

EFFECT OF INBREEDING ON SOME CHARACTERS OF THE COCONUT PALM

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Data of inbred and open-pollinated progenies relative to endosperm weight, embryo weight, leaf production and flowering-period are presented. There has been an inbreeding depression in all these characters, but the intensity has varied between families. There are indications that the rate of depression on endosperm weight and embryo weight is related to the breeding value of the seed parent.

INTRODUCTION

Two genetical principles—general combining ability and specific combining ability—have been used largely in breeding perennial crops. In crops that are propagated vegetatively, specific combining ability has been the main theme in producing high-yielding strains, e.g. Rubber and Cocoa. Remarkable advances have been made during the last 20 years or so in the production of high-yielding clones of rubber by the use of bi-parental crosses. The use of this method has rather restricted application in coconuts, as only a few seed-nuts are produced per palm per year, and there are no known methods of vegetative propagation. Even if successful bi-parental crosses are evolved, mass production of seed would not be possible. Thus, for the time being, emphasis has to be on general combining ability in a coconut breeding programme.

The high phenotypic value (copra) of a seed parent may be due to the additive or non additive effects of genes, and in the latter case the genotype is likely to break down and the progeny may not be true to type with respect to yield. The problem facing the coconut breeder is how to screen the latter type of palm during a reasonable period of time and eliminate them as seed parents. A possible approach to the problem is to ascertain correlations between juvenile characters of the progenies and the breeding value of the seed parent. The total number of leaves produced during the first 40 months per progeny within families of the best 10 percent palms in a block, is correlated to the breeding value of the seed parent. Thus, palms of high-yielding value could be identified tentatively within $3\frac{1}{2}$ years as against the usual 12 years required on a basis of progeny testing for yield (Liyanae, 1967).

The following is a preliminary report on the effect of inbreeding on endosperm weight, embryo weight, leaf production of young palms and on the flowering-period. The relationship between the inbreeding depression on the first two characters and the breeding value of the palm has been studied.

MATERIAL AND METHODS

Experiment 1*

Eight high-yielding coconut palms (var. *typica*) each giving a mean weight of over 45 lb. copra per year were selected from a population of 104 palms, whose breeding values were known. Two to three inflorescences from each palm were self-pollinated and two inflorescences were left for open pollination. Every alternate inflorescence was open-pollinated, taking care not to allow any inter-spadix pollination within the palm. Nuts were harvested during the 52nd week after pollination, and the wet weight of the endosperm and of the embryo were recorded on the 7th day after harvest.

Experiment 2

Twenty four palms of the *typica* variety from another population were taken at random and pollinations were carried out as in experiment 1. Nuts were harvested 12 months after the date of pollination and were planted in a nursery two weeks later. The seednuts sprouted between November 1960 and February 1961 and the seedlings were transplanted without any selection in May 1961.

Since all the pollinations were not successful, those families without 4 progenies, either selfed or open-pollinated were discarded. Progenies of 17 parents were transplanted in a randomised layout in a single block. After leaving out the casualties in the field, 257 progenies of 17 parents were available for analysis and their distribution is given below.

Palm No.	No. of progenies		Palm No.	No. of progenies	
	selfed	open- pollinated		selfed	open- pollinated
10	7	4	386	9	8
29	7	5	444	9	10
45	11	12	457	8	8
90	6	6	462	8	11
71	6	7	483	10	6
118	4	5	540	7	7
146	7	7	546	9	12
216	9	6	554	8	4
313	10	4			

The total number of green dissected leaves in each palm was scored when the palms were 12, 24, 36 and 48 months old. A young leaf where more than half the leaf blade has dissected was taken as a dissected leaf. The date of flowering of each palm, i.e. the date on which the first spadix is visible in the axil of the leaf was recorded. There were 5 palms from each of the groups, open-pollinated and self-pollinated, that have not flowered at the time of analysis of data. The flowering-period of each of these palms was taken tentatively as 91 months.

The leaf count data were transformed to $\log(X + 0.5)$, and the flowering data to \sqrt{x} prior to analysis of variance.

