OIL PALM GERMPLASM OF TANZANIAN ORIGIN[1] /

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Resumen

Se evaluó un grupo de progenies de palma aceitera provenientes de una población natural ubicada en el distrito de Kigoma en Tanzania. Se compararon características de crecimiento vegetativo, rendimiento y calidad de racimo de las progenies de polinización abierta de Tanzania con una progenie mejorada de origen nigeriano. En este estudio se observó mejores características en los materiales silvestres aunque la variabilidad genética fue limitada. Los resultados obtenidos sugieren una mayor probabilidad de éxito al promover un programa extensivo de colección de germoplasma de palma aceitera en esta región.

Introduction

The restricted genetic origin of comercial oil palm planting materials and the need for additional prospection, germplasm conservation and utilization has been emphasized by a number of authors (11, 12, 23). Although the reminder was appropriate, workers have been prospecting or collecting from wild or grove palms, or from plantations planted with seed from these types of palms, for a considerable time. By now, even a partial list of collections is impressive (Table 1). Breeders with other goals in mind have sometimes erred more by inadequately utilizing the available variability than by not assembling the necessary germplasm (12).

Prospecting efforts have varied widely, from the INEAC extreme of collecting data from tens of thousands of palms before selecting one, to the systematic sampling of an entire country (NIFOR/MARDI) with no or little selection, and the selection of a few palms in a unique area based on a one-time phenotypic evaluation (Bamenda). There is much to commend in systematic samplings of palms in areas of high genetic diversity with selection exercised at a later stage and under controlled conditions. Nevertheless, Blaak's idea, cited by Hardon (9), that "Broad variability is assured by collecting small samples over a wide area" should not be discounted.

Hartley (12) describes the geographical distribution of oil palm outside the main West African palm belt. These isolated populations resulted from seed introduced from the main area by man. Unlike a number of plant and animal species, the oil palm is favored by man's intervention through the development and maintenance of clearings where the palm can compete with forest and in seed dissemination (29).

It is probable that little selection of palm types was exercised at the time of seed distribution. It could be argued, therefore, that prospection within these scattered fringe populations may be no more interesting than prospection within the main palm belt, unless selection pressure unique to the new area has been able to operate since the time of population establishment. Hardon (8, 9) is sceptical about the role of natural selection in the development of interpopulation differences in oil palm and feels that genetic drift is a more likely cause.

According to Cole (5), the Sangoan tradition spread across the Congo Basin and into West Africa (previously unpopulated) about 40 000 year ago. Fruits, nuts and seeds were part of the diet of these early peoples, and although no specific reference is made to oil palm fruits, their contemporary use within the areas of oil palm distribution is not hard to envision. Oil palm seed distribution could have taken place from very early times; from 1 000 to 1 500 generations of palms may have occurred since the time of population establishment in some areas. It would appear that natural selection should not be ruled out as a possible cause of genetic diversity in isolated populations.

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Table 1 Partial list of oil palm collections from wild or "near wild" palms.

