

Evaluation of new cultivars of mango (*Mangifera indica* L.) in Ghana. 1. Growth performance

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SUMMARY

Data for girth and tree size are presented for 14 new mango cultivars planted at Ejura in the forest savanna transitional zone of Ghana. Girth increases in all cultivars were approximately linear from 1969 to 1971. Trunk increase was fastest in Sunset followed by Palmer and Jacquelin in that order. Ruby exhibited the slowest trunk growth over the period. Corresponding tree size development was most pronounced in the three cultivars with fastest trunk growth. Ruby size development was slowest among the cultivars. Edaphic and weather conditions at Ejura favouring general growth of mango are outlined.

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Introduction

Mango is a popular horticultural tree crop which thrives well throughout Ghana but occurs mostly in the forest savanna transitional zone in the Ejura, Wenchi and Kintampo districts and the coastal savanna areas of Accra and Somanya (Fig. 1). It is rarely grown in plantations.

The trees grow on fallow land and on sites of previous habitations or have been planted deliberately especially on agricultural stations. Fruits from the forest savanna transitional and coastal savanna zones are quantitatively and qualitatively better than those in the forest zone, even for the same cultivar (Godfrey-Sam-Aggrey & Abutiata, 1973). The fruits are mostly eaten fresh but in recent years some are processed into mango juice by the Cannery Company at Wenchi.

Mango is not indigenous to Ghana. Chandler

RÉSUMÉ

ABUTIATE, W. S.: *Evaluation des variétés cultivées nouvelles de la mangue (Mangifera indica L.) au Ghana. 1. La performance de la croissance.* Des données sur la circonférence et la taille d'arbre sont présentées pour quatorze variétés de la mangue cultivées dans la zone de transition de la forêt-savanne à Ejura au Ghana. L'augmentation de la circonférence de toutes les variétés cultivées était approximativement linéaire de 1969 à 1971. L'accroissement du tronc était très rapide dans Sunset, suivi par Palmer et Jacquelin, dans cet ordre. Le développement de la taille d'arbre correspondant était très rapide dans les trois variétés cultivées qui ont des troncs qui poussent très vite. Le développement de la taille de Ruby était le moins rapide parmi les variétés cultivées. Les conditions édaphiques et météorologiques à Ejura qui favorisent la croissance sont exposés.

(1958) stated that the mango-fruit almost certainly spread from southern Asia, probably India where it has been in cultivation for over 400 years.

Earlier introductions into Ghana included Peter, Blackman, Kinsington, Devine, Julie, Ceylon 1 and Ceylon 2 from Trinidad, and Jaffna and Rupae from Ceylon (Godfrey-Sam-Aggrey & Abutiata, 1973). Many of these cultivars were invariably planted on agricultural research stations. The surviving trees from these earlier introductions can still be seen at Ejura and Kpeve. At Ejura, records of the yield of some of the cultivars, the "local" and their crosses were kept from 1956 to 1961 (Miller, 1962).

Seedling races are predominant because propagation by seed is the usual practice particularly in the more favourable growing areas of Ejura, Kintampo and Wenchi. Jaffna has become very widespread because of the production of

Materials and methods

The Ejura Agricultural Station is situated at kilometre 100 along the former trunk road from Kumasi to Tamale. It is 3 km north of Ejura approximately at longitude 1° 21' West and latitude 7° 23' North. The station is located in the forest savanna transitional zone at an elevation of 232 m in the Afram Plains (Akutor, 1959). Miller (1962) mentioned that the station was acquired in the latter part of 1920 for crops and livestock investigations in this northern transitional zone.

Soils

The station is underlain by fine-grained voltaian sandstone which weathered to give rise to the soils of the Ejura-Denteso Association. Members of this association are Ejura, Amantin, Denteso and Sene series (Asiamah, 1986). The most important members of the series are Ejura and Amantin.

