SEASONAL VARIATION IN NUT PRODUCTION AND SEX EXPRESSION IN COCONUT

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In perennial crops, such as palms, there is considerable seasonal variation, over years and also within the year in production. This uncertaintity causes instability of production (Jackson, 1961). This appears to be true in coconut even in different soil conditions and, therefore, is not specific to any particular measurable environment. According to Patel (1938), the final yield of nuts per palm is dependent on the number of spadices and female flowers produced and the number of female flowers set and developed into nut. He observed annual vaiation as well as seasonal variation within the same year in the production of nuts and attributed this variation to the inherent characters of the palm, management practices and influence of weather. Sampson (1923) reported that the number of female flowers produced on an inflorescence varies from twenty to forty, though he had counted as many as 235 female flowers on one inflorescence. The variation in female flower production, according to Satyabalan, Shankar, and Ratnam (1969) is related more to the number of opened spadices than to the number of female flowers per bunch. Tammes (1937) suggested that the yield was not controlled by female flower production or pollination but exclusively by nutritional factors. Menon and Pandalai (1958) did not attribute the fluctuation in yield to the effects of season. Jack and Sands (1929) reported varietal differences in the number of female flowers produced per palm. Thus production appears to vary on the basis of genotypes, varieties, seasons, etc. Therefore, the nature of genotype × environmental interaction over years and over seasons within a year must be studied to identify the genotypes with greater stability over environments. The effect of seasonal variation on the emergence of bunches, production and distribution of female flowers in spikes and proportion of flowers set have been considered for this purpose. These aspects have been studied for a period of three years for a set of four different groups of palms, viz. regular and irregular bearing tall, dwarf green and dwarf orange varieties of coconut.

Material and Methods

Forty-eight coconut palms growing in the sandy loam soils of this Research Station and receiving the same cultural and manurial treatments form the material for the present study. They include 25 regular bearing palms, 15 irregular bearers and 4 each of dwarf green and dwarf orange. Data collected for three consecutive years from September 1964 to August 1967 on the emergence of inflorescence, number of male and female flowers, number of sterile spikes, spikes with one, two and more than two female flowers and proportion of flowers set, were statistically analyzed.

To study the effect of seasons on the emergence of bunches, production of female flowers and its distribution, a calendar year has been divided into four seasons—June to August representing South West monsoon period, September to November to represent North East monsoon period and December to February and March to May to represent winter and summer respectively.

The variations between groups, seasons and years and the two-way interactions were analyzed. The association between groups and seasons was also estimated.

Results

Since production is dependent on several characters, the nature of interaction has been studied for eleven characters, viz., emergence of bunches, production of female flowers, number and percentage of flowers set, number of sterile spikes and spikes with one, two and more than two female flowers, total number of spikes produced and average number of male and female flowers in a spike (Tables 1, 2). The differences among groups were substantial for all characters, except for number of male flowers per spike. The seasonal differences within each year were also substantial except for four characters, percentage of flowers set, total number of spikes produced, number of spikes with more than two female flowers and number of male flowers per spike. The differences between the years are limited, indicating that inter-seasonal variation within a year is more important than the difference over years. The interaction between the four genetic groups with seasons is not significant. This is probably due to the considerable heterogeneity within each group. However, there are differences in groups × years interaction for number of female flowers per spike and number of spikes with two female flowers. The seasons × years interaction is substantial, except for percentage of flowers set, number of sterile spikes and spikes with more than two female flowers. Therefore, the absence of differences between years may be due to a balancing mechanism of production among seasons with a year.

There is more variation among irregular bearers and dwarf orange as compared to regular and dwarf green in the case of number of bunches emerged. This appears to be true for some of the other important characters also, like male and female flower production, number and percentage of flowers set etc. The regularity of bearing appears to be a reflection of stability for all components of production. The means also are larger in the tall regular and dwarf green categories for number of bunches emerged and number of spikes

