RP 107

Reprint from the Indian Coconut Journal, Vol. XVII, No. 4
July-September 1964. Pages 155—164

Coconut Breeding: A comparative study of Tall x Dwarf, Tall x Gangabondam and Tall x Tall hybrid seedlings in the nursery for maximum expression of vigour

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K. SATYABALAN, M. V. GEORGE and V. RADHAKRISHNAN,

Central Coconut Research Station, Kasaragod

M. T. M. Press, Ernakulam.

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INTRODUCTION

THE exploitation of heterosis of hybrid vigour has now become a potent tool in plant breeding. Its utilisation in the improvement of forestry and agriculture has been widely appreciated in the modern scientific world. In a perennial crop like the coconut also the manifestation of hybrid vigour has been recorded by earlier workers and the possibility of its wide application for the improvement of the crop has been recognised by coconut breeders throughout the world. Patel (1937) was the first to show that hybrid vigour was met with in the coconut from a study of seedling characters of crosses between selected palms of tall variety. He also observed that maximum vigour was obtained in the crosses between the tall variety as female parent and the dwarf variety as pollen parent on the basis of seedling characters like the height, girth at collar and number of leaves which he considered as the criteria for ascertaining the degree of vigour exhibited by the seedling. According to him, it would seem that the quickest method and even possibly more fruitful would be the utilisation

of hybrid vigour through controlled cross-pollination. Since then a number of research workers on coconut have confirmed the occurrence of hybrid vigour in the progeny of tall female and dwarf male crosses. John and Narayana (1943) from a study of the progenies to the bearing stage established that they combine the desirable early flowering nature of the dwarf parent with the economic nut characters of the tall parent. Rao and Koyamu (1952) reported the existence of hybrid vigour in the seedlings obtained by crossing tall (female) and dwarf (male) and indicated the possibility of utilising this desirable phenomenon in coconut breeding. Liyanage (1955) has stated that there is an expression of marked hybrid vigour in certain combinations of varieties and forms of coconut. He (1956) also confirmed the early flowering nature of the tall x dwarf hybrids and noticed the production of inflorescences at shorter intervals due to the extra vigour of the F_1 progenies. Anon (1961) has reported that Tall x Dwarf seedlings displayed more hybrid vigour than Dwarf x Tall. According to Fremond (1961) breeding of coconut palms on the tropical Pacific Atolls is based on the phenomenon of heterosis, the existence of two complimentary forms of var. *typica* and the possibility of *typica* x *nana* crosses. Besides tall x dwarf, manifestation of hybrid vigour has been reported in certain other combinations also. Liyanage (1960, 1961) has reported that *typica* x *pumilla* hybrids showed heterosis. Anon (loc. cit.) had stated that tall x Gangabondam hybrids are superior to their parents in most characters. According to Pieris (1960) the progenies of *typica* and *spicata* crosses conducted in the Agricultural Research Station, Nileshwar (Kerala) showed hybrid vigour. From the above references it is evident that manifestation of hybrid vigour has been noticed in tall x tall, tall x dwarf and tall x Gangabondam crosses besides in other combinations. Increased productivity in coconut through hybrid vigour has been advocated by Harland (1957) who has stated that it is important that crosses be made between the large number of races of coconut scattered throughout a wide area. In this paper is presented results of a comparative study of the seedlings of three groups of hybrids, namely, tall x dwarf, tall x Gangabondam and tall x tall obtained from the same female parents to find out which combination has maximum expression of hybrid vigour manifested based on the characters studied.

MATERIALS AND METHODS

The coconut (*Cocos nucifera* Linn.) is divided into five varieties by Narayana and John (1949). Among them are (1) Tall var. *typica* Nar. (2) Dwarf var. *nana* (Griff) Nar. and (3) Intermediate between the tall and the dwarf var. *javanica* Nar. In the third variety is included the Gangabondam, an indigenous type cultivated in certain tracts of Andhra State. Fifty mother palms of the tall variety selected on the basis of yield and other desirable characters were fixed as female parents. A few selected palms of the tall variety, a few of green dwarf and a few palms of Gangabondam were selected

as pollen parents. In each female parent separate inflorescences were pollinated with the pollen of the tall, dwarf and Gangabondam. The hybrid nuts obtained from each bunch of all the fifty female parents were utilised for study. They were sown in the nursery and the seedlings raised under identical conditions. Daily observations on the sprouting of the seednuts in the nursery were made and recorded. Seedling characters such as girth at collar and number of leaves produced were taken for all the hybrid seedlings when they were exactly eight months old. The age of the seedling was calculated from the date of sprouting of the hybrid nut in the nursery. All precautions were taken to eliminate errors due to factors like month of harvest, individual tree differences etc.

