Table 13. Number of seedlings that died of bud rot disease in Trial 3

Variety/ Hybrids	No. of seedlings that died of bud rot disease and replaced
BRT o.p.	16
BGD X BRT	8
MYD X BRT	8
BGD X VTT	3
MYD x WAT	12
CRD x RIT	5
MRD x VTT	3
MRD x TAGT	1
VTT x TAG	4
SLT x TAG	1
TOTAL	**61**

In August 2004, initial vegetative data consisting of the number of leaves produced by the palms from the third batch were collected (Table 14). The data gathered shows that the BGD x BRT cross produced the most number of leaves.

Table 14. Initial vegetative data (average leaf production and plant height) of the palms in Trial 3 (as of August 2004)

Variety/ Hybrids	Average number of leaves produced
BRT o.p.	7.2
BGD x BRT	9.5
MYD x BRT	8.3
BGD x VTT	5.9
MYD x WAT	8.0
CRD x RIT	7.6
MRD x VTT	8.0
MRD x TAG	7.8
VTT x TAG	7.1
SLT x TAG	6.2
Mean	**7.6**

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Annex 1. Description and picturs of the parent varieties of the local hybrids used in the trials in Brazil[1]

Brazil Green Dwarf (BGD)

by R. Bourdeix, E. Tupinamba and J.L. Konan

History and description

The Brazil Green Dwarf (BGD) is a legendary coconut variety. Its sweet and delicious young nuts are sold for drinking along Copacabana and the other famous tropical beaches of Brazil. It is difficult to hunt down the history of Green Dwarfs all around the world. The BGD now conserved in Côte d'Ivoire was collected in Equatorial Guinea, an African country, around 1960. But this Dwarf was introduced in Africa from the city of Recife, Pernambuco, Brazil by an agronomist named Don Osman Silveira in June 1950. It is said that BGD was introduced to Brazil in 1920 from the Bogor Botanical Garden of Indonesia. Recent DNA analysis showed that BGD originated from the Philippines! The palm generally has a thin stem of about 20 to 25 cm in diameter, with no or little bole. The youngest leaves at the top of the palm are quite erect. Because of its short peduncle, the bunch is well supported by the leaf petioles. Fruits are oblong and of an intense green colour. The average fruit weighs from 556 g (in the dry zone of Tanzania) to 1090 g (in the rich volcanic soils of Vanuatu). Inside the fruits, the nuts are almost spherical and weigh from 353 g to 556 g on average.

Identification

More than 45 appellations of Green Dwarf are referenced worldwide. Some of them can be distinguished from the BGD. The Pilipog, Catigan, Tacunan, Sri Lanka and Thailand Green Dwarfs all have special fruit features that differentiate each from the others. Very probably, different names from different locations have been given to the same variety. For instance, BGD is also known as Equatorial Guinea Green Dwarf (EGD) in Africa. It remains very difficult to make comparison among coconut palms planted on other continents and diverse environments. DNA molecular techniques will probably help to reduce the number of varieties said to be distinct. BGD looks very similar to the variety known as the Malayan Green Dwarf in the Caribbean countries of Jamaica, Cuba and Haiti. Green Dwarfs recently introduced from Malaysia to Africa give fruits which are more rounded.

Yield and production

BGD generally starts to flower 2 to 3 years after planting. It may produce 50 to 100 fruits per palm per year in good natural conditions. With irrigation and fertilization, BGD produces around 150 nuts per palm per hectare at a planting density of 200 palms per hectare.

Other information

BGD has been tested as a female parent of many hybridization programmes. The progenies from BGD were more heterogeneous than those obtained with other dwarfs, such as MYD or CRD. In Africa, hybrids with BGD were also quite sensitive to nut fall caused by the fungus *Phytophthora* species. Nevertheless, the hybrid between BGD and the Rangiroa Tall (RGT) has been recommended for the coral soils of Polynesia in the Pacific.

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[1] For the description and pictures of Vanuatu Tall (VTT) and Malayan Yellow Dwarf (MYD), please refer to Annex 1 of "Coconut hybrid trials in Cote d'Ivoire" in this book, pp. 18-37.

Brazilian Green Dwarf (BGD)

Pictures courtesy of ***Dr. Roland Bourdeix****, CIRAD*

Coconut hybrid trials in Mexico

Ramon Artemio Castillo Gonzalez
Investigador del Sistema Producto, Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias, Campo Experimental Forestal Agricola y Pecuario Huimanguillo, Km 1 Huimanguillo-Cardenas 86400 Huimanguillo, Tabasco, México

Introduction

As of 2003, coconut in Mexico is cultivated on about 110 610 hectares, with a production rate of 145 838 tonnes of copra (dried coconut kernel) or an average yield of 1.03 t/ha. About 85% of the total land area devoted to coconut is located in the Pacific Coast region in the states of Guerrero (43 000 ha), Oaxaca (11 180 ha), Michoacan (9860 ha), Colima (25 200 ha), Jalisco (4540 ha) and Chiapas (1000 ha) while the remaining 15% is in the Gulf-Caribbean region in the states of Tabasco (14 700 ha) and Veracruz (1130 ha). There are about 61 500 farmers, mostly smallholders tending an average coconut farm size of 1.8 ha in Mexico.

