FRUIT CHARACTERISTICS IN *Cola acuminata*: I. POD WEIGHT, NUT WEIGHT AND NUT NUMBER[1] /

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Resumen

Las mazorcas frescas de Cola acuminata *se clasificaron por su peso, número de semillas y peso total de las semillas por mazorca. El peso de las mazorcas varió entre 30 y 550 g, la mayoría de ellas con un peso entre 101-200 y (43.11%) y un peso promedio de 209 g.*

El 53.85% de las mazorcas presentó entre 6-10 semillas mientras que el 24.33% y el 21.82% de las mismas presentó entre 1-15 y 11-15 semillas por mazorca, respectivamente. El promedio de semillas por mazorca fue de 7.9. La mayoría de las mazorcas tuvieron un peso de semillas entre 26 y 125 g con un peso promedio de semilla por mazorca de 88 g.

En el análisis estadístico se encontró diferencias significativas al 0.1% para el peso por mazorca, el peso total de semillas por mazorca, y el número de semillas. El efecto de la localidad de la plantación no fue significativa. Las interacciones entre el peso de la mazorca y el peso total de semillas por mazorca, el peso de la mazorca y el número de semillas, el peso total de semillas por mazorca y el número de semillas, peso total de semillas por mazorca y la localidad de la plantación, y el número de semillas y la localidad fueron significativas al 0.1% mientras que las interacciones entre el número de semillas, el peso total de semillas por mazorca y peso de mazorca, número de semillas, peso total de semillas por mazorca y localidad, y peso total de semillas por mazorca, peso de mazorca y localidad fueron significativas, las interacciones entre el número de semilla, el peso de la mazorca y la localidad no fueron significativas.

Introduction

The two most common species of the genus *Cola* are *Cola nitida* and *Cola acuminata. C. nitida* has, however, enjoyed greater popularity than *C. acuminata* both in commercial context and usage (Russell, 12; Eijnatten, 3; Ibikunle, 6). Similarly, much research work has been done on *C. nitida* to the total neglect of *C. acuminata.* Thus apart from taxonomic identification parameters, little or no information exists on its biology and cultivation.

However, this situation may soon change for better for *C. acuminata.* In February 1977, a survey of *C. acuminata* in Zaire was sponsored by an American company to evaluate the commercial viability of a Kola processing factory based on its production (Eijnatten, 4). Thus, soon, there will be a need to increase both its hectareage and productivity. An attempt at these two objectives can only succeed through well planned and executed selection and breeding programmes.

Quite a good deal of work has been done on selection in *Theobroma* cacao which belongs to the same family Sterculiaceae as *Cola.* Ruinard (11) stated that the total annual pulp production and the average weight of seeds are among the most important criteria in selecting new parent trees in a seedling population

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of cocoa. As early as 1967, Toxopeus and Jacob (7) and Toxopeus and Wessel (14) carried out pod and bean values studies on hand pollinated cocoa in Nigeria. The authors state that the number of beans in a cocoa pod is a component of pod value and as such is important yield factor. Similar studies on cocoa have been carried out by Atanda and Jacob (1) and Jacob and Atanda (7) who stated that, though pod production and pod value are two important yield components in cacao, pod value studies give finer details of yield characteristics than pod production. Most progeny and clonal trials in *C. nitida* are evaluated on the bases of total yield, nut number and nut weight per pod (Olaniram *et al.*, 10).

It is therefore necessary to start building up an informative picture on *C. acuminata* to facilitate a quick reference on the type and extent as well as the sources of variability of certain characters that are of importance in its crop selection and improvement. This paper is therefore the first in the series aimed at amassing information on *C. acuminata*.

Materials and method

Fresh pods of *C. acuminata* purchased directly from the farms and rural markets in Oyo and Ondo States were brought into the laboratory for processing. The pods were weighed individually and their length and girth were measured with vernier calipers. Individual pods were then split open and the number of the nuts per pod recorded. The nuts from each pod were first weighed while still covered with the testa. Each nut was then skinned and its final weight recorded.

From the data collected, percentage compositions by the pod husk, testa and nuts were worked out. The pods and the nuts were sorted out into weight classes as well as nut number classes and the number of pods occurring in each subclass was recorded. Finally, a three-way statistical analysis was carried out to determine some possible linkage among the three factors, pod weight, total nut weight per pod and nut number per pod.

