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Some Morphological Observations on Albo-nigrescens, Albo-virescens and Virescens Types of Oil Palm Planted at Yaligimba (DRC)

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Abstract This study has confirmed that the pure albescens oil palm does not exist. There are 2 types of albescens well-described in this paper: albo-nigrescens and albo-virescens. An open-pollinated albo-virescens progeny planted at Yaligimba has shown 36% albo-nigrescens, 36% of albo-virescens, 18 % virescens and 9% nigrescens palms. However, the self-pollinated albo-nigrescens progenies have revealed only two types of palms, 77% albo-nigrescens, 23% nigrescens palms, but no virescens and no albo-virescens. Differences among different oil palm types appear not only on the fruit colours, but also on the colours of rachis, petioles and inflorescences. The albo-nigrescens and albo-virescens progenies planted at Yaligimba plantation have shown short heights, and also has given acceptable bunch productions.

Keywords: *prospection, morphology, fruit colour, heritability*

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1. Introduction

The oil palm, *Elaeis guineensis* Jacq., is a tree originated from inter-tropical wet forest of Central and West Africa. This crop is now mostly planted in Malaysia and Indonesia, these two countries providing most of the international palm oil trade.

As the development of any crop needs the introgression of new genes, in 1984, Palm Oil Research Industry of Malaysia (PORIM) has organized a large collection of wild and semi-wild oil palms as new source of germplasm in the world [1]. Therefore, a large prospection has been also realized in all the DRC locations [2]. Small samples of this collection were given to the company "Plantations et Huileries du Congo" and planted in a trial at Yaligimba [3]. Among these oil palm planted materials, most were nigrescens as expected, but some rare virescens or albescens types have also been identified. In fact, Rajanaidu *et al*. [1] have found 6% of virescens in Cameroun wild materials, while [4] reported only 0.72% in Angola and 0.50% in Nigeria prospection. Prabhakaran [5] has noted only one virescens from 56 samples in Sierra Leone and zero virescens palm in Guinea on 61 samples. Recently, [6] have found only nigrescens fruit type from the wild collection done in the Northern regions of Ghana.

Usually, the level of carotenoids in the mesocarp of nigrescens and virescens varies, but is always much higher than in albescens [4]. It is the main reason of the non-development of this last palm type in palm oil industry. Nevertheless, the interest of albescens palm could result on its other oil nutritional value.

The aim of this paper is to give more details on the uncommon types of oil palm from Yaligimba plantation (DRC), albo-nigrescens, albo-virescens and virescens materials. The heritability of these materials which is not yet clearly revealed will be also analyzed. The first vegetative development and bunch production of these exceptional progeniess will be also appreciated.

2. Material and Method

2.1. Location and Experiments Planted

Feronia (PHC) research station, named *Creaty*, was located at Yaligimba, DRC, on 2°13' N, 20°31' E and 400 m as sea level. This region has an annual rainfall of 1,750 mm, with 2 months of non-drastic dry season. Two experiments were concerned in this study:

Experiment 1. This experiment (Exp.1) which referred to the DRC prospection materials was planted at Yaligimba in1986 and named "YAL 55". A total of 356 progenies have been planted. Each progeny was represented by 10 to 15 palms in the field. The trial planting design was a randomized block with two or three repetitions of 5 palms.

Experiment 2. This experiment (Exp.2), known as trial "YAL 92", was planted in 1990, with 10 self-pollinated progenies from Mayumbe materials. Mayumbe site is

located in western coastal region of DRC and characterized by short palms [4]. This trial was planted in a single palm plot randomized block design. Three of the 10 progenies were identified as albescens materials [7].

The 2 experiments were planted at 143 palms per hectare.

2.2. Collection of Data

The leaves, inflorescences, bunches or fruits of different oil palm types have been collected and observed in the field and, if required, sent to the laboratory for more accurate description.

The vegetative growth measurements have been done on the fourth year after planting, according to non-destructive method [4]. The production has been recorded by weighing bunches immediately after harvest, and has concerned only the first 3 production years.

3. Results and Discussions

3.1. Morphological Differences between Oil Palm Types

The nigrescens, virescens and albescens differences observed at Yaligimba on fruit external and internal colours are given hereafter. The differences on the leaves and inflorescences colours are also denoted.

3.1.1. Fruit Colour Observations

Figure 1 gives the comparative fruit pictures of different oil palm types.

