MORPHOLOGICAL CHARACTERIZATION OF INTERSPECIFIC HYBRIDS BETWEEN SUNFLOWER AND WILD HELIANTHUS SPECIES BASED ON DUS CHARACTERS

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ABSTRACT: Interspecific hybrids of M106 (Helianthus annuus L.) with wild diploid perennial Helianthus maximiliani, Helianthus occidentalis accessions were successful. Based on the guidelines formulated by PPV&FR (Plant Varietal Protection and Farmers Right) authority for the DUS character the observations were recorded for parent M-106 and the two inter specific F₁ hybrids M-106 × MAX 1631, M-106 × OCC 52. The interspecific hybrids have annual life cycle with branching stem, and anthocyanin stem pigmentation was observed in the hybrids these characters indicate the two interspecific hybrids consist of genetic material from both cultivated and wild sunflower. Two to three backcrosses required to eliminate the undesirable traits of wild sunflower however, the backcrosses cannot be avoided as the presence of undesirable characters will not only hamper the quality but also reduce the commercial value of the crop. The objective of this paper is to describe the interspecific hybrids of cultivated and their potential for improving cultivated sunflower.

Key words: Sunflower, Helianthus, Interspecific, Hybrids.

INTRODUCTION

The abundance and diversity of species within the genus Helianthus offer numerous and rewarding possibilities to sunflower breeders. The genus Helianthus is composed of 50 species and 19 subspecies with 14 annual and 36 perennial species (siler and riseberg 1997). Wild Helianthus species constitute the keeping very valuable traits for breeders all annual species and a large number of perennial species may be crossed to the cultivated sunflower by conventional hybridization methods. In this study two wild species Helianthus maximiliani, Helianthus occidentalis were used, they are highly resistant to necrosis and many pests. From the plant anatomy side these are larger leaf area, narrow and longer leaf, longer seeds, high plant biomass, short petiole and short plant angle.

MATERIALS AND METHODS

The materials for the present investigation were obtained from the Crop Improvement Section, Directorate of Oilseeds Research, Rajendranagar, and Hyderabad. In experiment wild diploid perennial species Helianthus maximiliani Schrader (2n 34; PI MAX 1631) Helianthus occidentalis Riddell (2n 34; PI OCC 52), was grown Directorate of Oilseeds Research, Rajendranagar, Hyderabad in 2012, the modern line M-106 of the cultivated Helianthus annuus L. grown in research form of college of agriculture Rajendranagar during kharif 2012. Seed materials for the experiment were sown in the research form of college of agriculture Rajendranagar during Rabi, 2012-13. The morphological observations were taken based on the guidelines formulated by PPV&FR (Plant Varietal Protection and Farmers Right) authority for the both interspecific hybrids and parent M106, the observation were mentioned Table 1.
Table 1: DUS characteristics of the parent and two interspecific crosses