The Ejura series occupy the flat summits and upper slopes of the catenary association. The soils are well-drained, red, deep, porous and permeable. This series consists of 30 cm of slightly humous, loose, porous, medium sand overlying a pale brown, fine to medium sandy loam to sandy clay. The horizon is underlain by a metre of red, sandy clay subsoil.

Amantin series is moderately well-drained, permeable, sandy clay, yellow to orange brown on middle to lower slopes. The top soils consist of about 30 cm of greyish brown to brownish grey fine medium sands overlying about 70 cm of slightly-deeply-mottled orange and brown sandy clay grading into varying depths of a layer of concretions. Denteso and Sene series occur at lower slopes to valley bottoms. They are deep poorly-drained soils.

The agricultural soils suitable for mechanical cultivation and for the production of cereals and other cash crops, are the Ejura and Amantin series. The mango museum is sited on these soil series.

Climate

Temperature. Temperature distribution is uniform throughout the year. The highest temp-

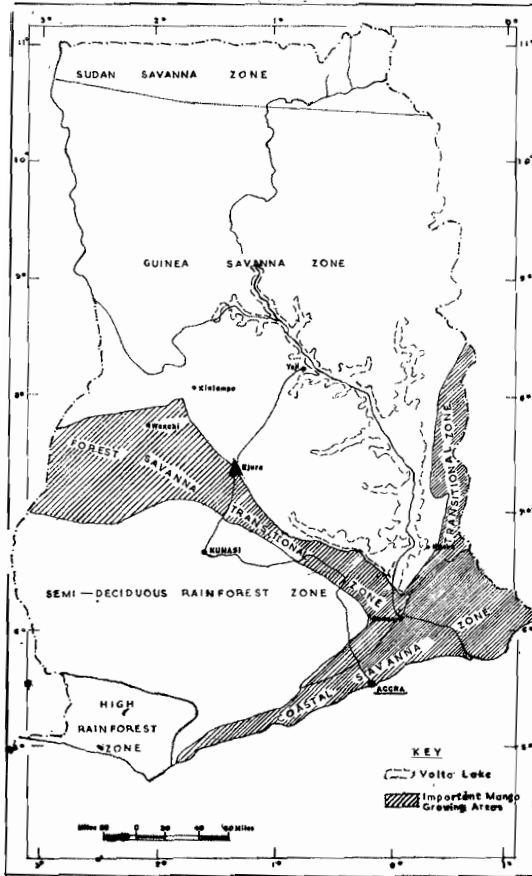


Fig. 1. Map of Ghana showing the location of Ejura station, savanna transition zone (shaded) and other areas mentioned in the text.

nucellar seedlings from the seed.

New cultivar introductions were made in the late 1960s by the Crops Research Institute and, these, together with budgrafts made from earlier ones planted at Somanya in the Eastern Region, were planted in a museum at Ejura.

The present study is based on the performance of these recent cultivars at Ejura in the forest savanna transitional zone of Ghana.

erature (36.0 °C) occurs in March or April just before the onset of the major rains in May. During the wet months of May to July, temperatures remain relatively low (26.7 °C). During the harmattan months (December-February) the afternoons are very hot but cold at nights. The average annual temperature recorded for the station is 27.2 °C (Ghana Meteorological Services Department, 1973).

Rainfall. The station is located between the 1375 and 1500 mm isohyte (Ussher, 1969) with mean annual rainfall (1931-1960) of 1410 mm (Tandoh, 1973). The rainfall pattern is characterized by a main rainy season from May to July and a minor season from August to October with a short dry spell in August. The dry season starts in November and runs through March or April (Ghana Meteorological Services Department, 1973).

Vegetation. Ejura lies in the Afram Plains with open tall grass woodland and savanna consisting of medium deciduous, fire-resistant species such as *Butyrospermum parkii*. The predominant grass cover is *Andropogon gayanus* (Akutor, 1959).

