BIOLOGY AND PERFORMANCE OF SURINAM *ELAEIS OLEIFERA* (H.B.K.) CORTES

Keywords: Surinam *Elaeis oleifera;* Yield; Growth; Inflorescences; Bunch characters; Oil composition.

V. RAO*, CHIN CHEUK WENG† and N. RAJANAIDU*

*Palm Oil Research Institute of Malaysia
†FELDA Agricultural Services Corporation
P O Box 11, Sg. Tekam 27000 Jerantut, Pahang, Malaysia.

The Elaeis oleifera *palms found in Surinam and Northern Brazil are exceptional among* oleifera *on account of their small size, very slow growth in height and small inflorescences on long peduncles. The abscission of their male flowers, shortly after anthesis, is a unique characteristic not found in other* oleifera *nor in* E. guineensis. *Fruit bunch yields of the Surinam* oleifera *are comparatively inferior due to low bunch weight and bunch number. There is relatively less parthenocarpy and the fertile fruits have more pulp than in Central American or Colombian* oleifera *but the pulp has considerably less oil. The oil, furthermore, is more saturated. Interspecific hybrids between the Surinam* E. oleifera *and* E. guineensis *are markedly more fertile than those using other* oleifera *and hence are potentially promising. The hybrids are smaller and more compact and their yields can be high, but the mesocarp oil content requires improvement through breeding and selection.*

INTRODUCTION

The South American counterpart of *Elaeis guineensis,* the African oil palm, is *Elaeis oleifera,* a closely related species which occurs from Brazil in the south to Honduras in the north.

Its yields are uneconomic but the species is of interest to breeders because it readily hybridizes with *E. guineensis,* transmitting in varying degrees desirable traits such as slower growth, more mono-unsaturated oils and some

disease resistance. Interest has waned in recent times however, as no remedy has been discovered for the partial sterility of these interspecific hybrids.

A very distinct population of *oleifera* found only in Surinam and in Northern Brazil is now known to give fertile hybrids (Lubis *et al.*, 1987, Rao, unpublished). This *oleifera* is described below.

PAST DESCRIPTIONS

Most observers and collectors of *Elaeis oleifera* have briefly reported on the distinctly smaller type found in Surinam and in Northern Brazil (de Blank, 1952; Wessels Boer, 1965; Meunier, 1975; Edson Barcelos *et al.*, 1985; Marcio de Miranda Santos *et al.*, 1985; Rajanaidu, 1983).

Meunier (1975) observed the palms to be very short compared with the *oleifera* from other parts of the continent and to have slender leaves with fewer, more widely spaced leaflets. The palms, monoecious like other oil palms, had smaller inflorescences subtended on comparatively longer stalks. Female inflorescences developed into bunches of bright green fruits which turned orange on ripening. Compared with other *oleifera,* the bunches had relatively more fertile fruits and the latter more pulp but less oil.

Richardson (1976), in a comparative trial of Central American, Colombian and Surinam *oleifera* found the last to be shorter and smaller; the petioles, though more slender, had large spines. The small fruit bunches were borne on long, slim stalks unlike the large bunches and short, stout stalks of other *oleifera.* Richardson noted that the Surinam *oleifera* showed a higher incidence of 'spear disease'.

In Brazil, in a biometrical survey of Amazonian *oleifera* populations, Edson Barcelos *et al.* (1985) and Marcio de Miranda Santos *et al.* (1985) found the northern population markedly different from the rest and more akin to that found in Surinam. The palms had the characteristically shorter rachises and much smaller bunches. More recently, Ghesquiere *et al.* (1987) showed this population to be electrophoretically distinct for an enzyme locus as well.

MATERIALS AND METHODS

A small collection of seeds were obtained from Surinam in 1977, germinated in Malaysia and planted at two sites in 1981. Site 1 at PORIM Research Station Kluang is on secondary soils receiving an average annual rainfall of 2060 mm while site 2, at FELDA Tun Razak Research Station, Sungai Tekam, is on similar soils and has an average rainfall of 1995 mm per year. The seedlings were four years old at field planting, their slow growth advising retention in the nursery longer than the usual 12 months for oil palms. They were planted 10 m apart on the standard triangular pattern, though it soon became obvious that the spacing was unnecessarily wide.

