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Compatibility studies in Cola *nitida* genotypes

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Cross and self-pollination compatibility studies were carried out using 10 *Cola nitida* genotypes from the Cocoa Research Institute of Nigeria, Ibadan. The few genotypes that were self-pollinated tended to show low pod production; whereas, crosses between the genotypes showed higher pod production. These data would suggest that multiple genotypes should be included in plantations to achieve higher levels of cross-pollination for seed production. Several genotypes (AA231, AA86 and AD44) used in crosses produced pods at a higher frequency. This would suggest higher compatibility of these genotypes. Successful crosses achieved in this work have therefore created a way by which *Cola* production could be given a boost in Nigeria. This could be achieved by substituting the incompatible genotypes in plantations with cross compatible genotypes discovered in this research work.

Key words: Compatibility, *Cola nitida*, cross and self-pollination, pod production.

INTRODUCTION

The genus *Cola* Schot and Endl., belongs to the family Sterculiaceae and is one of the economically important genera of this family. According to Bodard (1962), the genus is comprised 90 species with S50 native to West Africa. Two species, *Cola nitida* (Vent) Schot and Endl and *Cola acuminata* (Pal. De beauv) Scholet and Endl. are of major economic importance in Nigeria. Both species bear a striking resemblance to each other and are cultivated for their edible seeds (Kolanuts). The chromosome numbers of *C. nitida* and *C. acuminata* are 2n = 40, which also have been reported in wild *Cola* species (Adebola and Morakinyo, 2005). Purseglove (1968), reported that the basic chromosome number for the genus was n=10 indicating the occurrence of polyploids in the genus.

Kolanuts are regularly chewed and have varied socio-cultural importance. Nutritional analysis of three *Cola* species was carried out by Duran et al. (2015). They reported that the lipid content was very low and that the protein content in *C. nitida* and *C. acuminate* were relatively high, with high energy value and high mineral composition. *C. nitida* is characterized by nuts with two cotyledons and this species is of greater commercial importance as seeds are in higher demand for exports. *C. acuminata* has nuts with three to six cotyledons and this species is of social, religious and ceremonial values among the Yoruba, Edo, Igala, Igbo and Nupe societies of Nigeria. The *C. nitida* plants are functionally monoecious possessing both male and female (hermaphrodite) flowers. The male flowers have rudimentary gynoecium, which is non-functional. The hermaphrodite flowers have well-developed androecium

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and gynoecium. The pollen sacs in the hermaphrodite flowers do not dehisce nor sporulate. Although, pollen grains from hermaphrodite flowers are viable, they have been confirmed to be non-functional when used for either self or cross pollination (Opeke, 1982). *C. nitida* is self-fertile, although with varying degrees of self-incompatibilities occurring among individual trees (Bodard, 1995). The sticky nature and the size of *C. nitida* pollen grains indicate that pollination is likely to be anemophilous. The flowers of *Cola* have in addition a penetrating scent that attracts different types of insects (Bodard, 1962; Russel, 1955).

The main objective of the study is to develop *Cola* genotypes through cross pollination that would show some level of heterosis over the existing genotypes. These new genotypes would be used to replace the old and low yielding genotypes in the plantations.

MATERIALS AND METHODS

Ten *C*. *nitida* genotypes were selected from experimental plots (64/5) at the Cocoa Research Institute of Nigeria, Ibadan. The genotypes were randomly picked as representatives of various plots based on their yield performance. A diallele mating design including reciprocals was used to assay cross-pollination among genotypes. Pollinations were carried out during the major flowering season from July to September and also in the minor flowering period between November and December.

For cross-pollination, a female flower on an inflorescence was selected and bagged a day before anthesis after removing all the male and young flower buds on the inflorescence. On the day of anthesis, the protecting bag was quickly removed and fresh pollen grains collected from respective pollinator parent were transferred to the stigmatic lobes of the female flower. This was done carefully by removing the perianth of the male flowers and rubbing the fused stamens with the exposed pollen grains on the stigmatic lobes of the freshly opened female flower (Jacob, 1970). The pollinated flowers were re-bagged and properly labeled with tags indicating the date, parents, and serial number of pollination. The bags were removed after 48 h. Pollinations resulting in fruit production after two weeks were regarded as initial fruit set. Pollinations with fruits retained after 90 days were recorded as being successful. The number of pods collected on successful pollination was recorded. Percentage of harvested pods was calculated as:

$$H (\%) = X/PK$$

where X = Number of pods harvested, P = Total number of flowers pollinated, and K = A constant = 3.

RESULTS

A total of 180 flowers were pollinated during the study. From these pollinations, 88 flowers set fruits (45.6%) and 67 pods were harvested (11.57%). Data from the self and cross-pollinations for the 10 *C. nitida* genotypes are presented in Table 1. The small number of flowers pollinated for some genotypes was the result of non-synchronous flowering. For three genotypes that were self-pollinated, only AA 231 successfully produced pods, however, frequency of pod produced was low (5.5%). The harvested pods for this genotype are shown in Figure 1.

