Performance of Four Tall Coconut Population North Sulawesi for Assembling Coconut Composite Variety Specific for Upland on Wet Climate

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ABSTRACT

Coconut plant improvement was made to increase the average local production by 1 ton of copra per year nation wide through coconut composite plantation. Coconut Composites were constructed by combining the seven populations/genotypes selected with the production above 3.5 tons of copra/ha/year. Coconut composite superior possessing several advantages compared with other Tall coconut in general such as high productivity as well as high genetic variability inherited from both parents with different genetic composition. Assembling the Tall coconut composite is focused on the upland on wet climate. Performance the local Tall coconut that having potential as selected mother palm for several characters such are production components, pest and disease resistance included leaf physiology and biochemistry was evaluated. The results showed that the four genotypes was specific upland on wet climate with productivity from 3.7 to 4.8 tons of copra/ha/year. The results of this study are expected to produce high yielding coconut genotypes and available for farmers in large quantities so as to increase national production and increase farmers' income.

Keywords: Coconut, selection, composite varieties, palm weevils.

INTRODUCTION

Coconut has a growing requirement with a relatively wide range so that it can grow well in lowland and upland on wet climate and dry climate (Abdulrachman and Mulyani, 2003). Coconut can grow on upland on wet climate, i.e. areas where rainfall is above 2500 mm/year and the upland dry climate, i.e. regions with rainfall below 2000 mm/year. According to the Directorate of Plant Protection Plantation (2003), although coconut can grow on various environmental conditions through climate, soil, altitude places, as well as geography and topography, coconut development is constrained by pests and diseases. Level of pest/diseases and losses vary widely thus decreasing coconut production. Therefore, more than 90% of farmers generally choose Tall coconut variety with the consideration, although the production is lower than hybrid variety but relatively resistant to bud rot and nut fall diseases caused by Phytophthora sp. In addition, the Tall coconut
does not require intensive care in order to achieve a profitable level of production, and resistant to environmental stresses especially drought (Rethinam et al., 2002; Hosang, 2007 and Motulo, 2008).

Performance of a trait is the result of collaboration between genetic factors, environment and the interaction between genetic and environmental (Falconer and Mackay, 1996). Yield of a cultivar/genotypes of plants to environmental conditions are an interaction between cultivar/genotype by environment or cultivar/genotype with the seasons. Cultivar/genotype that can show appearances as well in a wide range of environmental conditions are expected by plant breeders. Environmental factors such as water availability, rainfall, temperature, duration of exposure and humidity can affect the growth and production of coconut palms. Finlay and Wilkinson (1963) argued that the genotype of a plant that has a high genotypic stability means the yields are fixed or nearly fixed, although planted on environmental conditions change.

In respond to the preferences of farmers, coconut breeders tries to improve the potential for coconut production through selection, hybridization, engineered varieties of synthetic and composite varieties. Coconut superior composites have several advantages compared to Tall coconut in general, because in addition to high productivity, high genetic variability has also inherited from the two parents with different genetic composition. Another advantage of coconut composite is the parent was derived from a natural population of randomly cross-pollinated so that the first-generation crosses of natural populations are genetically stable or is in genetic equilibrium (genetic equilibrium) followed the Hardy-Weinberg Law (Carpena et al., 1993). This means that the plant population genotype frequencies will not change from generation to generation. The implication farmers can use coconuts generation F2, F3, F4, and so on as a seed/plant material without a decline in production. To get the coconut composite seed is used natural crossbreeding methods so that seed production is low cost and affordable by the farmers.

Coconut Composite variety intervarietal hybrid is being developed in several locations such as Banyuwangi and Gorontalo in the upland on dry climate through hybridization of six Tall coconut (Kumaunang and Faozi, 2007; Matana and Kumaunang, 2007). In addition, the coconut composite variety that will be assembled is expected to meet the needs of farmers to get coconut production above the average of 1 ton of copra/ha/year. Superior Tall coconuts are spread on upland on wet climate especially in North Sulawesi (Novariant and Tampake, 2008). In this research we would like to do selection on several populations that perform high-yielding production in North Sulawesi as noticed as one center of coconut plantation. Through strict selection at the level of individual plant genotypes are expected to reach copra production over 3.5 tons of copra/ha/year are resistant to pests and diseases and suitable for upland on wet climate area and which is expected to meet farmers' requirements in superior coconut.

