tricolor) plays an important role in nutrition among the leafy vegetables grown in Bangladesh. The leafy amaranth is said to be the native of India (Shanmugavelu, 1989 and Nath, 1976). Among the leafy types, Amaranthus tricolor L. is the most commonly cultivated species in Bangladesh. However, during winter, its growth and development is slow than summer and rainy season (Bose et al., 1993). Normally plants are harvested at 20 to 30 days after sowing to consume as tender greens. Yawalkar (1985) reported that good green tender leaves without spines, stem green, medium thick and tender, petioles green, inflorescence terminal and medium sized, ready for first cutting after 30 days of sowing. Consumption of plants within 15 to 20 days as well as at the mature stages of 35 to 40 days after sowing is also not uncommon. Kader (1978) reported that the optimum stage of harvest in amaranth could be fixed at the 25th days after sowing, as this stage the performance of the types was found to be superior with increase in leaf weight, stem weight, leaf length, leaf breadth, stem diameter and plant height. According to Vijayarukumar (1980), the optimum stage of harvest in most of the types of amaranth could be fixed between 25-30 days after sowing to get the highest yield as well as nutritious and palatable greens. The optimum harvestable maturity stage of red amaranth when grown during winter season of Bangladesh is not available. Therefore, the present experiment was undertaken to find out the optimum harvestable stage to get maximum yield without being sacrificing the palatability.

Materials and Methods
An experiment was conducted at the Central Research Station of HRC, BARI, Joydebpur from November 1995 to February 1996. The experiment was laid out in a RCB (Factorial) design with three replications. The red amaranth variety BARI Lal sak-1 was included in this study. Unit plot size was 3.25 x 2.00 m². Seeds were sown on the every month starting from November 1995 to January 1996. The different sowing dates were considered as three levels of one factor and five different stages of harvest at each sowing were considered as five levels of the other factor. Seeds were sown in plots maintaining 20 x 5 cm² spacing. Initially, continuous broadcasting of seeds was done in lines. Subsequently plants were thinned maintaining 5 cm plant to plant spacing. The crop was fertilized cowdung, TSP, Urea and MP were applied as basal doses during final land preparation. Irrigation and other cultural operations were done as and when needed. Twenty plants were selected from each plot for recording data omitting border effects and following the destructive sampling rule of physiological study. The different parameters were plant height, total plant weight, length and breadth of the largest leaf and partitioning of the plant into its components like leaf, stem and root. Leaf-stem ratio was also calculated to get optimum palatability stage. Incidentally November sowing had only four harvests up to flower initiation. Therefore, considering four stages of harvest in November sowing as four treatments, the analysis was accomplished in a RCB design. While the other two sowings viz. December and January with five harvests level each were analyzed.
statistically in a factorial RCB design. While the other two sowing viz. December and January with five harvest levels were analyzed statistically in a factorial RCB design. Mean separation was done following Duncan’s multiple range test (DMRT).

Result and Discussion

The yield and yield contributing characters revealed that there had a significant difference among different parameters due to different harvesting dates in November, December and also January sowings. Plant height ranged from 6.95 to 39.13 cm in November sowing when harvested at 15 and 30 days respectively. Similar increasing trend of plant height was observed in December and January sowings and it varied from 5.33 cm (15 DAS) to 29.02 cm (35 DAS). Stem length after 15 days, of sowing was found 3.76 cm while it was 28.02 cm at 30 DAS in November sowing but the stem length differed from 2.23 cm to 19.60 cm in December and January sowings at 15 DAS and 35 DAS, respectively. It had been observed an increasing trend of each of the parameters as the harvesting was delayed. This was found to be equally effective when total weight of twenty plants were considered. It varied from 6.37 g to 123.40 g being the highest at 30 DAS and the lowest at 15 DAS in November sowing whereas, during December and January sowings, it ranged from 2.37 g (15 DAS) to 287.60 g (35 DAS). The length and breadth of the widest leaf was observed to increase when harvesting was delayed in all the sowings (Table 1). Percent dry matter of stem ranged from as low as 5.33 at 25 DAS to as high as 11.51 at 30 DAS. However, it was statistically similar among the percent dry matter of 15, 20 and 25 DAS in November sowing. Mean while, dry matter percent of stem was observed to vary from 4.92 at 35 DAS to 11.30 at 15 DAS in December and January sowings. Regarding dry matter percent of leaf, it was found to differ from 10.89 (25 DAS) to 13.96 (15 DAS) in November sowing. Statistically significant variation was also observed in percent dry matter of leaf in December and January sowings also.