Vegetative data were collected annually, fruit bunches were weighed at each harvest and samples of bunches were analysed for bunch components and the fatty acid composition of their oils. The methods and measurements were similar to those routinely used in oil palm breeding.

BIOLOGY

In Malaysia, as elsewhere, the Surinam *oleifera* are characteristically short with small, flat-topped crowns (*Figure 1*). The foliage appears paler than that of other *E. oleifera* or *E. guineensis* for the fronds produced are a lighter green and darken less with age. Mild sun scorching may be seen on some palms, which is not so surprising as they grow under forest in parts of their native habitat (Rajanaidu, 1983). The pinnae on each frond are arranged in a flat, single rank, as in other *oleifera,* except for the proximal ones, which are orientated like the upper rank leaflets of *E. guineensis.* It is the latter feature, perhaps, that suggested to de Blank (1952) an erroneous resemblence to *E. guineensis* fronds. As in other *oleifera,* the leaflet pulvini of the Surinam type are not as prominent as in *E. guineensis.*

Both male and female inflorescences are borne on comparatively long peduncles and the bunching of spikelets at the distal end, especially in the female, adds to the characteristic club-like appearance. As in most monoecious palms, the peduncle of the male inflorescence is slimmer and longer than that of the female. The inflorescences are comparatively small, with some 20 – 40 spikelets in contrast to the more than one hundred of other *E. oleifera* and *E. guineensis.* The spikelets are also small, each female spikelet, for example, bearing about 10 – 15 flowers compared with more than 20 in other *oleifera.* Each male spikelet bears about 800 – 1000 flowers.

A phenomenon unique to the Surinam *olei-*

fera, among oil palms, is the abscission of male flowers after anthesis. The flowers, unlike those in other oil palms, are not sessile when the inflorescence first becomes visible, but continue to emerge gradually from their floral sockets until superior on the rachilla at anthesis. The abscission follows separation at a clear zone at the base of the short pedicel of the rudimentary gynoecium, leaving a heavily pitted spikelet (*Figure 2*). This unique characteristic is partially transmitted to their interspecific hybrids, the male flowers of the latter being shed if their inflorescences are vigorously shaken after anthesis.

The male inflorescence of the Surinam *oleifera,* being smaller, produces much less pollen than may be obtained from those of *E. guineensis* or other *E. oleifera,* but the pollen is equally highly viable when fresh. The pollen grains are monosulcate as in the other *oleifera.*

GROWTH AND VEGETATIVE PERFORMANCE

Table 1 shows some vegetative features of the Surinam *oleifera* palms in their tenth year at the two sites. A few palms at the first site grew very slowly because of poor husbandry while growth at the second site has been uniformly better with all palms at a height of between 20 and 30 cm. It is quite obvious that the palms are of short habit, a ripe bunch on the tallest palm at Site 1, for example, being a mere 24 cm from the soil surface, whereas in a nearby collection of Costa Rican *oleifera* that was four years younger such a bunch was 52 cm from the surface. That the crowns are small may be seen from an average rachis length of 1.2 m compared with an average of 3.9 m for the Costa Rican collection.

While the individual leaflets of Surinam *oleifera* fronds are shorter and slightly less broad than in other *oleifera,* it is the markedly smaller number of leaflets, on a shorter rachis, that results in the much reduced frond leaf area. The short rachis is also very slender, with the petiole cross sectional area almost seven-fold less than in other *oleifera.*

The slow growth of the Surinam palms, however, belies their rate of frond production which is only marginally less. In the fifth year, for instance, the palms at Site 1 produced an average of 18 fronds each while the Costa Rican palms produced 21 fronds, and in the seventh year, both types produced 19 fronds.

