

EVALUATION OF GENOTYPES ARISING FROM F₂ GENERATION SEGREGATIONS IN DWARF X TALL CROSSES OF *COCOSNUCIFERA*

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ABSTRACT

Twenty seven F₂ generation palms belonging to selfed and crossed families of F₁, palms arising from a cross between dwarf green and Tall in *Cocos Nucifera* were studied for vegetative, reproductive and yield characters. The objective was to study the segregation patterns of the introgressed characters of the Dwarf x Tall hybrid in the F₂ generation and, to investigate the effects of selfing. An average of four palms were studied in each F₂ family.

The time taken for initial flowering was spread in a greater range in F₂ families arising from selfed F₁, compared to F₂ families originating from crossing two different F₁ palms. The pollination behaviour of the palms revealed to be segregating in two selfed F₂ families. Two palms, one in each F₂ family (selfed F₁) were found to be autogamous with overlapping male and female phases whilst the rest showed allogamy. Recombination of the autogamous nature along with the Tall characters were observed in the F₂ palms. The results suggest that the genetic control of the pollination behaviour is polygenic and an aggregate of several recessive genes are responsible for the autogamous nature of the palm. Certain genotypes arising from selfed families recorded high husked nut weights (650 - 700 gms) compared to crossed families indicating their resistance to inbreeding depression. The possibility of extracting recombined lines with desirable characters in order to improve the Sri Lankan Dwarf x Tall is also discussed

INTRODUCTION

The identification of the existence of hybrid vigour in inter-varietal crosses of *Dwarf x Tall* coconut caused a major break through in coconut breeding (Patel 1937). The F₁ hybrids exhibited precocity in bearing, high nut numbers and improved nut weights (Bhaskaran and Leela 1963; Liyanage 1956; Satyabalan et al 1970). Although the hybrids were at an obvious advantage in production potential, their stability in varying environmental conditions was at a low level. Bavappa et al (1973) reports that the dwarfness of the Dwarf Green 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. The Sri Lankan experience has shown that the farmer acceptance of Dwarf x Tall hybrid was not comparable with the levels of the traditional *Tall* cultivars or the improved tall. (Wickramaratne 1988). The theory of quantitative genetics provide interpretation to the above scenario, that along with the dominant and favourable alleles which bring the maximum heterosis for desirable characters, the recessive and unfavourable genes make their way into the cross thus decreasing its value. Therefore a long term strategy to remedy this situation is to eliminate the undesirable genes by selfing and selection which would also reduce the variability of the resulting progeny. Before initiating on this task it is important to study the segregation of characters in selfed generations of F₁, 's derived from *Dwarf green x Tall* crosses and investigate the nature of genetic control. The aim of this paper is therefore to determine the segregation patterns of the characters of economic importance in the F₂ families derived by selfing of F₁ 's of Dwarf green x Tall crosses. Numerous outbreeding crops such as maize, onion and Brussels sprout have taken the advantage of this method and significant yield improvements have indeed been made (Simmonds 1979). Not only these annual crops but also certain oil palm populations of exceptional value have been developed from advanced selections at F₃ and F₄, generations (Rosenquist 1986).

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MATERIAL AND METHODS

Selfed and controlled crossed progemies of seven randomly selected Dwarf green x Tall F₁ hybrid palms (Nos 125, 132, 144, 148, 157, 158 and 222) were planted in a fully randomized design at the Bandirippuwa Estate Lunuwila in June 1972 (Anon 1972). Of the F₂ population planted, seven families were selected for the present study on the basis at least 4-5 individuals of each family with contrasting morphological and reproductive characters were present. The breeding behaviour of each palm was determined by studying the duration of male and female phases. Height of the trunk of the palm as a measurement of vegetative growth was recorded. Yield data was gathered for 6 picks of 1994 on number of nuts and weight of 3 husked nuts from each palm. Analyses of variance tests were carried out to detect significant differences between the selfed and crossed families for flowering time, height and Yield data.