RESULTS

The data were statistically analysed and the results are presented in Table 1. The three measurable characters studied, help in assessing the vigour of the seedlings. In the time taken for sprouting, the tall x Gangabondam hybrid seedlings took lesser number of days than tall x dwarf and tall x tall hybrids. The time taken for sprouting of the nuts gives an indication of the potential earliness of the hybrid seedlings. In this respect the tall x Gangabondam hybrids are significantly superior to the other two combinations. There is not much difference between tall x dwarf and tall x tall in this particular character. In respect of girth at collar, the tall x Gangabondam hybrid seedlings are significantly superior to tall x tall hybrids. Between tall x Gangabondam and tall x dwarf hybrids though the difference is not significant, tall x Gangabondam hybrids are superior to tall x dwarf hybrids. Comparison between tall x dwarf and tall x tall indicates that tall x dwarf hybrids are slightly better than tall x tall hybrids, though the difference is not significant. As regards the number of leaves produced, tall x Gangabondam and tall x dwarf hybrids are significantly superior to tall x tall hybrids. Between tall x Gangabondam and tall x dwarf combinations there is no difference.

DISCUSSION

The present study has revealed that on the basis of the three characters studied, the tall x Gangabondam hybrids are significantly superior to tall x tall hybrids. They are significantly superior to tall x dwarf hybrids as regards early sprouting. In respect of girth at collar they are better than tall x dwarf though the difference is not significant and in leaf production they are equal to tall x dwarf. In respect of early sprouting the tall x Gangabondam hybrids took lesser number of days to sprout than tall x dwarf and tall x tall hybrid nuts. The early sprouting of the nuts gives an indication of the potential earliness of the seedlings to early maturity. According to Menon and Pandalai (1958) early germination is a very important criterion for seedling selection. Patel (1938) has stated that seedlings from early germinated nuts have a quicker rate of leaf production and since large number of leaves is correlated with early flowering and heavy yields, early germinated seedlings

should be selected. Liyanage (1955) has reported a positive correlation between periods taken for sprouting of seednuts and flowering of palms and a negative correlation between sprouting and yield indicating that when seednuts sprout early they give rise to palms that flower in a shorter period and are more productive than those that are grown from seednuts that sprout late. Jack and Sands (1929) are also of the same conclusion that early germinated seedlings will flower early. Charles (1959) has also stated that experimental results showed that higher yields in the early years of bearing were obtained from seedlings grown from early sprouting nuts. The other two characters studied were of the seedling, namely, the girth at collar and the number of leaves produced during a particular period. In these characters also tall x Gangabondam hybrid seedlings were significantly superior to tall x tall hybrids. They were decidedly better to tall x dwarf in respect of girth at collar, though in leaf production there was no difference between these two groups. Menon and Pandalai (loc. cit.) have stated that the vigour in the seedlings is indicated by the vegetative characters relating to growth such as number of leaves, height of leaves and girth at collar, the combined effect of which is reflected in the weight of the seedlings. All these characters are found correlated with the weight of the seedlings but girth at collar appears to be more important than the height. In this study, only the girth at collar and number of leaves produced were taken into consideration for assessment of vigour in the seedlings. According to Liyanage (1955) and Charles (1959) vigour is determined from the girth at the base of the shoot besides others like size, spread and colour of the leaves, etc. Nambiar and Nair (1962) have stressed the importance of selection of seedlings in the nursery based on measurable vegetative characters like girth, height and number of functioning leaves. The results of correlations worked out by Patel (1958) also indicate that trees with a large number of leaves commence their reproductive phase earlier than the trees having a low number of leaves. How far these seedling characters are correlated with the adult performance is yet to be ascertained. It is quite likely that the vigour exhibited by the seedling may fore-shadow subsequent higher yield. Aston (1949) has stated that in general heterosis is exhibited early in plant development, in faster growth in the seedling stages, it may also be observed in the later stages. Patel (1937) has made a detailed study of seedling characters and has come to the conclusion that the number of leaves, the height and girth are the only available characters to judge the vigour of the seedlings in coconut. According to him, it does not seem objectionable to take the number of leaves, the height and the girth as the criteria for ascertaining the degree of vigour exhibited by the seedlings. Menon and Pandalai (loc. cit.) state that selection of seedlings in the nursery is based on characters which are believed and in some instances actually proved to be associated with good yield in the adult palm such as early germination, rapidity of growth, early splitting of leaves into leaflets, vigour, sturdiness and freedom from pests and diseases. John and Narayana

(loc. cit.) have produced additional evidence to show that the hybrid vigour of the tall x dwarf hybrids manifested in the nursery continues beyond the seedling stage.