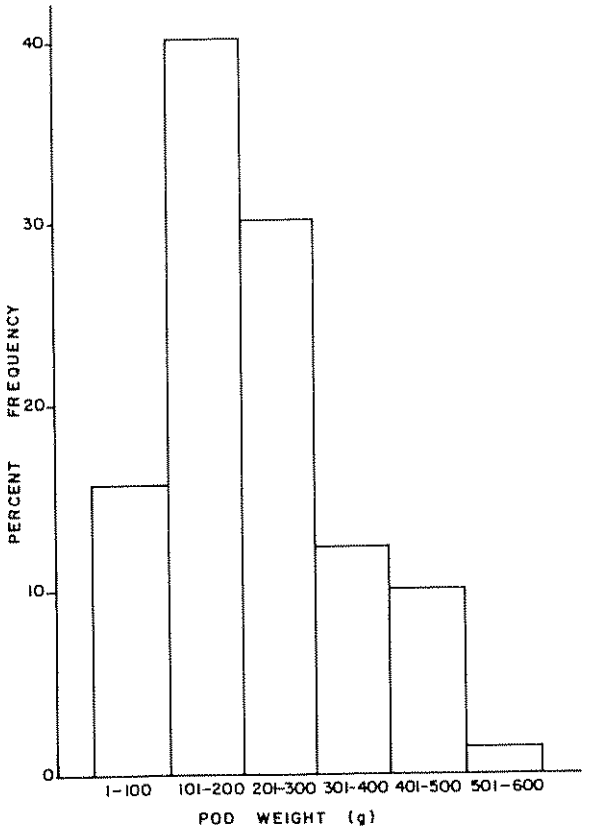

Fig 1. Percent frequency distribution of *Cola acuminata* pods on pod weight basis

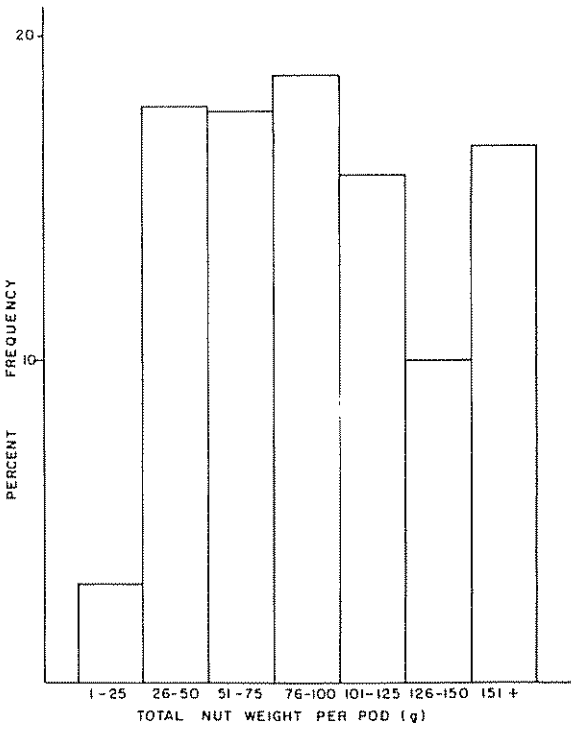

Fig 2. Percent frequency distribution of *Cola acuminata* pods on total nut weight per pod basis

Results

Pod weight class of 101-200 g resulted in the highest number of pods while that of 501-600 g size had the least (Figure 1). 70% of the total 919 pods considered occurred between 101-300 g weight, the mean pod weight being 209 g. The least in the total nut weight per pod distribution was 1-25 g size class while the highest was 76-100 g size class (Figure 2). Mean total nut weight per pod was 88 g. The highest number of pods contained 6-10 nuts per pod (Figure 3). The least number of pods was recorded by 11-15 nut number class while the mean nut number was 7 9

The pods from various locations (Figure 4) showed some slight differences with respect to pod weight distribution. While the pods from Ifewara were mostly light and small ones, the ones from Oke Agbe tend to be heavier. 101-200 g pod weight class accounted for at least 45% of the pods in the two of three locations considered, the exception bein Oke Agbe where 32.28% was recorded for that weight class.

The pods from Ifewara and Ondo were much more heavily distributed between 26 and 125 g weight class than those from Oke Agbe, where the pods were highly concentrated in heavier weight classes (Figure 5). Thus the nuts from Oke Agbe were relatively heavier than those obtained in other locations

In all the locations, 6-10 nut number class recorded the highest percentage scoring more than 50% in each location (Figure 6) except at Ondo where slightly less than 50% was recorded It is interesting to observe that in spite of heavier total nut weight per pod recorded for Oke Agbe, the majority of the pods have relatively lower nut number per pod, 91% having 1-10 nuts per pod.

Analysis of variance carried out on the data for all the locations showed that the effects of location as well as the second order interaction among pod weight, total nut number and location were not significant (Table 1). However, the interactions between pod weight and location, total nut weight per pod and location as well as nut number and location were significant. These are well illustrated in Figures 4 to 6. The effects of other main factors viz: pod weight, total nut weight per pod and total nut number as well as their interactions were significant ($P = 0.001$).

Multiple correlation and regression analyses were run among some of the pod characteristics. Table 2 shows the pairwise tabulation of the correlation coefficient factors while the regression curves for some of the significant regression analyses are shown in Figures 7 to 11. Table 3 shows the mean values of the pod characteristics.