<table>
<thead>
<tr>
<th>S.N0</th>
<th>CHARACTER</th>
<th>M-106</th>
<th>M-106 × MAX 1631</th>
<th>M-106 × OCC 52</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hypocotyl pigmentation</td>
<td>Absent</td>
<td>Absent</td>
<td>Strong</td>
</tr>
<tr>
<td>2</td>
<td>Days 50% flowering</td>
<td>Early (43)</td>
<td>Early (51)</td>
<td>Early (54)</td>
</tr>
<tr>
<td>3</td>
<td>Leaf size</td>
<td>Medium</td>
<td>Large</td>
<td>Large</td>
</tr>
<tr>
<td>4</td>
<td>leaf shape</td>
<td>Triangular</td>
<td>Cordate</td>
<td>Triangular</td>
</tr>
<tr>
<td>5</td>
<td>Leaf colour</td>
<td>Light green</td>
<td>Light green</td>
<td>Green</td>
</tr>
<tr>
<td>6</td>
<td>Leaf bleastering</td>
<td>Absent</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>7</td>
<td>Leaf serration</td>
<td>Medium</td>
<td>Coarse</td>
<td>Coarse</td>
</tr>
<tr>
<td>8</td>
<td>Leaf base</td>
<td>Acute</td>
<td>obtuse</td>
<td>Acute</td>
</tr>
<tr>
<td>9</td>
<td>Orientation of leaf blade</td>
<td>Erect</td>
<td>Erect</td>
<td>Erect</td>
</tr>
<tr>
<td>10</td>
<td>Leaf petiole pigmentation</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>11</td>
<td>Stem pigmentation</td>
<td>Absent</td>
<td>Present</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Ray floret number</td>
<td>Few</td>
<td>Medium (30-40)</td>
<td>Many (&gt;40)</td>
</tr>
<tr>
<td>13</td>
<td>Ray floret shape</td>
<td>Elongated</td>
<td>Ovate</td>
<td>Elongated</td>
</tr>
<tr>
<td>14</td>
<td>Ray floret colour</td>
<td>Yellow</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>15</td>
<td>Disc floret colour</td>
<td>Yellow</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>16</td>
<td>Disc floret pigmentation</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>17</td>
<td>Pollen colour</td>
<td>Yellow</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>18</td>
<td>Bract shape</td>
<td>Elongated</td>
<td>Round</td>
<td>Elongated</td>
</tr>
<tr>
<td>19</td>
<td>Position of later head to the central head</td>
<td>Absent</td>
<td>Below</td>
<td>Below</td>
</tr>
<tr>
<td>20</td>
<td>Head attitude</td>
<td>Half-turned down</td>
<td>Half-turned down</td>
<td>Half-turned down</td>
</tr>
<tr>
<td>21</td>
<td>Head diameter</td>
<td>Small</td>
<td>Large</td>
<td>Large</td>
</tr>
<tr>
<td>22</td>
<td>Head shape</td>
<td>Flat</td>
<td>Flat</td>
<td>Flat</td>
</tr>
<tr>
<td>23</td>
<td>Plant height</td>
<td>Very short (41.6)</td>
<td>Short (70.2)</td>
<td>Medium (118.4)</td>
</tr>
<tr>
<td>24</td>
<td>Plant branching</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>25</td>
<td>Type of branching</td>
<td>-</td>
<td>Overall</td>
<td>Overall</td>
</tr>
<tr>
<td>26</td>
<td>Seed length</td>
<td>Short</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>27</td>
<td>Seed shape</td>
<td>Elongate</td>
<td>Ovoid wide</td>
<td>Ovoid elongate</td>
</tr>
<tr>
<td>28</td>
<td>100 seed weight</td>
<td>Low (0.95)</td>
<td>High (6.23)</td>
<td>High (6.89)</td>
</tr>
<tr>
<td>29</td>
<td>Seed base colour</td>
<td>White</td>
<td>White</td>
<td>White</td>
</tr>
<tr>
<td>30</td>
<td>Seed stripes</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>31</td>
<td>Seed stripe colour</td>
<td>-</td>
<td>-</td>
<td>Gray</td>
</tr>
<tr>
<td>32</td>
<td>Hull content</td>
<td>22.06 low (&lt;25)</td>
<td>27% Medium (25-30)</td>
<td>29% Medium (25-30)</td>
</tr>
<tr>
<td>33</td>
<td>Seed oil content</td>
<td>34% low (&lt;35)</td>
<td>37% Medium (35-40)</td>
<td>42% High (40-45)</td>
</tr>
<tr>
<td>34</td>
<td>Bract pigmentation</td>
<td>present</td>
<td>present</td>
<td>Absent</td>
</tr>
</tbody>
</table>

Conveys the meaning of “irrelevant.

The morphological characterization will be done for 34 characteristics assigned by PPV&FR (Plant Varietal Protection and Farmers Right) authority.

