Genetic determinism in Dwarf coconut germ colour

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INTRODUCTION

Little is known about colour transmission determinism in coconut. Although this character is of no apparent agronomical interest, it does enable the legitimacy of certain artificial fertilizations or directed pollinations to be checked retrospectively. Moreover, colour is one of the factors which makes it possible to distinguish certain Dwarf ecotypes.

Certain methods are already used to produce hybrid seeds through assisted pollination [2]. Under Côte d'Ivoire conditions, PB 121 hybrid seed production (Malayan Yellow Dwarf x West African Tall) results in approximately 5 p. 100 illegitimates. As the seed gardens are isolated and selffertilizing Dwarfs are used for mother-trees, almost all of the illegitimates are yellow Dwarfs resulting from incomplete emasculation. It is easy to eliminate them because of the colour of the germ, a characteristic bright yellow, while the hybrids are green or brown in colour, closer to that of the African parent [4]. Similar systems are used for other hybrid types, including a yellow or red Dwarf parent.

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I. — MATERIAL AND METHOD

The experiment designed to try and specify germ colour genetic determinism was carried out on a trial set up in 1971 at Port-Bouët (PB-GC 4 [1]) which compares hybrid combinations between three Dwarfs : the Malayan Yellow Dwarf (MYD), Malayan Red Dwarf (MRD) and Equatorial Guinea Green Dwarf (EGD). These three ecotypes, which are preferentially self-fertilizing [3], are homogeneous with respect to colour and germ, and produced homogeneous progenies. They can therefore be classed as pure lines and homozygous for genes controlling germ colour.

The study involved four treatments : the progenies from three hybrids : MYD × MRD, MYD × EGD, MRD × EGD, and a MYD control.

Each experimental plot in PB-GC 4 contains 36 trees planted in 6 adjacent rows with 6 individuals per row. Only nuts from the 4 innermost trees of each plot were sampled. As the Dwarf parents are preferentially self-fertilizing, we assumed that the hybrids use the same reproduction method. The nuts sampled from the hybrids should therefore correspond to self-fertilization. Even if a few cross-fertilized individuals occur, the fact that the nuts are taken from the innermost trees of each elementary plot increases the probability of fertilization between trees of the same genetic nature. In effect, a tree generally has a better chance of being pollinated by close neighbouring trees.

All of the nuts were sampled during a fortnightly harvest ; the quantities appear sufficient :

MYD	355 nuts,
MYD × MRD	480 nuts,
MYD × EGD	395 nuts,
MRD × EGD	395 nuts.

These nuts were placed in the seed bed using the method recommended by the IRHO [6]. Colours were observed one week after the germ appeared, which is the period when colours are the easiest to distinguish : yellow, red, green and brown.

II. — RESULTS

Table I gives all of the colour segregations observed for the four treatments.

Cross-fertilization rate.

The percentage of non-yellow germs observed in the MYD × MYD control enables a minimum estimate of the cross-fertilization rate to be made : 4.9 p. 100. The value observed is less than the real value, since cross-fertilization between yellow Dwarfs is undetectable, given the experimental layout.

Interpretation of colour segregations.

The colour segregations obtained cannot be explained using a monofactorial model because within the EGD × MRD progenies, there is a not inconsiderable number of yellow germs, while the Dwarf parents are homozygous.

The simplest model consists in taking two couples of independent alleles : (r,R) and (g,G). Correspondances between genotypes and phenotypes would then be the following :

$$\frac{r}{r}\ \frac{g}{g} \qquad \text{[yellow germ]}$$

$$\frac{R}{r}\ \frac{g}{g} \quad \text{and} \quad \frac{R}{R}\ \frac{g}{g} \qquad \text{[red germ]}$$

$$\frac{r}{r}\ \frac{G}{g} \quad \text{and} \quad \frac{r}{r}\ \frac{G}{G} \qquad \text{[green germ]}$$

All of the other genotypes correspond to brown germs. The model leads to the theoretical frequencies given in Table II :

The validity of this hypothesis was tested by assuming that the green germs of the MYD × MRD cross and the red and brown germs of the MYD × EGD cross were illegitimates. Their low frequency, close to that observed for the control illegitimates, enabled this adjustment : frequencies were recalculated by eliminating detectable illegitimates.

The Chi-two test at 5 p. 100 leads to concordance between theoretical and observed numbers in two out of the three cases. With the MYD × EGD hybrid, proportions deviate significantly from the 3/4 1/4 ratio because of an exceedingly high proportion of yellow germs.

III. — DISCUSSION

Although significant, the discrepancy between theoretical and observed colour distribution in the progeny of the MYD × EGD hybrid remains relatively low : overall, ratios are 2/3 1/3 in favour of green germs instead of 3/4 1/4.

The difficulty in distinguishing certain colours, e.g. green, which is sometimes quite pale and may be classed as yellow [3], could explain the slightly higher occurence of this colour.

The fact that there are crossed fertilizations could also explain the discrepancies observed. In effect, the proportion of pollen from the Malayan Yellow Dwarf is much higher than that of the other types of coconut : the trial includes 300 Yellow Dwarfs (also used as border trees) compared to only 180 hybrid individuals. This imbalance could account for the high proportion of yellow germs in the MYD × EGD progeny.

This hypothesis implies a relatively high self-fertilization rate for the MYD × EGD (10 to 15 p. 100) and a lower rate for the MYD progenies. The low percentage of detectable illegitimates in the MYD × MRD progeny indicates that the hybrid is more autogamous than the Yellow Dwarf control. This suggests that the MRD, which is extremely autogamous, transfers this characteristic. The EGD, classified as a semi-direct autogamous type [3], is considered to be the least autogamous of the three Dwarfs.

Sangaré [5] showed that there exists pollen competition in coconut : MYD female flowers are generally more receptive to Dwarf pollen than tall pollen, and have a preferential ability to be fertilized by pollen of the same variety. The fact that such competition exists for Dwarf hybrids could explain the bias observed in the colour segregations.

CONCLUSION

Given the many uncertainties induced by the composition of the pollen cloud and the variable self-fertilization rates among the hybrids, there seems to be, initially, a very satisfactory agreement between the observations made and the determinism proposed.

Only an experiment based on artifical fertilization will enable this determinism to be definitively confirmed, through the absence of illegitimates. Pending this experiment, the simplest model to explain Dwarf coconut germ colour segregations remains determinism based on two couples of independent alleles.