Country	Organization	Collection Locality	Collection or Selection Pressure	Designation of Derivatives	Period	References
Indonesia	Buitenzorg Bot Gdn	Maritius/Reunion	4 duras	Deli dura	1848	1, 4, 8, 9, 10, 11, 12, 14, 22, 23, 25
Indonesia	A.P.A	Eala (Zaire)	38 progenies	SP-540 deriv	1921-22	8, 10, 11, 12, 22, 23
Zaire	INEAC	Eala, Yawenda, N'Gazi	–	Yangambi	1922-27	1, 2, 9, 10, 11, 12, 21, 22, 23, 24
Nigeria	Dept. Agric.	Calabar	22/449 plts.	Calabar	1922-28	1, 8, 9, 10, 12, 22, 23, 24
Congo	Agric Service	Bamboli	–	Sibiti	1922	6, 10
Ivory Coast	Agric Service	Bingerville	29 teneras	La Mé	1923	1, 6, 8, 9, 10, 12, 22, 23, 24
Benin	Agric. Service	Porto-Novo, Pobé	38 teneras	Pobé	1927	1, 6, 8, 10, 18, 22, 23
Cameroon	Pamol	N'Dian, Cowan (Nig)	42/35 000 plts.	Ekona	1933-51	10, 22
Nigeria	Dept. Agric	Aba	15 prog /11 ha	Aba	1939-41	1, 8, 9, 10, 12, 23, 24
Zaire	P.L.Z.	Illebo (Mapangu), Kikwit	–	Brabanta, Pindi	1930's-50's	10, 22
Zaire	INEAC/SCAM	Haut-Mayumbe	9 progenies	Mayumbe	1948-50	1, 8, 21, 22, 26, 27
Zaire	INEAC/SACCB	Binga, Ex-Besenge	–	Mongana	1948-51	1, 8, 21, 22, 26, 27
Zaire	INEAC/SAB	Likete	10/127 000 plts.	Likete	1950-51	1, 12, 21, 26
Zaire	INEAC	Kwango	17 plts/420 ha	Kwango	1954-56	12, 21
Nigeria	WAIFOR	Ufuma	25 teneras/49 ha	Ufuma	1956	1, 8, 9, 10, 12, 23, 24
Nigeria	WAIFOR/NIFOR	50 localities	–	Nigeria	1961-65	1, 8, 9, 10, 12, 15, 16, 20
Cameroon	Pamol	Bamenda Highlands	26 plants	Bamenda	1967	3, 8, 22
Ivory Coast	IRHO	11 localities	19 teneras	Yacoboué	1967-69	1, 8, 9, 10, 17, 18, 22
Angola	IRHO	Salazar, Caxito, Novo Redondo	14 teneras	Angola	1970	10, 13, 22
Nigeria	NIFOR/MARDI	45 localities	20 plts /site	Nigeria	1973	1, 13, 18
Cameroon	IRHO	Country wide	–	–	1976	18
Tanzania	G Blaak	Kwitanga, Simbo, Ilagala	6 plants	Kigoma	1977	4
Sierra Leone	G. Blaak	Kenema	12 plants	Mobai	1979	4
Brazil	Embrapa	Bahia Coast	–	Bahia	1982-83	–

Hartley describes one of these populations as a belt about 20 km wide on the eastern shore of Lake Tanganyika. The following note reports on the performance of material collected in this fringe population from Tanzania and evaluated in Coto, Costa Rica. Surprisingly, these open-pollinated descendents of grove palms compare favorably with selected breeding lines.

Materials and methods

In January, 1977, Blaak (4) collected seed lots from six wild palms in the Kigoma District along Lake Tanganyika in Tanzania. Four **tenera** palms were collected at Kwitanga, one **tenera** at Simbo and one **dura** at Ilagala. The area of collection is at about 850 m with extreme low temperatures reaching 11.8°C. The population has a high frequency of **tenera** types, and at the time of collection shell thinness appeared to be exceptional.

Unfortunately, the Ilagala seed lot failed to germinate and one of the Kwitanga seed lots germinated inadequately for incorporation in the replicated trial. Hence, the August, 1978 evaluation trial contained only one Simbo and three Kwitanga progenies. The randomized block trial with 56 palms per entry distributed in three replications included a T x T progeny from Highlands Estate, HIL539 (EWS81/11Tx NIF22T) for comparative purposes. Weekly yield recording of individual palms was initiated in July, 1980 and continued for a period of 47 months. Bunch analysis was carried out during the period when the palms were from 50 to 85 months old. Vegetative measurements were taken twice at palm age 86 months, utilizing the base of frond 41 for trunk height and leaf 17 for frond length.

The test area is characterized by rainfall totalling 4 000 mm/year with minimal water deficits, but limited solar radiation during seven months of the year, averaging only 267 Langleys per day between May and November. Minimum temperatures and diurnal temperature range are within norms for good production. Soils in the test area are deep alluvial clay loams of recent origin with poor structure, but good chemical composition.

Results and discussion

Segregation of fruit types and colors among the progenies is presented in Table 2. Although the sample was extremely small, we can estimate the frequency of the no-shell allele for fruit type in the Kwitanga population at about 21 percent and in the Simbo population at seven percent, since this seed was selected from **tenera** palms only. Virescens fruit color occurs in 6.0 percent of the trees of the Kwitanga progenies, but is absent from the Simbo palms. Apparently the cross of Nigerian **teneras** involved a virescens heterozygote as one of the parents.

Yield and vegetative characteristics of Kigoma progenies are presented in Table 3. Although the yield advantage of these progenies over the Nigerian tester was almost entirely due to higher bunch weights, Kigoma materials should be considered "high bunch number" types. The Simbo and one Kwitanga progeny yielded significantly more fruit than the Nigerian tester. With respect to variability within the two fruit yield components, bunch number (C.V. = 21.0%) is usually, but not always, more variable than average bunch weight (C.V. = 19.2%) in individual Kigoma progenies. Precocity for yield as

Table 2. Segregation of fruit type and color in Kigoma and tester progenies.

