CHARACTERIZATION OF COCONUT GERMPLASM BASED ON FRUIT COMPONENT ANALYSIS

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Abstract

The coconut germplasm collection at the Central Plantation Crops Research Institute consists of 62 exotic and 32 indigenous accessions. It is by far the largest collection available anywhere in the world, comprising representative samples from geographically divergent populations. The germplasm collection is divided into four major geographical sets based on the location of collection, namely, accessions from countries in South-East Asia, Pacific Islands, North-Central and South-American, and African region. Data on yield and nut characters in 40 accessions are presented in this paper. The annual out-turn of copra ranged from 7 to 30 kg/palm/year in Tall cultivars while in the Dwarfs it was less than 10 kg/palm/year. The classification system based on fruit component analysis, and the time taken for germination, has been adopted to identify the degree of introgression in different accessions. Priority areas for future collections are also discussed.

Introduction

Cocos nucifera L. is a monotypic species of pantropical distribution between 20°N-20°S latitudes. India with 1.1 milion hectares under this crop, with an annual production of 5837 million nuts, ranks third in the world in area and production. At the Central Plantation Crops Research Institute, Kasaragod, the coconut germplasm collection consists of 62 exotic and 32 indigenous accessions. It is probably the largest collection in terms of number of accessions available anywhere in the world. The exotic collection consists of accessions from 22 countries, being mostly the open-pollinated progenies of either primary or secondary introductions, obtained on exchange basis. Recently, 24 more accessions were collected from South–Pacific Islands. The identity of each individual introduction is maintained and considered as a separate accession due to the lack of reliable classification criteria through which the duplicates can be identified. Basically, there are only two distinct varieties in coconut, the Tall and the Dwarf. While the Tall is extensively grown commercially, the Dwarf, till recently, had only ornamental importance. With the standardization of commercial production of Dwarf x Tall hybrids, the dwarfs have also attained commercial importance. The Talls in general, are cross-pollinated and exhibit a wide range of variability for height of the palm, shape of crown, colour, shape and size of nuts, yield, and annual out-turn of copra. This could possibly be one of the reasons for identifying coconut varieties, especially the talls, by the location of the collection/cultivation. In addition, some of the cultivars are also known by the special features they possess, such as Laccadive Micro (a small-fruited variant of Lakshadweep Tall), Niu Bulundrau (producing 100 coconuts per bunch, from Fiji), and Kappadam (from Kerala having large quantity of nut water). The dwarfs, on the other hand, are distinguished by the colour of the nut, and the location of their general occurrence (e.g. Chowghat Dwarf Orange, Malayan Dwarf Yellow/Orange/Green, and Cameroon Red Dwarf).

The first systematic classification of coconut varieties and forms was attempted by Narayana and John (1949). Subsequently, Gangolly, Satyabalan and Pandalai (1957) reviewed the literature on coconut varieties. Liyanage (1958) classified the Ceylon coconut varieties. The criteria employed for all these classifications were, the plant habit, juvenile period and geographical source. The third classification was proposed by Fremond, Ziller and Lamothe (1966) on the basis of floral biology. One of the criteria common to all the systems is the importance given to the weight of meat and weight of copra. Harries (1978) while reviewing the evolution, dissemination and classification of coconut has proposed the use of fruit component analysis data as a rational approach to the classification of coconut varieties. In the present paper, an attempt has been made to test this classification system on 40 accessions, which are in stabilized bearing age, and assess the degree of introgression in them.

MATERIALS AND METHODS

Twelve-month-old nuts collected during summer months for analysis, were stored for one month till the husk dried completely.

Four nuts were sampled from each palm as this sample size was found to give reasonably accurate characterization of fruit components under Kasaragod conditions (Jacob Mathew, Bhaskara Rao and Satyabalan, 1978). Out of the pooled sample, 10 nuts were selected per accession randomly, and considered for analysis in the present study. An average of four consequetive annual yields was taken as the yield of the palm/year. Number of days taken for germination was recorded in the nursery starting from the date of sowing.

