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SOME RESULTS OF FIELD EXPERIMENTATION WITH *TYPICA* × *NANA* (F_1) HYBRIDS

I. Leaf production, flowering and yield

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The relative merits of the forms *pumila*, *eburnea* and *regia* of the variety *nana* (dwarf) as pollen parents for the production of *typica* × *nana* (F_1) hybrids are assessed. All three forms of dwarfs may be effectively used in the production of the above hybrid which is early-bearing, and which out-yields the *typica*. However, in view of the robustness of the form *eburnea* (dwarf ivory-yellow), it is suggested that this form may be used for the mass production of *typica* × *nana* (F_1) hybrids for rapid commercial exploitation, supplementing the current use of the form *pumila* (dwarf green) for this same purpose.

INTRODUCTION

There are a number of varieties and forms of the coconut palm *Cocos nucifera* L. growing in Ceylon (Liyanage, 1958). Of these, the *typica* form of the variety *typica* accounts for the 1.15 million acres under coconut cultivation in the island, the other varieties and forms being only of secondary importance. Certain varieties possess characters which are useful for breeding purposes *e.g.* the variety *nana* (dwarf) is early bearing and short in habit, the form *Kamandala* of the variety *typica* has large nuts with good copra out-turn.

Commencing in 1949, this Institute carried out a number of crosses between selected varieties and forms available in Ceylon. Early attempts in this work were mainly exploratory in nature as methods of pollen collection and storage, types of material for the making of isolation bags and the techniques of pollination had to be worked out. The crosses involved the variety *typica* form *typica*, variety *nana* form *pumila* and the variety *aurantiaca*, and from a study of the F_1 progeny of these crosses, *typica* × *nana* was found to be promising (Liyanage, 1955). This cross was repeated on a large scale in 1956, using improved techniques of pollination and the performance of the resulting hybrids under field conditions in relation to *typica* palms is reported in this paper.

In the discussion, the term *typica* × *nana* is used only when referring to hybrids between the two varieties; where no distinction is made among the three colour forms of the *nana* variety used in the crosses.

MATERIALS AND METHOD

(a) Production of *typica* × *nana:* Selected high-yielding palms from the Latin Square Experiment, Ratmalagara Research Station, were used as female parents. These were crossed with dwarf male parents, selected on their early flowering character as well as nut size, obtained from the Dwarf palm Block and Hybrid palms Block "A" at Ratmalagara Research Station.

(b) Production of *typica* × *typica:*—Selected high yielding palms at Achchitotam Estate, Mundel, Bandirippuwa Estate, Lunuwila, and Letchemy Estate, Nattandiya were crossed in pairs. The crossing programme was completed in 1956, and the technique used has been described earlier (Manthriratna and Liyanage, 1960).

From the two sets of crosses (a) and (b) above, progenies were selected for transplantation based largely on vigour of seedling at the third-leaf stage; at least four progenies were taken per cross.

Layout: 235 seedlings from (a) and 90 seedlings from (b) were transplanted in 1958 at Ratmalagara Research Station in seedholes 3′ × 3′ × 3′ filled with top soil without a layer of husks, on the Hedge Planting system (Liyanage, 1955), with a fully randomized distribution. Rows were spaced 26 feet (8

metres) apart, and within each row the seedlings were spaced 18 feet (5.5 metres). This gave an initial density of 93 palms/acre,* to be subsequently thinned down to the conventional density of 64 palms/acre,* based on growth and yield.

Routine cultural operations, fertilizer applications and pest and disease control were carried out. The following characters were recorded:— Leaf production, age of palms at production of first inflorescence, yield of nuts and weight of husked-nuts.

RESULTS AND DISCUSSION

Leaf production

The coconut palm usually bears an inflorescence in each leaf axil, and therefore any increase in the rate of leaf production would be reflected in the number of inflorescences (and bunches) produced. The total number of green dissected leaves carried on each palm was scored at 36 months from date of transplantation, and the following values were obtained.

(*a*) *Typica*×*nana* : 16.3 leaves per plant (S.D. = 2.45)

(*b*) *Typica*×*Typica:* 12.2 leaves per plant (S.D. = 2.30)

The differences between (a) and (b) were highly significant ($P. < 0.001$).

The *typica*×*nana* F_1 palms carried on an average four leaves more than the *typica* palms. Heterosis is evident in the rate of leaf production, and due to its relationships with production of inflorescences and nuts, is an important economic character. In the field, these hybrids have been observed to have appreciably longer leaves and leaflets as well as sturdier trunks, these being vegetative manifestations of hybrid vigour.