Mango cultivars

Thirteen cultivars were introduced from Miami, Florida, USA, in September 1966, as budgrafts. The rootstocks were not indicated. They were raised for 1 year at the Plant Introduction and Exploration Station at Bunso (now Plant Genetic Resources Centre) and then transferred to Kwadaso in March 1967 and later planted in a museum at Ejura the same year at a spacing of 12.2 m². Three cultivars, namely Haden, Cecil and Carrie, died leaving ten. Four cultivars Alphonso, Yellow Bombay, Haden and Keitt were raised at Kwadaso as graftlings on the "local" with budwood obtained from the United States Agency for International Development (USAID) followed by planting at Somanya in the Eastern Region. These were also planted in the Ejura museum in 1968 and 1969 at the same spacing. The 14 cultivars constituting the new introductions referred to are Earlygold, Eldon, Florigon, Irwin, Jacquelin, Palmer, Ruby, Springfels, Sunset, Zill, Keitt, Haden, Yellow Bombay and Alphonso. Each cultivar was represented by 1-10 trees in the museum.

Plantings were not replicated to enable statistical analysis of data to be carried out.

Girth measurements. The first girth measure on the 14 cultivars were made in December 1969, two years after planting the first 10 cultivars because many of them did not pick up active growth in the first year. For each measurement, a point 15 cm was marked above the graft-union and the girth measured with a thin tape. Subsequent annual girth measurements were made in December 1970 and 1971. Tree size was first determined in 1969 and again in 1970. As a measure of tree size, the height was first determined and then the tree spread was taken in two directions at right angles. Tree size(s) was then calculated according to the following formula (Oppenheimer, 1960).

$$s = 1/3 (d + h)$$

where d = mean diameter of tree canopy

h = tree height

The museum was periodically brushed and the trees sprayed with Arkotine at 4 ml/l of water to control insects especially aphids.

There were occasional attacks of a species of Hemiptera, *Anoplecnemis curvipes* (F) which bored into the current growth causing wilting and death.

Flowering and fruit setting

Flowering and fruit setting were first observed in 1970 in Palmer, Jacquelin and Sunset planted in 1967. Flowering started in December 1969 with fruit set occurring in January 1970. Although flowering was moderate there was a high incidence of shedding and premature fruit drop, characteristic of mangoes generally.

In 1971, nine out of 10 cultivars flowered and set some fruit. Ruby failed to flower 4 years after planting. Keitt and Haden [1968] flowered for the first time in 1971. Yellow Bombay [1968] and Alphonso [1969] however did not flower.

Ten cultivars namely Florigon, Eldon, Sunset, Zill, Keitt, Haden, Springfels, Palmer, Jacquelin and Earlygold flowered and set fruit in 1972. Alphonso,

Yellow Bombay, Ruby and Irwin did not flower in the year though Irwin flowered and set a few fruits in 1971.

The first fruit assessment was carried out on some of the cultivars in 1972. The cultivar Ruby flowered and fruited for the first time in 1973, six years after planting while Yellow Bombay and Alphonso remained vegetative.

Results and discussion

Trunk cross-sectional area was found in apple trees to bear a linear relationship to total above-ground weight. From this relationship, Westwood & Roberts (1970) showed that trunk measurements can be used to estimate the yield efficiency as fruit weight per cm² trunk cross-section of any orchard tree provided it is not pruned heavily. By measuring tree girth, therefore, one can make an estimate of the bearing surface potential (tree weight) per hectare (as cm² trunk area).

Girth data for the 14 mango cultivars in the museum are shown in Fig. 2. Although girth

increases in all cultivars appeared linear over a period after planting, it is more likely that growth was exponential, more so because measurements of tree growth were not taken in the first year of planting. The straight portion of the growth curve, therefore, very likely represents the middle portion of the sigmoid. Among the first 10 cultivars, the fastest growth was made by Sunset followed by Palmer, Jacquelin, Zill and Florigon in that order.