Rationale and justification of the project

From 1992 to 1998, coconut production in Mexico grew at an average rate of 3.15% per annum, or a total increment of 18.9% for the period. In 1998, the country produced 237 324 tonnes of copra. Despite this, the coconut oil obtained was not enough to cover national demand. From 1998 to 2003, average coconut production dropped 33% while copra production decreased by 38.55%. In the last four years, the average production of fatty and coconut oil in Mexico averaged only 52 800 tonnes per year, most of which were used in the soap-dish industry. The significant drop in coconut production in recent years is attributed to the following:

1. **Occurrence of lethal yellowing disease (LYD).** This disease, which is caused by an 'Organism-Type Mycoplasma' (OTM), has so far killed more than 3.2 million coconut palms in Mexico. The Atlantic Tall coconut plantations in the Gulf - Caribbean region are completely susceptible while 40% were affected in the Pacific Coast region.
2. **Low-yielding varieties.** The annual yields of the Mexican Pacific Tall and the Atlantic Tall, the two most commonly cultivated varieties in Mexico, average only 1.1 t/ha and 0.71 t/ha, respectively.
3. **Proliferation of old and senile palms**. About 95% of coconut palms planted in most plantations in Mexico are between 45 and 70 years old. This severely affects nut and copra yields as the production capacity of palms diminishes with age especially when senility sets in. During the last 10 years, some 40 000 hectares have been adversely affected by the 'physiologic death of palms' due to old age.
4. **Poor soil fertility and traditional farm management practices.** The areas in which coconut are planted in Mexico are usually characterized by sandy soils containing low levels of soil nutrients. This, coupled with farmers' lack of knowledge of modern and scientific farm management, especially fertilizer application, have contributed much to the decrease in coconut farm productivity.

From 1999 to 2004, Mexico, along with five other countries in Africa and LAC region (Brazil, Jamaica, Benin, Tanzania and Côte d'Ivoire), participated in a project entitled 'Multilocation trials to identify suitable hybrids and varieties for Africa, Latin America and Caribbean' which was funded by Common Fund for Commodities (CFC) and coordinated by IPGRI/COGENT. The objectives of this project were: (1) to identify suitable high- yielding varieties/hybrids that are well-adapted to prevailing local conditions; and (2) to determine the genotype x environment (G x E) interaction of these varieties and hybrids to serve as a guide to the application of the results to other countries with similar cultivation conditions.

Research methodology and results

Two batches of seedlings from Côte d'Ivoire were sent to Mexico. The first batch of seedlings (MYD x WAT, CRD x RIT, VTT x TAGT, MRD x VTT, MRD x TAGT, SLT x TAGT) was air-shipped to Mexico in November 1999, while the four local hybrids: Malayan Red Dwarf x Panama Tall (MRD x PNT), Malayan Yellow Dwarf x Mexican Pacific Tall 14 (MYD x $MXPT_{14}$), Malayan Yellow Dwarf x Mexican Pacific Tall 9 (MYD x $MXPT_{09}$) and Malayan Yellow Dwarf x Mexican Pacific Tall 2 (MYD x $MXPT_{02}$) were produced in Mexico (see Annex 1 for description and pictures of the parent varieties). These seedlings were planted at Zaragoza Community in Comalcalco and at the El Pailebot site in Cardenas, Tabasco State in February and August 2001, respectively. The trials consisted of four replications with nine palms per plot planted at normal spacing. These trials were planted in a typical farmers' field that included intercrops such as sweet potato, corn, cassava, and watermelon (in El Pailebot); and citrus, papaya, pumpkin and hot pepper (in Zaragoza community).

In 2001, the second batch of seednuts consisting of the same six hybrids produced in Côte d'Ivoire and another six hybrids (MYD x PNT_{01}, MYD x PNT_{02}, MYD x $MXPT_{14}$, MYD x $MXPT_{09}$, MYD x $MXPT_{10}$ and MYD x $MXPT_{02}$) produced in Mexico (Annex 1) were planted in the eight-hectare trial site in El Pailebot. The site is about 100 kilometers from the Instituto Nacional de Investigaciones Forestales Y Agropecuarias (INIFAP) Huimanguillo Experimental Station. Prior to planting, land clearing was done followed by field layout and digging holes. The male parent was primarily selected for its resistance to LYD as exhibited during the past six years. Each elementary plot consisted of 16 palms, planted at 8.5 m x 8.5 m in a randomized complete block design (RCBD) with five replications. Statistical analysis was carried out at country level to compare the different genetic materials, while a combined statistical analysis will be performed to determine the G x E interaction at a later date.