The annual vegetative records from the 6th to the 10th year at Site 2 provide data on growth rates of the Surinam *oleifera* (*Table 2*). Frond production declines with age, the reduction being similar to that of other *oleifera.* Frond leaf area increases rapidly, due both to an increase in the number of leaflets on progressively longer rachises and a near doubling of leaflet length over the same period. At both sites, the leaflets reached maximum width in the seventh year.

Yield

The Surinam *oleifera* palms came into bearing from about late 1985, eight years after seed germination. *Table 3* gives the yield for the two following years when the palms were nine and ten years old, respectively.

Clearly, besides being vegetatively smaller, the Surinam *oleifera* are also very different from the other *oleifera* in their low bunch production and with the yields of individual palms varying considerably around a very low mean. At Site 1 in the first year, for example, the palm with the highest yield produced nine bunches weighing only 11.9 kg, while the poorest palm yielded a single bunch weighing 360 grams. In the second year, the lowest yielder gave a single bunch of 220 g while the highest yielder produced 12 bunches weighing 13.38 kilograms. In both years, a significant number of palms produced just one or two bunches each. In marked contrast, all the palms in the nearby Costa Rican *oleifera* collection were in bearing in the fourth year with a mean yield of 60.4 kg per palm from about seven bunches.

Despite better husbandry at Site 2, the yields were not very different though mean bunch weights were higher and more uniform. In the first year, the poorest palm gave a single bunch of 1.5 kg while the best produced 11 bunches weighing 15.5 kilograms. The following year, the yields were less, with an average per palm of 4.9 kg from an average of four bunches.

The low yields of the Surinam *oleifera* may not be of serious consequence however, for their interspecific hybrids with *E. guineensis* produce yields comparable to the hybrids with other *oleifera* (Lubis *et al.,* 1987). Both bunch weight and bunch number are restored in the hybrids.

Size And Quality Of Fruit Bunches

Fruit bunches of the Surinam *oleifera* are

Figure 1. General view of a nine year old Surinam oleifera *palm.*

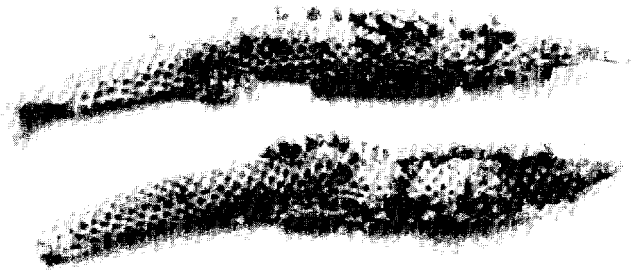

Figure 2. Spikelets from male inflorescence showing superior flowers and floral pits.

TABLE 1.
VEGETATIVE FEATURES OF TEN YEAR OLD[a] SURINAM *E. oleifera*

		Character					
		Number of Palms	Height[b] (cm)	Rachis Length (cm)	Petiole Cross Section Area (cm^2)	Leaf Area (m^2)	Trunk Diameter (cm)
Site 1 PORIM Kluang	mean	51	11	121	0.77	0.69	25
	max.		24	155	1.77	1.17	34
	min.		0	55	0.20	0.26	7
Site 2 FELDA Sg Tekam	mean	21	23.5	151	1.36	0.94	30
	max.		29.5	171	1.72	1.49	35
	min		20.0	133	0.75	0.59	25

[a]After four years in the nursery and six years in the field.

[b]Measured from soil level to lowest ripe bunch.