MATERIALS AND METHODS

The experiment was conducted in four districts in the North Sulawesi Province representing upland on wet climate (<3 months dry) from June 2009 to December 2010. The choice of location was the location of the existing High-yielding Block, which is in North Minahasa, South Minahasa, Southeast Minahasa and Bolaang Mongondow. At each location selected observations were made by choosing selected potential of mother palms (Tampake, 2006). Observations were made on each palm selected for each population, according to Stantech COGENT (Santos et al., 1996).

Other observations made to the character of leaf morphology and physiology. For every selected palms, five leaflet samples were taken from frond number 14. Analysis were conducted on: The content of proline on palm leaves were analyzed using the method of Singh (1973). The content of glycine-betaine were analyzed using the modified method of Stumpf (1984). ABA content was analyzed using the modified method of Sivaci (2008). Protein analysis is were done by sampling the fresh coconut leaflets cuts smoothly then weighed 1 g. Soaked in solvent them by 5 m for 30 min. After 30 min the supernatant was removed and was hed with 50% etanol for 3 times until the etanol colored clear. After washing with ethanol, the solvent was added 10% TCA (trichloro-acetate) 3 ml and leave it about 10 min. Supernatant was taken and then centrifuged for 5 min. Supernatant was discard and these diment was taken. Precipitate for med were tested total protein content using the method of Lowry et al. (1951). Lipid analysisis done by taking a sample of palm leaves cut in to pieces and then weighed 1 g and then added 5 ml of chloroform-methanol (2:1). Homogenated solution for 1 min and followed by the addition of 1.25 ml of chloroform and homogenized again for 30 seconds and then centrifuged at the speed of 3500 rpm for 15 min. Solution was kept for 90 min and then the solvent is evaporated. Result of evaporation extracts stored in a desiccator and then weighed with an analytical balance. Leaf picuticular wax content were done by using method of Akuba et al. (1998). Leaf chlorophyll
content was analyzed according to the method developed by Taulu et al. (1997).

Observation of important disease that attacks coconut populations in selected high yielding block were done through field observation and laboratory tested. Disease surveillance is directed at nut fall disease caused by Phytophthora sp. Disease resistance testing is done with nut fall bioassay method. Each treatment of 10 trees was selected from each population and each tree taken 2 coconut fruit aged six months to eight months. Each fruit was inoculated with a drop (+ 0.04 ml) suspension of Phytophthora palmivora in two places (Kharie et al., 1993). After inoculation observation of lesion growth was done every day. The observations made are the latent period, and lesion area.

Observation of the major coconut pest were done on Oryctes rhinoceros and the Brontispa longissima. The observation for pest Oryctes rhinoceros performed as follows: at each plant population was observed in 15 randomly selected trees. Observations were made by counting the number of cuttings on the affected leaf midrib, as the basis for calculating the percentage loss/assumed loss of coconut production. The observation for Brontispa longissima carried out as follows: counting the number of adult and larval populations are found in plants. At each plant population was observed 10 randomly selected trees. The leaves of the tree that was attacked were insert in the plastic bag and taken to the laboratory. On infected plants measured leaf area and leaf area affected by Brontispa. Percentage of crop damage is calculated based on the formula:

\[
\text{Leaf area affected} \times 100 \% \\
\text{Total leaf area}
\]