Soil characteristics of the trial sites

Soil analysis was carried out on the third year after the first batch of seedlings was planted in Zaragoza community. As indicated in Table 1, the soil in the trial site had sufficient amounts of organic matter, nitrogen, phosphorous and calcium but was low in potassium.

Table 1. Physical and chemical characteristics of the soil samples at Zaragoza community

Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH	Organic Matter	Ca	Mg	K	NH4	NO3	P
						Meq./100 g soil			Ppm		
0-30	44.71	18.41	36.88	5.59	3.4	15.2	1.3	0.3	11.2	1.7	20.8

In December 2003, soil samples from the El Pailebot site, where the second batch of seedlings was planted, were sent to the Soil-Plant Laboratory for physical and chemical analysis. Results showed that 1.5 years after planting the seedlings, the soil has improved in organic matter, nitrate, potassium and phosphorous content (Table 2) mainly due to the application of chemical and bio-fertilizers such as *Azospirillium* and mycorrizas. The result of the soil analysis was used as the basis for the bi-annual fertilizer application.

Table 2. Physical and chemical characteristics of the soil at El Pailebot 1.5 years after planting

Soil depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH	Organic Matter	Al	Ca	Mg	K	NH4	NO3	P	Fe	Cu	Mn	Zn
						Meq./100 g soil						ppm				
0-30	94	4	2	6.26	1.3	0.15	1.4	1.2	0.2	5.6	6.6	25.5	1.4	0.3	0.3	0.6
30-60	95	4	1	6.10	0.2	0.08	1.3	1.1	0.1	4.2	4.9	7.0	1.0	0.3	0.4	0.4

Similarly, leaf samples from the seedlings were analyzed 1.5 years after planting (Table 3). Results indicated that the improvement in the soil condition also enhanced the nutrient status of the leaves.

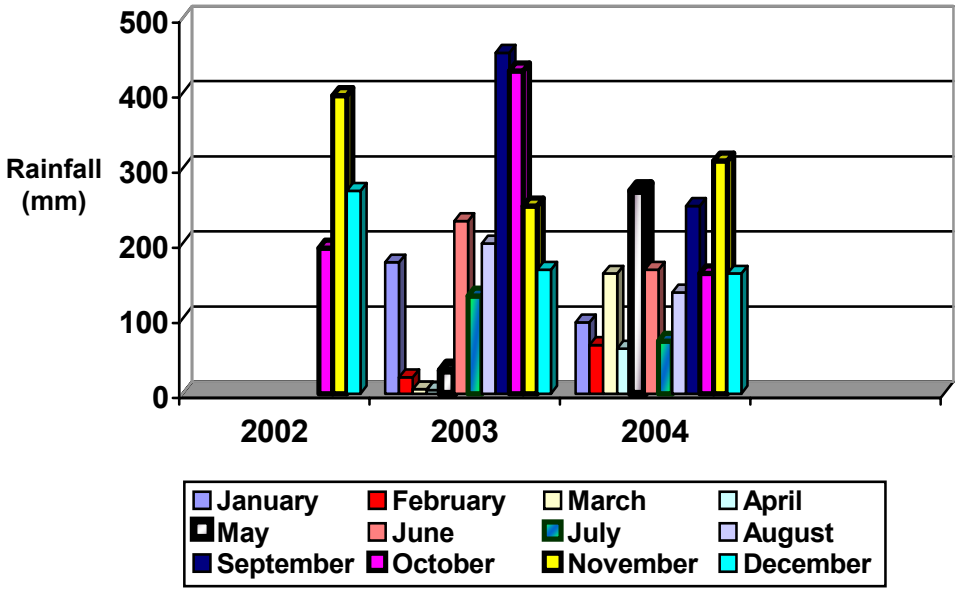
Table 3. Chemical analysis of leaf samples from the second batch of seedlings 1.5 years after planting

Na (%)	Ca (%)	Mg (%)	K (%)	NH4 (%)	P	Fe	Cu	Mn	Zn
					ppm				
0.24	0.41	0.28	0.40	1.9	0.22	166	4.7	152	12.5

Rainfall data

The rainfall pattern at the trial site was measured from October 2002 to August 2004 (Figure 1). In 2003, the total rainfall recorded was 2098 mm with 62 rainfall days. The following year (2004), the total rainfall recorded was 1900 mm with 56 days of rainfall. No drought was noted from March to May 2004.

Figure 1. Average rainfall distribution (in mm) at the El Pailebot trial site from October 2002 to December 2004



Vegetative and reproductive data

First batch of seedlings

The field vegetative data measurements for the first batch of seedlings at the El Pailebot site were gathered and analyzed every three months during the trials.