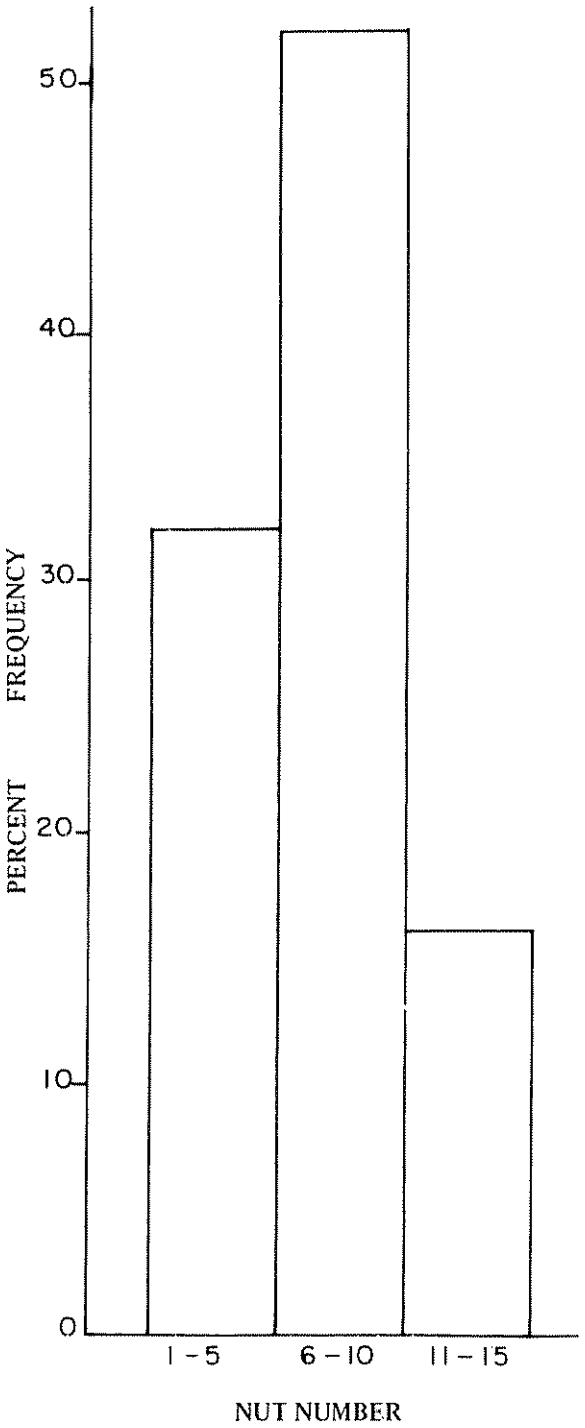

Fig. 3. Percent frequency distribution of *Cola acuminata* pod on nut number basis.