Age of palms at first flowering

Precocity in bearing is an useful attribute particularly in a perennial crop for this may mean quicker returns from investment in new planting or replanting. The frequency distribution of palms in flower at 78 months from date of transplantation is given in Table 1. The histogram (fig. 1) shows the pattern of flowering of the different hybrids, *typica*×*nana* form *pumila*; *typica*×*nana* form *eburnea* and *typica*× *nana* form *regia*.

Table 1—Frequency distribution of palms in flower

	Percent palms in flower	
Flowering period (Months) range	*typica* × *nana*	*typica* × *typica*
<30	16.6	1.4
31-36	66.8	1.4
37-42	89.1	19.4
43-48	95.9	44.4
49-54	96.4	48.6
55-60	97.9	75.0
61-66	99.0	84.7
67-72	99.0	95.0
73-78	99.0	97.2
Mean flowering period (months)	35.7 (SD=6.67)	52.1 (SD=11.97)

*1 hectare=2.471 acres.

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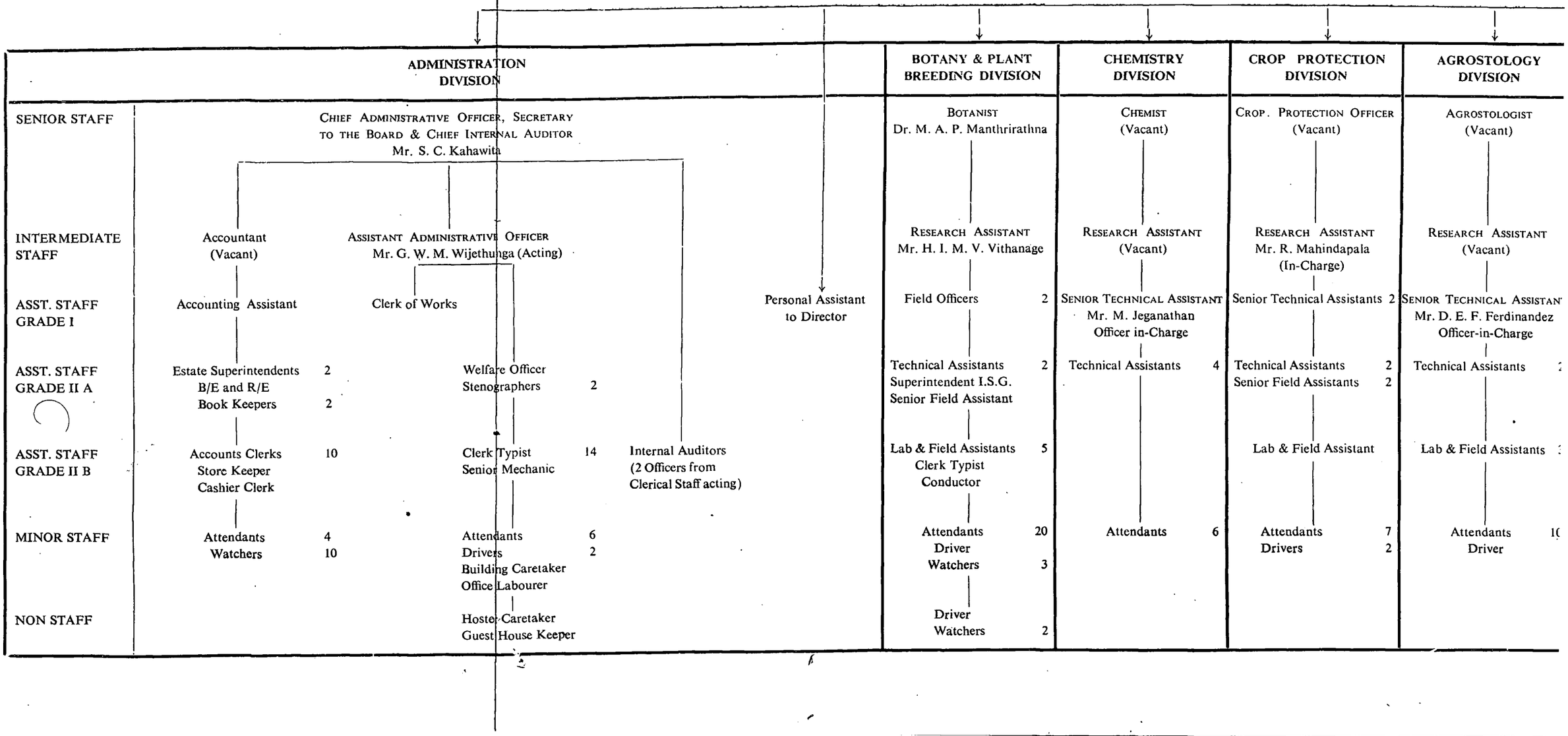

