Performance of SumBio Semi-clonal Progenies

Joko Handoko Hadi Prasetyo*; Baihaqi Sitepu*; Harry E Iswandar*; Jajan Djuhjana* and Stephen P C Nelson*

ABSTRACT

The increasing world demand for palm oil has generated rapid growth in the oil palm industry throughout the humid tropics and particularly in Indonesia and Malaysia. Sumatra Bioscience (SumBio) is selecting semi-clonal crosses for potential commercial planting to achieve higher yields and greater uniformity. The greater uniformity is because it is realistic to plant a single semi-clonal cross in one block rather than a mixture of seedling progenies. The planting of blocks of semi-clonal progenies provides the opportunity to improve management (harvesting and upkeep operations) and agronomic practices (optimise fertiliser recommendations for specific semi-clonal crosses). There is also potential to exploit genotype x environment interactions and to select specific semi-clonal crosses for planting in certain environments.

SumBio has used tissue culture protocols to clonally propagate dura palms for semi-clonal seed production. The resulting dura clones are field planted and crossed with provisionally selected pisifera (as male) to produce semi-clonal tenera (dura x pisifera) crosses. Semi-clonal planting material is new to Indonesia and allows the oil palm industry to gain value from the advances in oil palm tissue culture without the risk of flowering abnormality.

This article reports the results of a trial which compared the performance of progenies produced from a dura clone with dura seedling material. The dura seedling material used was coming from the settings of the palm which had been cloned.

INTRODUCTION

Palm oil is one of the fastest growing sectors of the global vegetable oil market with Malaysia and Indonesia leading the production and export to date. The growing demand for palm oil is because it is relatively inexpensive (compared to other vegetable oils) and versatile both in edible and non...
edible industrial applications. In terms of supply, there has been continued yield improvement in Malaysia and increasing in oil palm plantation areas in Indonesia (Carter et al., 2007).

There has been an increased demand for oil palm planting material in Indonesia for both new developments and for re-planting. The cloning of *tenera* oil palms offers the theoretical potential to greatly increase productivity because of the potential to select and clone superior genotypes. It should also be realistic for the oil palm industry to gain greater value by optimising the standards of field agronomy and, thus, increasing productivity (Mutert and Fairhurst, 1999).

Although there is evidence of increasing confidence in the oil palm tissue culture protocols because of the industry’s continuing investment in tissue culture laboratories, there is still risk of flowering abnormality (Corley et al., 1986). In the past, major problems were faced in oil palm cloning propagation and this resulted in catastrophic failure. The abnormal flowering is often described as ‘mantled’ because of the characteristic mantling of the fruit. One to six supplementary carpel-like structures develop around the central fruit and the central fruit is generally parthenocarpic resulting in bunch failure. Flower abnormality, its elimination and/or avoidance is therefore a major issue for the oil palm industry (Iswandar et al., 2009) and there are currently no written reports of a reliable marker being identified to ensure that clonal palms will flower normally.

The clonal and semi-clonal seed strategy is considered very low risk as it is only necessary to produce a low number of clonal palms from one genotype (ortet) to be able to produce large quantities of seeds from a single cross. Veerappan et al. (2000) reported flowering abnormality of two palms out of over thousand semi-clonal palms and similar results had been observed in the United Plantations trials.

Rao and Donough (1990) and Paranjothy et al. (1995) have shown that the offsprings of partially mantled palms may be abnormal, although at a much lower level than their parents. There have been no reports of normal clonal parents crossed with normal seedlings producing crosses with abnormal palms. There is uncertainty however of the risk of abnormality when crossing two normal clones (or selfing a normal clone).

In a favourable, or irrigated, environment the production of approximately one million seeds from a clone represented by 100 dura palms is realistic. Therefore millions of seeds from a specific cross may be produced from a single dura clone each year. A single selected pisifera can produce sufficient pollen to produce millions of seeds and therefore it may not be necessary to clone pisifera palms. However, breeding stations may decide to clone valuable pisiferas to conserve these genotypes for further breeding and/or for commercial seed production.

United Plantations Berhad officially launched its sales of commercial semi-clonal seeds in 2006. They listed the advantages of semi-clonal and bi-clonal seeds, which include a greater degree of uniformity of planting material, reduced cost per seed, reduced or zero risk of flowering abnormality and limited use of tissue culture facilities (Sharma, 2007).