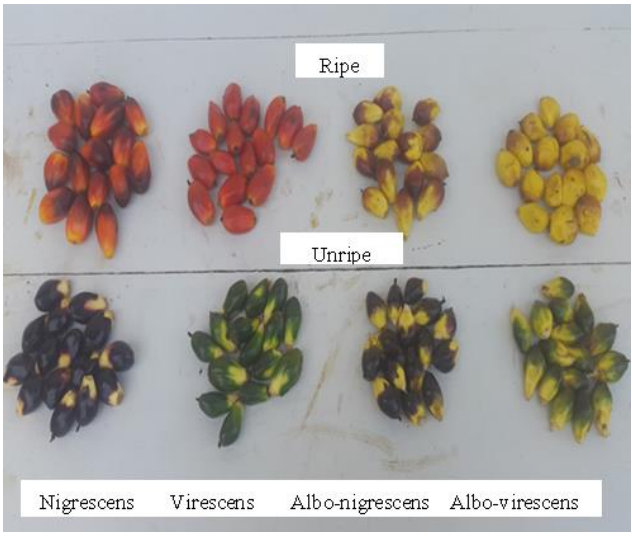


Figure 1. Unipe and ripe fruit of different oil palm types

The unripe and ripe observations on fruit colours of the 4 oil palm types are also detailed in Table 1. Normally, the fruit colour varies considerably in external appearance.

Table 1. Unripe and ripe details on fruit colours of oil palm type

1. Fruit ripe stage and type	Exocarp (external colour of fruit)		
	Apex colour	Top colour	Base colour
Unripe fruits			
Nigrescens	Black	Black	White yellowish
Virescens	Black-greenish	Green-violet	Ivory yellowish
Albo-nigrescens	Black	Black-brownish	Pale white-yellow
Albo-virescens	Black-greenish	Green	Pale white-yellow
Ripe fruits			
Nigrescens	Black	Brown-red	Red
Virescens	Black-green	Orange-reddish	Orange-reddish
Albo-nigrescens	Black	Ochre	Pale yellow
Albo-virescens	Black-green	Yellow deep	Yellow
2. Fruit ripe stage and type	Mesocarp (internal colour of fruit)		
	Pulp colour	Fibre colour	Oil colour
Unripe fruits			
Nigrescens	White-yellow	White &brown	No oli
Virescens	White-yellow	White	No oli
Albo-nigrescens	White-yellow	White	No oli
Albo-virescens	White-yellow	White	No oli
Ripe fruits			
Nigrescens	Rad	White & ochre	Red
Virescens	Orange reddish	White & ochre	Orange red
Albo-nigrescens	Pale-yellow	White & ochre	Ivory-yellow
Albo-virescens	Yellow	White & ochre	Light-yellow

The most common and cultivated type, well-known as nigrescens palm, has black or black-violet fruit colour when still unripen. As soon as ripen, the external colour changes and moves to black-brown in the high top and red in middle and base.

The second type is the virescens palm. This relatively uncommon type is characterized by green colour of the unripen fruits. Later, at maturity, the fruits become completely orange-reddish and could easily be confused with the nigrescens ripe fruits, as the colour is nearly the same. Some palms of this type have been observed in the prospection materials, Exp.1.

The albescens palm, the last oil palm type, however, are subdivided into two ‘subtypes’, and referred to as albo-virescens and albo-nigrescens oil palm type.

The albo-nigrescens unripen fruits are of black colour like the nigrescens, while the albo-virescens palms have green light fruit before ripening, same as the virescens ones.

The fruit colours change at maturity: the albo-nigrescens fruits become brown-ochre in the top and pale

yellow on the middle and base, the albo-virescens fruits move to yellow-green on the high top and light yellow on the middle and base, as reported in Table 1. The albo-nigrescens oil palm trees have been found in Exp.1 and 2, while the albo-virescens palms have been identified only in Exp.1.

The mesocarp colour or internal colour of fruit is less variable. The mesocarp colour of unripen fruits of all oil palm type is nearly close to white-yellowish. At maturity, the mesocarp becomes red or orange-red for the nigrescens and virescens fruits, but yellowish for the albo-nigrescens and albo-virescens ones. Figure 1, Table 1. These two last types ripe fruit colour explain the low carotene level in its mesocarps [4,8].

3.1.2. Leaf and Inflorescence Colour

Apart from fruits, the leaves and inflorescences of the different oil palm types have shown some perceptible morphological differences.