* Results of this experiment were presented at the South Pacific Commission Technical Meeting on Coconut Production, held in French Polynesia in August 1967.

TABLE I

The mean weight of endosperm and of embryos of eight high-yielding palms (Experiment I).

Seed parent				No. of Nuts	Endosperm weight per nut (gm)			Embryo weight (mg)		
No.	Phenotypic value	Breed-Value			Mean	Per-cent	C.V. %	Mean	Per-cent	C.V. %
55	56	59.6	open-pollinated selfed	34	362.8	100	6.3	126	100	15.5
				20	362.8	100	10.4	122	96.8	13.0
179	48	48.5	open-pollinated selfed	24	354.1	100	7.8	131	100	16.1
				19	353.0	99.7	11.7	135	103.1	12.7
85	56	31.5	open-pollinated selfed	18	319.0	100	14.2	118	100	11.5
				36	325.3	102.0	16.9	115	97.5	13.3
62	47	36.5	open-pollinated selfed	8	407.3	100	8.4	96	100	16.2
				5	394.0	96.7	12.1	87	90.6	12.4
105	47	18.0	open-pollinated selfed	27	325.0	100	9.0	107	100	15.5
				22	317.9	97.8	3.8	106	99.1	13.2
222	51	-9.3	open-pollinated selfed	14	329.6	100	8.0	119	100	15.8
				8	287.8	87.3	13.4	105	88.2	13.7
145	48	-15.6	open-pollinated selfed	21	285.6	100	3.2	116	100	9.8
				15	285.4	99.9	12.1	115	99.1	8.0
37	45	-28.5	open-pollinated selfed	8	398.3	100	11.6	135	100	11.7
				5	340.0	85.4	2.7	117	86.7	2.7

The phenotypic value is the mean weight of copra produced per palm per year (lb.). The breeding value has been taken as twice the deviation of progeny mean from the population mean.

TABLE 2

Mean number of green dissected leaves per plant and the mean flowering-period (Experiment 2)

Age of seedlings		Open-pollinated	Self-pollinated
12 months	...	7.6	7.1
24 "	...	8.2	7.5
36 "	...	11.1	9.7
48 "	...	14.7	12.6
Flowering-period (months)...		60.7	65.1

TABLE 3

Analysis of variance of leaf production (Experiment 2)

	DF	Age of palms (months)							
		12		24		36		48	
		Mean Square	V.R.	Mean Square	V.R.	Mean Square	V.R.	Mean Square	V.R.
Between females	16	0.0034	—	0.0115	1.15	0.0243	2.12	0.0272	2.05*
Open-pollinated x selfed	1	0.0406	4.59	0.1057	10.53***	0.1775	15.51**	0.2603	19.67***
Females x open-pollinated x selfed	16	0.0083	—	0.0130	1.29	0.0135	1.18	0.0162	1.22
Error	223	0.0088	—	0.0100	—	0.0114	—	0.0132	—

TABLE 4

Analysis of variance of flowering-period data (Experiment 2)

	DF	Mean Square	V.R.
Between females	16	1.9435	2.61**
Open-pollinated x selfed	1	4.9477	6.64*
Females x open-pollinated x selfed	16	0.9878	1.33
Error	223	0.7446	—

Significance * P = 0.05, ** P = 0.01, *** P = 0.001

TABLE 5

Mean number of leaves per plant when the palms were 48 months old and the mean flowering-period on a basis of families (Experiment 2)

<i>Palm No.</i>	<i>Open-pollinated</i>		<i>Self-pollinated</i>		<i>Percent *</i>	
	<i>Leaves</i>	<i>Flowering-period (mth)</i>	<i>Leaves</i>	<i>Flowering-period (mth)</i>	<i>Leaves</i>	<i>Flowering-period</i>
10	15.3	54.0	15.7	52.3	102.6	96.9
29	16.8	53.4	18.3	51.7	108.9	96.8
45	13.3	65.4	12.8	64.0	96.2	97.9
71	15.7	56.3	14.3	64.7	91.1	114.9
90	15.7	62.3	11.2	71.0	71.3	114.0
118	14.2	59.2	11.5	61.5	81.0	103.9
146	14.1	68.4	13.7	68.4	97.2	100.0
216	16.5	60.7	12.7	73.9	77.0	121.7
313	18.3	62.0	14.6	72.6	79.8	117.1
386	16.4	59.6	16.4	55.1	100.0	92.4
444	15.6	62.4	10.9	74.8	69.9	119.9
457	14.6	60.0	12.1	55.8	82.9	93.0
462	14.7	62.3	13.1	65.4	89.1	105.0
483	14.8	69.3	13.1	68.9	88.5	99.4
540	14.1	54.7	11.3	75.0	80.1	137.1
546	14.5	61.8	10.7	75.8	73.8	122.7
554	15.3	59.0	11.6	66.9	75.8	113.4