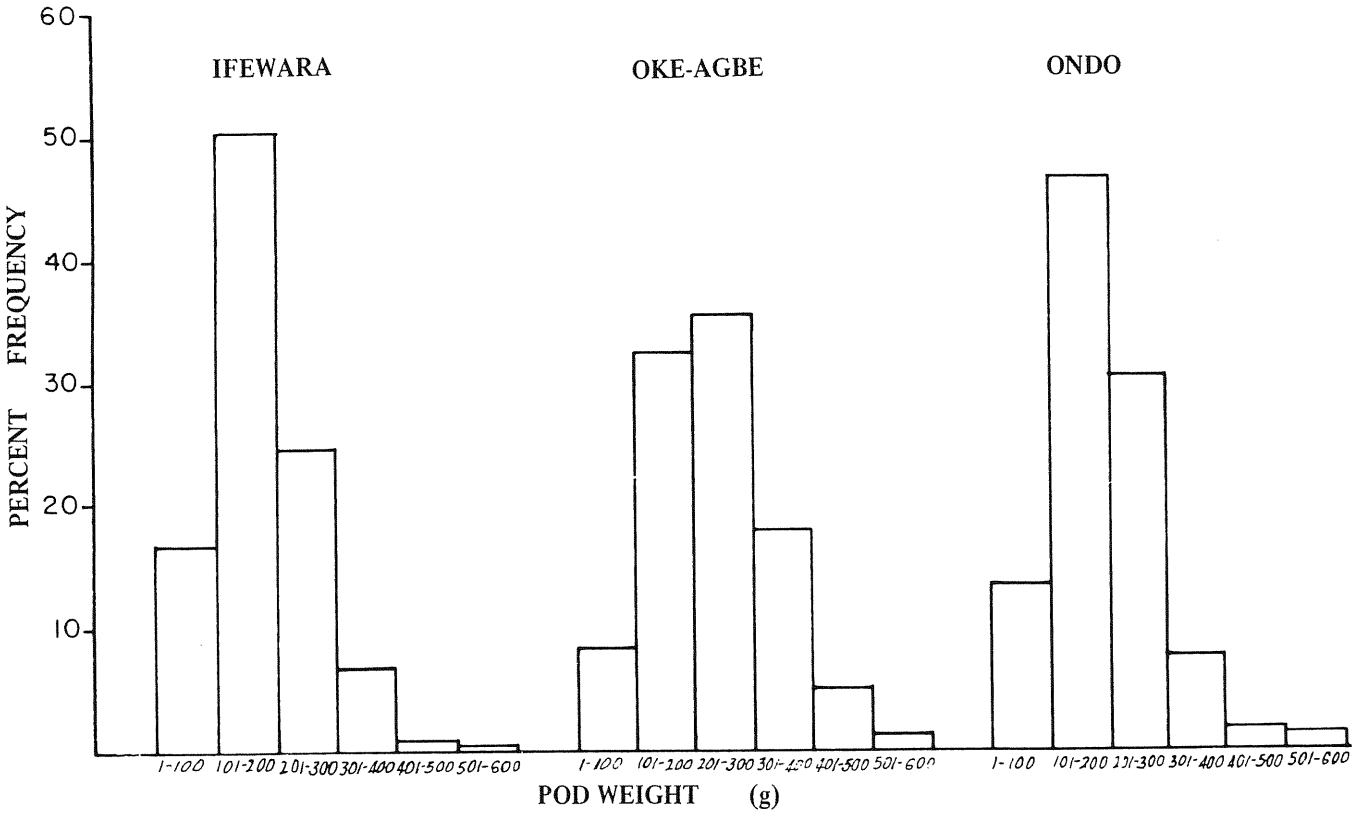

Fig. 4. Variation of *Cola acuminata* pod weight distribution with location.

Table 1. Analysis of variance table on the arcsin-transformed data of pod weight, total nut weight per pod, total nut number per pod and locations in *Cola acuminata*.

Sources of variation	D.F.	S.S.	M.S.	F	SIG. LEVEL
Pod weight (P)	5	1 547.82	309.565	91.00	* * *
Total nut weight (T)	6	287.547	47.924	14.09	* * *
Total nut number (N)	2	185.972	92.986	27.33	* * *
Location (L)	2	1.410	0.705	0.21	NS
P x T Interaction	30	3 129.732	104.324	30.67	* * *
P x N Interaction	10	224.386	22.439	6.60	* * *
P x L Interaction	10	79.159	7.916	2.33	*
T x N Interaction	12	168.859	14.072	4.14	* * *
T x L Interaction	12	186.445	15.537	4.57	* * *
N x L Interaction	4	57.622	14.405	4.23	* * *
P x T x N Interaction	60	385.756	6.429	1.89	* * *
P x T x L Interaction	60	395.615	6.593	1.94	* * *
T x N x L Interaction	24	168.835	7.035	2.07	* *
P x N x L Interaction	20	86.119	4.306	1.26	NS
Residual (P x T x N x L)	120	408.198	3.402	–	–
TOTAL	377	7 313. 481	–	–	

*** Significant at 0.1%. * Significant at 5.0%.

** Significant at 1.0%. NS Not significant.

Table 2. Linear correlation coefficients of some characteristics of *Cola acuminata* pods.

	Pod weight	Pod length	Pod girth	Nut number	Nut weight	Testa weight	Pod husk weight	Pod length / Pod width	No. of red nuts	No. of pink nuts	No. of white nuts	Percent pod husk weight	Percent nut weight	Percent testa weight
Pod weight	—	0.48***	0.28**	0.23*	0.89***	0.67***	0.88***	0.21*	0.17	0.00	0.20*	0.21*	0.14	0.13
Pod length		—	0.57***	0.43***	0.35***	0.31**	0.51***	0.37**	0.15	0.30**	0.17	0.04	0.06	0.07
Pod girth			—	0.21*	0.10	0.20*	0.39***	–0.51***	–0.06	0.32**	0.12	0.21	–0.24*	0.09
Nut number				—	0.26**	0.20*	0.14*	0.19*	0.69***	0.33***	0.07	–0.27**	0.19*	0.17
Nut weight					—	0.54***	0.61***	0.27**	0.21*	0.01	0.15	–0.52***	0.51***	0.03
Testa weight						—	0.48***	0.10	0.15	0.01	0.11	–0.32**	–0.02	0.76***
Pod husk weight							—	0.12	0.09	0.00	0.21	0.21*	–0.23*	0.02
Pod length / Pod width								—	0.22*	–0.07	0.04	–0.17	0.20*	–0.04
No. of red nuts									—	–0.43***	–0.21*	–0.19*	0.13	0.14
No. of pink nuts										—	0.10	–0.09	0.08	0.03
No. of white nuts											—	0.00	0.00	–0.01
Percent pod husk weight												—	–0.89***	–0.28**
Percent nut weight													—	–0.15
Percent testa weight														—