RESULTS AND DISCUSSIONS

Potential high-yielding palms are first selected by visual observation. This is facilitated by recognizing certain phenotypic characteristics such as closely spaced leaf scars, high production of fruits and high copra output. The results showed that the population of selected plant coconut in the Pounak Village (South Minahasa District), Kasinggolan Village (Bolaang Mongondow District), Liwutung Village (Southeast Minahasa District) and Werot Village (North Minahasa District) showed character on high meat weight between 491.45 - 596.92 g (Table 1). This result is comparable to the result of Tulalo and Tenda (2001) and Mangindaan et al. (2002) when they the meat weight Mapanget Tall 551.46 g, Tenga Tall 524.67 g and Mamuya Tall 506.00 g were noticed as local elite coconut in North Sulawesi. In four Tall coconut populations copra yields 33.34, 32.05, 29.09 and 28.52 kg/tree/year respectively (Figure 1). If the selected plants were taken from each fruit and then planted at a distance of 9 m x 9 m x 9 m triangles (143 trees/ha) with 130 plants achieve the estimated production life of the production of copra/ha/year plant was selected from the village of Pounak, 4334 kg copra/ha/year. While the population Kasinggolan, Liwutung and Werot with the same plant population estimate production such as 4166.5, 3781 and 3707.6 kg/ha.

Based on the results on leaf morphology and physiology characters showed the difference for all of the character observed such as content of proline, glycine-betaine, ABA, chlorophyll, epicuticular wax, proteins, and lipids. Significantly different results of wax content for the four coconut population in upland on wet climate compare to upland on dry climate which is represented by Bloro (East Nusa Tenggara) (Table 2). The highest epicuticular wax

<table>
<thead>
<tr>
<th>No</th>
<th>Location/Population Lokasi/Populasi</th>
<th>Number of bunch per palm Jumlah Bunga per pohon</th>
<th>Number of fruit per palm Jumlah buah per pohon</th>
<th>Total fruits per palm per year Jumlah buah/ Pohon/ Tahun (butir)</th>
<th>Meat weight (g) Berat daging basah (g)</th>
<th>Yield estimation/palm/year Estimasi produksi/pohon/tahun (kg)</th>
<th>Copra production/ha/year Produksi kopra/ha/tahun (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pounak Tall (South Minahasa) Dalam Pounak (Minahasa Selatan)</td>
<td>13.5</td>
<td>9</td>
<td>117</td>
<td>565.80</td>
<td>66.87</td>
<td>33.34</td>
</tr>
<tr>
<td>2.</td>
<td>Kasinggolan (Bolaang Mongondow) Dalam Kasinggolan (Bolaang Mongondow)</td>
<td>13</td>
<td>8</td>
<td>107</td>
<td>596.92</td>
<td>64.10</td>
<td>32.05</td>
</tr>
<tr>
<td>3.</td>
<td>Liwutung (Southeast Minahasa) Dalam Liwutung (Minahasa Tenggara)</td>
<td>13</td>
<td>8</td>
<td>109</td>
<td>565.80</td>
<td>66.67</td>
<td>33.34</td>
</tr>
<tr>
<td>4.</td>
<td>Werot (North Minahasa) Dalam Werot (Minahasa Utara)</td>
<td>13</td>
<td>9</td>
<td>116</td>
<td>491.45</td>
<td>57.05</td>
<td>28.52</td>
</tr>
</tbody>
</table>
content was found in Pounak (5.08) and the lowest was found Bloro (1.54 mg/cm²). Results on chlorophyll content in four populations resemble palm research on Kramat Tall and Molowahu Tall from Gorontalo 2.44 and 2.47 mg/g (Helianto and Tenda, 2010). According to Junior, (2008) lipid is an essential element of the cellular membrane that plays an important function in the preparation of the structure and metabolic processes. Water stress and some other types of stress can alter the composition of the lipid membrane. As a result, cellular metabolic activity is also changing. Lack of water can alter plasma membrane lipid into different cytoplasmic organelles that affect its function in cellular metabolism. Plants that have high lipid content in their organ will be able to maintain physiological activity and metabolism. Akuba et al. (1998) stated that the coconut cultivar is said to have a high lipid content if it has lipid content is higher than 3.5%.

Figure 1. Performance of Tall coconut Pounak (a), Kasinggolan (b), Liwutung (c) and Werot (d).

Gambar 1. Penampilan populasi kelapa Dalam Pounak (a), Kasinggolan (b), Liwutung (c), dan Werot (d).