It is expected that crosses between widely different varieties usually give a greater degree of hybrid vigour than crosses between less diverse varieties. Liyanage (1955) has stated that there is an expression of marked vigour in certain combinations of varieties and forms of coconut. Patel (1937) has recorded that maximum vigour has been obtained in the crosses between the tall mother and the dwarf father, because they are the crosses between two widely separated races and therefore they naturally exhibit very good vigour. Gangabondam has been classified under another distinct variety called *javanica* by Narayana and John (loc. cit.). As it is considered a separate breed it can be expected that tall x Gangabondam hybrids also will exhibit marked vigour.

Based on the characters studied maximum expression of vigour manifests in the tall x Gangabondam hybrids when compared with tall x dwarf and tall x tall hybrid seedlings. It has also been reported (Anon. 1961) that tall x Gangabondam hybrids are superior to their parents in most characters. Hence it can be safely presumed that tall x Gangabondam hybrids will be superior to tall x dwarf and tall x tall hybrids in their yield performance also as they exhibit maximum expression of vigour among the three combinations of seedlings studied in the nursery.

SUMMARY

A comparative study of tall x dwarf, tall x Gangabondam and tall x tall hybrid seedlings obtained from fifty female parents in the nursery on the basis of the three characters, namely, number of days taken for sprouting of the nut, girth at collar of the seedling and number of leaves produced by it at a particular period has indicated that tall x Gangabondam hybrids are significantly superior to tall x tall hybrids for all the three characters studied. They are significantly superior to tall x dwarf with regard to early sprouting of the nut and are definitely better to tall x dwarf in respect of girth at collar and are almost equal to tall x dwarf hybrids as regards the production of leaves. Since the seedling characters studied are indications of the vigour of the plant it can be said that tall x Gangabondam hybrid seedlings are the most vigorous when compared to the other two combinations. Expression of maximum vigour is noticed in tall x Gangabondam hybrids than in the other two combinations. As tall x Gangabondam hybrids are reported to show hybrid vigour and are superior to their parents in most characters it is expected that this combination will be superior to tall x dwarf and tall x tall hybrids in their yield performance also.

ACKNOWLEDGEMENT

The authors are indebted to Dr. K. M. Pandalai, Director, for the keen interest he has evinced in this work.

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Received in November, 1964

TABLE 1

Progeny means of hybrids for number of days taken for sprouting, girth at collar and number of leaves

Sl. No.	Mother palms (Female parents) Field	Tree No.	Progenies (Hybrids) Average no. of days taken for sprouting T x D A	T x G B	T x T C	Average girth at collar (cms) T x D A	T x G B	T x T C	Average number of leaves T x D A	T x G B	T x T C
1	2	3	4	5	6	7	8	9	10	11	12
1.	I	11	121.2	58.0	63.3	10.0	10.2	9.3	4.8	6.0	4.7
2.	,,	24	96.4	56.0	85.0	11.4	10.8	8.3	5.9	6.0	5.0
3.	,,	34	71.1	97.5	89.6	8.9	10.0	8.8	5.7	6.4	5.0
4.	,,	41	76.1	54.6	84.3	9.6	11.2	10.6	5.3	6.0	5.3
5.	,,	58	108.6	25.0	70.1	10.1	10.1	8.2	5.3	5.0	4.6
6.	,,	90	64.8	74.9	69.8	8.9	9.2	10.0	5.3	5.1	5.4
7.	II	27	49.6	50.6	61.5	10.9	10.4	10.3	5.4	5.4	5.3
8.	,,	40	97.0	61.1	79.0	9.4	9.5	9.7	5.5	5.1	5.0
9.	,,	62	102.4	117.9	95.7	9.8	9.5	8.7	5.9	5.6	5.5
10.	,,	95	79.3	74.2	79.2	9.1	8.9	8.6	5.4	5.5	5.2
11.	IV	42	38.6	59.0	51.0	9.9	10.0	9.2	5.3	5.0	5.5
12.	VI	131	96.4	50.5	91.0	10.1	10.3	9.2	5.8	5.5	5.3
13.	VII	27	125.5	73.3	108.0	10.5	9.8	10.4	5.2	5.8	6.0
14.	VIII	55	77.7	72.0	89.0	10.1	8.9	10.1	5.7	5.7	5.4
15.	,,	56	89.8	50.0	62.2	10.2	10.9	9.6	5.2	6.6	5.0
16.	IX	137	67.8	68.3	125.8	10.2	10.3	11.4	5.4	5.7	6.5
17.	,,	151	75.3	56.0	69.0	9.8	10.2	9.6	5.4	6.0	6.0
18.	X	11	51.5	41.1	56.5	9.4	9.9	9.9	5.3	5.3	5.4