RESULTS AND DISCUSSION

The fruit component analysis data, along with yield and number of days taken for germination, in 40 accessions from different countries, was grouped into four major geographic groups, namely, South-East Asian, Pacific Ocean, North-Central and South American, and African accessions. For convenience in presentation, the data from 25 accessions belonging to six countries from South-East Asian region are presented in Table-1 and the rest in Table-2. The percentage of husk which has been considered as the chief distinguishing character by Harries (1978), was plotted against the weight of whole fruit (Text Figs. 1 and 2). The argument for considering this particular character to distinguish the introgressed forms from the naturally evolved types is based on the importance of proportion of husk in the natural dissemination of the crop. In addition, the data on fruit components are available from almost all the coconut growing countries, whereas the specific palm characters are not readily available. One more point in favour of using the relationship between the components rather than absolute values is that it eliminates the differences due to management or growing conditions to which the palm is exposed. In addition, the measurements in terms of absolute values of palm height, leaf length and bunch production, depend more on the age of the palm and need repeated recording, whereas the fruit components are more or less stable throughout the stabilized yield period.

Another point to be considered is that the varieties evolved through human selection are distinctly different from those evolved naturally. The kernel was given higher commercial importance,

Table 1. Fruit and yield characteristics in coconut accessions from South-East Asian countries

Country/ Cultivar (g) 1	Wt. of whole fruit (g) 2	Wt. of husked nut (g) 3	% of husk of whole fruit 4	Wt. of kernel (g) 5	Wt. of copra (g) 6	Yield of nuts/palm/ year 7	Out-turn of copra (kg) 8	No. of days for germination 9
INDIA								
Andaman Ordinary	823 (19.9)*	511 (25.6)	39 (9.6)	287 (16.8)	169 (13.3)	127 (40–202)**	21.5	103
Andaman Giant	1094 (15.4)	672 (19.6)	39 (14.4)	325 (15.9)	181 (21.0)	110 (69–149)	19.9	64
Kappadam	1806 (8.9)	112 (5.9)	38 (12.3)	541 (6.9)	299 (8.9)	90 (37–156)	36.9	72
Laccadive Ordinary	787 (23.1)	497 (22.7)	37 (9.0)	262 (19.9)	169 (19.8)	127 (64–166)	21.5	86
Calangute	708 (23.0)	485 (20.0)	31 (11.4)	239 (15.5)	127 (7.4)	58 (27–112)	7.4	97
Laccadive Micro	503 (17.0)	305 (15.9)	39 (7.8)	109 (12.6)	85.8 (11.5)	119 (19–523)	9.9	110
Nadora	888 (9.1)	606 (8.3)	32 (8.4)	306 (22.9)	163 (16.0)	46 (9–107)	7.5	96
Benaulim	884 (11.6)	482 (11.5)	45 (6.7)	240 (18.3)	140 (17.3)	73 (14–144)	10.2	95
W.C.T.	922 (5.6)	446 (9.3)	52 (10.8)	252 (11.7)	150 (5.0)	70 (12–124)	10.5	109

Table 1 (*Contd.*)