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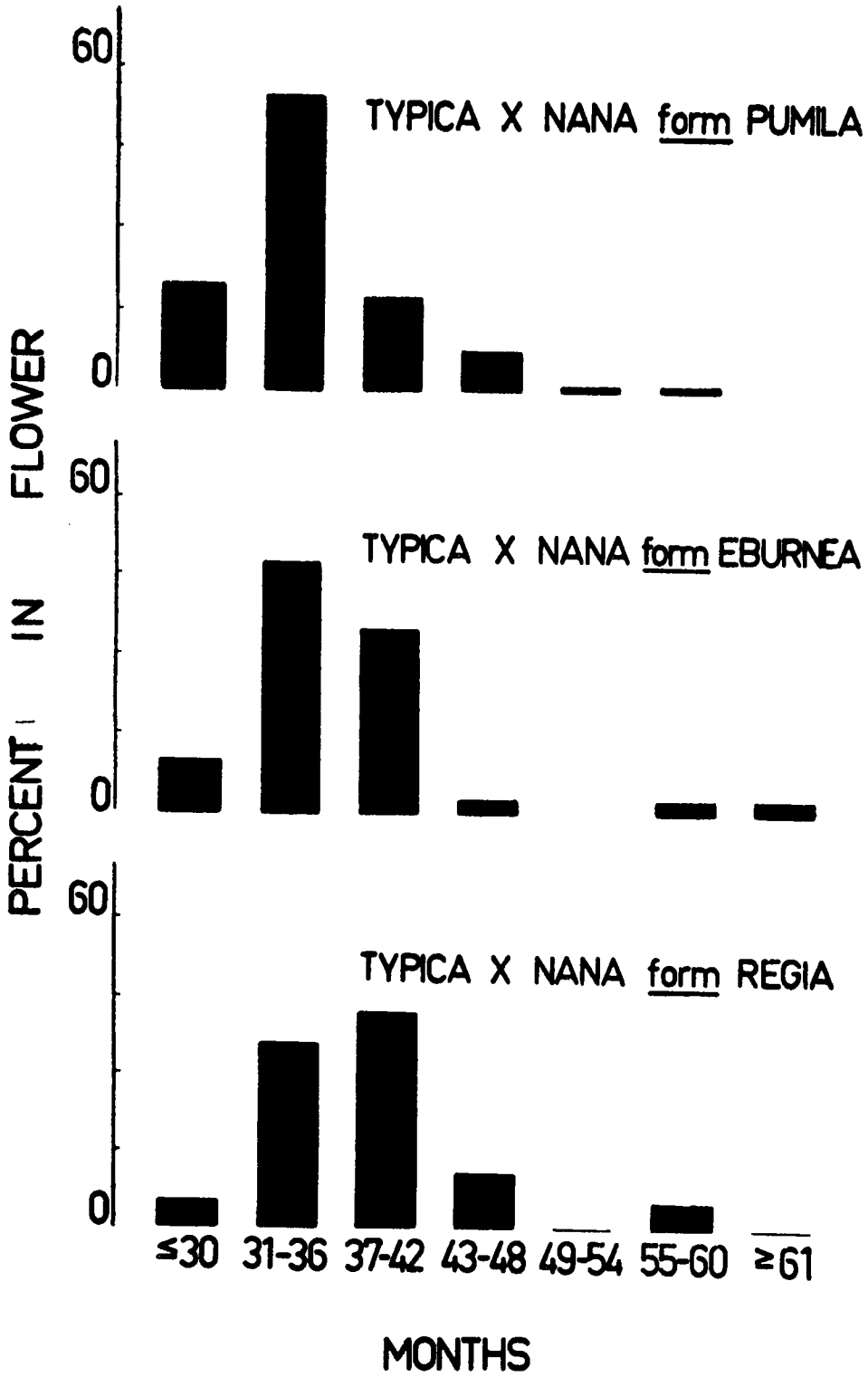

Fig. I. Flowering pattern of *typica* × *nana* F1 hybrids.