RESULTS

The time taken to flowering of each F₂ palm was recorded and the mean flowering time with the range appears in Table 1. The mean flowering time varies from 59 months in the selfed family of 144 to 76 months in the cross 158 x 125. No significant differences were present between the selfed and crossed families of individual F₁'s for flowering time. The range of flowering time within a family, varied from 11 months to 35 months. The two selfed families had the highest range for flowering time compared to the crossed families. The data on the breeding behaviour revealed that two palms out of the 27 individuals studied, showed overlapping male and female phases indicating autogamy. Both palms arose from selfs of 144 and 157. Data on the duration of male and female phases along with the period of overlap for 5 inflorescences opened during the period March to June of the two autogamous palms are given in Table 2. The mean number of days which the male phase lasted was 18 in both palms but the female phases were of the duration of 4 and 5 days. The whole duration of the female phase overlapped with the male phase in both palms.

The segregation of vegetative and Yield characters of the palms were of great importance. The family means for height of palms, number of nuts/palm and weight per husked nut appear in Table 3 along with the results of the analyses of variance tests. The amount of total copra was estimated as 32% of the husked nut weight multiplied by the number of nuts harvested during the period. Significant differences ($P=0.05$) were shown for number of nuts between the selfed and crossed families of palms nos. 157 and 125 and for mean husked nut weight between the selfed and crossed families of palm nos. 125 and 144. The mean height of palms; of the individual families varied from 4.6 meters to 7.3 meters at the age of 21 years from planting. Both extremes were observed in the selfed families of 157 and 144 respectively. The mean number of nuts for 1994 varied from 66 in the selfed families of 125 and 157 to 115 in the cross 158 x 125. The highest husked nut weight was recorded in the selfed family of 144 and it was of a magnitude of three fold of the mean husked nut weight of the cross 157 x 125. A significant difference in the yield of copra was observed between the selfed and crossed families of palm no. 144.

A brief description of the segregation and recombination pattern of the identified vegetative, reproductive and yield characters of 5 palms is given in Table 4. The palm no 4865 arising from the self of 144, shows inbreeding behaviour but has a stature equivalent to a Tall palm and bears nuts weighing 713 gms of mean husked nut which compares well with a standard nut from an elite Tall palm (700 gms) and a yield of 105 nuts/palm/yr. The palm No. 4945 arising from the self of 144 shows typical Tall characters along with a record yield of 164 nuts/palm/year. The palm no 4856 originating from the cross 157 x 125 is allogamous, shows a short stature and a reduced nut weight but with a yield of 198 nuts/palm/year.

DISCUSSION

The task of describing and using within population diversity and generating further diversity by strategic crossing is longer term and requires the special skills of the Geneticist (Foale 1992). The objectives of this paper are two fold. Firstly to study the patterns of segregation and recombination of characters in the selfed progenies of *Dwarf x Tall* hybrid crosses and to investigate the consequences of selfing on the characters of economic importance in coconut. Secondly to determine the possibility of developing lines combining the favourable characters of Dwarf and Tall varieties; in order to produce a viable alternative to the hybrid.

The results on the flowering time revealed that the highest variation for flowering time was generated. in the two selfed. families. It is important to note that the progeny of selfed 144 had potential of generating the whole range of variation for flowering time among the 27 individuals studies.

The autogamous nature of the two palms arising from the selfs of 144 and 157 was controlled by an overlap of the female phase lasting for about 4-5 days and. of a male phase of about 18 days. According to Liyanage (1 949), the male phase of Sri Lankan 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. 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. for the cross 158 x 125 but total yield was not the highest since the nut weight was small in this family. The highest nut weights were recorded in the selfed families of 144 and 125 with 633 gms and 603 gms respectively elucidating the fact that these genotypes are resistant to inbreeding depression. A total copra yield of 21 Kg was obtained by the selfed family of 144 with a superior mean annual nut Yield of 104. On the contrary the selfed family of 157 showed short stature, and low yield. Although there were no significant differences between the selfed and crossed families of palms 125 and 157 for mean copra weight, certain individuals with great potential for improvement were present among these families. The experience in Oil palm (*Elaeis guineensis*) was similar that extraordinarily superior lines of Oil palm were developed by selfing the crosses of the fruit forms tenera and dura resulting in a combination of favourable characters (Rajanaidu 1986)