1	2	3	4	5	6	7	8	9
SRI LANKA								
King Coconut	448 (12.4)	304 (16.6)	32 (11.1)	204 (11.1)	125 (13.9)	52 (27–72)	6.5	101
Gonthembili	847 (5.5)	497 (8.3)	41 (5.5)	260 (23.9)	180 (13.1)	49 (39–56)	8.8	90
Ceylon Tall	1013 (23.5)	601 (22.5)	41 (10.3)	374 (26.5)	213 (21.1)	39 (16–48)	8.3	99
VIETNAM								
Cochin China	957 (7.8)	638 (11.5)	33 (8.9)	334 (9.6)	198 (10.6)	88 (17–190)	17.4	30
INDONESIA								
Std. Kudat	820 (10.6)	455 (12.5)	44 (7.3)	215 (28.3)	46 (18.1)	46 (16–69)	6.7	102
Kong Thien Yong	906 (26.9)	591 (40.4)	37 (23.2)	325 (35.0)	151 (24.1)	32 (15–59)	6.3	59
Java	1261 (5.7)	896 (8.6)	29 (10.0)	493 (7.3)	298 (5.9)	101 (61–189)	30.1	70
Borneo	1288 (23.2)	860 (23.0)	33 (20.6)	412 (20.6)	215 (17.6)	74 (31–132)	15.9	57

Table 1 (Contd.)

1	2	3	4	5	6	7	8	9
MALAYSIA								
SS Green	909 (6.5)	603 (7.1)	34 (4.5)	336 (5.8)	189 (8.4)	97 (74–137)	18.3	84
FMS	1241 (13.8)	816 (22.0)	35 (20.8)	442 (25.1)	240 (21.4)	82 (29–209)	19.7	81
Klapawangi	894 (12.2)	597 (10.6)	33 (8.9)	319 (6.5)	182 (6.3)	71 (35–91)	12.9	82
PHILIPPINES								
San Ramon	1753 (20.8)	1251 (19.2)	28 (25.5)	648 (12.0)	346 (12.4)	64 (58–68)	22.1	45
Phil. Ordinary	938 (14.7)	599 (8.5)	35 (16.8)	341 (10.8)	198 (9.2)	110 (70-209)	21.8	83
Phil. Lono	(1000 (12.1)	719 (13.3)	28 (11.7)	198 (14.2)	148 (8.8)	56 (36–80)	8.3	60
Phil. Laguna	(1624 (11.30)	1074 (19.7)	35 (20.7)	282 (15.6)	209 (11.8)	91 (58–97)	19.1	90
Phil. Dalig	836 (13.7)	484 (19.3)	42 (10.7)	173 (24.7)	126 (10.8)	72 (46–95)	9.1	89

*CV **range

Table 2. Fruit characteristics and yield of coconut accessions from Pacific, N.C. and S. America, and Africa

Country/Cultivar	Wt. of whole fruit	Wt. of husked nut	% of husk of whole fruit	Wt. of kernel	Wt. of copra	Yield of nuts/palm/	Outturn of copra	No. of days for germination
1	2	3	4	5	6	7	8	9
PACIFIC								
B.S.I.	685 (21.7)?	460 (21.2)	31 (43.1)	321 (25.2)	161 (21.2)	106 (62–133)**	17.1	70
Guam I	1133 (14.3)	682 (16.1)	40 (4.0)	395 (13.6)	224 (18.1)	101 (32–171)	22.6	90
Guam II	908 (13.6)	601 (11.9)	33 (12.4)	331 (11.5)	194 (14.2)	93 (46–121)	18.0	85
Guam III	1017 (20.6)	594 (21.8)	42 (7.8)	365 (24.8)	214 (23.4)	120 (21–295)	25.7	110
Fiji Tall	964 (5.2)	577 (7.1)	40 (3.9)	327 (6.1)	179 (10.7)	104 (50–163)	18.6	101
Fiji Rotuma	1448 (8.6)	1014 (12.0)	30 (20.3)	292 (15.7)	179 (4.1)	40 (16–68)	7.2	90
N.C. AMERICA								
Jamaica	1551 (9.1)	957 (14.0)	39 (9.2)	459 (21.4)	277 (13.7)	61 (29–233)	16.9	56
Panama	1609 (16.3)	912 (7.3)	42 (16.1)	340 (30.7)	248 (14.4)	74 (26–144)	18.4	109
St. Vincent	1356 (20.8)	769 (18.2)	43 (7.0)	223 (10.7)	186 (13.6)	38 (16–62)	7.1	110

Table 2 (Contd.)

