A short duration high yielding culture - Barnyard millet ACM 10145


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ABSTRACT
A short duration high yielding barnyard millet culture ACM 10145 was developed at the Department of Plant Breeding and Genetics, Agricultural College and Research Institute, TNAU, Madurai. The culture inflorescence is pyramidal shape, incurred compact raceme and yield on an average 1700 kg/ha and 2500 kg/ha grain under rain-fed and irrigated condition which was 22 % and 17.6 % improved yield over VL 172 and CO (Kv) 2 respectively. The grains are yellowish grey, oval and bold in size (1.09 mm) with high iron content (16 mg/100g). The white rice recovery of the milled rice and good taste that well suits the consumer’s preferences and acceptance. The culture recorded the quality and average yield of fodder is also better than local check CO (Kv) 2.

Key words: ACM 10145, Barnyard millet, Nutrition, Qualitative traits, Short duration.

INTRODUCTION
Barnyard millet (Echinochloa frumentacea (Roxb.) Link) is the fastest growing crop among all millets. Barnyard millet species are known for their fast maturity, high storability, and the ability to grow on poor soils (Yabuno, 1987). In India, this millet is either harvested as a weed along with a main crop or is grown in a mixture with finger millet and foxtail millet (Gupta et al., 2009). It is generally cultivated on hilly slopes in tribal areas where few other agricultural options exist and is indispensable in the northwest Himalayan region (Gupta et al., 2009). In India, it is cultivated in tribal belts of Orissa, Maharashtra, Gujrat, Madhya Pradesh, Tamil Nadu, Bihar and hills of Uttar Pradesh. In Tamil Nadu, it is locally known as kudiraivali and is cultivated in dryland and hill areas of Ramnad, Madurai, Virudhunagar, Theni, Salem, Namakkal, Viluppuram, Dindigul, Coimbatore and Erode districts. Nutritionally grains are rich in fibre content, phosphorus, calcium, magnesium, iron and zinc content. Due to low glycemic index and high dietary fibre, it helps in preventing diabetes and cardio vascular disease with regular intake. It is reportedly known for its high degree of tolerance against drought, salinity and water logging conditions. The straw has a good fodder value. The fodder also contain good amount of protein and digestible fibre. The area under barnyard millet is about 1.95 lakh hectares and production of 1.67 million tonnes with the productivity of 857 kg/ha. As there is a huge demand for the produce, barnyard millet is being grown in kharif, rabi and summer under irrigated and rainfed condition. The latest released variety in barnyard millet was CO (Kv) 2, which was supposed to be a high yielding line released during the year 2009, with the objective of higher yield. Nevertheless, it performance in drought prone regions in the southern districts of Tamil Nadu was mere satisfactory due to their photosensitivity and longer duration. Hence the objectives of genetic improvement were to produce an early maturing, high yielding line which suits all seasons in southern districts of Tamil Nadu. In order to fulfill the above objectives, the culture, ACM 10145 an high yielding, early maturing, high milling percent culture with desirable cooking quality traits was developed at Department of Plant Breeding and Genetics, Agricultural College & Research Institute, Madurai.

MATERIALS AND METHODS

The culture, ACM 10 145 is a pureline selection from Aruppukottai local, a village which is about 70 km away from Madurai, Tamil Nadu. Single plant with desirable attributes for yield (early maturity, increased raceme numbers, high fodder and grain yield) and micronutrient content was selected from the local collection where high percent of variability observed for morphological as well as nutritional traits. The selected lines were advanced as single plant to progeny rows. The progenies were assessed for their performance in comparison with the check CO (Kv)2 under station trials at AC & RI, Madurai, from summer 2009 to rabi 2012, Multi Location Trials during 2012-13, All India Coordinated Small Millets Improvement Project – Barnyard millet Advanced Varietal Trials, during 2013, Adaptive Research Trial during 2013-16 and under Large scale demonstration from 2014-2016. Simultaneously the culture was evaluated for its grain qualities and its end user acceptability.
RESULTS AND DISCUSSION

Morphological features of the culture: A wide variation was found in barnyard millet crop in Aruppukottai regions of Virudunagar district of Tamil Nadu for yield, inflorescence related traits and nutritional traits (data not shown). The culture ACM 10145 that excelled over the mean of evaluated local land races was further selected through pureline based breeding was found to be maturing in 95-100 days, high yielding, grows up to a height of 130-170 cm and produces on an average of 3-8 productive tillers. The plant of ACM 10145 culture was green, erect type, pyramidal shaped compact panicle, incurved racemes, white plumose stigma and closer flag leaf to lower raceme (Table 2). The grains of this line are yellowish grey colour and oval shape. The thousand grain weight measure between 3.4 - 3.8 g and individual grain thickness is 1.09 mm which were different

Table 1: Mean performance of ACM 10145 over check in various trials for grain yield.