It will be observed that about 96 percent of the *typica*×*nana* F_1 palms have flowered in under four years compared with 44 percent of *typica*×*typica*. The mean flowering period of *typica*×*nana* (F_1) palms is 35.7 months (CV 18.7%) compared with 52.1 months (CV 23.7%) for *typica*×*typica* palms. Thus the *typica*×*nana* (F_1) hybrid is superior to the *typica* form with respect to the character early flowering (bearing age). As suggested by Tammes (1955), this hybrid can be used under conditions where early fruit-bearing is of prime importance, for instance in new settlements.

The three colour forms, *pumila* (dwarf green), *eburnea* (dwarf ivory-yellow) and *regia* (dwarf red) have been used as pollen parents, and Table 2 gives the mean flowering period (months) of families resulting from crosses involving the form *typica* as female parent and the forms *pumila*, *eburnea* and *regia* as male parents. An analysis of variance for this character (Table 3) indicates that the choice of the form of the *nana* variety would be reflected in the period for flowering of the progeny. The between families item is also significant, ($P < 0.01$). However, when the mean flowering periods are considered, the difference is only of the order of 2-4 months.

Table 2—Flowering period (months) of *Typica* × *nana* (F_1) progeny

Typica × *nana* form *pumila*			*Typica* × *nana* form *eburnea*			*Typica* × *nana* form *regia*		
Family	*n*	*Mean*	*Family*	*n*	*Mean*	*Family*	*n*	*Mean*
391×52	5	34.60	9×584	4	35.75	241×116	4	37.25
412×51	6	33.50	59×493	5	36.20	285×476	5	38.00
418×45	4	34.00	78×471	5	34.20	336×476	2	38.00
478×384	6	35.00	93×528	4	33.50	215×115	2	52.50
479×45	5	34.20	207×584	7	40.00	240×527	6	36.67
78×840	6	32.50	570×584	6	34.83			
157×58	5	36.00	267×584	3	45.33			
207×557	3	35.67	240×528	3	40.67			
391×840	5	44.40	285×493	3	36.33			
9×51	4	41.75						
241×37	3	37.67						
285×45	2	37.50						
336×36	3	33.67						
336×54	3	33.00						
337×45	5	32.20						
337×36	5	33.20						
59×36	7	33.43						
59×54	7	33.00						
69×47	6	32.33						
93×49	6	32.50						
93×36	5	35.00						
101×45	6	35.67						
183×36	6	38.83						
215×54	6	35.00						
215×36	5	31.40						
572×47	4	33.50						
	128	34.80		40	37.12		19	38.95

Table 3—Flowering period (months) Analysis of variance

Source	*d.f.*	*S.S.*	*M.S.*	*V.R.*
Bn. Types	2	386		
Bn. Families	39	2319		
Total	186	6054		
Bn. Types	2	386	193.00	3.69*
Bn. Families Wn. Types	37	1933	52.24	2.06**
Wn. Families	147	3735	25.41	