Field resistance of Tall coconut populations in major diseases

Based on visual observations in the field showed there is no bud rot and nut fall disease caused by Phytophthora palmivora. However, to see the types of coconut resistance in upland on wet climate of North Sulawesi is done by taking the young fruit age 6-8 months to be tested at the Laboratory of Pests and Diseases of IPRI. The observation of a young coconut fruit inoculated with Phytophthora palmivora isolates showed that the four populations tested in the coconut, showing symptoms of Phytophthora palmivora first time called the latent period varies between populations were tested. The latent period of Pounak Tall coconut population is equal to Nias Yellow Dwarf coconut which is vulnerable as control while the other palm where showed appearance of symptoms at fourth day. From ten mother palms tested from each population of coconut, there are three populations, namely Pounak, Kasinggolan and Liwutung contained one parent trees do not show any disease symptoms of nut fall even after inoculated with isolates of Phytophthora palmivora.

Observations on the development of lesion area 3-9 days after inoculation ranged 6.92 - 10.43 cm² still smaller than controls on Nias Yellow Dwarf coconut (13.72 cm²) were classified as susceptible (Table 3). This shows four other populations more resistant than the control Nias Yellow Dwarf (NYD). In general, the type of Tall coconut such as Tenga Tall, Bali Tall, Palu Tall, Takome Tall, (DTE), Paslaten Tall, and Banyuwangi Tall is more resistant than the Dwarf types of coconut such as Nias Yellow Dwarf, Bali Yellow Dwarf and Tebing Tinggi Dwarf is classified as vulnerable. On the other hand, Raja Brown Dwarf and Salak Green Dwarf were recognizing as resistance to nut fall disease (Lalong, 1994; Billotte, 1996). Fourth populations tested were noted as the area that vulnerable to bud rot and nut fall diseases caused by Phytophthora palmivora, i.e. areas with high rainfall. The greater the amount of annual rainfall, the higher the rate of bud rot disease, and the greater the number of months with rainfall > 200 mm/month, the higher rate of bud rot disease (Akuba et al., 1991).

Field resistance of Tall coconut populations in major pests.

Observation conducted in four populations in North Sulawesi coconut describe that there is a major pest of coconut although at a low level (Table 4). Oryctes beetle dominant at three locations have been analyzed and showed a low level of attack between 0.08 to 0.10 that if associated with a decrease in production and a number of cutouts predictable production decline below 10%. Pest Oryctes rhinoceros beetle recognizable bite that causes leaf seems to have a V-shaped frond cut. Adult beetles usually fly into the canopy of coconut at night, and go through one armpit to the top of the canopy. The adult beetle bores into the soft tissue of the bud or cabbage by cutting
and chewing the tender unopened leaves and inflorescences (Singh and Arancon, 2007; Kalshoven, 1981 in Alouw et al., 2008). Increased Oryctes rhinoceros populations are influenced by environmental factors such as the availability of breeding grounds. Animal waste, organic waste and stem rot of coconut and sugar cane scraps is a source of organic matter and a breeding ground favored by Oryctes rhinoceros. This led to a population explosion often occurs in a dirty palm plantations are located in or around the places that contain many breeding places such as animal cages (Alouw et al., 2008).

Brontispa pests were also detected in the population of Pounak Tall coconut at South Minahasa, North Sulawesi. Attack rate was also lower, at 0.01 that is not damage the existing coconut plantation.

The observations made during field survey were showed that this pest have been reduced because there are no more eggs, larvae and pupae in the former affected leaves. Symptoms Brontispa pests attacking unopened coconut bud and leaf parenchyma broaching the epidermal layer, causing brown spot extending in a straight line and parallel lines with each other. Attacks continue to cause these spots together so that the leaves turn brown and then dry, look wrinkled, so after fully open leaf midrib looks like a burn. Damage is often aggravated by other pests such as Oryctes, Pleisipha and Aspidiotus (Alouw et al., 2008).

Table 2. The average content of Prolin, Prolin, ABA, Glysin Betain, Wax, Lipid, Protein, Chlorophyl and Stomata Index of four coconut population from dry land in North Sulawesi.