Table 1: Yield and yield contributing characters of red amaranth as influenced by four stages of harvest in November sowing and five harvesting stages of December and January

<table>
<thead>
<tr>
<th>Treatments (DAS)</th>
<th>Plant height (cm)</th>
<th>Stem length (cm)</th>
<th>Total wt. of 20 plants (g)</th>
<th>Length of widest leaves (cm)</th>
<th>Breadth of widest leaves (cm)</th>
<th>Percent day matter (%)</th>
<th>Leaf stem ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 DAS</td>
<td>6.95c</td>
<td>3.76c</td>
<td>6.370c</td>
<td>2.04c</td>
<td>1.75g</td>
<td>6.91b</td>
<td>13.90b</td>
</tr>
<tr>
<td>20 DAS</td>
<td>19.33c</td>
<td>7.45c</td>
<td>41.37c</td>
<td>4.32b</td>
<td>3.56c</td>
<td>6.47b</td>
<td>11.98b</td>
</tr>
<tr>
<td>25 DAS</td>
<td>31.25b</td>
<td>19.69b</td>
<td>89.09b</td>
<td>8.16a</td>
<td>5.82b</td>
<td>5.33b</td>
<td>10.80b</td>
</tr>
<tr>
<td>30 DAS</td>
<td>39.13a</td>
<td>28.02a</td>
<td>123.40a</td>
<td>9.21a</td>
<td>7.16a</td>
<td>11.51a</td>
<td>12.13b</td>
</tr>
<tr>
<td>CV%</td>
<td>12.64</td>
<td>15.84</td>
<td>11.72</td>
<td>13.35</td>
<td>10.20</td>
<td>11.23</td>
<td>5.67</td>
</tr>
<tr>
<td>15 DAS</td>
<td>5.33e</td>
<td>2.23e</td>
<td>9.53e</td>
<td>1.14e</td>
<td>0.86e</td>
<td>11.30a</td>
<td>11.60b</td>
</tr>
<tr>
<td>20 DAS</td>
<td>9.38d</td>
<td>4.14d</td>
<td>9.53d</td>
<td>2.15d</td>
<td>1.49d</td>
<td>7.31c</td>
<td>12.40b</td>
</tr>
<tr>
<td>25 DAS</td>
<td>15.12c</td>
<td>6.74c</td>
<td>45.66c</td>
<td>3.97c</td>
<td>2.90c</td>
<td>6.59c</td>
<td>12.47b</td>
</tr>
<tr>
<td>30 DAS</td>
<td>19.02b</td>
<td>12.82b</td>
<td>173.6b</td>
<td>5.61b</td>
<td>4.25b</td>
<td>6.59c</td>
<td>8.48b</td>
</tr>
<tr>
<td>35 DAS</td>
<td>29.02a</td>
<td>19.60a</td>
<td>287.60a</td>
<td>6.82a</td>
<td>5.05a</td>
<td>9.42d</td>
<td>12.65b</td>
</tr>
</tbody>
</table>

Means followed by common letters differ significantly at P < 0.01

Table 2: Main effect of date of sowing on the yield and yield attributes of red amaranth

<table>
<thead>
<tr>
<th>Treatments (DAS)</th>
<th>Plant height (cm)</th>
<th>Stem length (cm)</th>
<th>Total wt. of 20 plants (g)</th>
<th>Length of widest leaves (cm)</th>
<th>Breadth of widest leaves (cm)</th>
<th>Percent day matter (%)</th>
<th>Leaf stem ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>December</td>
<td>21.66</td>
<td>12.69</td>
<td>152.53</td>
<td>5.16</td>
<td>3.77</td>
<td>7.12</td>
<td>11.85</td>
</tr>
<tr>
<td>January</td>
<td>9.89</td>
<td>6.15</td>
<td>54.96</td>
<td>2.86</td>
<td>2.05</td>
<td>8.55</td>
<td>13.75</td>
</tr>
</tbody>
</table>

