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Reprinted from: PLACROSYM-V : 1982 : pp. 131-137.
Proceedings of the Fifth Annual Symposium on Plantation Crops,
held at CPCRI, Kasaragod in Dec. 15-18, 1982.
Sharada Press, Mangalore-575 005
November, 1984

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ABSTRACT

A diallel programme with 36 crosses and nine parents was undertaken to analyse the general and specific combining abilities (*gca* and *sca*) of nine coconut cultivars of diverse origin, and their hybrids, for five important characters. Results of diallel analysis showed that girth, height, total leaf production and leaf production during the year, were significant among the characters studied. The cross combinations, Laccadive Ordinary × Jamaica, and Fiji × Jamaica exhibited high *sca* effects for total leaf production and leaf production during the year. Laccadive, Jamaica, Java, Fiji and San Ramon cultivars proved useful as parents among the Tall cultivars. The D × T and T × D crosses involving Gangabondam as the dwarf parent flowered early. The total leaf production was also high in these crosses. In T × T crosses, Java × SS Green, Laccadive Ordinary × Jamaica, and Fiji × Jamaica flowered early.

INTRODUCTION

Coconut occupies a unique position among the commercial crops of India. The need for developing early flowering, high yielding hybrids suitable for different areas, and less susceptible to pests and diseases, has been keenly felt. To achieve this objective a diallel programme involving 36 crosses among nine parents, was undertaken for the first time. Nine different coconut cultivars of diverse origin were selected to study their general and specific combining abilities, in order to understand not only the genetic make-up of diverse parental materials, but also to provide useful information on breeding potential of selected genotypes. By introducing new, exotic varieties, the variability can be increased in existing coconut populations. The number of nuts of Tall palms required to produce 1 ton of copra is said to be 4500 in Philippines, 4,800 in Ceylon, and 6,000 to 8,000 in South India and Pacific Islands. Similar variations exist within countries. In San Ramon

variety of Phillippines, and certain Tall forms in other parts of the world the out-turn index is 2,800 to 3,300, and in the dwarf palms and few other Tall forms with very small nuts, it varies from 8,400 to 10,000.

Based on fruit analysis of important commercial varieties of coconut in Fiji, Satyabalan (1972) showed that the same variety grown in different islands showed great variation for different characters studied. Kannan and Nambiar (1974) using Gangabondam as male parent in crosses with six Tall types, found that Laccadive Ordinary × Gangabondam combination was superior to all others in respect of leaf production, fruit-set, nut yield and copra out-turn. Satyabalan *et al.* (1964) observed that the West Coast Tall × Gangabondam hybrid was significantly better than Tall × Tall hybrid with respect to number of days taken for germination, girth at collar and total number of leaves, and better than other Tall × Dwarf hybrids, in days taken for germination. WCT × G also had greater collar girth than the WCT × CDO hybrids and produced almost as many leaves. Narasimhayya and Sukumaran (1978) worked out heritability values as above 50 per cent, for plant height, total leaf production and time taken for flowering, observed at different stages of growth in West Coast Tall cultivar. Lamothe *et. al.* (1980) mentioned that the coconut breeding method chosen by IRHO is based on estimation of combining abilities between individuals or origins and phenotypical choices for heritable characters.

Materials And Methods

Nine cultivars, West Coast Tall, Laccadive Ordinary, San Ramon, Fiji, Jamaica, Java, Gangabondam, S.S.Green, and New Guinea, selected for this diallel mating system were planted during the years 1972 and 1973. They were crossed in all possible combinations (excluding reciprocals). A cultivar was taken as a unit, and mixed pollen of each was used separately for pollination. Thus, 360 seedlings belonging to 36 crosses and nine parents were planted at CPCRI Kasaragod in two replications of RBD with four seedlings in each plot, at a spacing of 7.5 × 7.5m^2 Observations on five important growth characters: (1) girth, (2) height, (3) total leaf production, (4) leaf production during

the year, and (5) number of functional leaves on the crown, were recorded during 1981-82. The method of diallel analysis used here is based on that of Griffing (1956), applicable generally to diallel crosses n (n-1)/2, where n is the number of varieties to be tested namely, 9(9-1)/2 =36.

