Morphology and Yield on Second Generation of Tall x Dwarf Coconut Crosses (Cocos nucifera L.)

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***Abstract*—** 200 of 2nd generation stage of palms arising from a cross tall and dwarf of Cocos nucifera were evaluated for the morphology and yield characters. The objective of this study is to determine the segregation patterns of the morphology and the yield characters on the tall x dwarf cross at the 2nd generation stage planted in the field. In the 2nd generation population planted, 4 segregation genotypes were selected for the present study on the contrasting morphological and production characters. Data on year 4 of segregation, flowering phases, stem height, stem diameter, stem perimeter, and yield was recorded. The segregation to hybrid was the highest number of plants compared to others with 116. Recombination of the autogamous nature along with the tall characters was observed in the 2nd generation palms in terms of stem height and perimeter. Certain segregated genotypes arising from the 2nd generation recorded the high potential number of nuts per hectare/year that comprised dwarf segregation up to 25,000 compared to other segregated varieties due to their resistance to inbreeding depression. The possibility of extracting recombined lines with desirable characters to improve the Malayan tall x dwarf is also discussed.

***Keywords*—** Coconut, Morphology, Second generation, Segregation.

I. INTRODUCTION

In coconut replanting, tall x dwarf (T x D) coconut variety hybrids are preferred over the late maturing, and lower-yielding tall varieties because of their precocity, higher and more stable yield, uniformity, and ability to quickly recover from stress. The identification of the existence of hybrid vigor in intervarietal crosses of tall x dwarf coconut caused a breakthrough in coconut breeding (Patel, 1937). The F1 hybrids exhibited precocity in bearing, high nut numbers and improved nut weights (Bhaskaran & Leela, 1963., Liyanage, 1956., Satyabalan & Kunjan, 1970). Although the hybrids were at an obvious advantage in production potential, their stability in varying environmental conditions was at a low level. The dwarfness of the coconut is controlled by a heterozygous state and depending upon the heterozygosity of the parents involved in the cross, segregation of dwarfs in the F1 population may vary increasing the variability of the F1 population (Bavappa et al., 1973). The theory of quantitative genetics provides interpretation to the above scenario, that along with the dominant and favorable alleles which bring the maximum heterosis for desirable characters, the recessive and unfavorable genes make their way into the cross thus decreasing its value. Therefore, a long-term strategy to remedy this situation is to eliminate the tin desirable genes by selfing and selection which would also reduce the variability of the resulting progeny. Before initiating this task, it is important to study the segregation of characters selfed generations of F1 is derived from dwarf x tall crosses and investigate the nature of genetic control. Proper selection and planting of good quality seed nuts must be done to ensure a productive plantation (Magat, 1999). Therefore, the objective of this study is to determine the segregation patterns of the morphology and the yield characters on tall x dwarf cross at the 2nd generation stage planted in the field located in MARDI Bagan Datuk, Perak, Malaysia.

II. METHODOLOGY

Experiment sites

The experiment was conducted in a plot at MARDI Bagan Datuk. The site was located at 3°53'36.0" N latitude and 100°51'24.0" E longitude. The experiment site was a rain forest agroecology characterized with more than 1900 mm annual rainfall, 24 – 36ºC annual temperature, and 79% – 83% relative humidity. The soil of MARDI Bagan Datuk was generally classified as riverine with medium pH and low availability of N and K.

Planting materials

200 F2 progeny of coconuts at the age of twelve-month old were planted in a fully randomized design horizontally on raised plots at a spacing of 7.0 m between seedlings and 7.0 m between rows triangularly.

Treatments

Of the F2 population planted, 4 segregation genotype varieties were selected for the present study on the basis at least 40-50 individuals of each family with contrasting morphological and reproductive characters were present.

Data collections

The breeding behavior of each palm was determined by studying the duration of flowering phases. The stem height was measured from the base to the tip of the lowest frond by using a steel ruler. The parameter of stem diameter and perimeter of the stem was collected at the height of 1 meter from the bottom of the stem using a caliper and measuring tape. The yield of nuts per palm was recorded periodically at each harvest and pooled to get nut yield per palm per year. Yield components data was gathered from the number of nuts and weight of 10 husked nuts from each palm. The data were gathered for the 4th year of mid-2020 on each palm.