The wild sunflower *Helianthus maximiliani* stem is from 1.5 to 2 m tall. Leaves are alternate, simple and sessile, lanceolate, mostly 14 to 30 cm long and 20 to 55 mm broad. Leaf margins are entire to obscurely serrate, surgically with many short hairs imparting a grayish-green color. Their heads are in a simple terminal racemose arrangement. Ray florets are 25 to 35 mm long and light orange in color and the disk florets are 10 to 12 mm long. Achenes are small, parti-coloured to light brown and crumbly (Fig 1a and b). Linolic acid content in the oil is high - 79.6% and species could be used as source of genes for developing hybrid cultivars with variable oil content. This species is resistant to the pathogens caused *Sclerotinia sclerotioum*, phomopsis, verticillium, rust, downy mildew and the parasite broomrape. Another wild species used in this study was *H. occidentalis* it is distinctly different from all other sunflowers.
Plants have a red stem, 0.6 to 1.5 m tall and reduced leaves with oval to ovate shape. Numerous inflorescences (heads) are 0.9 to 1.4 cm in diameter and have from 10 to 15 orange to yellow rays up to 2 cm long. The haploid number of chromosomes is \( n = 17 \). The Plants from the species are known to exhibit antibiotic and autotoxic properties and possess diterpenoid acids and resistance to some insect pests of cultivated sunflowers. Achenes are small ovide long shape; small brown colour spots are present on the seed. Linolic acid content in the oil is high nearly 71.7 % (Fig 1c and d).

RESULTS AND DISCUSSION

Hypocotyl pigmentation was absent in the parent and in the hybrid M-106 × MAX 1631. Whereas, for the cross M-106 × OCC 52 strong hypocotyl pigmentation was recorded. For days to 50% flowering parent and both the F₁ hybrids falls under early duration type. These results are also in accordance with the results obtained by Dudhe (2012) reported that the F₁ hybrids derived from cross between ARM 243 A × 6D1 grouped under medium duration and they have with strong hypocotyls pigmentation. Parent ARM 243 A grouped under early type and 6D1 under medium type which exhibited its dominant expression in the hybrid. Parent M-106 (9.46 cm) grouped under medium size whereas M-106 × MAX 1631 (14.46 cm), M-106 × OCC 52 (11.96 cm) both grouped under large leaf size. Atlagic and Skoric (1999) repered larger leaf size in F₁ hybrids derived from cross between H. annuus × H. laevigatas. For the character like leaf shape parent taken under round type whereas M-106 × MAX 1631, M-106 × OCC 52 F₁ hybrids categorised under cordate and triangular respectively. These results in accordance with the results Terzic et al. (2006) they reported intermediate type of leaf shape in interspecific hybrids. For the character leaf colour the parent and M-106 × MAX 1631 grouped under light green leaf colour whereas the other interspecific hybrid M-106 × OCC 52 is grouped under green leaf colour character. Similar results were reported by Dudhe (2012) for hybrid derive from cross between ARM 243 A × 6D1, he obtained dark green leaf colour in hybrid. The character leaf bleastering which is absent in the parent M-106 whereas the two F₁ hybrids had medium expression. Prabakaran and Sujatha (2004) reported leaf bleastering in the interspecific sunflower hybrid obtained from cross H. annuus × H. simulans. For the leaf serration parent grouped under medium leaf serration but the two F₁ hybrids shows coarse type of leaf serration. Acute leaf base reported in parent and M-106 × OCC 52, whereas obtuse type was reported in the interspecific hybrid M-106 × MAX 1631. There is no variation in orientation of leaf blade which is erect type in all plants. Leaf petiole pigmentation was absent in parent and both of the interspecific hybrid F₁ hybrids. Dudhe (2012) reported that the leaf petiole pigmentation was absent in F₁ hybrids derived from cross between ARM 243 A × 6D1, he obtained dark green leaf colour in hybrid. The character leaf bleastering which is absent in the parent M-106 whereas the two F₁ hybrids had medium expression. Prabakaran and Sujatha (2004) reported leaf bleastering in the interspecific sunflower hybrid obtained from cross H. annuus × H. simulans. For the leaf serration parent grouped under medium leaf serration but the two F₁ hybrids shows coarse type of leaf serration. Acute leaf base reported in parent and M-106 × OCC 52, whereas obtuse type was reported in the interspecific hybrid M-106 × MAX 1631. There is no variation in orientation of leaf blade which is erect type in all plants. Leaf petiole pigmentation was absent in parent and M-106 × MAX 1631 crosses where as it is present in the 6D1. Stem pigmentation was absent in parent and M-106 × MAX 1631 crosses where as it is present in M-106 × OCC 52 crosses. (Fig 2). Similar results were reported by Prabakaran and Sujatha (2004), they reported stem pigmentation in the hybrid derived from H. annuus × H. simulans. Character like ray floret number parent M-106 (28) falls under few floret number, whereas M-106 × MAX 1631 (32), M-106 × OCC 52 (50) grouped under medium (30-40) and many (>40) categories respectively. These results are in accordance with Hristova-Cherbadzi et al. (2011) they recorded many ray florets in F₁ plants derived from cross between H. annuus × H. maximiliani.