Results And Discussion

Table-1 gives a list of good general and specific combiners with regard to various characters under study. Diallel analysis shows that the treatment and general combining ability differences are found to be significant for girth, height, total leaf production, and leaf production during the year, whereas the specific combining abilities are found to be significant only with regard to total leaf production. A perusal of Table 2 indicates very high $\frac{\sigma^2}{e}$ (environ-

Table 1. Good general and specific combiners for different characters

Character	Good general combiners	Good specific combiners
Height	Java (+)* Gangabondam (-)*	West Coast Tall×Laccadive (-) Laccadive×Fiji (+) Laccadive×Jamaica (+) Laccadive×Java (-) Laccadive×SS Green (+) Jamaica×Gangabondam (-) Java×Gangabondam (-)
Girth	Gangabondam (-)* San Ramon (+)* Jamaica (+)	Laccadive×Gangabondam (+) Gangabondam×New Guinea (-)
Total leaf production	Gangabondam (+)* West Coast Tall (-)*	*Laccadive×Jamaica (+) *Fiji×Jamaica (+) *Java×Gangabondam (-) Java×SS Green (+)
Leaf production during the year	San Ramon (+) Gangabondam (+) New Guinea (-)	Laccadive×Jamaica (+) Fiji×Jamaica (+) Java×SS Green (+)
Number of functioning leaves	West Coast Tall (-)	Laccadive×Jamaica (+) Fiji×Jamaica (+)

*Significant at 5% level
+indicates positive value for combining ability
-indicates negative value for combining ability

Table 2. Table showing estimates of components of variance

Character	σ^2 GCA	σ^2 SCA	σ^2 e	σ^2 a	σ^2 d
Height	589.00*	721.00	1160.00	1177.00	720.84
Girth	29.72*	0.00	38.06	59.44	0.00
Total leaf production	2.89*	13.09*	18.83	5.78	13.09
Leaf production during the year	0.1132*	0.1664	0.5583	0.2264	0.1664
No. of functional leaves	0.00	0.7241	4.5884	0.00	0.7241

*Significant at 5% level

Zeros indicate negative values of the variance estimates.

mental variance) which may be the main cause for not detecting the significance of the specific combining ability differences with regard to the remaining characters also. Table-2 also indicates the larger additive genetic variances with regard to height, leaf production during the year, and girth, compared to dominance variances, whereas with regard to total leaf production, dominance variance is larger compared to additive genetic variance. The estimates of general combining ability and the additive genetic variances for number of functional leaves, and specific combining ability for girth are found to be negative. Since variances cannot take negative values, zero values are shown against them.

Java is found to increase plant height and Gangabondam decreases height in their hybrid combinations with the cultivars selected in the trial. Laccadive Ordinary induces greater height in F_1 when crossed with Jamaica and Fiji, whereas it decreased the height when crossed with Java and SS Green. Jamaica also increased height and Java decreased it in the F_1 hybrids with Gangabondam.

San Ramon and Gangabondam increased leaf production during the year whereas New Guinea decreased the same. The crosses of Laccadive Ordinary and Fiji with Jamaica, and Java × SS Green, also increased the leaf production during the year.

When Tall cultivars are crossed with Gangabondam the pre-flowering leaf production increased in their T×D hybrids. In crosses of Laccadive and Fuji with Jamaica, and in Java×SS Green also, the total leaf production increased.

San Ramon, Jamaica, Java and West Coast Tall are good general combiners for girth. In West Coast Tall, the girth of seedlings showed a high correlation with yield. Gangabondam decreased the girth, whereas San Ramon and Jamaica induced larger girth in their F_1 hybrids. Gangabondam when used as male parent in crosses with Laccadive Ordinary, increased girth, but as a female parent in crosses with New Guinea, it decreased the girth.

Thus, the choice of parents should be based not only on their combining ability for one main component, but also on their merit in cross combinations with other major components.