TABLE 2.
GROWTH IN SURINAM *E. oleifera* PALMS AT SITE 2

Age (years)	Character						
	Frond Production (number per year)	Rachis Length (cm)	Number of Leaflets	Petiole Area (cm^2)	Leaflet Width (cm)	Leaflet Length (cm)	Leaf Area (m^2)
6	–	71.6	43.2	0.29	2.8	35.7	0.26
7	20.1	90.2	45.0	0.49	3.7	48.6	0.48
8	18.9	100.2	49.8	0.61	3.7	49.7	0.53
9	18.5	128.1	62.0	0.86	3.8	57.9	0.82
10	17.1	151.0	65.8	1.36	3.8	64.9	0.94

TABLE 3.
FRUIT BUNCH YIELD OF SURINAM *oleifera* AT TWO SITES IN MALAYSIA

Age (years)	Number of Palms	Yield (for the year)	Site 1			Site 2		
			mean	min.	max.	mean	min.	max.
9	21	FFB (kg/palm)	3.55	0.36	11.94	6.7	1.5	15.5
		Number of bunches	5.1	1.00	14.00	4.9	1.0	11.0
		Bunch weight (kg)	0.68	0.27	1.78	1.4	0.9	1.5
10	21	FFB (kg/palm)	4.06	0.22	13.38	4.9	1.0	13.2
		Number of bunches	5.30	1.00	12.00	4.0	1.0	12.0
		Bunch weight (kg)	0.76	0.20	1.62	1.2	0.9	1.6

TABLE 4.
FRUIT BUNCH CHARACTERISTICS OF THE SURINAM *oleifera* COMPARED WITH TWO OTHER TYPES

Fruit Type	Number of Palms		Character							
			Mean Fruit Weight (g)	%F/B	%M/F	%DM/WM	%O/DM	%O/B	%K/F	%S/F
Surinam fertile (from site 1)	47	mean	2.3	45.8	49.3	48.1	27.4	2.9	6.8	43.7
		range	1.3-3.9	21.0-64.1	32.7-58.8	31.0-70.4	12.9-41.7	0.8-6.2	0.8-12.0	36.8-55.1
Surinam parthenocarpic	23	mean	0.7	10.4	93.6	36.3	26.9	0.9	—	6.3
		range	0.4-1.1	2.2-24.8	78.5-100.0	26.3-47.5	7.4-38.9	0.1-3.1	—	0.0-21.4
Costa Rican fertile	130	mean	3.2	28.3	37.9	46.3	39.3	1.9	13.2	48.8
		range	2.3-6.9	6.3-56.1	26.6-60.8	18.4-71.1	6.6-71.2	0.2-5.6	0-19.3	34.1-60.0
Costa Rican parthenocarpic	130	mean	1.2	20.5	80.2	36.5	37.4	2.2	—	19.2
		range	0.5-2.2	2.5-40.2	64.0-100.0	17.3-62.7	13.0-63.2	0.2-8.5	—	0.0-35.9
KLM fertile[a]	13	mean	7.0	3.8	39.2	62.8	52.0	0.5	10.7	50.0
		range	5.5-10.3	1.2-9.0	35.1-44.4	56.2-69.2	41.4-71.8	0.1-1.1	1.5-17.2	44.2-62.1
KLM parthenocarpic	13	mean	2.7	37.7	87.7	55.5	54.6	9.8	—	12.7
		range	1.5-10.1	24.3-51.2	81.1-98.7	33.0-66.6	46.6-64.1	5.4-15.3	—	1.2-31.4

[a]Selfs of an early *oleifera* introduced from Zaire, but possibly of Brazilian origin, called the Kuala Lumpur *melanococca* (KLM)

F/B = Fruit/Bunch
M/F = Mesocarp/Fruit
DM/WM = Dry Mesocarp/Wet Mesocarp
O/DM = Oil/Dry Mesocarp
O/B = Oil/Bunch
K/F = Kernel/Fruit
S/F = Shell/Fruit

TABLE 5.
FATTY ACID COMPOSITION OF SURINAM *oleifera* MESOCARP OIL AND RELATED OILS[1]