<table>
<thead>
<tr>
<th>Trials</th>
<th>Grain (kg/ha) ACM 10145</th>
<th>Fodder (kg/ha)</th>
<th>Grain (kg/ha) CO (Kv)2</th>
<th>Fodder (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station trials</td>
<td>2284</td>
<td>3721</td>
<td>1748</td>
<td>2683</td>
</tr>
<tr>
<td>Multilocation trial (2012-13)</td>
<td>2677</td>
<td>2984</td>
<td>2312</td>
<td>2425</td>
</tr>
<tr>
<td>AICSMIP – BAVT (2013)</td>
<td>1722</td>
<td>6325</td>
<td>1769*1411**</td>
<td>4900</td>
</tr>
<tr>
<td>Large scale demonstration trial</td>
<td>1955</td>
<td>2788</td>
<td>1693</td>
<td>2413</td>
</tr>
<tr>
<td>Overall weighted mean yield in kg/ha</td>
<td>1722</td>
<td>3115</td>
<td>1463</td>
<td>2873</td>
</tr>
<tr>
<td>Percent increase over the check</td>
<td>17.6</td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Regional check - VL172, * Local check - CO (Kv)2

Table 2: Botanical and morpho-agronomic description.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Characteristics</th>
<th>ACM 10145</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Plant height</td>
<td>130-170 cm</td>
</tr>
<tr>
<td>2.</td>
<td>No. of Basal tillers</td>
<td>4-9</td>
</tr>
<tr>
<td>3.</td>
<td>No. of productive tillers</td>
<td>3-8</td>
</tr>
<tr>
<td>4.</td>
<td>Flag leaf length (cm)</td>
<td>24.2-30.8</td>
</tr>
<tr>
<td>5.</td>
<td>Flag leaf width (cm)</td>
<td>3.4-4.6</td>
</tr>
<tr>
<td>6.</td>
<td>Peduncle length (cm)</td>
<td>7.8-13.1</td>
</tr>
<tr>
<td>7.</td>
<td>Inflorescence length (cm)</td>
<td>21.6-27.5</td>
</tr>
<tr>
<td>8.</td>
<td>Length of lower raceme (cm)</td>
<td>3.5-4.9</td>
</tr>
<tr>
<td>9.</td>
<td>Days to 50 % flowering</td>
<td>56-58</td>
</tr>
<tr>
<td>10.</td>
<td>Days to maturity</td>
<td>95 – 100</td>
</tr>
<tr>
<td>11.</td>
<td>Grain yield per plant (g)</td>
<td>35-48</td>
</tr>
<tr>
<td>12.</td>
<td>Straw yield per plant (g)</td>
<td>52-70</td>
</tr>
<tr>
<td>13.</td>
<td>Thousand grain weight (g)</td>
<td>3.2 – 3.8</td>
</tr>
<tr>
<td>14.</td>
<td>Harvest index</td>
<td>0.40 – 0.47</td>
</tr>
<tr>
<td>15.</td>
<td>Growth habit</td>
<td>Erect</td>
</tr>
<tr>
<td>16.</td>
<td>Plant pigmentation at flowering</td>
<td>Green</td>
</tr>
<tr>
<td>17.</td>
<td>Culm branching</td>
<td>Present</td>
</tr>
<tr>
<td>18.</td>
<td>Degree of lodging at maturity</td>
<td>Low</td>
</tr>
<tr>
<td>19.</td>
<td>Inflorescence colour</td>
<td>Green</td>
</tr>
<tr>
<td>20.</td>
<td>Inflorescence shape</td>
<td>Pyramidal</td>
</tr>
<tr>
<td>21.</td>
<td>Inflorescence compactness</td>
<td>Compact</td>
</tr>
<tr>
<td>22.</td>
<td>Shattering of inflorescence</td>
<td>Absent</td>
</tr>
<tr>
<td>23.</td>
<td>Grain colour</td>
<td>Yellowish grey</td>
</tr>
<tr>
<td>24.</td>
<td>Grain shape</td>
<td>Oval</td>
</tr>
<tr>
<td>25.</td>
<td>Grain size</td>
<td>Bold</td>
</tr>
<tr>
<td>26.</td>
<td>Shape of lower raceme</td>
<td>Straight</td>
</tr>
<tr>
<td>27.</td>
<td>Lower raceme thickness</td>
<td>slender</td>
</tr>
<tr>