The petioles and the closing part of rachis are clearly light-green or pale-green for the albo-nigrescens and albo-virescens palm leaves. On the contrary, the petioles of nigrescens and virescens leaves are green-deep or green-ochre with some brown or ochre irregular and interrupted stripe on the abaxial face for the. Figure 2.

Figure 2. Petioles and rachis of different oil palms: 3 green albo-nigrescens on the left, 3 green albo-virescens on the right and 3 brown nigrescens in the middle

The spines of rachis seem to be also of distinguishing colours: green-yellowish for albo-nigrescens and albo-virescens, but brownish or yellow-ochre for nigrescens and virescens. According to [4], the variation in petiole colouring appears to be genetic, and can be helpful in distinguishing between clones. It may also be the case for the petiole, rachis and spines colours of leaves from different oil palm types, which may be a genetic character. The male inflorescence colours of albo-virescens and albo-nigrescens are whites inside the spathes, with also whitish spikelets and pale green spines on the top. The nigrescens spikelets are deep-brown and the spines on the top of spikelets are dark-brow. Figure 3.

Figure 3. Male inflorescence of nigrescens (at left) and of albo-virescens (at right)

The female inflorescences are also different: the spikelets are orange-brownish for nigrescens and pale yellow-whitish for albo-virescens and albo-nigrescens.

3.2. Inventory of Virescens, Albo-nigrescens and Albo-virescens Palms in the Field

3.2.1. Yaligimba Trial Inventories

The census of oil palm types done in Exp.1 confirms that most of the planted trees are nigrescens palms (99.25%). Only 18 virescens palms have been observed, corresponding to 0.50 % of total planted palms. A few albescens palms (9 palms) have been also noted in Exp.1 (0.25%), coming mainly from the same bunch or progeny (code 143). This remarkable albo-virescens bunch has been reported as collected at Yangambi site during the prospection of wild materials. In Exp.1, another progeny (code 155) has also shown two different palm types: 1 albo-virescens and 2 nigrescens palms. The actual number of palms in this last progeny is too small to be taken later into account for any comment on heritability.

The other albo-nigrescens palms were noted in Exp. 2, from the 3 self-pollinated albo-nigrescens progenies, where 56 of the 73 planted palms were identified of this same type. Table 2.

Table 2. Inventory of fruit types of palms in Exp.1 and 2

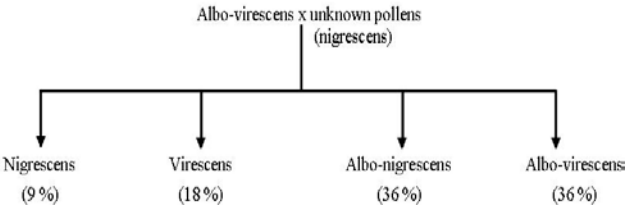
Progeny code	Nb palms in the field	Fruit character type identification			
		Nigrescens	Virescens	Albo-nigrescens	Albo-virescens
Exp.1					
Code 143	11	1 (9%)	2 (18%)	4 (36%)	4 (36%)
Code 155	3	2 (67%)	0 (0%)	0 (0%)	1 (33%)
Exp.2					
Code 946	18	2 (11%)	0 (0%)	16 (89%)	0 (0%)
Code 948	27	7 (26%)	0 (0%)	20 (74%)	0 (0%)
Code 950	28	8 (29%)	0 (0%)	20 (71%)	0 (0%)
Total	73	17 (23%)	0 (0%)	56 (77%)	0 (0%)

3.2.2. Heritability of Oil Palm Type

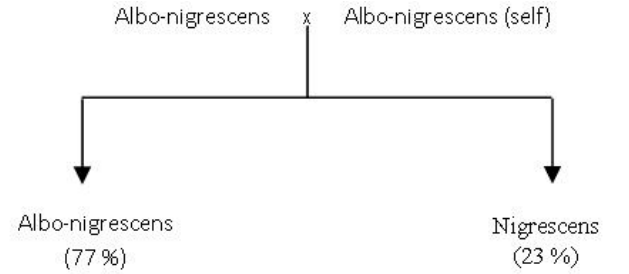
The heritability of fruit colours from planting progenies in Exp.1 and Exp.2 is shown in Table 2. In Exp.1, the 11 planted palms of code 143 are split into 4 distinguishing palm types: 4 albo-nigrescens (36%), 4 albo-virescens (36%), 2 virescens (18%) and 1 nigrescens (9%).