Table 4 shows the average number of leaves and height of the hybrids three years after planting. The Vanuatu Tall x Tagnanan Tall (VTT x TAGT) hybrid had the highest number of leaves. On the other hand, the Mexican Pacific Tall $_{11}$ x Pacific Tall Group$_1$ (MXPT$_{11}$ x PTG$_1$) hybrid was found to be the tallest compared to the other hybrids. Statistical analysis of the vegetative data indicated that there was no significant difference in the number of leaves and plant height among the hybrids. The coefficients of variation (CV) were computed to be 8.38% and 21.01% for number of leaves and height of plant, respectively.

Table 4. Vegetative data of the first batch of seedlings from El Pailebot three years after planting

Hybrid	Parental crosses	No. of leaves produced	Plant height (cm)
MXPT$_{11}$ x PTG$_1$	Mexico Pacific Tall $_{11}$ x Pacific Tall Group $_1$	22.16	243
PTG$_1$ x PTG$_3$	Pacific Tall Group $_1$ x Pacific Tall Group $_3$	20.90	187
MXPT$_{04}$ x PTG$_1$	Mexico Pacific Tall $_{04}$ x Pacific Tall Group $_1$	23.47	237
PTG$_2$ x PTG$_1$	Pacific Tall Group $_2$ x Pacific Tall Group $_1$	22.25	216
SLT x TAGT	Sri Lanka Tall x Tagnanan Tall	23.00	230
VTT x TAGT	Vanuatu Tall x Tagnanan Tall	23.90	240
Mean		**22.61**	**225.5**
CV (%)		**8.38**	**21.01**

In Zaragoza, vegetative data from the first batch of seedlings gathered 3.5 years after planting show that the hybrids Malayan Yellow Dwarf x Mexico Pacific Tall $_{09}$ (MYD x $MXPT_{09}$), Malayan Yellow Dwarf x Mexico Pacific Tall $_{10}$ (MYD x $MXPT_{10}$) and Malayan Yellow Dwarf x Mexico Pacific Tall $_{11}$ (MYD x $MXPT_{11}$) had more leaves compared to the other hybrids (Table 5). However, MYD x PNT, MYD x $MXPT_{10}$ and MYD x $MXPT_{11}$ were taller compared to the other hybrids. The analysis indicated that there was no significant difference in the number of leaves and plant height among the hybrids under study. The CVs were 12.20% and 14.66% for number of leaves and height of plant, respectively.

Table 5. Vegetative data of the first batch of seedlings from Zaragoza community 3.5 years after planting

Hybrid	Parental crosses	No. of leaves produced	Plant height (cm)
MYD x $MXPT_{02}$	Malayan Yellow Dwarf x Mexico Pacific Tall $_{02}$	31.80	287
MYD x $MXPT_{09}$	Malayan Yellow Dwarf x Mexico Pacific Tall $_{09}$	34.25	265
MYD x $MXPT_{10}$	Malayan Yellow Dwarf x Mexico Pacific Tall $_{10}$	34.12	300
MYD x $MXPT_{11}$	Malayan Yellow Dwarf x Mexico Pacific Tall $_{11}$	34.00	303
MYD x $MXPT_{14}$	Malayan Yellow Dwarf x Mexico Pacific Tall $_{14}$	33.28	255
MYD x $MXPT_{05}$	Malayan Yellow Dwarf x Mexico Pacific Tall $_{05}$	33.30	265
MYD x MXAT	Malayan Yellow Dwarf x Mexico Atlantic Tall (TR)	32.12	242
MYD x PNT (MAYPAN)	Malayan Yellow Dwarf x Panama Tall	32.20	300
MYD x WAT+ (PB121)	Malayan Yellow Dwarf x West African Tall	33.50	252
Mean		**33.17**	**274.33**
CV (%)		**12.20**	**14.66**

Second batch of seedlings

For the second batch of seedlings, vegetative data measurements were taken in September 2004 or two years after planting. Table 6 shows that the hybrid MYD x $MXPT_{09}$ was the tallest and had more number of leaves than the other hybrids. The analysis indicated that there were significant differences in the number of leaves and height of plant among hybrids. The CVs were 9.22% and 14.31% for number of leaves and height of plant, respectively.