(*Percent calculated by equating the respective open-pollinated mean value = 100)

DISCUSSION

Generally, there has been an in-breeding depression on all the characters studied ; inbred plants carried less leaves and have taken a longer period to flower than open pollinated plants. But, the intensity of depression has varied between families, e.g. the mean number of leaves per plant (Table 5) of family 10 was practically the same for inbred and out-bred plants, whereas the inbred plants of family 444 have given 30 per cent less leaves than the out-bred plants. These differences are of genetical significance.

There is considerable variation in the weight of endosperm and of embryo of open-pollinated nuts between and within palms : the mean endosperm weight between palms has ranged from 286 to 407 gm., and embryo weight from 96 to 135 mg. These variations are to be expected due to the natural out-crossing habit of the variety of palms under consideration. If the weight of either of these characters is under genic control, one could expect differential behaviour between genotypes when selfed, depending on the nature of the genes involved. If it is largely due to the additive effects of genes, then the breeding depression may be less marked or even negligible than when it is controlled by dominance and epistasis.

Five of the 8 palms that have been taken for experiment 1, (Nos. 55, 179, 85, 62 and 105) are of good breeding value and the remaining three (Nos. 222, 145 and 37) are of low value (Table 1). The loss in weight of endosperm and of embryo of selfed nuts in the former group of palms, has been low in relation to those of open-pollinated nuts ; in each case the selfed weight being less than 5 percent, except embryo weight of palms 62 which has shown a difference of 9.4 percent. On the other hand, two of the palms of low breeding value have shown a marked decrease in weight of endosperm and embryo on selfing—over 12 percent in each case.

The behaviour of palms 145 is quite inconsistent : the two characters have shown no in-breeding depression, although the palm is of low breeding value. It is likely that the high phenotypic values of palms 55, 179, 85 and 105 are mainly due to the additive effects of genes rather than to other causes.

The correlation coefficient between gain/loss in endosperm weight and the breeding value of the palm is high ($r=0.6935$). Thus, there is an indication that palms of high breeding value could be isolated from phenotypically superior palms (copra production), by selfing and studying the depression on endosperm and embryo weights relative to the open-pollinated nuts. In the present study, 5 palms (55, 179, 85, 105 and 145) would have been picked out as desirable genotypes on the above basis ; 4 of them have turned out to be of good breeding value and the other (palm 145) of low value as judged from progeny trials. This method takes only 12 months for testing for relative breeding values.

The coconut endosperm is composed mostly of triploid tissue (Abraham and Mathew, 1963) and the embryo diploid. The genic balance may be unlike in the two tissues owing to the double contribution of the female parent to the endosperm. Yet, the percentage loss in weight of endosperm and embryo has been practically the same on selfing, but the coefficient of variation of endosperm weight has increased with selfing.

In palm No. 55, the weight of 33 embryos (other being aborted) of open-pollinated nuts ranged from 63 to 152 mg. with a mean weight of 126 mg., and similar variations were common for the other palms. An interesting study of immense practical value will be to ascertain any useful correlations between weight of embryo, and vigour and yield of the resulting palm within families using embryo culture techniques. Are the heavier embryos within a family an expression of specific combining ability ?

The differences between families with respect to the intensity of inbreeding depression on leaf production and flowering-period may have some relationship as outlined for endosperm and embryo weights. But, these factors cannot be established, as the breeding values of palms used for experiment 2 are not known.

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