Progeny	Origin	Cross	Number of palms by fruit type				Virescens Palms (%)
			Dura	Tenera	Pisifera	Total	
TAN 544	Kwitanga	Open pol.	20	29	9	58	5.2
TAN 545	Kwitanga	Open pol.	22	29	3	54	3.7
TAN 546	Kwitanga	Open pol.	29	35	7	71	8.5
TAN 548	Simbo	Open pol.	25	22	2	49	0.0
TOTAL	Kigoma	–	96	115	21	232	4.7
HIL 539	Nigeria	T x T	43	69	36	148	45.9

Table 3. Yield and vegetative measurements of Kigoma progenies and tester.

Progeny-Origin	Bunch Yield	Bunch Number	Bunch Mean Wt.	Trunk Height	Frond Length	Petiole Length	Rachis Length
	(kg/p/yr)	(no/p/yr)	(kg)	(cm)	(cm)	(cm)	(cm)
TAN 544(K)	107.3a	20.8	5.2a	173	631	126	505 bc
TAN 548(S)	106.1a	21.4	5.1ab	164	633	131	502 c
TAN 546(K)	96.2ab	19.3	5.0ab	164	665	124	541a
TAN 545(K)	90.0 b	19.7	4.6 bc	169	641	126	515 bc
HIL 539(N)	89.0 b	20.4	4.4 c	164	650	125	525ab
Mean Expt.	97.7	20.3	4.9	167	644	126	518
Level of Sig. (Anova)	0.01	NS	0.01	NS	0.10	NS	005

Values followed by the same letter are not significantly different – Duncan, P=0.05.

K – Kwitanga
S – Simbo
N – Nigeria

measured by the ratio of yield in year one to total yield was higher in Kigoma progenies (0.26) than in the tester (0.22).

The Kigoma palms are similar to the Nigerian tester in both trunk height and frond length at the seven-year stage, except for one Kwitanga accession (TAN546) with slightly longer fronds. Coefficients of variation for trunk height range from 17.2 to 26.9%, which suggests ample variation for selection of even shorter palms. Within progenies, petiole length is more variable than rachis length.

In bunch composition (Table 4), the Kwitanga germplasm is superior to the Nigerian cross. All three Kwitanga progenies give oil bunch values considerably higher than the tester and the Simbo progeny. This superiority is due, almost entirely, to very good oil mesocarp values. Kernel bunch values also are considerably higher in the wild materials. Specifically, the Kigoma lines are good in oil mesocarp, except for the Simbo progeny, and in the shell kernel ratio, except for TAN 545. Accession TAN 544 is outstanding for shell thinness, and overall is the most interesting progeny.

The degree of variability obtained in these extremely limited collections is of interest in terms of future selection. In Tables 5 and 6, coefficients of variation among palms for bunch yield and quality are compared with published data for other palm sources (7, 17, 19).

The level of variability among palms for both yield and bunch composition in Kigoma materials is low and fairly comparable to variability existing in the inbred Deli **dura** population. In spite of limitations in population size and variability, it has been possible to

Table 4. Bunch characteristics of Kigoma progenies.

Progeny/ Origin	Number of Analyses (Bunch:Oil)	F/B[1] (%)	M/F (%)	S/F (%)	K/F (%)	S/K (Ratio)	O/M (%)	O/B (%)	K/B (%)	Wt/F (%)
				Dura Segregates						
TAN546 (K)	38:46	71.5	57.3	33.3	9.4	3.6	51.2	21.1	6.7	9.7
TAN545 (K)	29:31	73.0	56.0	36.5	7.6	4.9	52.7	21.6	5.5	11.3
TAN544 (K)	29:38	69.7	58.8	31.6	9.5	3.3	52.1	21.7	6.6	8.9
TAN548 (S)	23:27	72.5	50.7	37.8	11.5	3.5	44.5	16.2	8.3	9.2
HIL539 (N)	51:55	70.5	56.5	36.5	7.0	5.5	45.6	18.2	4.9	10.5
ALL DURAS	170:197	71.3	56.3	35.2	8.6	4.4	49.0	19.7	6.1	10.1
				Tenera Segregates						
TAN546 (K)	61:73	68.0	78.9	10.9	10.2	1.1	52.1	28.1	6.9	7.4
TAN545 (K)	48:55	67.6	78.4	12.1	9.5	1.3	52.9	28.1	6.4	8.2
TAN544 (K)	66:82	68.0	81.4	9.2	9.4	1.0	50.0	27.6	6.4	7.3
TAN548 (S)	50:56	69.5	74.8	13.3	11.9	1.1	46.0	24.0	8.3	7.2
HIL539 (N)	124:141	63.9	87.9	6.9	5.1	1.4	42.0	23.6	3.3	7.4
ALL TENERAS	349:407	66.7	81.9	9.7	8.4	1.2	47.4	25.9	5.6	7.5