1	2	3	4	5	6	7	8	9
Blanchissues	831 (12.5)	590 (13.5)	29 (6.2)	196 (12.6)	148 (9.7)	83 (17–158)	11.5	97
AFRICA								
Nigerian Dwarf	771 (1.3)	518 (2.5)	33 (3.1)	361 (9.1)	169 (2.5)	28 (8–60)	4.7	96
Nigerian Tall	1668 (18.9)	998 (10.6)	39 (20.3)	481 (9.0)	290 (6.3)	76 (25–104)	22.0	104
Zanzibar	826 (18.2)	566 (20.9)	32 (8.5)	343 (12.7)	215 (10.3)	101 (34–281)	21.7	84
Kenya	979 (16.1)	650 (12.7)	33 (20.2)	341 (14.3)	193 (12.6)	84 (34–155)	16.2	82
Seychelles	908 (15.4)	374 (30.1)	59 (12.6)	245 (34.1)	151 (27.9)	73 (37–125)	11.0	*N.A.*

*C.V. **range.

whereby the selection pressure was always in the direction of bigger nuts (to realize higher kernel/copra) with lesser husk. Harries (1978) classified them as 'Niu Vai', and the naturally evolved ones as 'Niu Kafa' types.

Among the 25 accessions from South-East Asian countries studied, Kappadam from India, San Ramon and Philippines Laguna from the Philippines, Borneo and Java from Indonesia, and F.M.S. from Malaysia, exhibited low proportion of husk with high values for whole fruit weight (Text Fig. 1). The high values for the total out-turn of copra (Kappadam-26.9 kg/palm/year; San Ramon-22.1 kg; Philippines Laguna-19.1 kg; Borneo-15.9 kg; Java-30 kg and FMS-19.7kg), confirm the contention that these are evolved as a result of selection pressure operating towards

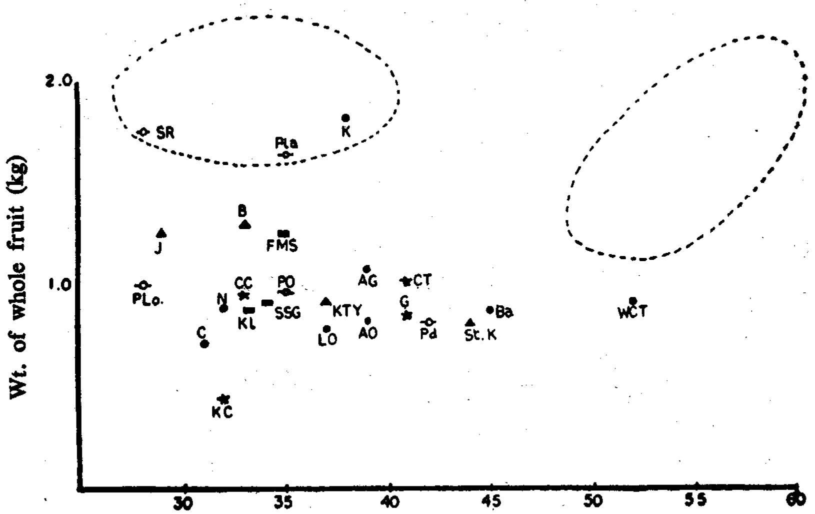

Fig. 1. Coconut germplasm accessions from South-East Asian countries

SR—San Ramon; PLa—Philippines Laguna; K—Kappadam; J—Java; B—Borneo; FMS—Federated Malay States; PLo—Philippines Lono; N—Nadora; CC—Cochin China; SSG—Strait Settlements Green; Kl—Klapawangi; PO-Philippines Ordinary; KC—King Coconut; KTY—Kong Thien Yong; LO—Laccadive Ordinary; AG—Andaman Giant; AO—Andaman Ordinary; CT—Ceylon Tall; G—Gonthembili; PD-Philippines Dalig; St. K.—Standard Kudat; Ba—Benaulim; WCT—West Coast Tall; C—Calangute.