Mother palms (Female parents)			Progenies (Hybrids)								
			Average no. of days taken for sprouting			Average girth at collar (cms)			Average number of leaves		
Sl. No.	Field	Tree No.	T x D A	T x G B	T x T C	T x D A	T x G B	T x T C	T x D A	T x G B	T x T C
1	2	3	4	5	6	7	8	9	10	11	12
19.	X	15	82.9	107.0	122.6	9.1	8.8	9.4	5.4	5.0	5.8
20.	,,	26	81.7	86.5	88.0	9.1	8.8	9.5	5.4	5.2	5.0
21.	,,	31	64.0	71.3	102.5	9.8	10.6	10.3	6.0	6.0	5.0
22.	,,	35	68.9	43.3	106.9	10.3	9.7	10.3	5.9	5.2	5.2
23.	O.C.	1	65.2	62.9	57.7	10.6	10.9	10.3	6.4	5.8	6.2
24.	,,	22	116.0	66.6	79.5	10.0	10.2	10.8	6.0	5.7	5.5
25.	,,	34	89.3	56.5	66.8	9.8	9.4	8.9	6.1	6.3	6.0
26.	,,	59	75.6	91.7	87.4	9.5	10.9	9.6	5.2	5.7	4.8
27.	39/2-1	138	51.4	41.0	73.3	9.6	9.8	10.2	5.7	6.1	5.5
28.	,,	144	73.5	72.3	97.6	9.4	10.7	10.7	5.4	6.1	5.5
29.	,,	205	84.0	145.0	93.5	10.1	10.1	10.5	6.1	5.1	5.8
30.	,,	286	79.8	62.2	114.6	9.6	9.6	9.5	5.7	5.8	5.7
31.	R.S. 40	484	78.3	113.0	62.0	10.1	8.8	10.6	5.6	5.0	6.0
32.	,,	513	102.5	95.0	92.0	12.5	12.0	9.4	6.8	6.0	5.0
33.	R.S. 41	489	118.4	45.0	61.5	10.6	10.3	9.7	5.5	5.5	4.7
34.	,,	491	69.8	108.9	102.8	10.2	9.4	8.6	5.4	5.1	5.4
35.	,,	588	76.1	82.1	86.9	11.3	11.5	9.9	5.9	6.1	5.5
36.	E.B.	121	101.3	71.0	89.0	9.7	11.1	9.5	5.0	6.0	5.6
37.	,,	146	80.9	67.0	58.3	10.8	10.8	9.4	6.2	6.0	5.0
38.	27. S.	171	98.6	91.5	93.5	12.2	11.5	10.6	6.2	5.3	5.3
39.	,,	277	75.4	60.8	58.3	10.6	11.0	11.2	6.0	6.2	6.3

Sl. No.	Mother palms (Female parents)	Tree No.	Progenies (Hybrids) Average No. of days taken for sprouting T x D A	T x G B	T x T C	Average girth at collar (cms) T x D A	T x G B	T x T C	Average number of leaves T x D A	T x G B	T x T C
1	2	3	4	5	6	7	8	9	10	11	12
40.	27. N.	196	88.6	50.5	62.0	9.9	10.4	10.4	5.7	5.5	4.5
41.	,,	356	73.7	91.0	84.5	10.0	9.1	10.7	5.9	4.0	6.0
42.	,,	358	73.9	84.6	90.9	9.8	10.9	10.7	5.9	6.3	5.6
43.	,,	378	95.6	56.5	58.1	10.4	9.9	10.7	5.4	5.8	5.6
44.	29. S.	91	82.7	78.8	71.3	9.5	10.0	9.8	5.0	5.4	5.3
45.	,,	277	65.5	94.0	89.5	10.3	11.0	9.4	6.5	6.5	5.4
46.	,,	305	81.1	97.0	85.7	9.7	8.9	8.9	5.2	4.8	4.9
47.	29. S.	309	74.1	93.6	84.5	10.9	10.4	10.6	6.2	6.3	7.0
48.	29 N	170	95.1	99.0	80.4	9.9	10.1	9.9	5.3	6.6	5.7
49.	,,	312	68.0	97.0	84.0	9.8	9.5	9.2	5.1	5.4	5.1
50.	,,	337	102.7	89.0	69.6	9.3	10.2	9.6	5.6	5.0	5.4
Total No. of seedlings studied			382	360	399						
Mean			87.44	79.90	81.70	10.03	10.13	9.81	5.64	5.64	5.63
Standard Error			13.46	23.33	17.86	0.77	0.82	0.75	0.42	0.53	0.50
Whether differences significant (P=0.05)				Yes			Yes			Yes	
C. D. at 5% (between hybrids)				7.33			0.26			0.17	
Conclusion				A C B			B A C			A B C	