Table 6. Average vegetative data on the second batch of seedlings

Hybrid	No. of leaves* (Sept/04)	Plant height (cm)*
Vanuatu Tall x Tagnanan Tall	20.65 a	127 ab
Sri Lanka Tall x Tagnanan Tall	18.31 abc	103 abc
Malayan Yellow Dwarf x West African Tall	19.75 ab	124 bc
Camerun Red Dwarf x Rennell Island Tall	18.96 abc	112 abc
Malayan Red Dwarf x Vanuatu Tall	19.48 ab	120 abc
Malayan Red Dwarf x Tagnanan Tall	19.94 ab	127 ab
Malayan Yellow Dwarf x Mexico Pacific Tall $_{09}$	21.38 a	140 a
Malayan Yellow Dwarf x Mexico Pacific Tall $_{10}$	18.45 abc	118 abc
Malayan Yellow Dwarf x Mexico Pacific Tall $_{02}$	18.70 abc	128 ab
Malayan Yellow Dwarf x Mexico Pacific Tall $_{14}$	17.61 abc	108 abc
Malayan Yellow Dwarf x Panama Tall Monagre	16.35 bc	90 c
Malayan Yellow Dwarf x Panama Tall Agua Dulce	15.67 c	88 c
Mean	**18.77**	**115.42**
CV (%)	**9.22**	**14.31**

**Averages sharing the same letter(s) are statistically similar in accordance with the Tukey test at 0.5% probability*

The way forward

In order to fully realize the results of the project to improve Mexico's coconut production and apply its potential benefits for the country's poor coconut farmers and their dependents, the Government of Mexico has pledged to continue with the hybrids trials using local funds and expertise. Also, the Government has endorsed and has expressed its interest and support to participate in a follow-up project entitled "Overcoming poverty in coconut growing communities in Mexico", the proposal of which would be put together by IPGRI/COGENT for submission to CFC and other interested donors.

Annex 1. Description and pictures of the parent varieties of the local hybrids used in the trials in Mexico[1]

Mexican Atlantic Tall (MXAT)

History and description

The Mexican Atlantic Tall (MXAT) was first introduced in 1550 from Cabo Verde Islands in West Africa to Veracruz, Mexico, and from Santo Domingo to Campeche, Mexico in the same year. At the end of the 19th century, the first coconut plantations were established in Carmen Island, Campeche, Mexico. From 1901 at 1915, some 150 ha in Tonala, Veracruz, Mexico were planted to coconuts. Some years later, in 1930, MXAT was introduced in Tabasco with seednuts coming from Campeche and Veracruz.

Identification

The palms of MXAT are robust, the crown is spherical in shape, the petioles are strong and wide and its leaves are narrow thereby offering little resistance to wind. The shaft is strong without bole and is located 3.5 m above ground at 10 years of age. The variety's inflorescence is green in color, ranging from medium to big size with a short female phase without overlapping with the male phase. The fruits are medium-sized and green-coloured with three marked ridges.

Yield and production

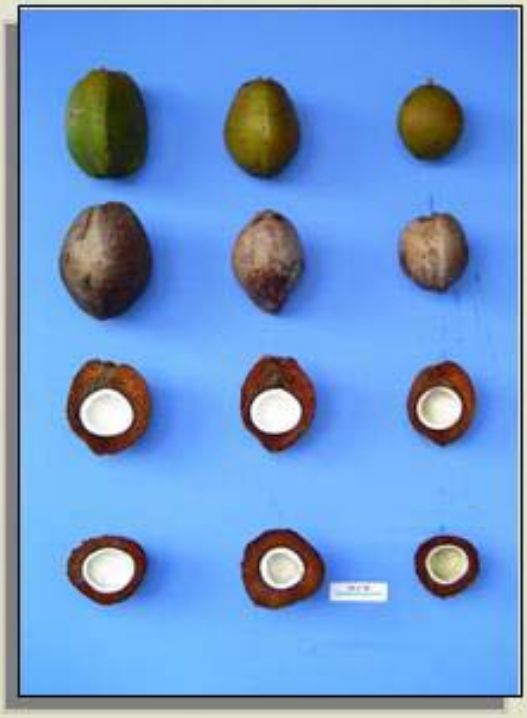
After six to eight years of planting, MXAT palms bear an average of 12 - 13 bunches per year, with the number of fruits varying from two to nine per bunch. Each fruit weighs about 1140 g, with 194 g of fresh albumen and 59% oil content in dry matter.

Other information

The MXAT is resistant to drought but is susceptible to lethal yellowing disease.

[1] For the description and pictures of Malayan Red Dwarf (MRD) and Malayan Yellow Dwarf (MYD), please refer to Annex 1 of the article "Coconut hybrid trials in Cote d'Ivoire" in this book, pp. 32-51; for the description and pictures of Panama Tall (PNT), please refer to Annex 1 of the article "Coconut hybrid trials in Benin" in this book, pp.58-61.

MEXICAN ATLANTIC TALL



Mexican Pacific Tall 09 (MXPT 09)

History and description

The Mexican Pacific Tall 09 (MXPT 09) was first introduced in Callejones de Ortega, Colima in 1539 from Panama. At the end of the 16th century, the first coconut plantation was established in the community of Rio Grande in Colima, Mexico.

Identification

The trees of this variety are robust, its crown is X-shaped 'silhouette', the petioles are medium-sized and strong, and its leaves are narrow thereby offering little resistance to wind. The shaft is very strong without bole and is located 3.5 m above ground at eight years of age. Its inflorescence is yellow and big-sized with a short female phase without overlapping the male phase. The fruits are big, round and yellow in color.