TABLE 1

Analysis of variance for different characters

Source of variation	Degrees of freedom	Mean sum of squares for the different characters									
		Bunches emerged /tree	Female flowers produced /tree	Flowers set/tree	% age set/tree	Female flowers/ spike	Sterile spikes/ bunch	Spikes with one female flower/ bunch	Spikes with 2 female flowers/ bunch	Spikes with more than 2 female flowers/ bunch	Spikes/ bunch	Male flowers/ spike
Groups	3	4·144	2954·97	391·21	672·99	0·2646	298·96	63·00	3·73	4·28	467·05	3024·67
Seasons	3	2·571	12507·15	946·59	252·92	0·7177	140·82	200·34	7·37	6·63	61·25	3417·67
Years	2	0·889	152·62	25·40	192·44	0·0150	17·06	15·91	1·39	1·58	33·16	3227·00
Groups × Seasons	9	0·283	318·58	46·39	137·53	0·0292	39·88	9·92	0·41	1·27	41·44	1460·67
Groups × Years	6	0·248	800·36	96·37	126·03	0·0926	3·89	6·42	2·26	3·77	25·14	1634·33
Seasons × Years	6	2·449	3924·71	163·68	67·46	0·1475	4·94	87·90	1·33	1·58	110·62	4444·00
Error	18	0·794	678·90	54·54	80·68	0·0230	19·80	11·95	0·56	1·41	37·66	1060·78

TABLE 2

Showing the differences between varieties and seasons for the different characters

	Bunches emerged/tree	Female flowers/tree	Flowers set/tree	% set/tree	Female flowers/spike	Sterile spikes/bunch	Spikes with one female flower/bunch	Spikes with 2 female flowers/bunch	Spikes with more than 2 female flowers/bunch	Spikes/bunch	Male flowers/spike
Groups											
Regular	14·42	291·03	202·51	38·78	0·56	17·95	17·03	0·77	0·38	36·13	204·60
Irregular	12·00	330·51	92·41	27·30	0·60	15·79	13·94	1·84	1·35	32·76	170·38
Dwarf Green	12·58	319·16	55·66	21·43	0·83	9·31	17·77	1·62	1·14	29·82	188·40
Dwarf Orange	8·79	192·50	61·92	25·11	0·48	7·59	13·08	0·78	0·09	21·54	160·96
Seasons											
North East monsoon	10·62	142·40	43·92	27·17	0·30	17·49	9·93	0·23	0·05	27·58	153·09
Winter	10·61	250·50	73·96	30·01	0·62	11·85	15·04	1·39	0·67	28·95	178·54
Summer	14·54	453·86	127·83	33·13	0·90	9·40	19·38	2·13	1·78	32·70	200·32
South West Monsoon	12·00	286·45	66·77	22·32	0·64	11·90	17·47	1·25	0·44	31·04	192·07
Critical Difference (5% level) (Group means/season means)	1·53	44·71	12·67	7·70	0·13	3·82	2·96	0·64	1·02	5·27	—
Standard Error (Group means/Season means)	0·515	15·049	4·264	2·593	0·043	1·285	0·998	0·217	0·334	1·772	9·402

TABLE 3

Showing the variations between groups and seasons, averaged over years and χ^2 for testing association

Character	Group	Seasons				χ^2 (9 df)
		N.E.M.	W	S	S.W.M.	
(i) Total number of bunches emerged (per tree)	Regular	3·47	3·31	4·21	3·43	0·477
	Irregular	2·49	2·78	3·69	3·04	
	Dwarf green	3·17	2·83	3·33	3·25	
	Dwarf orange	1·50	1·69	3·31	2·29	
(ii) Total number of female flowers produced (per tree)	Regular	50·61	60·07	111·15	69·20	9·274
	Irregular	37·96	74·60	133·82	84·13	
	Dwarf green	34·00	72·58	133·58	79·00	
	Dwarf orange	19·83	43·25	75·31	54·11	
(iii) Number of flowers set (per tree)	Regular	17·88	23·84	39·33	21·46	4·264
	Irregular	9·38	23·07	40·76	19·20	
	Dwarf green	9·08	14·00	19·00	13·58	
	Dwarf orange	7·58	13·06	28·75	12·53	
(iv) Percentage set (per tree)	Regular	38·78	44·39	38·35	33·67	15·369
	Irregular	21·62	29·63	37·32	20·70	
	Dwarf green	28·43	23·85	16·35	17·14	
	Dwarf orange	19·92	22·21	40·54	17·81	
(v) Number of female flowers (per spike)	Regular	0·40	0·52	0·78	0·54	0·091
	Irregular	0·29	0·60	0·89	0·60	
	Dwarf green	0·35	0·84	1·25	0·87	
	Dwarf orange	0·18	0·50	0·69	0·55	
(vi) Number of sterile spikes produced (per bunch)	Regular	22·18	18·40	12·65	18·58	12·81
	Irregular	20·62	14·68	11·63	16·22	
	Dwarf green	19·64	8·82	2·95	5·85	
	Dwarf orange	7·53	5·50	10·37	6·95	
(vii) Number of spikes with one female flower (per bunch)	Regular	14·53	15·87	19·20	18·51	3·29
	Irregular	9·60	12·73	18·05	15·37	
	Dwarf green	10·17	18·97	21·79	20·15	
	Dwarf orange	5·43	12·61	18·46	15·84	
(viii) Number of spikes with two female flowers (per bunch)	Regular	0·11	0·63	1·78	0·58	1·04
	Irregular	0·62	1·87	3·05	1·83	
	Dwarf green	0·11	1·90	2·39	2·06	
	Dwarf orange	0·07	1·19	1·30	0·55	

TABLE 3—(Contd.)