Type		C12:0	C14:0	C16:0	C18:0	C18:1	C18:2	Others	I.V.
Surinam *oleifera*	mean	–	0.2	27.0	2.4	62.5	6.4	1.5	64.7
	range		0.1-0.5	23.9-33.4	1.2-4.6	54.3-67.4	4.0-11.3	0.4-3.2	59.2-69
Colombian	mean	0.02	0.15	17.64	1.01	59.80	18.91	2.21	83.95
oleifera	range	0.00-0.02	0.10-0.30	13.50-24.90	0.50-3.20	49.70-66.80	14.30-23.60	0.40-3.70	76.97-88.49
E. guineensis	mean		0.93	44.53	4.51	37.98	11.35	0.56	52.21
	range		0.3-1.9	35.3-52.4	2.9-7.9	31.3-45.8	6.0-15.7	0.2-1.1	45.2-59.5
E. oleifera	mean	0.005	0.35	32.80	2.85	51.04	12.19	0.65	64.86
E. guineensis	range	0.00-0.08	0.10-1.10	22.00-47.60	1.70-4.50	29.90-61.23	8.56-18.90	0.20-1.40	55.86-75.08
Olive			1	7.20	1-3	65-86	4-15		

1 – Data for related oils from Arasu (1985)

C12:0 = Lauric Acid
C14:0 = Myristic Acid
C16:0 = Palmitic Acid
C18:0 = Stearic Acid
C18:1 = Oleic Acid
C18:2 = Linoleic Acid

I. V. = Iodine Value

less than half the size of an average bunch from the other *oleifera*. Both the central stalk and spikelets are also correspondingly smaller but, because there are even fewer flowers, the fruits are more widely spaced and hence larger; but the most significant of differences in fruit bunch components is the relatively higher proportion of fertile fruits and the correspondingly reduced parthenocarpy (*Table 4*).

Both the fertile and parthenocarpic fruits have more pulp compared with the fruits of Central American and Colombian *oleifera*, but much less oil. This low pulp oil content, noted by Meunier (1975) as well, may be a serious shortcoming of the Surinam *oleifera* as their hybrids are also poor for this important character (Lubis *et al.*, 1987). However, because of more mesocarp, at the expense of the kernel and shell, the Surinam palms may have a superior oil/bunch ratio when only fertile fruits are considered. This is clearly seen for the palms at Site 2, where a mean percentage fruit in bunch of 62.3 and mesocarp in fruit of 55.4 gave a bunch oil content of 4.4% the range being 2.4% to 7.0%.

Oil Quality

Besides shorter stature and disease resistance, an important character of *oleifera* palms in general is their more unsaturated oil. The oil is liquid at ambient tropical temperatures and is closer to olive oil than is palm oil in its fatty acid and triglyceride composition.

The mesocarp oil of the Surinam *oleifera* is particularly interesting in this respect (*Table 5*). The levels of C18:1 (the highest among the *oleiferas*) and of C18:2 (at about a third of that found in the others) are closest to those in olive oil. Because the additional oleic acid does not compensate for the reduction in linoleic acid, the iodine value at about 65 is, however, less than that of the oils of other *oleifera* or of olive oil. Indeed, this figure is more commonly found with the oils of interspecific hybrids.

CONCLUSION

The Surinam *oleifera*, themselves of little commercial value because of uneconomic yields, are of interest to oil palm breeding because they readily hybridize with *E. guineensis* and the hybrids are potentially promising.

The most important advantage of these hybrids compared with those derived from Central American and Colombian *oleifera* is the markedly improved fertility. Male inflorescences produce pollen in adequate quantities and fruit set is generally satisfactory. In contrast, the hybrids derived from other *oleifera* produce almost completely sterile male inflorescences and show high levels of parthenocarpy.

A second advantage of the Surinam *oleifera* hybrids is their smaller crowns and greatly reduced height. By contrast with the massive foliage of the other hybrids, with frond lengths exceeding seven metres for example, the crowns of these hybrids, which are smaller than those of *E. guineensis*, even suggest higher density planting. Furthermore, the dwarf habit that the *oleifera* in general contribute to the interspecific hybrids is very obvious in the Surinam *oleifera* hybrids, whose height increment is less than half that of the other hybrids (Lubis *et al.*, 1987).