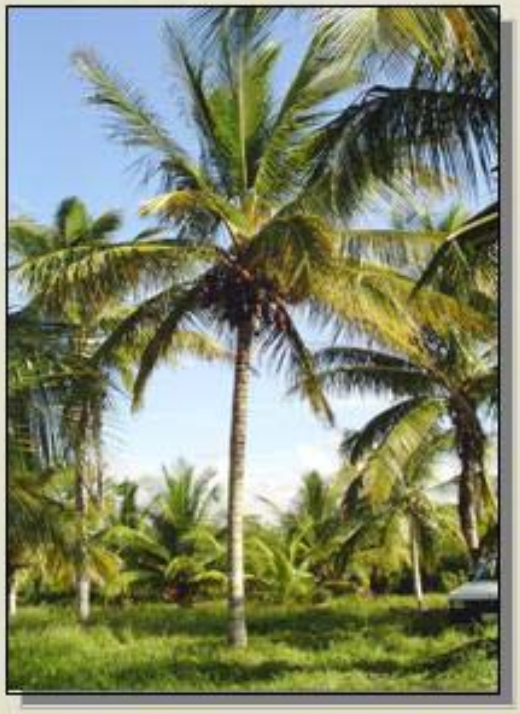
Yield and production

MXPT 09 starts fruiting 6 to 7 years after planting. Palms bear an average of 12-13 bunches, with each bunch having an average of 4-8 fruits. Each fruit weighs about 1450 g, with 278 grams of fresh albumen and 60% oil content in dry matter.

Other information

MXPT 09 has shown resistance to drought and lethal yellowing disease.

MEXICAN PACIFIC TALL 09



Mexican Pacific all 10 (MXPT 10)

History and description

Mexican Pacific Tall 10 (MXPT 10) was first introduced in 1569 from the Solomon Islands to Colima, Mexico. At the end of the 16th century, this variety has been planted on about 75 ha in Tecoman community, Colima, Mexico mainly to to produce wine.

Identification

MXPT 10 palms are robust, with a semi-spherical crown, long and strong petiole and broad leaves. The shaft is strong without bole and is located 3.5 m above ground at five years of age. Its inflorescence is yellow and medium-sized with a short female phase without overlapping the male phase. Its fruits are medium in size, angular and green in colour.

Yield and production

MXPT 10 bear fruits at six to seven years after planting. Each palm produces 12-13 bunches per tree per year, with each bunch having 4-7 fruits. Each fruit weighs about 1220 g, with 240 grams of fresh albumen and 60% oil content in dry matter.

Other information

MXPT 10 has shown resisitance to drought and to lethal yellowing disease.

MEXICAN PACIFIC TALL 10

Mexican Pacific Tall 14 (MXPT 14)

History and description

The Mexican Pacific Tall 14 (MXPT 14) was first introduced in 1569-1571 from Solomon Islands to Colima. At the end of the 16th century, this variety was planted on a few hectares in Cihuatlan community, Jalisco, Mexico, mainly to produce wine.

Identification

The trees of MXPT 14 are robust, with a spherical crown, long and strong petioles and broad leaves. The shaft is strong without bole and is located 3.5 m above ground at 5 to 6 years of age. Its inflorescence is green and medium in size with a short female phase without overlapping with the male phase. Its fruits are medium-sized, round and green.

Yield and production

MXPT 14 starts bearing fruits at six to seven years after planting. Each palm produces about 12-13 bunches per year, with each bunch having an average of 4-7 fruits. Each fruit weighs about 1220 g, with 240 grams of fresh albumen and 60% oil content in dry matter.

Other information

MXPT 14 has shown resisitance to drought and to lethal yellowing disease.

MEXICAN PACIFIC TALL 14

Coconut hybrids trials in Jamaica

Basil Been
Director of Research, Coconut Industry Board, 18 Waterloo Road, Kingston 10, Jamaica

Research methodology and results

Six hybrids (MYD x WAT, MRD x RIT, MRD x VTT, CRD x TAG, VTT x TAG and SLT x TAG) were produced in Côte d'Ivoire in 2000 and 2002, while four local hybrids: Malayan Yellow Dwarf x Panama Tall (MYD x PNT) Malayan Yellow Dwarf x Thailand Tall (MYD x MPET (THT)), Cameroon Green Dwarf x Panama Tall (CGD x PNT) and Cameroon Green Dwarf x Thailand Tall (CGD x MPET (THT)) were produced in Jamaica.

Initially, the proposed trial site was at Darlingford in Portland, which is in the main coconut growing region. Due to low germination and the inadequate number of seedlings for the replicated trial, that site was not used. Instead, the seedlings were planted as observation plots in farmers' fields in Rio Nuevo (see Annex 1 for description and pictures of parents of the hybrids), Green Castle and Darlingford. The seedlings were grown under normal farm conditions without replication. All of these sites are situated in the main coconut growing region in the northeast, which is within 100 m of the coastline. The lethal yellowing disease (LYD) was found to be active at Green Castle and Darlingford but not at Rio Nuevo.