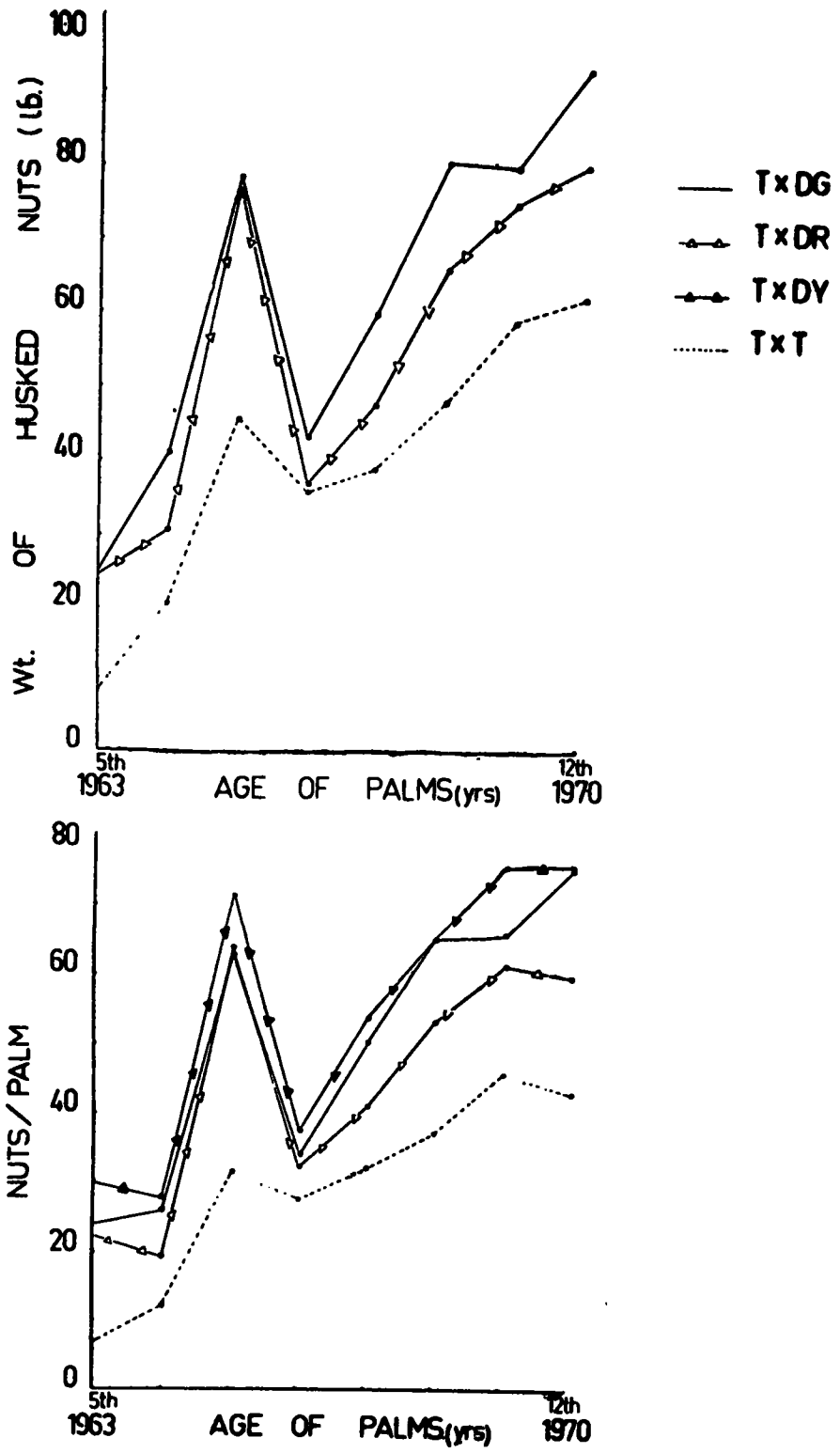

Fig. 11. Yield of the progeny *typica* × *nana* F1 hybrids, compared with *typica* × *typica*.

Hybridization programmes are also being carried out mainly in India, Jamaica and the Ivory Coast and it would appear that the choice of the colour form of the dwarf variety is different *e.g.* In India, Satyabalan *et al.* (1968) report that the nut and copra characters of the hybrids of the tall palm with dwarf orange as the pollen parent are far superior to those obtained when dwarf green was used as the pollen parent. Likewise, in the Ivory Coast, dwarf yellow and dwarf red are used for the large-scale production of *dwarf* × *tall* "directed cross" hybrids (de Nuce de Lamothe, 1971). From the results of this field trial it would appear that all three colour forms of the variety *nana* could be used for the production of early-bearing *typica* × *nana* (F_1) hybrids.

Yield of nuts: The mean yield of nuts/palm/year for the period 1963-1970 of *typica* × *nana* (form *pumila*), *typica* × *nana* (form *eburnea*), *typica* × *nana* (form *regia*) and *typica* × *typica* is represented in figure 2. During this eight year period the *typica* × *nana* hybrids have out-yielded the *typica* × *typica*. In the 5th year (1963), these hybrids have given 23-29 nuts per palm compared with 6 nuts from *typica* × *typica*. Likewise, in the 12th year (1970) the corresponding figures are 60-75 nuts and 43 nuts respectively.

It would appear that the three colour forms of the variety *nana* are equally suitable as pollen parents as evidenced by the yield of the progeny. An analysis of variance for the character yield of nuts for the period 1967-1970, indicates that differences in yield resulting from the use of three colour forms of the variety *nana* are not significant, (Table 4).