Table 3: Interaction effect of date of sowing and harvesting stages

<table>
<thead>
<tr>
<th>Treatments (DAS)</th>
<th>Plant height (cm)</th>
<th>Stem length (cm)</th>
<th>Total wt. of 20 plants (g)</th>
<th>Length of widest leaves (cm)</th>
<th>Breadth of widest leaves (cm)</th>
<th>Percent day matter (%)</th>
<th>Leaf stem ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Dec</td>
<td>8.10c</td>
<td>2.97g</td>
<td>4.13g</td>
<td>1.60d</td>
<td>1.37e</td>
<td>11.2a</td>
<td>9.40c</td>
</tr>
<tr>
<td>20 Dec</td>
<td>13.69d</td>
<td>5.40f</td>
<td>15.25c</td>
<td>2.61c</td>
<td>1.88d</td>
<td>8.12c</td>
<td>14.59a</td>
</tr>
<tr>
<td>25 Dec</td>
<td>22.0e</td>
<td>9.14d</td>
<td>78.55d</td>
<td>3.46d</td>
<td>3.94b</td>
<td>6.66c</td>
<td>11.31d</td>
</tr>
<tr>
<td>30 Dec</td>
<td>30.32b</td>
<td>19.46b</td>
<td>292.6b</td>
<td>7.21a</td>
<td>5.98a</td>
<td>4.49d</td>
<td>11.12d</td>
</tr>
<tr>
<td>35 Dec</td>
<td>34.11a</td>
<td>23.34a</td>
<td>372.2a</td>
<td>8.10a</td>
<td>6.67a</td>
<td>5.14c</td>
<td>12.82c</td>
</tr>
<tr>
<td>15 Jan</td>
<td>2.48f</td>
<td>1.48g</td>
<td>0.60e</td>
<td>10.08a</td>
<td>0.32f</td>
<td>11.40c</td>
<td>13.84abc</td>
</tr>
<tr>
<td>20 Jan</td>
<td>5.07f</td>
<td>2.88g</td>
<td>3.81e</td>
<td>1.58e</td>
<td>1.10e</td>
<td>9.98b</td>
<td>15.13a</td>
</tr>
<tr>
<td>25 Jan</td>
<td>8.23f</td>
<td>4.34f</td>
<td>12.80f</td>
<td>2.59d</td>
<td>1.87d</td>
<td>7.95c</td>
<td>13.48abc</td>
</tr>
<tr>
<td>30 Jan</td>
<td>9.27c</td>
<td>6.14e</td>
<td>54.57d</td>
<td>3.56c</td>
<td>2.52c</td>
<td>8.68f</td>
<td>13.83abc</td>
</tr>
<tr>
<td>35 Jan</td>
<td>23.93c</td>
<td>15.87c</td>
<td>203.0c</td>
<td>5.44b</td>
<td>4.45b</td>
<td>4.71d</td>
<td>12.46c</td>
</tr>
<tr>
<td>CV%</td>
<td>9.90</td>
<td>15.61</td>
<td>17.51</td>
<td>14.41</td>
<td>12.24</td>
<td>15.78</td>
<td>8.52</td>
</tr>
</tbody>
</table>

Means followed by different letters differ significantly at P < 0.01 by DMYR test

DAS = Days after sowing.
ranged from 11.60 (15 DAS) to 14.86 (20 DAS). But the other harvesting stages were found in significant
pertaining to dry matter percent of leaf in December and
January sowings. There had not have any statistical
variation regarding dry matter percent of leaf in November
sowing due to different harvesting dates (Table 1). But
much variation was observed in December and January
sowings. It varied from 8.48% in 30 DAS to 12.40% in 20
DAS. Leaf-stem ratio ranged from 0.59 (30 DAS) to 1.59
(15 DAS). Considering the palatability stage through leaf-
stem ratio, harvesting at 15 DAS in November sowing
should be considered best but it was not economical in
terms of yield. Thus, harvesting at 20 DAS was
considered to be suitable for November sowing
considering yield as well as palatability. Further, during
December and January sowings harvesting could be done
up to 30 DAS having good palatability (Table 1).
Main effect of dates of sowing (Table 2) indicated that
December sowing superseded the January sowing in most
of the parameters except dry matter percent and leaf-stem
ratio. Plants of December sowing attained the maximum
height (21.66 cm) compared to January sowing (9.80 cm).
This trend was also maintained in case of the length and
breadth of the widest leaf. But it was noted that the
percent dry matter of leaf, stem and root as well as leaf-
stem ratio was superior in January.
Delayed harvesting of red amaranth exhibited superior
performance in plant height, stem length, total weight of
twenty plants and size of the biggest leaf. But this trend
was not noticed in case of percent dry matter of stem, leaf
and root. On the contrary, the reverse trend was observed
as to the parameter leaf-stem ratio. Considering
palatability, yield of greens and dry matter content of stem
and leaf, harvesting of the crop at 30 DAS is found to be
superior over the other stages of harvest. Yawalkar (1985)
reported that good green tender leaves without spines,
thick and soft stem with fibreless petioles of red amaranth
becomes ready for first cutting after 30 days of sowing.
The interaction effect of two dates of sowing and five
stages of harvest exhibited significant variation in all the
parameters studied (Table 3). It is noted that in both
December and January sowings plant height, stem length,
total weight of twenty plants and size of the widest leaf
increased as the harvesting dates were delayed. But the
parameter, per cent dry matter of stem and leaf decreased
gradually as the harvesting dates were delayed in
December and January sowing except the harvesting at 30
DAS in later sowing. Pertaining to leaf-stem ratio, gradual
decline was observed in both the sowings as the
harvesting were delayed. It was also noted that plants
sown in December and harvested at 25 DAS showed
moderate palatability with leaf-stem ratio 1.33. Enyi (1965)
suggested transplanting of plants within 27 days of
sowing to ensure good yield. Besides, when plants were
raised in January and harvested at 30 DAS showed
acceptable leaf-stem ratio (1.71) among the other dates of
harvest. Therefore, it could be concluded that red
amaranth should be harvested 25 and 30 DAS in
December and January sowing respectively.

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