*** Significant at 0.1%.
** Significant at 1.0%.
* Significant at 5.0%.

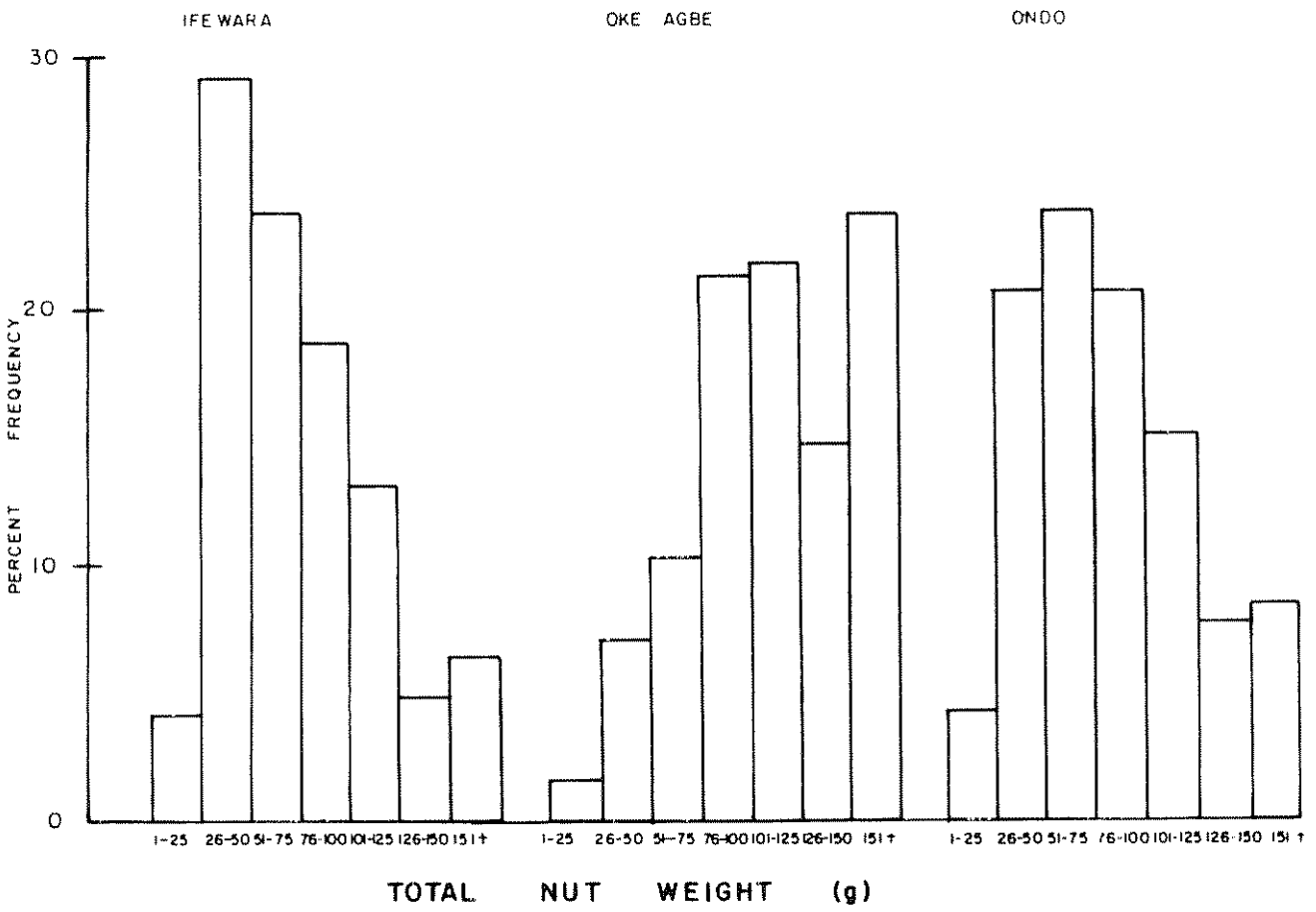

Fig. 5. Variation of *Cola acuminata* total nut weight per pod distribution with location.

Discussion

The highest frequency of pods occurred between 101 and 300 g weights, while the majority of pods have between 26 and 125 g weights for the total nut weight content. The nuts at the extreme ends of the pods were found to be smaller than the ones in the middle as reported for *C. nitida* by Eijnatten (3). The average pod weight was found to be 209 g, while the mean total nut weight per pod was 88 g.

It is significant to note that increase in pod weight was much more due to increase in nut weight than that which was due to increase in nut number. This is well illustrated in Figures 4 and 5 where heavy pod weight recorded for Oke Agbe was rather due to heavy nuts contained by the pods. Table 2 and Figure 9 also show that the correlation and regression between total nut weight per pod and pod weight were very highly significant. This is in agreement to what was obtained in cocoa where the increase in pod weight was accounted for jointly by both

Table 3. Mean values of pod characteristics of *Cola acuminata*.

Characteristics	Mean Values[1]
Pod weight (g)	208.66 ± 93 97
Pod length (cm)	15.13 ± 2.85
Pod girth	16 70 ± 3.35
Nut number per pod	7.86 ± 2.86
Total Nut weight per pod (g)	88.22 ± 47 72
Testa weight (g)	21.01 ± 15.19
Pod husk weight (g)	99.43 ± 46.05
Pod length	
Pod width	1.85 ± 0.37
Number of red nuts	3.01 ± 2.02
Number of pink nuts	6.67 ± 3.18
Number of white nuts	0.16 ± 0.62
Percent pod husk weight	49.00 ± 9.74
Percent nut weight	41 27 ± 9.51
Percent testa weight	9.70 ± 4.65