**EXPERIMENTAL**

**Semi-clonal Materials**

Semi-clonal crosses were produced from one dura clone (BL012) and 12 normal flowering clonal palms (ramets) that were used as parents in this study. The original palm (ortet) which was cloned to produce BL012 was also selfed to produce progeny BL10874. A progeny field trial which was carried out in 2004 tested 55 progenies of the following planting materials:

- thirty Bah Lias semi-clonal DxP progenies (BL012 ramets crossed with four selected pisifera palms);
- twenty-one Bah Lias DxP progeny (BL10874 dura sibs crossed with four selected pisifera palms); and
- four Bah Lias standard DxP crosses.

The trial design was an alpha design with four replicates, seven blocks per replicate, eight plots per block, and 16 palms per plot.

Yield and vegetative measurements were recorded using methodologies described by Breure and Verdooren (1995). A sample of approximately 60 individual bunches from each progeny was analysed using the methods described by Blaak et al. (1963) and Rao et al. (1983).

**RESULTS AND DISCUSSION**

All semi-clonal palms flowered normally. *Figure 1* shows the relationship between trunk height and mean annual oil and kernel yield (OKY) in tonne per hectare over three years recording. There was as expected, no significant differences in OKY between semi-clonal progenies and DxP progenies because both planting materials had the
same genetic background. There was, however, greater variation between the *dura* seedling palms for estimates of general combining ability when compared with the clonal parents within BL012. This was expected because each *dura* seedling sib is genetically different while the BL012 clonal material should be genetically the same.

*Table 1* shows mean yield performance for BL012 and BL10874 crossed with different male parents.

**Performance SumBio Semi-clonal Progenies in Term of Vegetative Growth**

Summary of vegetative progeny results are shown in *Table 2*. There were no significant differences in vegetative growth between progenies. Semi-clonal progenies derived from *dura* clone BL012 crossed with *pisifera* BL147/21-05 had higher vegetative growth in terms of frond weight and frond length.

**Performance SumBio Semi-clonal Progenies in Terms of Bunch Character**

Oil-to-bunch (OB) is an important character in determining OKY and there were no significant differences between progenies for OB. The higher mean OB ratio in semi-clonal progenies was achieved by crosses between *dura* clone BL012 x BL148/05-08, which is supported by high oil-to-dry

### TABLE 1. MEAN YIELD PERFORMANCE OF SUMBIO SEMI-CLONAL PROGENIES

<table>
<thead>
<tr>
<th>Progeny</th>
<th>No. of progeny</th>
<th>Mean annual data</th>
<th>Number</th>
<th>Mean (t ha⁻¹ yr⁻¹)</th>
<th>NOB/palm</th>
<th>OKY (t ha⁻¹ yr⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Standard Crosses</td>
<td>4</td>
<td></td>
<td></td>
<td>21.2</td>
<td>21.0</td>
<td>7.37</td>
</tr>
<tr>
<td>Mean BL10874 x BL148/05-08</td>
<td>4</td>
<td></td>
<td></td>
<td>22.3</td>
<td>24.8</td>
<td>7.76</td>
</tr>
<tr>
<td>Mean BL10874 x BL143/04-06</td>
<td>6</td>
<td></td>
<td></td>
<td>22.2</td>
<td>24.2</td>
<td>7.53</td>
</tr>
<tr>
<td>Mean BL10874 x BL147/21-05</td>
<td>3</td>
<td></td>
<td></td>
<td>22.1</td>
<td>22.3</td>
<td>7.45</td>
</tr>
<tr>
<td>Mean BL10874 x BL148/19-03</td>
<td>8</td>
<td></td>
<td></td>
<td>22.3</td>
<td>24.3</td>
<td>7.59</td>
</tr>
<tr>
<td>Mean BL012 x BL143/04-06 *</td>
<td>10</td>
<td></td>
<td></td>
<td>22.4</td>
<td>23.2</td>
<td>7.53</td>
</tr>
<tr>
<td>Mean BL012 x BL148/19-03 *</td>
<td>9</td>
<td></td>
<td></td>
<td>22.2</td>
<td>24.0</td>
<td>7.63</td>
</tr>
<tr>
<td>Mean BL012 x BL147/21-05 *</td>
<td>2</td>
<td></td>
<td></td>
<td>22.5</td>
<td>22.1</td>
<td>7.69</td>
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<tr>
<td>Mean BL012 x BL148/05-08 *</td>
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<td></td>
<td></td>
<td>22.2</td>
<td>24.2</td>
<td>7.66</td>
</tr>
<tr>
<td>Mean trial</td>
<td>-</td>
<td></td>
<td></td>
<td>22.2</td>
<td>23.6</td>
<td>7.58</td>
</tr>
</tbody>
</table>

Note: * Semi-clonal crosses.