1 F-fruit, B-bunch, M-mesocarp, S-shell, K-kernel, O-oil, Wt-weight.

Table 5. Coefficients of variation (%) for bunch yield in palm population.

Lines	No. Families	No. Palms	Number of Bunches	Bunch Yield	Mean Bunch Weight
			– Duras –		
Deli	11	418	30.0	25.3	26.9
La Mé	20	529	32.5	24.2	35.6
Yangambi	18	328	36.1	22.8	28.6
Kwitanga	3	71	22.2	28.7	19.0
Simbo	1	25	21.8	27.0	24.0
			– Teneras –		
La Mé	20	586	31.7	23.2	30.5
Yangambi	18	529	34.1	26.1	28.9
Kuitanga	3	93	21.8	25.4	19.4
Simbo	1	22	16.3	17.5	21.2

Table 6. Coefficients of variation (%) for bunch composition in palm populations.

Line	No. Families	No. Palms	F/B (%)	M/F (%)	K/F (%)	O/M (%)	Wt/F (%)
			– Duras –				
Deli	15	578	6.7	9.6	22.7	9.7	21.9
La Mé	26	572	10.6	13.5	20.8	11.7	26.2
Yangambi	20	376	10.2	13.5	21.9	9.3	28.4
Yocoboué	–	75	15.9	10.2	21.3	9.7	23.3
Sassandra	–	109	9.3	13.4	22.4	15.5	24.2
Kwitanga	3	71	6.8	8.2	16.3	9.5	27.0
Simbo	1	25	5.3	13.5	20.7	9.8	35.0
			– Teneras –				
La Mé	26	660	11.7	10.1	25.5	9.5	25.7
Yangambi	20	521	11.3	8.3	23.0	7.3	27.1
Yocoboué	–	42	16.0	9.7	25.4	6.7	27.0
Sassandra	–	35	12.3	9.0	31.8	10.8	25.1
Kwitanga	3	93	7.2	6.8	22.6	9.5	26.1
Simbo	1	22	5.2	6.4	19.1	9.7	22.0

select several exceptional palms based on phenotypic characteristics.

Conclusion

The evaluation of the four Kigoma progenies indicates that this is interesting germplasm which warrants further investigation. Vegetative measurements, yield and bunch quality means are good, but the levels of variability are low. The limited variability is not surprising considering the type of collection made. More extensive collections in the Kigoma district are probably warranted, to obtain a broader range of this germplasm. Further, these results indicate that prospection within fringe populations outside the main palm belt may be worth while.

The several good characteristics of Kigoma germplasm should be exploited in the breeding program. Accordingly, several crossing programs are underway, including: 1) deli dura x Kigoma test crosses; 2) Kigoma introgressed into diverse male parents; 3) Kigoma x short-stemmed palms (Compacts) and 4) construction of a Kigoma breeding population.

Summary

Yield, vegetative and bunch quality characteristics are presented for a collection of open-pollinated progenies of grove palms from the Kigoma District in Tanzania. Progeny means compare favorably with those of an improved tester of Nigerian origin, but the variability within the materials obtained is limited. It is suggested that more extensive oil palm germplasm collection from the same is warranted.

Literature cited

1. ARASU, N.T.; RAJANAIDU, N. 1976. Oil palm genetic resources. In Proceedings Malaysian Agriculture Oil Palm Conference Kuala Lumpur. p. 16-26.

2. BEIRNAERT, A. 1933. La sélection de palmier à huile. Bulletin Agricultural Congo Belge 24:418-458.

3. BLAAK, G. 1967. Oil palm prospection tour in the Bamenda Highlands of West Cameroon. Internal report, Unilever, London.