Fig 1 morphological variation among wild species and cultivated species
Yellow ray and disc floret colour expressed by the parent, whereas the two interspecific hybrids express orange ray and disc floret colour, but medium disc floret pigmentation was absorbed in all plants. For Pollen colour parent had yellow pollen colour whereas both the interspecific F1 hybrids grouped under orange pollen colour. Similar results were reported by Hristova-Cherbadzi et al. (2011) in interspecific hybrids of *H. annuus × H. maximiliani* they reported orange ray floret and pollen colour in F1 hybrids. Elongated bract shape was present in parent and M-106 × OCC 52 cross, but another interspecific hybrid M-106 × MAX 1631 have round type. Later heads absent in the parent M-106, but both the interspecific hybrids M-106 × MAX 1631, M-106 × OCC 52 have lateral heads below to a central head type (Fig 3).

![Image](246x748 to 536x761)

**Fig 2** stem pigmentation differences interspecific F1 hybrids and cultivated parent M-106.

For the Head attitude parent M-106 and both of the interspecific hybrids M-106 × MAX 1631, M-106 × OCC 52 were falls under Half-turned down. Similar results were reported by Dudhe (2012) for the hybrids derived from cross between ARM 243 A × 6D1, he reported that F1 plants and its two parents had half turned head attitude. Parent M-106 (7.06 cm) grouped under small type head diameter whereas both interspecific hybrids M-106 × MAX 1631 (20.22 cm), M-106 × OCC 52 (20.38 cm) grouped under large type head diameter. Hristova-Cherbadzi et al. (2011) reported intermediate type head in the F1 hybrid *H. annuus × H. Maximiliani* but Atlagic et al. (1995) reported larger heads in *H. annuus × H. mollis*. Atlagic and Skoric (1999), Nikolova et al. (2004) reported a larger head diameter in the F1 hybrids of *H. annuus × H. laevigatus*. Flat type shape was reported in two crosses M-106 × MAX 1631, M-106 × OCC and parent M-106. Similar results were reported by Dudhe (2012) for hybrid derive from cross between ARM 243 A × 6D1 he obtained convex head shape F1 hybrids. Very short type of plant height recorded in parent M-106 (41.6 cm) whereas M-106 × MAX 1631 (70.2 cm) grouped under short type of plant height and M-106 × OCC 52 (118.4 cm) grouped under medium plant height. Espinase et al. (1995) reported short F1 interspecific hybrid in F1 hybrids of *H. annuus × H. mollis*. But Nikolova et al. (2004) recorded F1 plants with higher plant height than their parents. Terzic et al. (2006) recorded intermediate plant height in F1 interspecific hybrids. Plant branching was absent in parent M-106 whereas it is present in both interspecific hybrids (Fig 4.2). Similar type of results reported by Hristova-Cherbadzi et al. (2011) in F1 hybrids derived from *H. annuus × H. maximiliani*. Prabakaran and Sujath (2004) also reported profusely branching in the hybrids obtained from *H. annuus × H. tuberosus*. In the parent M-106 plant branching was absent whereas both the interspecific hybrids grouped under overall type plant branching (Fig 3). These results in accordance with the results of Faure et al. (2002) they reported F1 hybrids with top branching. For the seed length parent M-106 (0.9 cm) falls under Short type of seed length, whereas both the interspecific hybrids M-106 × MAX 1631 (1.2 cm), M-106 × OCC 52 (1.3 cm) falls under medium type seed length (Fig 4). Similar results also reported by Dudhe (2012) for hybrids derived from cross between ARM 243A × 6D1 he obtained medium type seed length F1 hybrids. Elongated type of seed shape recorded in parent M-106 (41.6 cm) whereas M-106 × MAX 1631 (70.2 cm) grouped under ovoid wide seed shape and M-106 × OCC 52 (118.4 cm) grouped under ovoid elongated seed shape. For the 100 seed weight parent M-106 (0.95g) categorised under low seed weight whereas both interspecific hybrids M-106 × MAX 1631(6.23g), M-106 × OCC 52 (6.89g) categorised under high seed weight. Similar type of white seed base colour was observed in the parent M-106 as well as two interspecific hybrids without any variability. The seed stripes which are absent in parent M-106 s also absent in one of its hybrid M-106 × MAX 1631 but in the cross M-106 × OCC 52 are present (Fig 4).
