

BOTANY

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The oil palm (*Elaeis guineensis* Jacq.) originated in the Guinea Coast of West Africa. Semi-wild and wild palm groves are still existing in the tropical West African countries. In the 15th century, oil palms were introduced to Brazil and other tropical countries by the Portuguese. But it did not flourish in these countries till 19th century. During 1848 the Dutch people imported oil palm seeds from West Africa via Amsterdam and four seedlings were planted in Bogor, Indonesia. The progenies of these palms were planted as ornamental palms in Deli and are later known as *Deli dura*. Commercial planting of oil palm started in Malaysia during 1917.

The Seed

Oil palm seed is a nut consisting of the shell and one, two or three kernels. In most of the cases the seed may have only one kernel as a result of the abortion of the other two ovules in the tri-carpellary ovary. Abnormal seeds may rarely occur giving rise to even five kernels. The size of the seed varies according to the thickness of shell and size of kernel. The seed may weigh from 1 g to 13 g. The shell has long fibres adhering to the seed and short fibres in the form of a tuft at the base. Each seed has three germ-pores corresponding to the three carpels of the ovary. A plug of fibres is formed in each of the gempore. These fibres join at the base to form a plate-like-structure. The kernel is seen inside the shell containing oily endosperm cells which is gray white in colour. The kernel is surrounded by a dark brown testa covered with a network of fibres. Embryo is embedded in the endosperm

facing one of the gempores. The embryo is straight and about 3 mm long. Its distal end lies opposite to the gempore which is separated by a thin layer of endosperm cells. The testa, the plate-like structure and the layer of endosperm cells together form the operculum.

Seed germination

The process of germination involves the emergence of embryo which forms a button in the beginning. It soon gains a plumular projection while from the end of the embryo the persistent radicle emerges. Both plumule and radicle emerge through a cylindrical ligule close to the seed. The haustorium develops inside the seed rapidly. In three months time, the spongy haustorium absorbs the endosperm fully and fills the cavity of the nut.

Oilpalm seeds do not germinate quickly under natural conditions since it has a long dormancy period. If the seed is planted in sand or soil and allowed to germinate under natural conditions, irregular germination would occur after 3-6 months or longer with total germination of about 50 per cent. It has been found possible to reduce this period and increase the germination percentage by improved techniques.

The seedlings

The plumule does not emerge from the plumular projection until the radicle has reached 1 cm in length. The first adventitious roots are produced in a ring just above the radicle-hypocotyle junction and they give rise to secondary roots before the first foliage leaf is

emerged. Two blade-less plumular sheaths are produced before a green leaf is emerged. This leaf is recognised by the presence of a lamina which is produced after one month from germination. After this, leaves are produced at the rate of one leaf per month until the seedlings are six months old. The base of the stem becomes a swollen bulb after about 4 months and the primary roots emerge from it. The first few leaves are lanceolate. In later leaves a split is formed resulting in bifurcate leaves and subsequently the leaflets become entirely separate.

The stem

Initial growth of the palm after the seedling stage is marked by the formation of a wide stem-base without internodal elongation, on which the future stem column can rest firmly. The palm has only one growing point. Branch-

ing very rarely occurs possibly due to damage in the growing point. The stem-apex is conical in shape. The mass of young leaves and leaf bases together is known as the cabbage. Stem-thickening is attained through a process called primary thickening which is brought about by the activity of a meristem which continues beneath successive leaf bases. Internodal elongation begins only after attaining the maximum diameter of the stem. When the palms are young, the base of the stem assumes the shape of an inverted cone. Primary roots emerge in large numbers from this cone. As soon as the inter nodes begin to elongate, a columnar stem with adhering leaf-bases is formed. The leaf bases adhere to the stem for at least 12 years or longer. They start falling away from the base, top or the middle of the stem and the palm becomes smooth-stemmed instead or roughstemmed. The leaves are