Experimental design and data analysis

The experimental design was a Complete Randomized Design. Analysis of variance tests was carried out to detect significant differences between the parameters collected with 4 replications.

Means of the measured variables were compared by using the appropriate ANOVA procedure (SAS Institute 1989) and the Duncan test ($P<0.05$).

III. RESULTS AND DISCUSSION

Growth characters of segregation palm

Data on the stem perimeter, height, and diameter of autogenous palms are given in Figures 1, 2, and 3. The segregation of growth characters of the palms was of great importance. The stem perimeter was estimated highest at the segregation of tall with 88.54 ± 41.31 cm while non-parental segregation was the lowest stem perimeters recorded with 86.82 ± 41.91 as shown in figure 1.

Significant differences for the mean of stem height tremendously show at tall segregation genotypes with 101.32 ± 28.05 cm compared to other segregation varieties while dwarf shows the lowest stem height characters with 100.87 ± 28.05 cm as mentioned in figure 2.

Figure 3 revealed the mean stem diameter of palms; of the individual varied from 32.55 cm to 32.97 cm at the age of 4 years from planting which non-parental segregation variety was the highest and dwarf could be the lowest respectively. The seedling vigor was highly correlated with adult palm characteristics such as early flowering, nut yield, and copra production (Liyanage & Abeywardena, 1957). The fertilizer application is mainly based on chemical fertilizers which are costly and exerts negative impacts on soil health (Jithya, 2010).

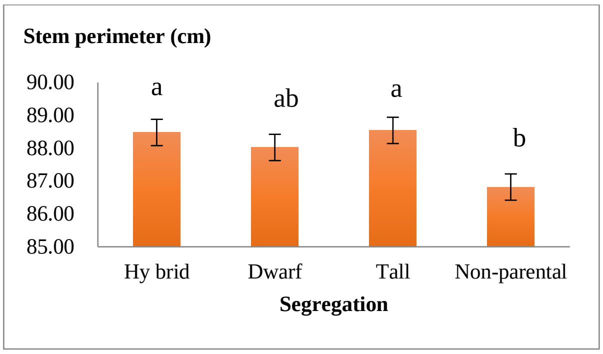

Figure1: Vegetative data of the 2nd generation on stem perimeter. Bars with the same letter for each treatment are not significantly different at $P < 0.05$.

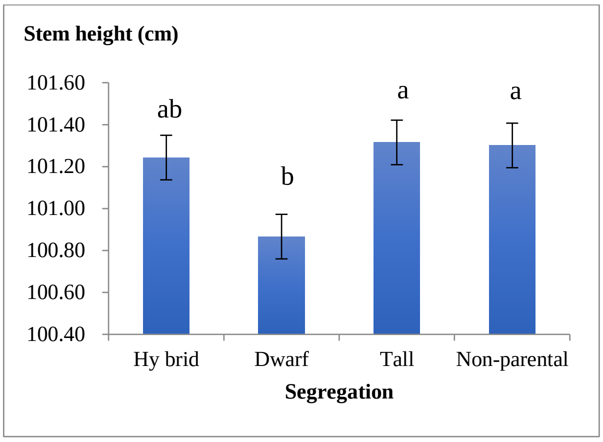

Figure 2: Vegetative data of the 2nd generation on stem height. Bars with the same letter for each treatment are not significantly different at $P < 0.05$.

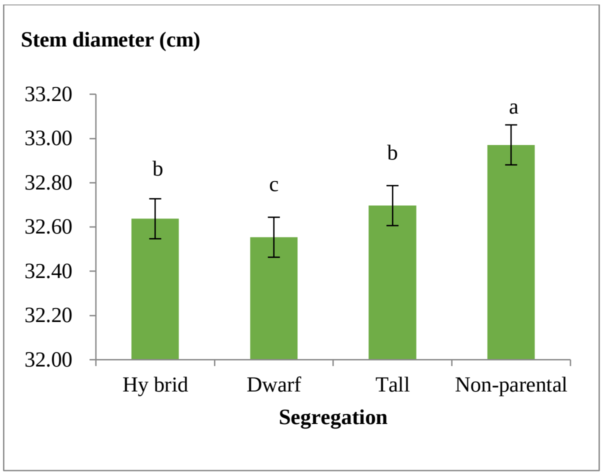

Figure 3: Vegetative data of the 2nd generation on stem girth. Bars with the same letter for each treatment are not significantly different at $P < 0.05$.