From the 90 possible cross-pollination combinations, crosses were conducted for 18 combinations (Table 1). Fifteen of these combinations successfully produced pods. Two failed to set fruit and one set fruit, but failed to produce pods. Pods from crosses AA 231 × AD44 and AA231 × AB 15 are presented in Figures 2 and 3. Seeds harvested from three successful crosses are presented in Figure 4. The level of compatibility within and between selected genotypes is given in Table 2. Among theselections, AA231 × AD 44 scored the highest percentage of flower setting (55.5%) and fruit harvest(18.5%). For the cross-pollinations, fruit set averaged 45.3% with cross AA86 × T5139 showing the highest frequency of fruit set; whereas, the highest percentage of pods harvested was observed for cross AA86 × L47 (Table 1). However, genotype AA231 tended to show pod produced in crosses with a greater number of genotypes suggesting a higher level of compatibility.

DISCUSSION

The productivity of *C. nitida* groves in Nigeria is extremely variable, where a large number of trees are either non-productive or low yielding. Russell (1955) estimated that as much as 72% of the total yield from some *C*. *nitida* groves at Agege, Nigeria might be realized from only 21% of the trees if they were normally productive. This means that most of the Nigerian groves need either complete or selective rehabilitation. From the results of this study, clones such as AA231, AF112 and AD44 can be used for rehabilitation. According to Jacob (1973), compatibility is confirmed if 15% fruit set and 5% fruit harvest result from either self-pollination involving a single genotype or cross pollination involving two different genotypes. Reports of Bodard (1962), Russell (1955), and Eijnatten (1969) indicated that usual range of success lies between 30% and 50%. The close range obtained in this study could be attributed to the use of three distinct Cola populations of different origins.

Findings from this study may partly explain the complaints made by farmers that plantations are not yielding at all or yielding at low capacity, because of the compatibility status of the materials originally planted. It is thereby recommended that for commercial production of *C*. *nitida* nuts, some of the compatible clones identified during this work could be used to establish new *C*. *nitida* plantations or rehabilitate unproductive groves.

Conclusion

Considering the socio-economic importance of *C*. *nitida*, breeding new varieties that would enhance greater

Table 1. Results of pollination in diallele combinations involving 10 *Cola nitida* genotypes.

Female/Male		AA231 (%)	AA86 (%)	AB15 (%)	AD44 (%)	AD56 (%)	AF112 (%)	AF129 (%)	L47 (%)	L48 (%)	TS139 (%)
	P	12	-	-	2	4	2	-	-	-	-
AA231	S	8 (66.67)	-	-	1 (50.00)	2 (50.00)	1 (50.00)	-	-	-	-
	H	2 (5.5)	-	-	1 (16.67)	1 (8.35)	1 (16.67)	-	-	-	-
	P	18	10	-		-	-	-	-	-	-
AA86	S	9 (50.00)	0 (0)	-	-	-	-	-	-	-	-
	H	6 (11.11)	0 (0)	-		-	-	-	-	-	-
	P	16	-	-	5	-	-	-	-	-	-
AB 15	S	7 (43.75)	-	-	3 (60.00)	-	-	-	-	-	-
	H	7 (14.58)	-	-	1 (6.67)	-	-	-	-	-	-
	P	18	4	-	-	-	4	-	6	-	-
AD 44	S	10 (55.55)	2 (50.00)	-	-	-	2 (50.00)	-	3 (50.00)	-	-
	H	10 (18.50)	2 (16.67)	-	-	-	1 (16.67)	-	3 (16.67)	-	-
	P	5	3	-	-	4	-	-	-	-	-
AD 56	S	0	0 (0%)	-	-	3 (75)	-	-	-	-	-
	H	0	0 (0%)	-	-	0	-	-	-	-	-
	P	13	-	-	-	-	-	-	-	30	-
AF 112	S	7 (53.84)	-	-	-	-	-	-	-	12 (40.00)	-
	H	7 (17.95)	-	-	-	-	-	-	-	12 (13.35)	-
	P	-	-	-	-	-	3	-	-	-	-
AF 129	S	-	-	-	-	-	1 (33.33)	-	-	-	-
	H	-	-	-	-	-	0 (0)	-	-	-	-
	P	4	4	-	-	-	-	-	-	-	-
L 47	S	2 (50.00)	3 (50.00)	-	-	-	-	-	-	-	-
	H	2 (16.67	3 (25.00)	-	-	-	-	-	-	-	-
	P	-	-	-	-	-	-	-	-	-	-
L 48	S	-	-	-	-	-	-	-	-	-	-
	H	-	-	-	-	-	-	-	-	-	-

Table 1. Contd.