<td>28.</td>
<td>Length of lower raceme (cm)</td>
<td>Medium (3.5-4.2), present closer to flag leaf</td>
</tr>
<tr>
<td>29.</td>
<td>Spikelet arrangements</td>
<td>Arranged around rachis</td>
</tr>
<tr>
<td>30.</td>
<td>Senescence</td>
<td>Absent</td>
</tr>
<tr>
<td>31.</td>
<td>Branching of lower raceme</td>
<td>Absent</td>
</tr>
<tr>
<td>32.</td>
<td>Inflorescence exertion at maturity</td>
<td>Full exertion</td>
</tr>
<tr>
<td>33.</td>
<td>Stigma colour</td>
<td>White</td>
</tr>
<tr>
<td>34.</td>
<td>Shape of raceme</td>
<td>In-curved</td>
</tr>
</tbody>
</table>
Table 3: Comparison between barnyard millet ACM 10145 culture, CO (Kv)2 and VL 172.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>ACM 10145</th>
<th>CO (Kv)2</th>
<th>VL 172</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to maturity</td>
<td>95 – 100</td>
<td>100-105</td>
<td>93-95</td>
</tr>
<tr>
<td>Plant pigmentation at flowering</td>
<td>Green</td>
<td>Pink at basal stem</td>
<td>Green</td>
</tr>
<tr>
<td>Inflorescence shape</td>
<td>Pyramidal</td>
<td>Cylindrical</td>
<td>Pyramidal</td>
</tr>
<tr>
<td>Inflorescence compactness</td>
<td>Compact</td>
<td>Compact</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Grain colour</td>
<td>Yellowish grey</td>
<td>Grey</td>
<td>Grey + Straw white</td>
</tr>
<tr>
<td>Length of lower raceme (cm)</td>
<td>Medium (3.5-4.2), present closer to flag leaf</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Stigma colour</td>
<td>White</td>
<td>Purple</td>
<td>White</td>
</tr>
<tr>
<td>Shape of raceme</td>
<td>In-curved</td>
<td>Top-curved</td>
<td>Top-curved</td>
</tr>
<tr>
<td>Thousand grain weight (g)</td>
<td>3.80</td>
<td>3.40</td>
<td>3.00</td>
</tr>
<tr>
<td>Grain thickness (mm)</td>
<td>1.09</td>
<td>0.98</td>
<td>0.95</td>
</tr>
<tr>
<td>Sensory evaluation (hedonic rating)</td>
<td>Good taste and highly Preferred (appearance)</td>
<td>Dull appearance, less taste</td>
<td>Dull appearance</td>
</tr>
<tr>
<td>Milling percent</td>
<td>70</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>Whiteness percent</td>
<td>32.40</td>
<td>24.20</td>
<td>25.00</td>
</tr>
</tbody>
</table>

Table 4: Composition of nutrients

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Grain</th>
<th>Raw rice</th>
<th>Parboiled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACM 10145</td>
<td>CO(Kv) 2</td>
<td>ACM 10145</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>5.5</td>
<td>5.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Crude fibre(%)</td>
<td>10.1</td>
<td>9.8</td>
<td>6.8</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>11.8</td>
<td>11.6</td>
<td>9.5</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>4.4</td>
<td>4.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Iron (mg/100g)</td>
<td>17.5</td>
<td>16.6</td>
<td>11.5</td>
</tr>
<tr>
<td>Zinc (mg/100g)</td>
<td>5.9</td>
<td>6.3</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Table 5: Fodder quality.