Ruby exhibited the slowest growth among the 10 cultivars. Field observations showed that the annual growth of Ruby was severely retarded during the first 4 or 5 years after planting. The tree remained very dwarf in comparison with other cultivars. Branch development was also sparse. This retarded development could be due to cultivar × environment interaction. Perhaps also, the creosote used in painting the wooden box in which this cultivar was potted for sometime before transplanting into the field proved deleterious to the plant and, therefore, retarded its growth.

Haden developed fastest among the cultivars

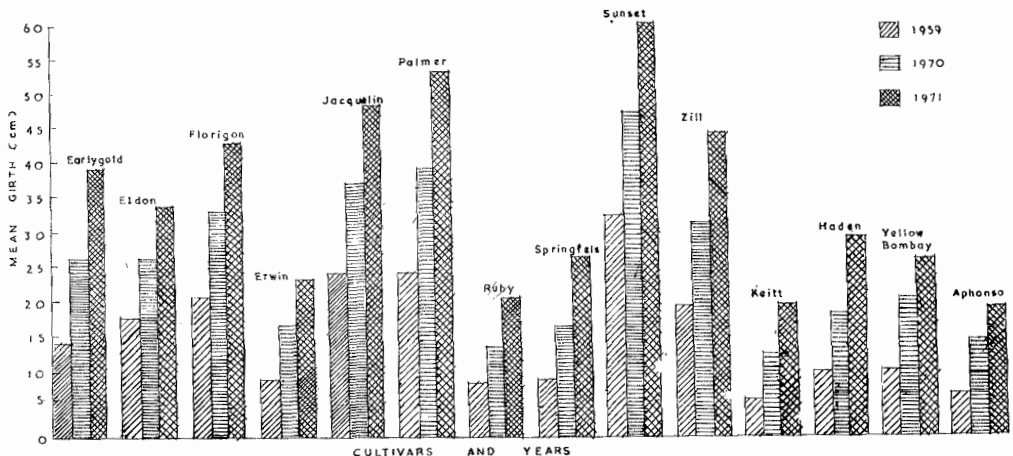


Fig. 2. Relative annual girth development in 14 new cultivars of mango at Ejura.

planted in 1968. The growth even surpassed that of Springfels planted in 1967 and was equal to Yellow Bombay also planted in 1968. Alphonso, though planted in 1969, six months later than Keitt, caught up with it in 1971 indicating very rapid growth of this cultivar.

The mango is not exacting in its soil requirements and is relatively tolerant to drought and marginal soil conditions but grows and produces best in soils that are deep, well-drained and medium-textured with low water table (Yee, 1964; Singh, 1968). It is cultivated in Hawaii in areas of less than 1500 mm of annual rainfall (Yee, 1964). In Ghana, until recently, mango was found as an escape from cultivation, being most abundant in the savanna areas of the country.

The well-drained soils of the Ejura and Amantin series developed over voltaian rocks, no doubt favoured the mango saplings and contributed to their rapid development and growth. As stated by Akutor (1959), tree species with girth ranging between 90 and 180 cm are common at Ejura. The earlier mango cultivar introductions on the station fall within this girth limits and are still actively productive.

Besides, the temperatures are high and the mean annual rainfall of 1410 mm (Tandoh, 1973) is also ideal for mango to thrive and produce abundantly. Prolific cultivars, namely Sunset, Palmer and Jacquelin, made very rapid development and grew quickly while Zill which is known to be a thrifty grower (Singh, 1968) fell half way between Sunset and Eldon in its development.

The absence of strong winds which can sometimes rip off branches from trees was probably another factor which promoted the orderly growth of the trees in the museum.

Generally, girth increase was more pronounced in 1970 than in 1971. For example, Yellow Bombay showed an increase of 136 per cent over 1969 in 1970 as compared with 33 per cent over 1970 in 1971.