1 Each figure is a mean of 919 pods.

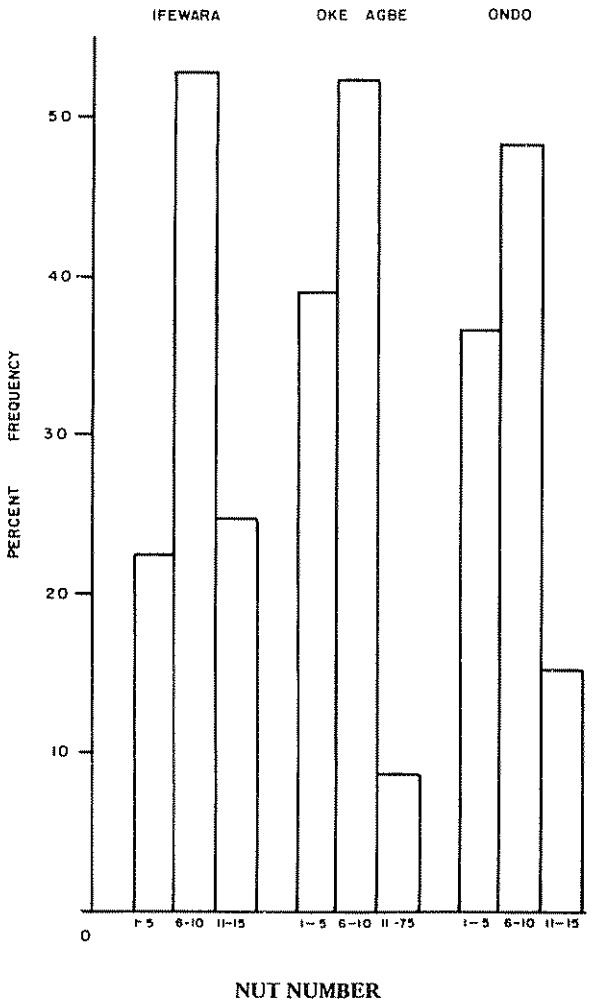

Fig. 6. Variation of *Cola acuminata* nut number per pod distribution with location.

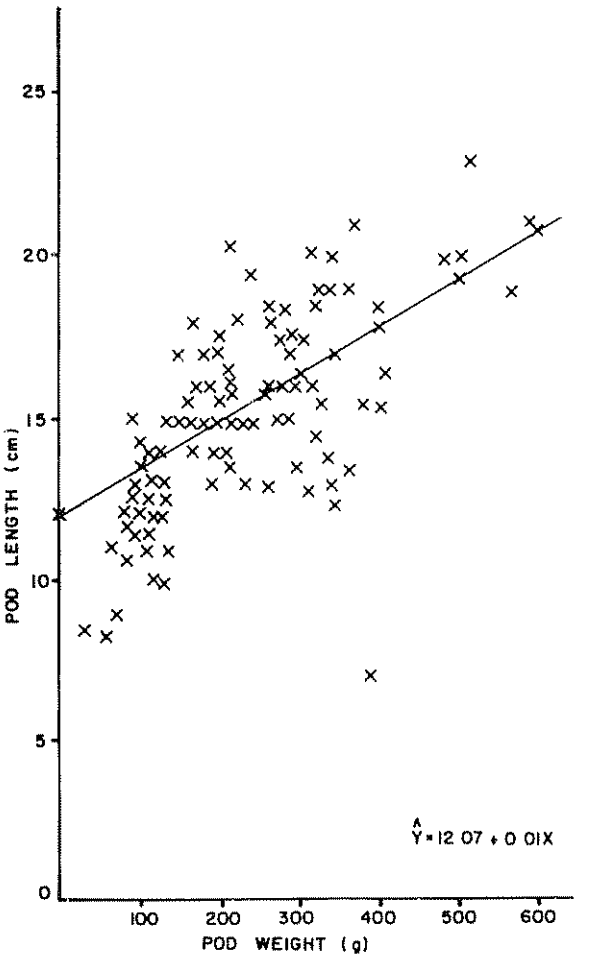

Fig. 7. Regression curve of pod length with pod weight in *Cola acuminata*

the increase in the number of seeds and increase of the average weight per seed (Ruinard, 11), although the author did not specify which one of the factors predominated. The regression curves of nut number and total nut weight per pod and per cent nut weight with pod weight (Figures 8 and 9) showed that there is a minimum size the pod must have to contain minimum sizeable nuts. The curves also showed that although a given pod may contain nuts in good condition and may have reasonable size, the nuts may be entirely testa or too small to be economically useful. This phenomenon is not unknown with kola pods.

The highest nut number per pod obtained was 13, while the least was 1. This and the fact that the majority of the pods had between 6 and 10 nuts per pod agree with those of Keay *et al.* (8), Russell (12), but disagree partially with Hutchinson and Dalziel (5) who put the nut number at 1-9. Dublin (2) recorded an average of 7.2 nuts per pod for *C. nitida* with a range of 1-15 nuts per pod. His findings thus agree well with these results as the mean nut number per pod recorded here was 7.9.