<table>
<thead>
<tr>
<th>Nutrition (%)</th>
<th>ACM 10145</th>
<th>CO(Kv)2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>7.6</td>
<td>8.3</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>23.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Ash content</td>
<td>12.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Fat</td>
<td>2.0</td>
<td>1.6</td>
</tr>
</tbody>
</table>

and higher than that of local check (CO (Kv) 2) and national check (VL 172) (Table 3). The morphological differences between the culture and two checks namely CO (Kv) 2 and VL 172 were given in Table 3.

Enhancement of yield: The mean performance of the culture, ACM 10145 and the varieties, CO (Kv)2 and VL 172 for grain yield were consolidated in Table 1. The results of station trials proved that, the culture ACM 10145 showed superiority compared to CO (Kv) 2. It recorded an average grain yield of 2284 which is30 per cent increase over the check CO (Kv) 2. Henceforth it was further forwarded to Multi Location Trial in various locations of Tamil Nadu and identified that the culture recorded an average yield of 2984 kg/ha which was 23 per cent increase over check CO (Kv) 2 (2425 kg/ha). An average yield of 1722 kg/ha was recorded by ACM 10145 culture in AICSMIP –  BAVT trials conducted in six locations of India with national check VL 172 which was 22 per cent higher than that of national check (Annexure I). The culture was promoted to Adaptive Research Trials (ART) across various parts of Tamil Nadu from 2013-2016. The results of the ART trials estimated that the culture, ACM 10145 recorded increased grain yield of 17.6 per cent over check variety CO (Kv) 2. Under Large scale demonstration trials, the culture registered an average yield of 1955 kg/ha where the local check registered 1693kg/ha which is 15.5 per cent increase over check. From the overall trials conducted at various locations, the culture ACM 10145 registered 17.6 per cent increase yield over check variety CO (Kv) 2. Correspondingly it also registered 8 per cent higher fodder than the check CO (Kv)2 though some of locations showed that on par with CO (Kv) 2 (Table 1).

Grain quality and nutritional parameters: The ACM 10145 culture grains were analyzed for nutritional status in various forms were given in Table 4. The culture ACM 10145 showed good amount of fat 3.6-5.5 %, crude fibre 6.8 -10.1 %, protein 9.5 – 11.8 % and iron 11.5 -17.5 mg/100g compared to CO (Kv) 2. Milling percentage of ACM 10145, CO (Kv)2 and VL 172 were found to be 70, 64 and 64 percent respectively. Through sensory analysis (infra red) of milled rice, the recovery of whiteness was recorded 32.40 % by ACM 10145, whereas CO (Kv) 2 and VL 172 registered about 24.20 and 25.20 percent respectively (Table 3). The fodder quality comparison was given in Table 5.
Annexure I


<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Location</th>
<th>Season</th>
<th>ACM 10145</th>
<th>CO(Kv)2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Days to maturity</td>
<td>Grain yield (kg/ha)</td>
</tr>
<tr>
<td>1.</td>
<td>Vizianagaram</td>
<td>Kharif</td>
<td>92</td>
<td>1449</td>
</tr>
<tr>
<td>2.</td>
<td>Dholi</td>
<td>Kharif</td>
<td>99</td>
<td>1358</td>
</tr>
<tr>
<td>3.</td>
<td>Bangalore</td>
<td>Kharif</td>
<td>92</td>
<td>1862</td>
</tr>
<tr>
<td>4.</td>
<td>Rewa</td>
<td>Kharif</td>
<td>96</td>
<td>1926</td>
</tr>
<tr>
<td>5.</td>
<td>Coimbatore</td>
<td>Kharif</td>
<td>91</td>
<td>3093</td>
</tr>
<tr>
<td>6.</td>
<td>Madurai</td>
<td>Kharif</td>
<td>97</td>
<td>1630</td>
</tr>
<tr>
<td>7.</td>
<td>Chettinad</td>
<td>Rabi</td>
<td>93</td>
<td>1146</td>
</tr>
<tr>
<td>8.</td>
<td>Almora</td>
<td>Kharif</td>
<td>110</td>
<td>1314</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td></td>
<td>96</td>
<td>1722</td>
</tr>
</tbody>
</table>

Percentage increase over regional check \(22.0\%\)

CONCLUSION

The new culture ACM 10145 is found to be unique in having 1000 grain weight, high milling percent, white rice recovery and also coupled with higher yield. This culture is different from local check CO (Kv) 2 and national check VL 172. Hence the culture, ACM 10145 has been recommended as a suitable variety for all the districts of Tamil Nadu.

REFERENCES