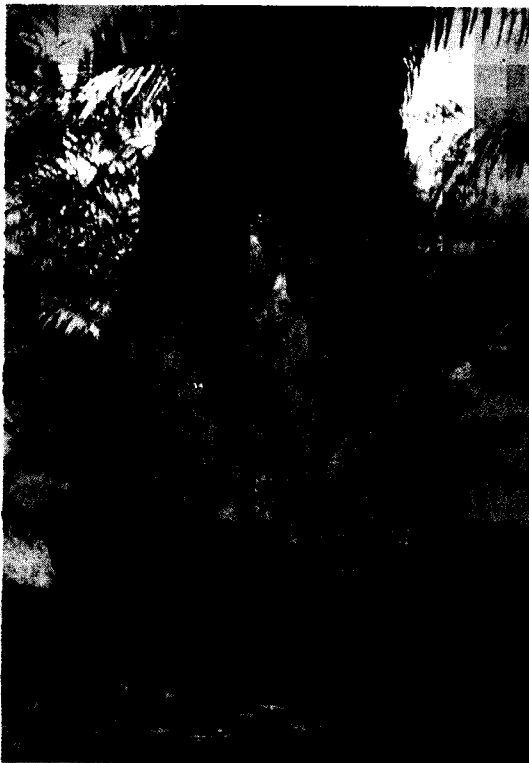


Fig. 1 & 2. The spiral arrangement of leaves (8+13)

produced in an orderly manner which is roughly triangular. This arrangement gives rise to sets of spirals. In an adult palm, two sets of spirals are visible, eight running in one way and thirteen in the other (Fig. 1 & 2). This arrangement is described as (8+13). If the leaf bases are chronologically numbered, it becomes clear that in one way, 8th leaf is seen to be in the same spiral while the other way every 13th leaf appears in the same (more or less vertical) spiral. These spirals are in either direction, left hand or right hand, more or less on a 50:50 ratio. In practice the total number of leaves can be clearly calculated by counting the number of spirals with eight leaves and multiplying the figure by eight and then adding the number of leaves in the incomplete spiral. The average increase in height of the stem is from 0.3 to 0.6 m/year. The palm reaches a height of about 30 m. The width of the stem unclothed

by leaf-bases varies from 20 to 75 cm. the stem functions as a support, vascular and storage organ. The anatomy of the oilpalm stem is typical of that of monocotyledons. In the cross section, there is a wide central cylinder with a very narrow cortex. In the periphery numerous vascular bundles with fibrous phloem sheaths are embedded in the sclerotic ground tissue. In the central zone the vascular bundles are found embedded in the parenchymatous ground tissue. Longevity of Oilpalm is believed to be upto 200 years.

The leaf

In the crown of the adult palm, about 50 leaves could be observed in various stages of development. Each leaf remains enclosed for about two years and then rapidly develops into a central spear leaf which finally opens. Mature leaf is simply pinnate with linear leaf-