Character	Group	Seasons				χ^2 (9 df)
		N.E.M.	W	S	S.W.M.	
(ix) Number of spikes with more than two female flowers (per bunch)	Regular	0	0·30	1·04	0·18	1·02
	Irregular	0·21	1·34	2·67	1·17	
	Dwarf green	0	0·92	3·30	0·30	
	Dwarf orange	0	0·13	0·13	0·11	
(x) Total number of spikes produced (per bunch)	Regular	36·81	35·18	34·68	37·86	6·12
	Irregular	30·57	30·61	35·40	34·47	
	Dwarf green	29·89	30·59	30·45	28·36	
	Dwarf orange	13·03	19·43	30·27	23·45	
(xi) Number of male flowers (per spike)	Regular	203·30	203·59	212·07	199·47	45·380
	Irregular	132·75	152·20	220·75	174·45	
	Dwarf green	186·20	172·10	189·95	205·35	
	Dwarf orange	90·10	186·25	178·50	189·00	

N.E.M. : North East Monsoon (September — November)
W : Winter (December — February)
S : Summer (March — May)
S.W.M. : South West Monsoon (June — August)

with one female flower. The seasonal differences are mainly due to higher means of characters in summer, except for sterile spikes. The number of spikes with one female flower is higher in regular and dwarf green than in the other two groups, but not the number of spikes with two and more than two female flowers. Therefore, the number of spikes with more than one female flower is not necessarily a determinant of production in palms. Stability appears to be mainly due to number of spikes with one female flower and total number of spikes produced per tree, while the total number of female flowers per bunch has no bearing on production. The percentage set is also higher in regular bearers.

The interaction χ^2 between the groups and seasons is very low indicating no specific association between seasonal production and genotypic groups, except in the mean number of male flowers per spike and number of sterile spikes. Therefore, by selecting genotypes having more number of spikes with one female flower or at most two female flowers it is possible to stabilize yields over seasons. The absence of such an association with other characters makes it possible to get genotypes with the required combination of characters. The higher means in summer for all characters is due to the emergence of more bunches which indirectly increases the number of female flowers and spikes and reduces the proportion of sterile spikes. The relative proportion of spikes with one, two and more than two female flowers appears to be similar in all the four seasons with slightly higher values in summer for spikes with one female flower.

Discussion

The results of the present investigation have shown that the instability in production is due to seasonal differences within each year. While some of these seasonal differences could be reduced, selection for higher bunch production during summer appears to provide stability for yield over years. The absence of interaction between groups × seasons which could be due to the heterogeneity within the groups can be considered as due to the wrong classification of materials into these four groups. Moreover, the similarity of interaction indicates that it is possible to select genotypes within each group with greater stability. Selection should emphasise total number of bunches and number of spikes with one female flower, both over the seasons and also in summer. The higher female flower production affects the distribution of female flowers in spikes resulting in greater proportion of spikes with more than one female flower. While the number of spikes with two and more than two female flowers is high in irregular bearers and dwarf green, the percentage of flowers set is low in these two groups compared to regular bearers. Since the increase in spikes with two and more than two female flowers adversely affects setting, higher female flower production will be undesirable (Charles, 1961) and will only lead to exhaustion of the plant resulting in reduction of female flower production in the succeeding spadices. Sampson (1923) also observed much steadier cropping in groups of trees which produce fewer female flowers but at the same time set high proportion of these. These trees, according to him, do not show seasonal variation to the same extent as the average trees. Therefore, selection for stability of production within limits, rather than increase in female flower production, appears to be more important. Since differences between years are very small, the repeatibility of this character appears to be high and any loss due to genetic slippage may be low.

Summary

The bearing tendency of coconut palms and associated yield components was examined for 48 palms, comprising tall regular bearers, tall irregular bearers, dwarf green and dwarf orange types, for a period of three years, for fixing the criteria for selection of genotypes that give higher and stable yield. The instability in production was found to be due to seasonal differences within each year. The differences over years were not significant. Number of spikes with one female flower and total number of spikes contribute to greater stability of production than other characters studied.

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