The results presented in Table-3 also show that both D×T and T×D crosses involving Gangabondam as the Dwarf parent flowered early. The total leaf production is also high in these crosses. The results indicate that the Dwarf parent induces early flowering. The data also shows that the T×T crosses namely, Java×SS Green, Laccadive×Jamaica, Fiji×Jamaica, and Fiji×SS Green also flowered early. Lamothe *et al.* (1980) showed that the T×T hybrids are as precocious and productive as D×T. West African Tall×Rennel Tall crosses had produced 14.3 tons of copra/ha by the end of 9th year which is the same as that of MAWA hybrid PB-121, and 2.27 times more than that of the West African Tall control. These results justify the undertaking of studies on individual combining abilities of Rennel and West African Talls. Diallel cross analysis also shows that Laccadive×Jamaica, and Fiji×Jamaica are also good combiners for total leaf production and leaf production during the year.

Conclusions

A study of the effects of general and specific combining abilities would indicate better combinations involving one or both parents of high *gca* effects, for exploitation in breeding programmes. Laccadive Ordinary, Jamaica, Java, Fiji and San Ramon

Table 3. Mean values of morphological characters and flowering in diallel cross progenies

Cross	Total Plants	No. of seedlings flowered	Time taken for flowering (months)	Flowering leaf axil No.	Total leaf production	Total height (cm)
Gangabondam as a male parent in T×D crosses						
Laccadive×G	8	7	64.3	48.3	88.5	555.8
Fiji×G		6	67.3	54.4	85.1	695.3
Java×G		5	72.7	50.7	73.7	549.4
West Coast Tall×G		6	74.7	51.9	80.8	606.7
San Ramon×G		8	75.8	61.3	90.8	515.3
Gangabondam as a female parent in D×T crosses						
G×S. S. Green	8	8	53.0	44.3	91.9	545.0
G×New Guinea	8	7	42.7	40.0	93.7	524.7
Tall×Tall crosses						
Laccadive×Jamaica	8	7	69.7	60.1	94.4	722.8
Fiji×Jamaica		6	69.8	52.7	86.4	628.7
Java×S.S. Green		6	69.3	52.2	92.5	681.7
Fiji×S.S. Green		8	70.8	55.8	89.5	675.6
Laccadive×Fiji		6	71.9	55.9	83.9	655.8
West Coast Tall×Java		6	78.8	55.4	78.4	704.3
W.C. Tall×Laccadive		8	80.8	53.5	77.8	527.9
S.S. Green×New Guinea		5	80.7	57.4	82.0	658.8
Jamaica×S.S. Green		6	87.9	50.1	83.1	642.3
Laccadive×San Ramon		7	87.8	68.6	85.5	636.1

are found to be useful parents among the Tall varieties, and Gangabondam Dwarf parent induces early flowering in both D×T and T×D cross-combinations.

ACKNOWLEDGEMENT

I wish to thank Dr. K. V. Ahamed Bavappa, Director, Central Plantation Crops Research Institute, for providing facilities; Dr. R. D. Iyer, Head, Division of Genetics, for guidance, scrutiny of the manuscript and valuable suggestions; Sri M. V. George and Sri G. Narasimhayya Biometricians, for help in statistical analysis and interpretation of the data. Thanks are also due to Drs. M. C. Nambiar and K.U.K. Nampoothiri who were associated with this work during the initial stages.

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DISCUSSION

C. S. SRINIVASAN (Coffee Res. Sub-Station, Chethalli):

1. Which is more important in coconut breeding, G.C.A. or S.C.A.?
2. Whether homozygosity of the parents was assured before taking up diallel crossing, as it is a prerequisite?

C. K. SUKUMARAN: (1) SCA is more important; (2) Homozygosity has not been assessed but material was drawn from a relatively homogeneous population.

K.U.K. NAMPOOTHIRI (CPCRI, Palode): The author recommends production of T×T crosses in view of the earliness of some combinations. This interesting observation needs thorough deliberation before publication.

C. K. SUKUMARAN: This point can be fruitfully deliberated when the yield of these palms also become available.