The segregation and recombination of the characters at the F₂ generation revealed interesting results that stature, flowering time, breeding behaviour and yield segregates independently in the individuals of the families studied. The palm No 4865 arising from the self of 144, combines: the Dwarf character inbreeding, with tall stature, a high husked nut weight equivalent to Tall variety and high nut number. This indicates the fact that inbreeding could be recombined. with other desirable Tall characters. The palm 4856 recombines the short stature and reduced nut weight with allogamy and a very high nut number (198 nuts/palm/year). Considermig the above facts it is possible to genetically tailor the individuals of Dwarf x Tall crosses of coconut by selfing, provided. the level of selfing which would resist in breeding depression is detennined. Developing lines combining the autogamous nature and. early flowering with high yield and. resistance to environmental fluctuations: is indeed advantageous as the genetic stability of the lines are assured by an additive nature of genes rather than. the dominant heterozygous fonn which would segregate, in the next generation as of the present F₁ hybrids. Furthermore the benefits of this procedure could be harnessed immediately with the success of in-vitro propagation of coconut.

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Table 1. Mean flowering time for the F2 selfed and crossed families and Range (results of the F test for selfed vs cross families are given Where both families are present; ns = Pr. of F>0.05				
F1 palm No.	Cross	Mean F1 time (months)	Range (months)	Pr. Of the F test
125	125 x 125	73	55-84	ns
	125 x 144	68	56-80	ns
144	144 x 144	59	45-77	
	144 x 158	65	52-79	ns
158	158 x 157	69	59-79	
	158 x 125	76	71-82	-
157	157 x 125	60	54-65	-

Table 2. Description of the duration of male and female phases of 5 Inflorescens of the two autogamous palms					
Palm of	Date of Opening Of spathe	Male phase		Female phase	
		First day	Last days	First day	Last day
4865	15/2	16/2	9/3	3/3	7/3
	11/3	13/3	24/3	18/3	22/3
	16/4	18/4	4/5	29/4	3/5
	2/5	4/5	24/5	16/5	22/5
	2/6	5/6	20/6	14/6	18.6
Mean (days)		Male phase	18	Female Phase	5
4917	26/2	27/2	21/3	16/3	18/3
	23/3	25/3	11/4	7/4	9/4
	16/4	18/4	4/5	29/4	3/5
	6/5	8/5	23/5	19/5	21/5
	26/5	28/5	15/6	10/6	13/6
Mean (days)		Male phase	18	Female Phase	4

Table 3. Vegetative and yield data of the F2 selfed and crossed families (significant levels of the F test are given for selfed vs crossed families; *, Pr = 0.05; ns = not significant)								
yield in 1994								
Cross	Mean height (meters)		Mean no. Nuts		Mean husked Nut wt/nut/gms		Total copra (kg)	
		Pr.		Pr.		Pr.		Pr.
125 x 125	5.00	ns	66	*	603	*	12.7	ns
158 x 125	5.65		115		443		15.9	
144 x 144	7.28	ns	104	ns	633	*	21.1	ns
125 x 144	7.44		92		417		12.3	
157 x 157	4.60	ns	66	*	352	ns	7.4	ns
157 x 125	5.41		133		248		8.9	

Table 4. Five genotypes arising from selfed and crossed families showing Segregation and recombination of characters						
Cross	Progeny No.	Time to Flower	Pollination Behavior (months)	Height (m)	No. nuts 1994	Husked Nut wt (gms)
144 x 144	4945	80	Outbreeding	7.47	164	554
	4865	52	Inbreeding	7.70	105	713
157 x 125	4856	63	Outbreeding	4.71	198	271
	4907	54	Inbreeding	6.57	126	260
157 x 157	4917	48	Inbreeding	4.66	66	352