The highly significant interactions recorded for nut number and location, total nut weight per pod and location, and the slight significance of the interaction between the pod weight and location underscore the variability of these characters from one location to the other and at the same time foreshadow the likely genetic variability involved barring any distinct edaphic soil factors. The three characters (pod weight, total nut weight per pod

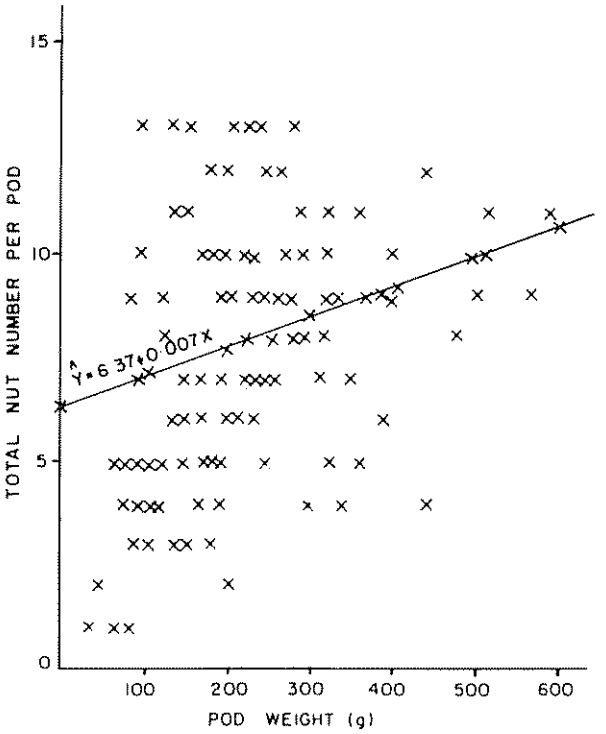

Fig. 8. Regression curve of total nut number per pod with pod weight *in Cola acuminata*.

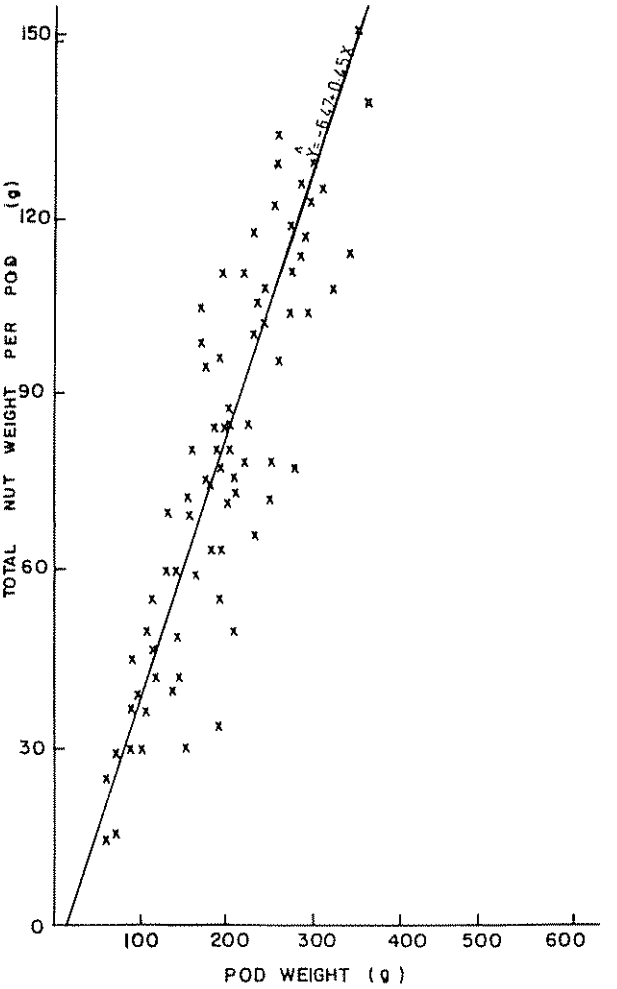

Fig. 9. Regression curve of total nut weight per pod with pod weight in *Cola acuminata*.

as well as total nut number per pod) show a highly significant interaction. It is noteworthy that of the four main factors, i.e. pod weight, total nut weight per pod, total nut number per pod and location, only the latter was not significant. This further shows that the differences and interactions recorded for the characters are mostly likely to be genetically controlled.

Pod weight correlated positively with its three components viz: nut weight, testa weight and pod husk weight and the correlations were highly significant though nut weight and pod husk weight were equaly but much more significant than testa weight. Pod weight was also significantly correlated with pod length and pod girth but slightly with nut number. This is not surprising as the size of the pod dictates the pod husk weight, the latter being strongly correlated with pod weight. It is significant to note that pod weight is significantly negatively correlated with per cent pod husk. This is a welcome situation in that the fraction of the husk decreases while that of nut weight increases with increase in pod weight. In fact, per cent pod husk deservedly and highly significantly correlated negatively with per cent nut weight. Finally, it is not surprising that pod length correlated strongly with nut number since the more the number of the nuts within a pod, the longer it should be, if not wider.

The mean values of the pod characteristics tabulated in Table 3 are of tremendous value when considering the various characteristic components of a kola pod and the possibility of improving upon any of them. The mean fractional composition of pod husk, total nut weight and testa viz: 49.0%, 41.0% and 10.0% respectively, agree well with the findings of Ogutuga (9) who reported 44.3% , 40.4% and 14.30% for pod husk, total nut weight and testa respectively for *C. nitida*.