The main trial site for the second batch of seednuts is at Pimento Piece, a section of Holland Estate (Annex 2) located near the east end of the island. The plot size is 16 palms with five blocks. A randomized complete block design and a 9 m x 9 m triangular spacing were employed in the plot. The field preparation was delayed by tropical storms and flooding. Adequate precautions have been taken to prevent animal damage by using double fencing in some areas.

The first batch of imported and local hybrid trials

A total of 523 hybrid seednuts were received from Côte d'Ivoire in 2000 and planted together with 144 local hybrid seednuts. Seedlings at the three sites were grown under normal farmer's field conditions. The Coconut Industry Board assisted with the plant management and data were collected regularly.

The seedlings that were planted at Rio Nuevo had a 98.4% survival rate, while the survival rates at Darlingford and Green Castle were 10.6% and 23.5%, respectively. Lethal yellowing disease has caused the deaths of 84.4% of the population at Darlingford and affected all six imported hybrids. Two palms died from LYD at Green Castle. There had been no cases of LYD at Rio Nuevo. At Darlingford, weeds were removed manually to protect the intercrops. In Rio Nuevo, weeds were controlled by using glyphosate. The owner of Green Castle informed the Project Leader that inorganic fertilizer and herbicides were no longer being used because he was seeking to attain organic status for the farm. In other sites, fertilizers were applied twice a year, in April and September, just before the onset of the rainy season.

The second batch of imported and local hybrid trials

A total of 1640 seednuts arrived from Côte d'Ivoire in mid-March 2002 and were sown in the nursery (Table 1). Each polybag from Côte d'Ivoire was carefully opened and seednuts were laid out separately by variety. The nursery beds were prepared and the nuts were placed horizontally. Nursery beds were watered every two days in the absence of rain. Weeds were manually removed. Field planting was carried out in Pimento Piece, a section of Holland Estate near the eastern end of the island in December 2003. This was followed by fertilizer application. Neither insecticide nor fungicide was used in the site. However, as the female

parents of the local hybrids produced very low fruit set, additional pollination was carried out.

Table 1. Germination of seednuts from Côte d'Ivoire and the local hybrids for the second trial

Hybrids	No. of seednuts sown	Germinated seednuts		Seedlings developed from germinated seednuts	
		No.	%	No.	%
A. Imported seednuts from Côte d'Ivoire					
1. MYD x WAT	400	305	76	293	96
2. CRD x RIT	400	241	60	215	89
3. VTT x TAGT	210	167	80	163	98
4. SLT x TAGT	210	182	87	178	98
5. MRD x VTT	210	149	80	147	99
6. MRD x TAGT	210	176	84	174	99
Subtotal	***1640***	***1220***	***74***	***1170***	***96***
B. Locally produced					
1. CGD x PNT	265	123	46	99	81
2. CGD x MPET	237	128	54	120	94
3. MYD x PNT	233	110	47	108	98
4. MYD x MPET	210	90	43	85	94
Subtotal	***945***	***451***	***48***	***412***	***91***
GRAND TOTAL	**2585**	**1671**	**65**	**1582**	**95**

Soil characteristics of the trial site

Soil samples from Pimento Piece were analyzed for physical and chemical properties. Table 2 shows the results of the soil analysis, which indicated that the soil is very poor in nitrogen and high in phosphate. The data was used as the basis for fertilizer application.

Table 2. Physical and chemical characteristics of the soil at Pimento Piece

Soil depth (cm)	N_2 (%)	EC	pH	Ca	Mg	Cu	Fe	Mn	Zn	K_2O	P_2O	Cl
				Meq./100 g soil				ppm				
0.05	0.05	0.08	7.29	11.5	3.06	2.52	91.76	45.6	1.69	207.2	346.9	0.08

Climatic/ environmental data

Meteorological data was collected from the St. Thomas Sugar Company, Ltd at Duckenfield, St. Thomas, which is an estate adjoining Holland Estate. The data in Table 3 shows that the average annual rainfall, temperature and relative humidity for 2004 were 164.42 mm, 25˚C and 76.7%, respectively.