Morphology characters from 2nd generation and plants segregated.

The time taken to the flowering of each 2nd generation palm was recorded and the mean flowering time with the range appears in Table 1. The mean flowering time varies from 20 months to 36 months in the cross of dwarf and tall. There are no significant differences between the segregation crossed varieties. Table 2 shows the number of plants and percent that are segregated from 2nd generation plants.

It shows that segregation to hybrid was the highest number of plants compared to others with 116 or 58.00 % out of total samples.

The lowest segregation is significantly at non-parental varieties with 9 plants or 4.50% out of total samples. The work on describing and using within-population diversity and generating further diversity is longer-term and requires the specialties of the geneticist (Foale, 1992).

Table 1: Genotypes arising from 2nd generation of T x D crosses.

Variety segregation	Pollination behavior	Time to flower (month)
Hybrid	Inbreeding	32 a
Dwarf	Outbreeding	20 b
Tall	Outbreeding	36 a
Non-parental	Inbreeding	24 b

Mean value with the same letter for each treatment are not significantly different at $P < 0.05$

Table 2: Plants arising characters from 2nd generation of T x D crosses.

Variety segregation	No of plants	% of plants
Hybrid	116 a	58.00 a
Dwarf	36 b	18.00 b
Tall	39 b	19.50 b
Non-parental	9 c	4.50 c

Mean value with the same letter for each treatment are not significantly different at $P < 0.05$

The results on the flowering time were significantly revealed that the highest variation for the flowering time was generated. It is important to note that the progeny of the 2nd generation had the potential of generating the whole range of variation for a flowering time among the 200 individual studies.

The male phase of tall and dwarf varieties lasts for about 18 days but the female phase lasts for 5-7 days in Tall palms and 10-16 days in dwarf varieties (Liyanage, 1949).

Yield characters of segregation palm

A brief description of the segregation and recombination pattern of the identified vegetative, reproductive, and yield characters of 4 segregated palms were given in Table 3, figure 4, and table 4.

Table 2 shows the mean data of vegetative the 2nd generation of segregation variety for yielded plants. Out of 116 plants evaluated as shown in table 1, 63 or 54% of plants were yielded in hybrid segregation.

It was followed by a dwarf with 23 out of 36 plants or 64% and tall segregation with 9 out of 39 plants or 23%, whereas non-parental varieties were 6 out of 9 plants or 67%.

The inbreeding nature of the present material is assured by following a shorter female phase as of the Tall variety but with an overlap with the male phase.

When considering the vegetative and yield characters of the families indicated in Table 3, the highest nut number was recorded respectively elucidating the fact that these genotypes are resistant to inbreeding depression.

Figure 4 revealed the mean number of bunches per plant each year and potential nuts each bunch.

Significant differences ($P. < 0.05$) were shown for the amount of bunch each plant was estimated as highest at 14 in non-parental variety, followed by a dwarf with 11 bunches and hybrid segregation with 10 bunches, but unfortunately tall variety as the lowest recorded.

There, a potential number of nuts between the segregated families of palms was highest in the non-parental family with 12 nuts while dwarf shows the lowest potential for each bunch with 10 nuts.

Table 3: Vegetative parameter of 2nd generation T x D crosses for yielded plants

Variety segregated	No of plants	% of plants
Hybrid	63 a	54 a
Dwarf	23 b	64 b
Tall	9 c	23 c
Non-parental	6 c	67 a

Mean value with the same letter for each treatment are not significantly different at $P < 0.05$