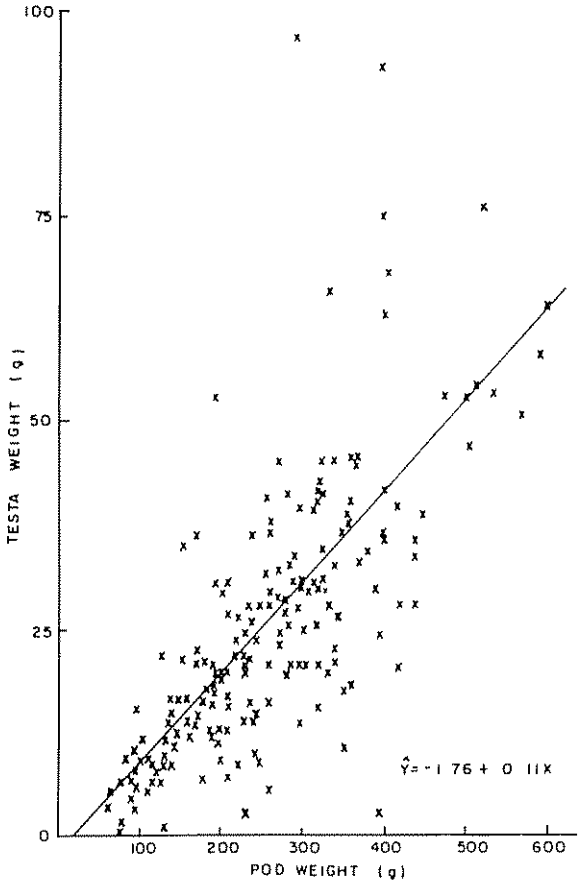

Fig. 10. Regression curve of testa weight with pod weight in *Cola acuminata*

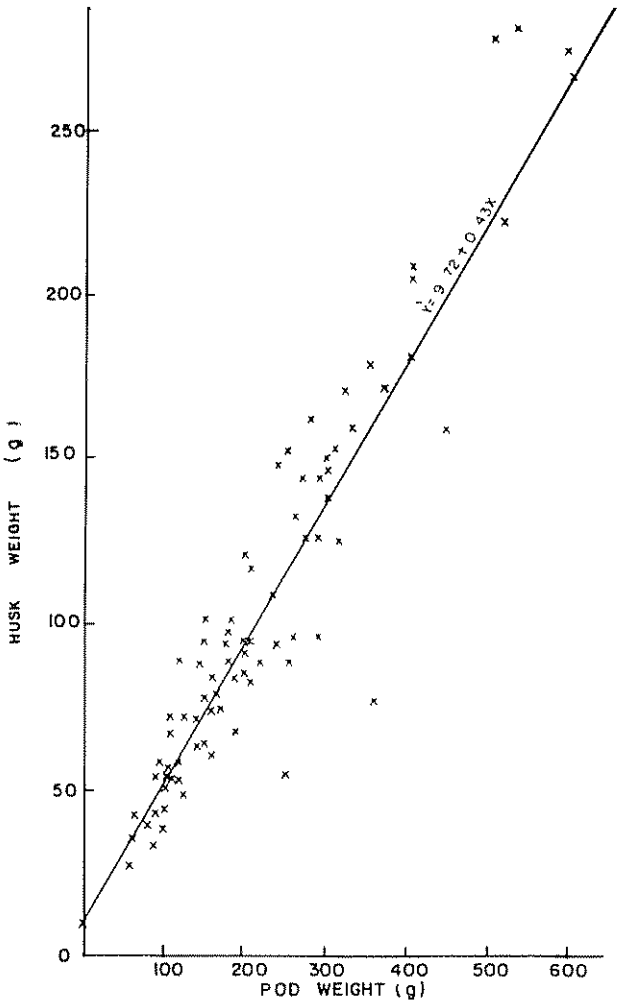

Fig. 11. Regression curve of husk weight with pod weight in *Cola acuminata*

Conclusions

The findings reported above show that *C. acuminata* pod is full of variable characters which are genetically based. As a good number of these factors interact significantly, it is very likely that a good number of them will be linked. The degree of such linkage will no doubt determine the ease, or otherwise, as well as the success of subsequent breeding programmes.

Abstract

Fresh *Cola acuminata* pods were classified into pod size, nut number and total nut weight per pod. Pod sizes varied from 30 g to 550 g with the majority of them falling into 101-200 g size (43.11%). Mean pod weight was 209 g. 53.85% of the pods have 6-10 nuts per pod while 24.33% and 21.82% have 1-5 and 11-15 nuts per pod respectively. Mean nut number per pod was 7.9. A majority of pods had total nut weight of 26 g to 125 g with average total nut weight being 88 g.

Statistical analysis gave 0.1% significant difference for pod weight, total nut weight per pod, and nut number. Planting location effect was not significant. Interactions between pod weight and total nut weight per pod, pod weight and nut number, total nut weight per pod and nut number, total nut weight per pod and location and nut number and location were also significant at 0.1% level. While the interactions between nut number, total nut weight per pod and pod weight, nut number, total nut weight per pod and location and total nut weight per pod, pod weight and location were significant, interactions between nut number, pod weight and location were not significant.

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