Table 4—Mean Yield (nuts) 67-70 Analysis of variance

Source	*d.f.*	*S.S.*	*M.S.*	*V.R.*
Bn. Types	2	1695.30		
Bn. Families	39	26703.37		
Total	160	70086.50		
Bn. Types	2	1695.30	847.65	1.25
Bn. Families wn. Types	37	25008.07	675.89	1.89*
Wn. Families	121	43383.13	358.54	

Weight of husked nuts

The total weight of husked nuts/palm/year for the period 1963-1970 of *typica* × *nana* and *typica* × *typica* (F_1) hybrids is represented in figure 2. The values for *typica* × *nana* form *eburnea* have been omitted as the data is incomplete.

Weight of husked-nuts is a direct measure of weight of copra, and from figure 2b it is evident that *typica* × *nana* F_1 hybrids out-yield the *typica* in respect of this character. An analysis of variance of weight of husked nuts for the period 1967-1970 of F_1 hybrids resulting from crosses using the three colour forms of the variety *nana* as pollen parents is given in Table 5. Differences in yield (weight of husked nuts) between types are not significant.

Table 5—Weight of Husked Nuts (Mean) 67-70 Analysis of variance

Source	*d.f.*	*S.S.*	*M.S.*	*V.R.*
Bn. Types	2	2268.66		
Bn. Families	35	42116.29		
Total	149	125891.32		
Bn. Types	2	2268.66	1134.33	0.94
Bn. Families Wn. Types	33	39847.63	1207.50	1.64*
Wn. Families	114	83775.03	734.87	

The performance of the three progeny-types compared with *typica* with respect to the three characters discussed in this paper is summarised in Table 6.

Table 6

Progeny Type	*Period for flowering (months)*	*Nuts*	*Mean yield* (1967-1970) *wt. of husked nuts*		*wt/nut*	
			lb.	*Kg.*	*lb.*	*g.*
Typica × *nana* (form *pumila*)	34.8	64	79.10	35.84	1.24	562.45
Typica × *nana* (form *eburnea*)	37.1	67	79.90	36.29	1.19	539.77
Typica × *nana* (form *regia*)	38.9	55	65.89	29.94	1.20	544.30
Typica × *typica*	52.9	39	52.25	23.59	1.34	607.87

It would appear from the above figures that in terms of precocity in bearing, the performance of the *typica*×*nana* F_1 hybrids is superior to that of *typica*×*typica*. Furthermore, the former yields more nuts and copra (estimated on weight of husked nuts) than the latter. The first experimental material of *typica*×*nana* hybrids has out-yielded the hybrids described in this paper and at the corresponding ages their mean yields were as follows, (Liyanage 1963).

	No. of nuts	*Wt. of husked nuts*
5th year (1955)	23	16.33 Kg. (36.0 lb.)
12th year (1962)	146	128.83 Kg. (284.1 lb.)

The rather low yields obtained with the material described in this paper may be attributed to two factors, *viz.* (1) the soil being a heavy clay-loam tends to "cake-up" even during short spells of dry weather, adversely affecting growth and yield and (2) the system of planting where the planting density has been high particularly during the first few years. The thinning of the stand was continued over the years and during 1970/1971 the density has been reduced to about 64 palms/acre.* It is anticipated that yields will now improve.

Characters of economic importance of the nuts from these hybrids (weight of endosperm, weight and quality of copra, and oil content) are now being studied and will form the subject matter of another paper wherein the impact of these results for future planting and replanting programmes will also be discussed. However, in view of the robustness of the ivory-yellow dwarf (variety *nana* form *eburnea*), compared with dwarf green (form *pumila*) and even some strains of dwarf red (form *regia*), it may not be premature to use the dwarf ivory-yellow in hybridization programmes for the mass production of hybrid seed material.

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REFERENCES

de Nuce de Lamothe, M. 1971 Personal communication.
Liyanage, D. V. 1955 *Ceylon Cocon. Q.* **6**: 24.
Liyanage D. V. 1956 *Ceylon Cocon. Q.* **7**: 45.
Liyanage D. V. 1958 *Ceylon Cocon. Q.* **9**: 1.
Liyanage, D. V. 1963 *Ceylon Cocon. Q.* **14**: 26.
Manthriratna, M. A. P. P. & Liyanage, D. V. 1960. *Ceylon Cocon. Plrs. Rev.* 1 (2): p. 3.
Satyabalan, K., Ratnam, T. C. & Menon, R. M. 1968 *Indian J. Agric. Sci.* **38**: 155.
Tammes, P. L. M. 1955 *Euphytica* **4**: 17.

*1 hectare=2.471 acres