FFB = fresh fruit bunch; NOB = number of bunch; OKY = oil and kernel yield.
TABLE 2. VEGETATIVE GROWTH PERFORMANCE OF SUMBIO SEMI-CLONAL PROGENIES

<table>
<thead>
<tr>
<th>Progeny</th>
<th>No. of progeny</th>
<th>Growth data</th>
<th>Trunk height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LA (m²)</td>
<td>FRW (kg)</td>
</tr>
<tr>
<td>Mean Standard Crosses</td>
<td>4</td>
<td>6.24</td>
<td>1.85</td>
</tr>
<tr>
<td>Mean BL10874 x BL148/05-08</td>
<td>4</td>
<td>6.56</td>
<td>1.90</td>
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<td>Mean BL10874 x BL143/04-06</td>
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<td>6.06</td>
<td>1.73</td>
</tr>
<tr>
<td>Mean BL10874 x BL147/21-05</td>
<td>3</td>
<td>6.15</td>
<td>1.99</td>
</tr>
<tr>
<td>Mean BL10874 x BL148/19-03</td>
<td>8</td>
<td>6.30</td>
<td>1.93</td>
</tr>
<tr>
<td>Mean BL012 x BL143/04-06 *</td>
<td>10</td>
<td>6.26</td>
<td>1.80</td>
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<tr>
<td>Mean BL012 x BL148/19-03 *</td>
<td>9</td>
<td>6.40</td>
<td>1.97</td>
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<td>Mean BL012 x BL147/21-05 *</td>
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<td>6.18</td>
<td>2.08</td>
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<tr>
<td>Mean BL012 x BL148/05-08 *</td>
<td>9</td>
<td>6.55</td>
<td>1.93</td>
</tr>
<tr>
<td>Mean trial</td>
<td>-</td>
<td>6.33</td>
<td>1.89</td>
</tr>
</tbody>
</table>

Note: *Semi-clonal crosses.
LA = leaf area; FRW = frond weight; LAR = leaf area ratio; FRL = frond length; F1B = frond 1 marked on 3.5 year after planting.

TABLE 3. BUNCH CHARACTER PERFORMANCE OF SUMBIO SEMI-CLONAL PROGENIES

<table>
<thead>
<tr>
<th>Progeny</th>
<th>No. of progeny</th>
<th>Bunch character data (2007-2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FB (%)</td>
</tr>
<tr>
<td>Mean Standard Crosses</td>
<td>4</td>
<td>69.9</td>
</tr>
<tr>
<td>Mean BL10874 x BL148/05-08</td>
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<tr>
<td>Mean BL10874 x BL143/04-06</td>
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<td>71.1</td>
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<tr>
<td>Mean BL10874 x BL148/19-03</td>
<td>8</td>
<td>69.5</td>
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<tr>
<td>Mean BL012 x BL143/04-06 *</td>
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<td>70.5</td>
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<tr>
<td>Mean BL012 x BL148/19-03 *</td>
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<td>69.2</td>
</tr>
<tr>
<td>Mean BL012 x BL147/21-05 *</td>
<td>2</td>
<td>70.6</td>
</tr>
<tr>
<td>Mean BL012 x BL148/05-08 *</td>
<td>9</td>
<td>70.4</td>
</tr>
<tr>
<td>Mean trial</td>
<td>-</td>
<td>70.0</td>
</tr>
</tbody>
</table>

Note: *Semi-clonal crosses.
FB = fruit to bunch; MF = mesocarp to fruit; OWM = oil to wet mesocarp; ODM = oil to dry mesocarp; SF = shell to fruit; SK = shell to kernel; OB = oil to bunch; KB = kernel to bunch.

CONCLUSION

These trial results have shown that there is less variability between DxP progenies produced from a single clone compared to a self progeny (self of the genotype which was cloned). The level of variation between sibs of a self progeny will depend on the heterozygosity of the genotype which was selfed. In this study, there was no evidence of specific combining ability which would result in a semi-clonal progeny having superior performance to the self progeny. In this trial only one clone was investigated and was only crossed with four AVROS pisifera.

REFERENCES