higher copra. The West Coast Tall which is the most commonly grown tall variety in the West Coast of India, showed higher husk proportion, and is very near to the values of 'Niu Kafa', the putative parental type described by Harries (1978). Similarly, Benaulim from Goa coast, Standard Kudat from Malaysia, Ceylon Tall and Gonthembili from Sri Lanka, and Philippines Dalig from Philippines, are also nearer to the 'Niu-Kafa' type. The annual out-turn of copra ranging between 6.7 kg/palm/year to 10.5 kg/palm/year, also shows the relatively less selecion pressure evidenced in these accessions. The island populations from India such as Andaman Ordinary, Andaman Giant and Laccadive Ordinary with intermediate husk values and higher out-turn of copra represent introgressed forms. In general, the 'Niu Vai' showed lesser number of days for sprouting than the 'Niu Kafa' types.

The accessions from Pacific, North-Central America and Africa are plotted in Fig. 2. The interesting data recorded in the

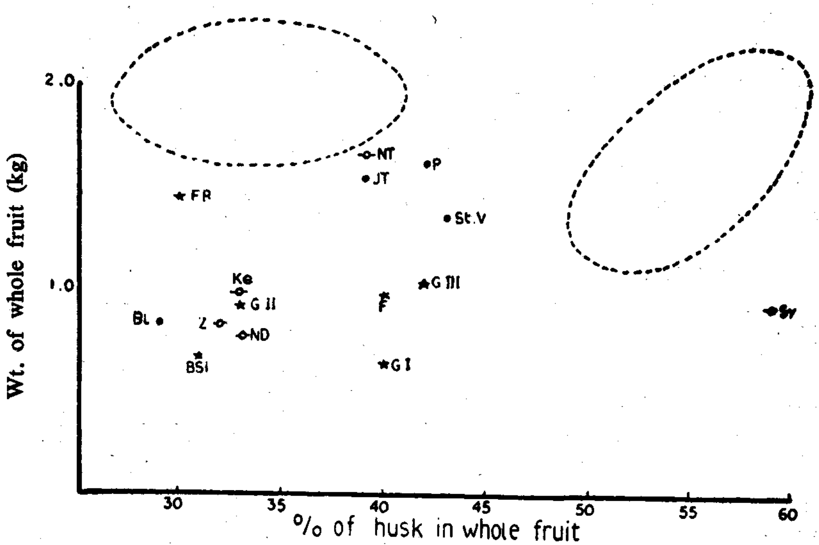

Fig. 2. Coconut germplasm accessions from Pacific, N.C. America and Africa

Fig. 2. FR—Fiji Rotuma; NT—Nigerian Tall; JT—Jamaica Tall; P—Panama Tall; St. V.—St. Vincent; Ke—Kenya Tall; Bl—Blanchissues; Z—Zanzibar Tall; BSI—British Solomon Islands Tall; ND—Nigerian Dwarf; G I–III—Guam Tall I; Guam Tall II; Guam Tall III; F—Fiji Tall; Sy—Seychelles Tall.

two collections from Fiji, is that the Fiji Tall showed intermediate values in respect of husk percentage and Fiji Rotuma from the Rotuma island showed lesser proportion of husk but significantly lower out-turn of copra. However, the lesser number of days taken for germination and higher whole fruit weight values, indicate that Fiji Rotuma could be a 'Niu Vai' type and the Fiji Tall could have arisen by introgression. The Seychelles Tall from the African coastal island showing the highest value for percentage of husk (59 per cent) must have originated from the 'Niu Kafa' putative parent. The Blanchissues from West Indies, Zanzibar Tall from Zanzibar, B. S. I. from Solomon Islands, and Kenya Tall from Kenya, represent the introgressed forms derived from the 'Niu Vai' type.