Table 3. Meteorological data from January to November 2004

Month	Rainfall (mm)	Rainy days	Temperature (ºC)		Mean relative humidity (%)		Mean pressure	Vapor
			Mean Max.	Mean Min.	0700 EST	1300 EST	0700 EST	1300 EST
January	136.4	15	28.4	19.9	86	73	21.1	27.2
February	24.1	10	29.2	20.7	78	69	26.1	27.2
March	111.0	15	27.3	21.0	83	70	26.9	27.0
April	40.5	5	29.8	20.7	82	69	27.2	28.2
May	155.9	15	30.2	23.4	83	74	30.5	30.4

Month	Rainfall (mm)	Rainy days	Temperature (ºC)		Mean relative humidity (%)		Mean pressure	Vapor
			Mean Max.	Mean Min.	0700 EST	1300 EST	0700 EST	1300 EST
June	35.7	7	31.5	24.6	78	71	31.5	31.4
July	125.4	17	31.7	23.3	83	70	31.8	31.5
August	102.4	11	32.0	23.4	79	69	31.4	31.6
September	559.7	14	31.9	21.7	85	73	32.1	32.5
October	304.0	15	30.2	24.3	86	80	31.9	32.3
November	213.6	14	29.5	24.3	84	78	31.5	31.2

Biotic stresses and abiotic stresses

Thirty plants died with symptoms typical of LYD. The planted seedlings were also affected during the hurricanes that visited the country from January to September of every year. Additionally, during the months of February, April and June, rainfall was low, although it could not be described as drought. Some palms were damaged but not destroyed by a fire in early April 2004.

Initial vegetative data

Field vegetative data of the first batch of planted seedlings

Due to severe animal damage at Green Castle, leaf production data were not collected regularly. However, at Rio Nuevo, the petiole length ranged from 160.01 ± 15.1 cm for SLT x TAGT to 119.6 ± 16.3 cm for MRD x VTT. However, the rachis length ranged from 542.3 ± 48.8 cm for SLT x TAGT to 369.0 ± 17.4 cm for MRD x VTT. Mean stem height ranged from 77.8 ± 32.0 cm for MRD x WAT to 52.8 ± 16.1 cm for VTT x TAGT. The mean girth at 20 cm height ranged from 178 ± 16.2 cm for VTT x WAT to 107.7 ± 32.8 cm for MRD x TAGT.

The palms at Darlingford and Rio Nuevo began to flower in December 2003, while palms in Green Castle only started to flower in November 2004 (Table 4).

Table 4. Percentage of flowering plants in the trials (December 2003 and November 2004**)**

Hybrids	Sites		
	Darlingford (%) Dec 2003 / Nov 2004	Green Castle (%) Dec 2003 / Nov 2004	Rio Nuevo (%) Dec 2003 / Nov 2004
VTT x TAGT	0 / 0	0 / 0	0 / 24
SLT x TAGT	0 / 0	0 / 0	0 / 33
MRD x TAGT	63 / 67	0 / 29	72 / 84
MRD x VTT	42 / 47	0 / 57	62 / 91
MYD x WAT	16 / 20	0 / 15	32 / 82
CRD x RIT	20 / 20	0 / 0	38 / 88

Field vegetative data of the second batch of planted seedlings

Table 5 shows the average leaf production of the second batch of seedlings, which ranged from 12.0 ± 2.9 for MYD x WAT to 8.6 ± 3.7 for CRD x RIT. Stem girth at soil level varied from a high of 65.8 ± 22.6 for MYD x WAT to 44.6 ± 17.6 for CGD x MPET.

Petiole length ranged from 83.3 ± 21.3 cm for MRD x VTT to 63.9 ± 11.8 cm for CGD x PNT. Rachis length ranged from 207.8 ± 60.4 cm for MRD x TAGT to 148.9 ± 47.1 cm for MYD x MPET. Plant height ranged from 272.0 ± 55.7 cm for MYD x WAT to 211.0 ± 68.2 cm for MYD x MPET.

Table 5. Leaf production and stem girth measurement (at soil level) of the second batch of imported and local hybrids

Hybrids	Number of leaves ± SD	Stem girth ± SD (cm)
A. Imported hybrids		
MYD x WAT	12.0 ± 2.9	65.8 ± 22.6
MRD x VTT	10.8 ± 3.6	57.5 ± 35.9
MRD x TAGT	10.9 ± 3.2	61.4 ± 28.9
SLT x TAGT	10.1 ± 3.1	55.2 ± 16.0
VTT x TAGT	11.1 ± 3.9	57.4 ± 20.2
CRD x RIT	8.6 ± 3.7	47.2 ± 20.4
B. Local hybrids		
CGD x MPET	10.4 ± 2.4	44.6 ± 17.6
MYD x PNT	9.6 ± 3.9	45.6 ± 28.0
MYD x MPET	9.9 ± 2.4	45.3 ± 19.1
CGD x PNT	10.9 ± 2.8	47.7 ± 16.6

The way forward

The Coconut Industry Board is committed to the project and for as long as is necessary the trial sites will be maintained properly, further data collected and analysed, and information disseminated.

Annex 1. Photographs of some of the hybrids being grown in the observation plot at Rio Nuevo, St. Mary


MRD x VTT


MRD x TAGT


VTT x TAG


VTT x TAGT

Annex 2. Photographs of some of the hybrids being grown at the Holland, St. Thomas trial site