	P	-	13	-	-	-	-	-	-	-	-
T 5139	S	-	10 (76.92)	-	-	-	-	-	-	-	-
	H	-	5 (12.82)	-	-	-	-	-	-	-	-

Number of flowers pollinated (P); number of initial fruit set (S); number of pods harvested (H) percentage in parenthesis.

Figure 1. Harvested pods of self-pollinated AA231, 130 days after pollination.

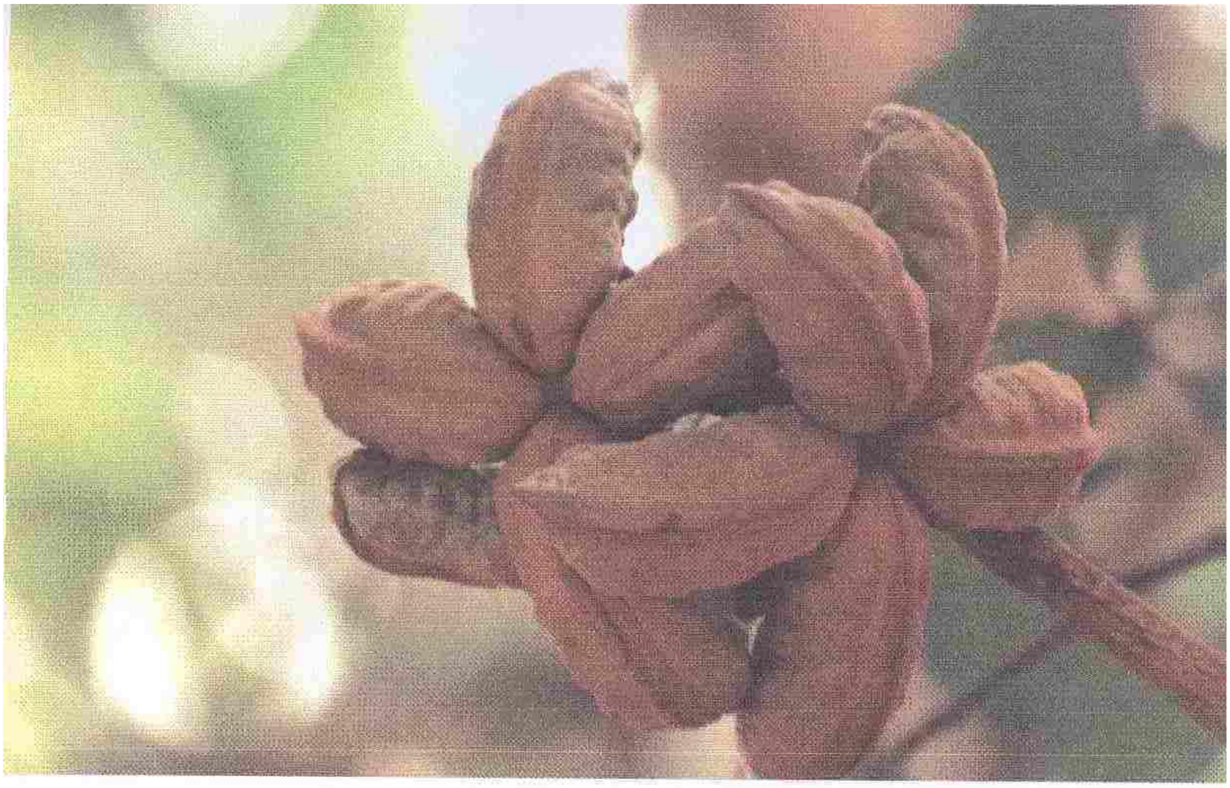

Figure 2. Matured pods of successful cross compatible genotypes of AA231XAD44.

Figure 3. Matured pods of successful cross compatible genotypes of AA231XAB15.

Figure 4. (1) The nuts of AA231XAB15; (2) The nuts of AA231XAD44; (3) The nuts of L48XAF112.

Table 2. Compatible genotypic combinations among *Cola nitida*.

Selection (Male × Female)	Number of flowers pollinated	Number of fruit set	Percentage of fruit set	Number of fruits harvested	Percentage of fruits harvested
AA231 × AD 44	18	10	55.55±2.05	10	18.50±1.15
AD 44 × AA 231	2	1	50.00±1.85	1	16.67±0.07
AF 112 × AA 231	2	1	50.00±2.1	1	16.67±1.05
AA231 × AF 112	13	7	53.84±2.25	7	17.95±1.25

production should be vigorously pursued.

Moreover, statistics on the existing *Cola* trees have shown that most of the existing *Cola* stands on our various plantations are old thereby reducing their yield capabilities. Efforts should therefore be geared towards self and cross breeding of these old stands to replace them with more vigorous hybrids to ensure continuous production.

It is hereby recommended that further breeding studies be carried out on *Cola* to enhance its productivity. This has become imperative because greater percentage of the existing populations is less productive due to age and climate change. Breeding of more vigorous genotypes and those that could be more tolerant to the ever changing climatic conditions would sustain the yield and production of kolanuts.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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