The collections from Jamaica, namely the Jamaica Tall and Panama do not conform to the description of Whitehead (1966). The data showed that Panama tall with lesser husk proportion belonged to 'Niu Vai' group occurring on the Pacific Coast of America, whereas Jamaica Tall with higher proportion of husk and lesser fruit number, belonged to the 'Niu Kafa' group found on the Atlantic coast of Africa. However, in the present study, both these groups, showing intermediate husk proportion and more or less similar yield pattern for copra, can be classified as introgressed forms with greater affinity towards 'Niu Vai' group.

The classification as detailed above indicates the possible locations where the naturally evolved coconuts are still present. For genetic conservation of variability, this information would be of immense use. The areas presently known to have the 'Niu Kafa' types or the introgressed forms from 'Niu Kafa' putative parent, have hence to be extensively surveyed on priority basis. There is a greater possibility for the immediate replacement of these types due to their uneconomical characters such as higher husk and lesser out-turn of copra. The classification system itself has an added advantage in that it is simple enough to use in the field to determine the type that is generally present in any given area. This will enable the collection teams to decide whether to make a coarse-grid sampling or a fine-grid sampling.

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REFERENCES

FREMOND, Y., ŻILLER, R. and de NUCE de LAMOTHE, M. 1966. *Le Cocotier*. Maisonneuve & Lavoise, Paris.

GANGOLLY, S. R., SATYABALAN, K., and PANDALAI, K. M. 1957. Varieties of the coconut. *Indian Cocon. J.* **10**: 3-28.

HARRIES, H. C. 1978. The evolution, dissemination and classification of *Cocos nucifera* L. *Bot. Rev.* **44**: 265-319.

JACOB MATHEW, BHASKARA RAO, E.V.V., and SATYABALAN, K. 1978. Sampling procedure for coconut germplasm collection. In: *Proc. National Symp. on Plant and Animal Genetic* Resources, NBPGR, Dec. 1978, New Delhi.

LIYANAGE, D. V. 1958. Varieties and forms of the coconut palm grown in Ceylon. *Ceylon Coconut Q.*, **9**: 1-10.

NARAYANA, G. V. and JOHN, C. M. 1949. Varieties and forms of the coconut. *Madras Agric. J.*, **36**: 349-366.

WHITEHEAD, R. A. 1966. Sample survey and collection of coconut germplasm in the Pacific Islands. HMSO Lond. 78p.

DISCUSSION

M. V. RAO (ICAR, New Delhi): The data shows that there is a great deal of variability for copra yield/palm/year in the tall cultivars as compared to that obtained in the D×T and Malayan Dwarf Green. If the Talls are capable of giving high yields why should we go in for D×T or other dwarfs? Why not we exploit the high yielding tall types themselves?

R. V. PILLAI: The yield of copra in a few Tall cultivars is high and even on par with D×T. The reason for going in for D×T is that this hybrid has shown some degree of tolerance to root (wilt) disease whereas none of the cultivars has so far shown any tolerance. Moreover, the availability of the material of these high yielding Talls is also very limited.

K.U.K. NAMPOOTHIRI (CPCRI, Palode): Comment—It is found that Malayan Dwarf Green is not as homogeneous as the other Dwarfs. It will be wise to compare the experience of scientists on this variety outside the country.

K. KANNAN (R.A.R.S., Pilicode): The nut size, copra content and other fruit components are highly variable under different climatic and cultural conditions. Even in the same variety, individual tree variations are noticed. So how can we take the fruit component as a basis for classification?

R. V. PILLAI: The nut characters are definitely influenced by environment. Only the absolute values may vary, but not the ratios of the components. Hence this can be used for the classification of cultivars.

R. GOPIMONY (KAU): Will the ratio be the same for percentage of husk also?

R. V. PILLAI: The ratio will not change for the husk and copra. Only the absolute values will vary.