4. BLAAK, G. 1977, 1979. Personal communication.

5. COLE, S.M. 1985. Africa: Prehistory. In Encyclopedia Britanica (15th Ed.), University of Chicago.

6. GASCON, J.P.; DE BERCHOUX, C. 1964. Caractéristiques de la production d' *Elaeis guineensis* (Jacq.) de diverses origines et de leurs croisements. Oleagineux 19(2):75-84.

7. GASCON, J.P.; NOIRET, J.M.; BERNARD, G. 1966. Contribution a l'étude de l'herédité de la production de régimes d' *Elaeis guineensis* (Jacq.). Oleagineux 21(11):657-661.

8. HARDON, J.J. 1974. Oil palm. **In** Handbook of Plants: Introduction to Tropical Crops. FAO Agric. Studies No. 93. Rome.

9. HARDON, J.J. 1976. Oil palm breeding-introduction. **In** Oil Palm Research. Elsevier, Amsterdam.

10. HARDON, J.J.; GASCON, J.P.; NOIRET, J.M.; MEUNIER, J.; TAN, G.Y.; TAM, T.K. 1976. Major oil palm breeding programs. **In** Oil Palm Research. Elsevier, Amsterdam.

11. HARDON, J.J.; THOMAS, R.L. 1968. Breeding and selection of the oil palm in Malaysia. Oleagineux 23(2):85-90.

12. HARTLEY, C.W.S. 1967. The Oil Palm. Longman, London.

13. I.R.H.O. 1978-1979. Rapport D'Activitiés. Paris.

14. JAGOE, R.B. 1952. Deli oil palm and early introduction of *Elaeis guineensis* to Malaysia. Malaysina Agricultural Journal 35:3-11.

15. MENENDEZ, T.M.; BLAAK, G. 1963. Plant breeding division. W.A.I.F.O.R. Eleventh Annual Report 1962:58-66.

16. MENENDEZ, T.M.; BLAAK, G. 1964. Plant breeding division. W.A.I.F.O.F. Twelfth Annual Report, 1963-1964: 49-75.

17. MEUNIER, J. 1969. Etude des populations naturelles d' *Elaeis guineensis* en Cote d' Ivoire. Oleagineux 24(4):195-201.

18. MEUNIER, J. 1976. Les prospections de palmacées. Oleagineux 31(4):153-155.

19. NOIRET, J.M.; GASCON, J.P.; BERNARD, G. 1966. Contribution a l'etude de l'héredité des caractéristiques de la qualitié du régime et du fruit d'*Elaeis guineensis* (Jacq.). Oleagineux 21(6):343-349.

20. OBASOLA, C.O. 1969. Plant breeding division. N.I.F.O.R. Fifth Annual Report 1968-1969:35-75.

21. PICHEL, R. 1957. L'amélioration du palmier á huile au Congo belge. Bulletin Agriculture Congo Belge 48(1):67-76.

22. ROSENQUIST, E.A. 1985. The genetic base of oil palm breeding populations. **In** I.S.O.P.B. Workshop on oil palm germplasm and utilization. Bangi Selangor, Malaysia.

23. SPARNAAIJ, L.D. 1969. Oil palm. **In** Outlines of Perennial Crop Breeding in the Tropics. Wageningen Misc. Papers No. 4.

24. SPARNAAIJ, L.D.; MENENDEZ, T.; BLAAK, G. 1963. Breeding and inheritance in oil palm. Part I. The design of the breeding programme. Journal of the West African Institute for Oil Palm Research 4:126-145.

25. TOOVEY, F.W.; BROEKMANS, A.F.M. 1955. The Deli palm in West Africa. Journal of the West African Institute of Oil Palm Research 1(3):9-50.

26. VANDERWEYEN, R. La prospection des palmeraies congolaises et ses premiers résultats. Bulletin Inf. INEAC 1(4):357-382.

27. VANDERWEYEN, R.; ROELS, O. 1949. Les variétés d'*Elaeis guineensis* (Jacq.) du type albescens et l'*Elaeis melanococca* Garther (em. Bailey). Publs. INEAC Serie Sci., No. 42.

28. WATERSTON, J.M. 1953. Observations on the influence of some ecological factors on the incidence of oil palm diseases in Nigeria. Journal of the West African Institute for Oil Palm Research 1(1):24-59.

29. ZEVEN, A.C. 1968. Oil palm groves in southern Nigeria. II Development, deterioration and rehabilitation of groves. Journal of the West African Institute for Oil Palm Research. 5(17):21-39.