Gray seed stripes reported in the interspecific hybrid M-106 × OCC 52 whereas seed stripes are absent in parent M-106 and in M-106 × MAX 1631 (Fig 4). For the hull content parent M-106 (22.06%) falls under low hull content whereas both the interspecific hybrids M-106 × MAX 1631 (27%), M-106 × OCC 52 (29%) falls under medium hull content. These results in accordance with results of Dudhe (2012) for hybrid derive from cross between ARM 243 A × 6D1 he obtained medium hull content F1 hybrids. In case oil content Low seed oil reported in parent M-106 (34%) whereas M-106 × MAX 1631 (37%) grouped under medium seed oil content and M-106 × OCC 52 (42%) grouped under high seed oil content. Similar results were also reported by Hristova-Cherbadzi et al. (2011) in interspecific hybrids of H. annuus × H. maximiliani they reported high oil content in the interspecific hybrids. Bract pigmentation present in parent M-106 and interspecific hybrid M-106 × MAX 1631 whereas it is absent in M-106 × OCC 52. For the characters like 50% flowering, Leaf base, Orientation of leaf blade, Leaf petiole pigmentation, Disc floret pigmentation, Head attitude, Head shape, Seed base colour the two inter specific hybrids M-106 × MAX 1631, M-106 × OCC 52 shows similarity with their parent M-106 without having any slight variation in them thus share the characters of the parent similarly. Hypocotyl pigmentation, Leaf colour, Stem pigmentation, Seed stripes, Seed stripe colour, Bract pigmentation characters the inter specific hybrid M-106 × MAX 1631 shows similarity with its parent M-106 thus sharing the similar character of parent, where the other inter specific hybrid M-106 × OCC 52 show variation in these characters thus varying with the parent. Characters like ray floret shape, bract shape the inter specific hybrid M-106 × OCC 52 sharing similar characters of the parent without any variation where the other inter specific hybrid M-106 × MAX 1631 show variation and not showing any similarity with its parents in these characters. For the characters like Plant height, Ray floret number, seed length, oil content characters the two inter specific hybrids differ among them and also differ with their parent in these characters without showing any similarity with their parent and among them. Characters like plant branching, type of plant branching, Position of later head to the central head, Pollen colour, Ray floret colour, seed shape, hull content, the two inter specific hybrids differ with their parent in these characters without showing any similarity with their parent.

Fig 4. Seed length stripe variation between the two interspecific hybrids and their cultivated parent

a) M-106 × MAX 1631 1.2 cm b) M-106 parent 0.9 cm c) M-106 × OCC 52 1.3 cm
CONCLUSION

The interspecific hybrids have annual life cycle with branching stem, and anthocyanin stem pigmentation was observed in the cross M-106 × OCC 52 these characters indicate the two interspecific crosses consist of genetic material from both cultivated and wild sunflower. Two to three backcrosses required to eliminate the undesirable traits of wild sunflower characters however the wild perennial Helianthus spp. are becoming more important as a genetic resource in broadening the germplasm base of sunflower, and the use of interspecific hybridization is increasing in many sunflower breeding programs.

REFERENCES