In Exp.2, the palms have shown only 2 different fruit colours, corresponding to 56 albo-nigrescens (77 %) and 17 nigrescens palms (23 %). No albo-virescens and no virescens have been observed from these 3 self of albo-nigrescens. Table 2.

The palm dissociation graphics according to fruit colouring census done in the 2 experiments could be drawn as follows:



and:



The code 143 planting materials of Exp.1 came from an open-pollinated albo-virescens bunch. In fact, the female inflorescence flowers have been pollinated by unknown pollens, coming probably essentially from the nigrescens which is the most common type in the field. So, this result is a first tendency to be confirmed later by other data, because of the small number of existing palms in the study to allow very accurate heritability. The result of Exp.2 is of course more reliable with a bigger palm sample.

Nevertheless, according to other studies, the open-pollinated of albo-nigrescens gave either no albescens or only 1-5% in the progeny [8]. Corley and Tinker [4] and [9] reported also that the albescens type was hereditary, recessive, and probably controlled by a single-dominant gene. Recently, the identification of the virescens gene has shown that only one gene controls the fruit exocarp colour [10]. However, the results obtained so far at Yaligimba in the 2 experiments with an albo-virescens type from an open-pollinated bunch (code 143) and self albo-nigrescens progenies (code 946, 948 and 950) seem to show other evidence. Therefore, on base of these experiment results, it may be possible that the fruit colour characters are controlled by more than only one gene.

One of the problems for the use of albo-nigrescens in the field could be the difficulty to recognize easily a mature bunch, the top of ripe fruit colour being still brown, closed to the unripe one. An important loose of production could be expected in plantation with this fruit type.

3.2.3. Fruit Forms

Regarding the fruit forms, all the virescens palms from prospection materials, Exp.1, are dura. At ASD de Costa Rica, [11] reported that they have identified from the Nigeria origin 3 virescens tenera and 3 virescens pisifera palms where the virescens character is in a homozygous condition.

The albo-virescens and albo-nigrescens in Yaligimba plantation are also all dura palms, except 1 albo-nigrescens palm from progeny 143 identified as tenera, found in Exp. 1. This palm will certainly help for future breeding program if required to obtain some pisifera of albo-nigrescens type.

3.3. Bunch Production and Vegetative Development

The bunch production (FFB) and palm vegetative growth data, given in Table 3, concern only the progenies with albo-nigrescens or albo-virescens materials, in Exp.1. So, the performance of progenies 143 and 155 are compared with the experiment trial mean. The FFB yields of the 2 progenies are above the trial mean, by 2% and 9% respectively.

At the 4th year after planting, before palm competitions, the palms of progeny 143 have shown short height and low leaf area, 30% and 6% below the trial mean respectively. The higher leaf weight than trial mean is also denoted from this progeny.

Table 3. Performance of progenies with albescens palms compared to trial mean

a. FFB production

Location code	Progeny code	Progeny FFB per palm		
		Kg	St. dev. (std)	% trial mean
C	143	129	11	102
D	155	138	20	109
Trial mean		126	9	100

b. Vegetative development

Location code	Progeny code	Vegetative growth at 4 years after planting			
		Height (cm)	Leaf number	Leaf area 17 (m^2)*	Leaf weight 17 (kg)*
C	143	19	28	3.08	1.26
D	155	32	35	3.58	1.26
Trial mean		27	32	3.27	1.22

*Measurement done on the 17 ^{e} leaf by non-destructive methods

Reducing height and leaf area and increasing leaf weight help to obtain good bunch index, which is the ratio of fruit bunch dry weight to total dry matter production. Selection for high bunch index is now emphasized in several oil palm breeding programmes.

Planted as collection germplasm materials, the palms of this trial have not received fertilizers and it is the main reason of their low FFB yields and palm growths.

4. Conclusion

This study has confirmed that there are 2 types of albescens clearly identified: the albo-nigrescens and albo-virescens palms. After planting, the seeds from an open-pollinated albo-virescens material are split into 4 different oil palm types on base of fruit colours: 36% albo-virescens, 36% albo-nigrescens, 18% virescens and 9%

nigrescens. However, the self-progenies of albo-nigrescens have given 77 % albo-nigrescens and 23 % nigrescens palms, but no virescens and no albo-virescens denoted. The differences among palm types appear not only on the fruit colours, but also in the colours of leaves and inflorescences.

The albo-nigrescens progenies planted at Yaligimba plantation have shown relatively short heights and acceptable productions. Unfortunately, the real need of albo-nigrescens and albo-virescens for palm oil industry is not yet clearly demonstrated.

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