<table>
<thead>
<tr>
<th>Population/Genotypes</th>
<th>Prolin (µg/g)</th>
<th>Glycin-betain</th>
<th>ABA (ng/g)</th>
<th>Chlorophyl Klorofi (mg/g)</th>
<th>Wax (mg/cm²)</th>
<th>Protein (ppm)</th>
<th>Lipid (%)</th>
<th>Stomata Index/Indeks Stomata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalam Pounak</td>
<td>116.20 c</td>
<td>34.74 a</td>
<td>1224,5 b</td>
<td>2.23 a</td>
<td>5.04 b</td>
<td>2682.90c</td>
<td>4.66b</td>
<td>0.63 bc</td>
</tr>
<tr>
<td>Dalam Werot</td>
<td>96.56 ab</td>
<td>50.06 b</td>
<td>306.78a</td>
<td>2.93 b</td>
<td>5.79 b</td>
<td>938.30 b</td>
<td>4.19 ab</td>
<td>0.67 b</td>
</tr>
<tr>
<td>Dalam Liwutung</td>
<td>132.12 c</td>
<td>39.67 b</td>
<td>715.80 ab</td>
<td>2.42 ab</td>
<td>4.36 b</td>
<td>762.30 a</td>
<td>3.49 a</td>
<td>0.60 c</td>
</tr>
<tr>
<td>Dalam Kasinggolan</td>
<td>77.77 a</td>
<td>46.14 ab</td>
<td>682.63 a</td>
<td>2.76 ab</td>
<td>6.10 b</td>
<td>882.70 ab</td>
<td>4.44 ab</td>
<td>0.66 b</td>
</tr>
<tr>
<td>Dalam Bioro (Control)</td>
<td>127.76 c</td>
<td>42.21 ab</td>
<td>1146.80 a</td>
<td>1.89 a</td>
<td>1.54 a</td>
<td>832.90 ab</td>
<td>4.76 b</td>
<td>0.39 a</td>
</tr>
</tbody>
</table>

Note: Number followed by the same letter are not significant at the 0.5% of LSD test.

Table 3. The observation of latent period and lesion area of four Tall coconut populations in North Sulawesi after the inoculation of Phytophthora palmivora isolates.

<table>
<thead>
<tr>
<th>Population/Genotypes</th>
<th>Laten period</th>
<th>Wide spot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Periode laten</td>
<td>Luas bercak (cm²)</td>
</tr>
<tr>
<td>GKN Kontrol/ Kontrol (GKN)</td>
<td>3</td>
<td>13.72</td>
</tr>
<tr>
<td>Pounak Tall/ Dalam Pounak</td>
<td>3</td>
<td>7.84</td>
</tr>
<tr>
<td>Werot Tall/ Dalam Werot</td>
<td>4</td>
<td>6.92</td>
</tr>
<tr>
<td>Kasinggolan Tall/ Dalam Kasinggolan</td>
<td>4</td>
<td>10.43</td>
</tr>
<tr>
<td>Liwutung Tall/ Dalam Liwutung</td>
<td>4</td>
<td>9.65</td>
</tr>
</tbody>
</table>

Table 4. Types of pests were detected at four location of coconut population in North Sulawesi.

<table>
<thead>
<tr>
<th>Population/Genotypes</th>
<th>Types of pest detected</th>
<th>Notes Keterangan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pounak Tall/ Dalam Pounak</td>
<td>Oryctes dan Brontispa</td>
<td>Low/Tingkat serangan rendah</td>
</tr>
<tr>
<td>Werot Tall/ Dalam Werot</td>
<td>Oryctes</td>
<td>Low/Tingkat serangan rendah</td>
</tr>
<tr>
<td>Kasinggolan Tall/ Dalam Kasinggolan</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Liwutung Tall/ Dalam Liwutung</td>
<td>Oryctes</td>
<td>Low/Tingkat serangan rendah</td>
</tr>
</tbody>
</table>
CONCLUSION

There are four population of Tall coconut namely Pounak Tall, Werot Tall, Kasinggolan Tall and Liwutung Tall were selected as a high yielding potential of coconut mother palm. The productions are from 3.7 to 4.3 tons/ha/year. These four Tall coconuts from North Sulawesi are resistant to nut fall diseases caused by Phytophthora palmivora and there is low level of Oryctes sp and Brontispa pest attacks. These four Tall coconut populations are recommended to assembly coconut composite variety that could enhance high productivity for upland on wet climate up to 3.5 tons copra/ha/year.

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