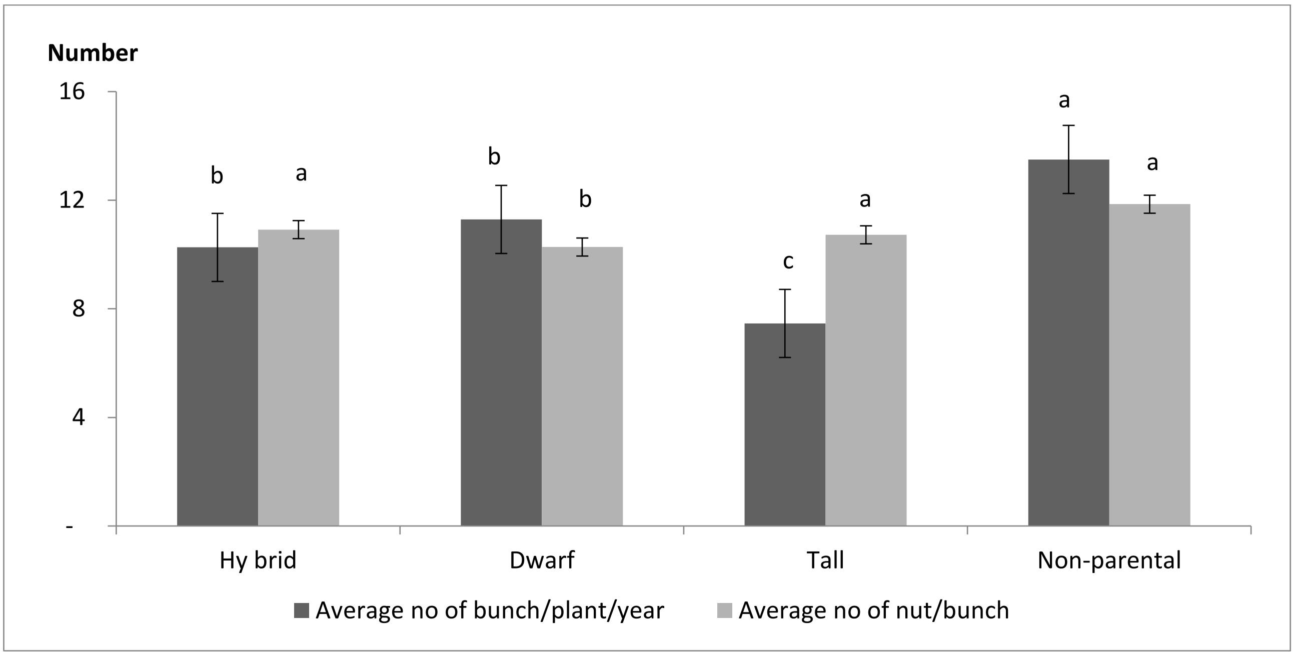

Figure 4: Yield parameters of 2nd generation T x D crosses for bunch and nuts. Mean value with the same letter for each treatment are not significantly different at P < 0.05

Yield data of the segregation families for yielded plants at parameter number of nuts and potential yield per hectare/year was mentioned in table 4. A significant difference in the yield of nuts/plants and nuts/hectare/year was observed between the segregated families. The palm of dwarf progeny shows the outbreeding behavior has a stature equivalent to a hybrid palm of 110 nut/ plant/ year but the potential nuts/hectare/year was highest with 25,816 compared to hybrid segregated progeny with 19,766. The bear's nuts numbers of 77/plant/year were examined on the Tall palm which potentially rises to only 10,932 of nuts/hectare/year.

IV. CONCLUSION

The segregation and combination of the morphology characters at the 2nd generation revealed significant and tremendous results on the growth behavior and yield segregates independently in the individuals of the families examined. The dwarf character of inbreeding, with tall stature, a stem height equivalent to tall variety, and high nuts counting.

This indicates the fact that inbreeding genotype could be combined with other desirable tall characters. The segregated palm of dwarf and hybrid significantly showed a very potential nut number of more than 19,000 and 25000 nuts /ha /year. It is possible to genetically tailor the individuals of Tall x Dwarf crosses of coconut by itself.

The finding could assist the farmers to have options in adapting the multi-variety of coconuts in their farming. The lines developed are expected to be early flowering with high yield and. resistance to environmental fluctuations as the genetic stability of the lines is assured by an additive nature of genes rather than the dominant heterozygous which would segregate, in the next generation as of the present F1 hybrids.

Table 4: Yield data of the 2nd generation segregation families for yielded plants

Variety segregated	No of nuts/ plant/year	Number of nuts	Potential No of nuts/ Ha/ Year
Hybrid	110 b	1,764 a	19,766 b
Dwarf	110 b	667 b	25,816 a
Tall	77 c	180 c	10,932 c
Non-parental	168 a	240 c	23,852 a

Mean value with the same letter for each treatment are not significantly different at P < 0.05

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