All the cultivars first made a slow start but when active growth started after establishment, growth was very rapid as new branches were formed and flushes of leaves developed.

Tree size measurements made in 1969 and 1970 are shown in Table 1. Tree size gives an estimate of branch and leaf development of a tree. The

TABLE 1

Tree Size Measurements of 14 Cultivars of Mango at Ejura Taken in 1969 and 1970

Cultivar	Date planted	Mean tree size (cm)	
		1969	1970
Earlygold	26/9/67	98.5	165.1
Eldon	"	138.0	179.3
Florigon	"	141.7	193.5
Irwin	"	66.0	182.9
Jacquelin	"	155.4	217.4
Palmer	"	175.3	244.6
Ruby	"	66.0	94.0
Springfels	"	90.9	145.5
Sunset	"	218.4	281.9
Zill	"	154.4	199.6
Keitt	8/10/68	60.2	100.3
Haden	"	75.2	108.2
Yellow Bombay	"	97.5	139.0
Alphonso	14/4/69	49.5	111.5

determination of tree size in the different cultivars would, therefore, supply information on the development of the potential bearing surface of each cultivar. Tree size showed a very close relationship with girth measurements. As in the case of girth development, tree size was greater in Sunset followed closely by Palmer, Jacquelin, Zill and Florigon in that order. Tree size (canopy development) in Ruby was only 30 per cent as great as in Sunset, indicating again the dwarfing of this cultivar as shown in Fig. 2. Canopy development in other cultivars, except Keitt, was intermediate between these.

Among cultivars planted in 1968 and 1969, the highest tree size (139 cm) was attained by Yellow Bombay. The size development in Keitt, Haden and Alphonso was very similar.

The results of the initial yields, sizes and other fruit characteristics of 10 of the new cultivars of mango are shown in Table 2 for 1972.

The flowering pattern followed that of the "local" in which the reproductive phase starts in December

TABLE 2

Initial Yields, Weight and other Characteristics of New Cultivars of Mango at Ejura (1972)

<i>Cultivar</i>	<i>Number of fruits harvested</i>	<i>Mean fruit weight (g)</i>	<i>TSS % (at soft-eating stage)</i>	<i>Flesh colour</i>
Jacquelin	70	727	16.4	Yellow
Palmer	60	651	16.2	Yellow
Keitt (10)	32	538	14.6	Yellow
Sunset	300	311	15.6	Yellow
Haden (7)	112	424	17.4	Yellow
Zill (2)	160	396	18.9	Yellow
Eldon	50	509	15.9	Pale yellow
Springfels	10	736	16.3	Slightly-yellow
Earlygold	15	396	15.2	Yellow
Florigon (2)	150	396	16.0	Yellow
Julie (Ejura) ^a	NA	311	18.3	Yellow
Jaffna (Ejura) ^a	NA	212	17.0	Yellow
'Local' (Ejura) ^a	NA	142	14.0	Yellow

Figures in brackets indicate the number of trees; others single.

^a Cultivars meant for comparison only.

NA - No data available.

especially after some rainfall during the harmattan months. The high shedding of flowers and premature fruit drop are not peculiar to these new cultivars but are a general phenomenon observed in mango. However, the very low fruit set observed in Irwin especially seems to indicate there may be a problem of pollination in this cultivar.

Fruit weight distribution indicates that the cultivars may, initially, be roughly divided into three grades as follows:

1. Cultivars producing very large fruits, i.e. 700 g mean fruit weight (Jacquelin and Springfels).
2. Cultivars producing large fruits, i.e. 500-600 g mean fruit weight (Keitt, Eldon and Palmer).
3. Cultivars producing small to medium size fruits, i.e. 300 - 400 g mean fruit weight.

This fruit weight distribution agrees very closely with that recorded in Florida for Keitt, Haden, Palmer, Zill, Florigon and Springfels (Lynch &

Mustard, 1950).

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