Though the Surinam *oleifera* themselves are very low yielding, there is, fortunately, complete restoration in the hybrids, the yields of which are comparable to those of *E. guineensis* (Lubis *et al.*, 1987). The improved yields, derived from an increase in bunch number and bunch weight, suggest *E. guineensis* dominance for these characters.

A major drawback of the Surinam *oleifera* which is transmitted to their hybrids is the low mesocarp oil content. Lubis *et al.* (1987) recorded 35.8% for Surinam *oleifera* hybrids whereas Colombian *oleifera* hybrids contained 48.8 percent. In attempts to improve this trait note should be taken of the additive mode of inheritance suggested by the data of *Table 4* and Lubis *et al.* (1987).

Finally, the data on fatty acid composition (Lubis *et al.*, 1987) show that the oil from the Surinam *oleifera* hybrid is more saturated than that of hybrids derived from Central American or Colombia *oleifera*, the mean I.V. of 62.3 of the former being at the lower end of the range for the latter. The same data and that of *Table 5* suggest that the proportion of palmitic acid in the hybrid oil is additively inherited from both parents while the *E. guineensis* parent shows some dominance for myristic acid and the unsaturated acids, C18:1 and C18:2. This suggestion must be considered tentative however, as the hybrids studied by Lubis *et al.* (1987) were derived from a different group of Surinam *oleifera* palms.

ACKNOWLEDGEMENTS

PORIM authors wish to thank the Director-General for permission to publish this paper. Thanks are also recorded to the General Manager, FELDA Agricultural Services Corporation.

REFERENCES

ARASU, N T (1985). Genetic variation for fatty acid composition in the oil palm (*Elaeis guineensis* Jacq.) Ph.D Thesis, University of Birmingham.

BARCELOS,E; DE MIRANDA SANTOS M; VASCONCELIOS M E C (1985). Phenotypic variation in natural populations of Caiaue *Elaeis oleifera,* H.B.K. Cortes in the Brazilian Amazon. *Proc. of International Workshop on Oil Palm Germplasm and Utilization.* PORIM, Kuala Lumpur, 1985, p. 102.

DE BLANK, S (1952). A reconnaissance of the American oil palm. *Trop. Agric. Trin.* 29 : 90 – 101.

DE MIRANDA SANTOS, M; BARCELOS E and NASCIMENTO J C (1985). Genetic resources of *Elaeis oleifera* (H.B.K.) Cortes in the Brazilian Amazon. *Proc. of Int. Workshop on Oil Palm Germplasm and Utilization.* PORIM. Kuala Lumpur. 1985, p. 95.

GHESQUIERE, M; BARCELOS: DE MIRANDA SANTOS; M. and P AMBLARD (1987). Polymorphisme enzymatique chez *Elaeis oleifera* H.B.K. (*E. melanococca*). Analyse des population du Bassin amazonien. *Oleagineux,* 42 ; 143 – 153.

LUBIS, R A; PAMIN, K and LUBIS, A U (1987). Prospects of *E. oleifera* × *E. guineensis* hybrids for breeding purpose in Indonesia. *Proc. of ISOPB/PORIM Workshop on Prospects of Interspecific Hybrids,* PORIM, Kuala Lumpur, 1987, p.23

MEUNIER, J (1975). Le palmier a huile' americain *Elaeis melanococca. Oleagineux 30* ; 51 – 62.

RAJANAIDU, N (1983). Elaeis oleifera collection in South and Central America. *Plant. Genet. Res. Newslett., 56* : 42 – 51.

RICHARDSON, D L (1976). Palm Research Programme Annual Report (unpublished) 352 p. as cited in Escobar, R (1982). Preliminary Results of the Collection and Evaluation of the American Oil Palm *Elaeis oleifera* (HBK, Cortes) in Costa Rica, pp. 79 - 94 in E. Pushparajah and Chew Poh Soon (eds.). *The Oil Palm in Agriculture in the Eighties.* PORIM/ISP. Kuala Lumpur.

WESSELS BOER, J G (1965). *The indigenous palms of Surinam.* E J Brill, Leiden.