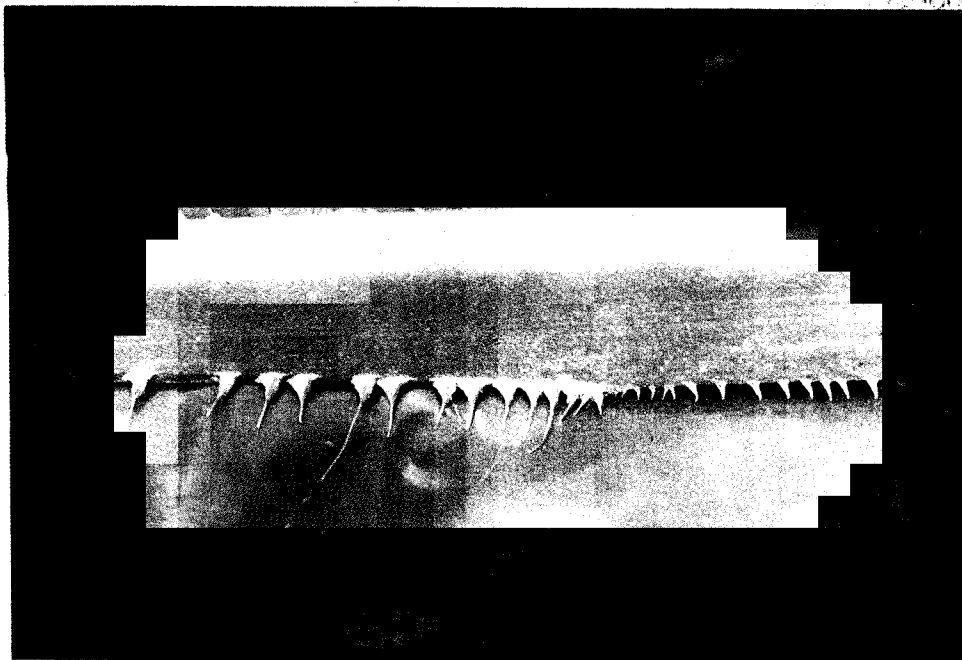


Fig. 3. The leaf Petrole

lets on each side of the leaf stalk. The leaf stalk has two zones, a leaflet bearing portion and the petiole. Two kinds of spines are seen in the petiole region. They are the fibre pines and the midrib spines (Fig. 3). The fibrespines are seen on the lower portion which is a modification of the leafsheath, while the midrib spines are seen in the upper portion of the petiole. These are modified midribs of leaflets. The long leafstalk is a hard fibrous body which may be as long as 8 m. Leaflets are produced by splitting of an entire leaf by the elongation of the leafaxis. Leaflets are arranged laterally in upper and lower ranks, giving a shaggy appearance. Individual leaflets are linear having a terminal pair. Each leaf will have about 250-300 leaflets and are about 13 m long and 6 cm broad. The midrib is very rigid and the laminae sometimes tear backwards from tip. The number of leaves produced annually by a mature palm is about 25.

The root system

Oilpalm has a typical adventitious root system. At the seedling stage, adventitious primary roots emerge from the radicle-hypocotyl junction and then from the basal cone or bole. In an adult palm, thousands of primary roots spread from the bole region. Individual primary roots travel upto 19 m from the stem. Two types of primary roots are observed. They are the descending and radiating primaries. The descending primaries are for anchorage. From the radiating primaries, large number of ascending and descending secondaries emerge, more or less in equal numbers. These secondaries give raise to horizontally growing tertiaries. From them a mass of quarternaries develop. The density of all classes of roots in the top 40 cm. of soil usually decreases with distance from the palm. But in adult palms, the total quantity of absorbing roots increases at

least to a radius of 4.5m. Absorption of nutrients is through the quarternaries and absorbing tips of primaries, secondaries and tertiaries, bulk of which are seen in the top 15-30 cm of soil.

The anatomy of the roots consists of an outer epidremis and lignified hypodermis surrounding a cortex in which well developed air lacunae are found. Within the cortex is the stele surrounded by a endodermis, vascular strands or xytem and phloem and the pith. The quarternary roots are not lignified and perform the main function of absorption of water and nutrients. The roots of oilpalm are characterised by the presence of pneumathodes. These are seen both in underground and ariel roots. Such roots are supposed to ventilate the root system.

Reproduction

In the axil of each leaf, there is a bud which may develop into a male, female or hermaphrodite inflorescence. The oil palm is monoecious (producing male and female inflorescences in the same palm, borne separately). Each inflorescence primordium is a potential producer of both male and female organs. Each inflorescence is a compound spike or spadix carried on a stout peduncle. 30-45 cm long spikelets are arranged spirally around a central axis. An inner and outer spathe tightly enclose the inflorescence upto six weeks before anthesis. Afterwards both the spathes are split open and inflorescence pushes its way out. Six to ten long bracts are seen below the lowest spikelets, two of them extend to the top of the inflorescence.

The female inflorescence reaches a length of 30 cm or more before opening. The female spikelets are thick and fleshy and develop in

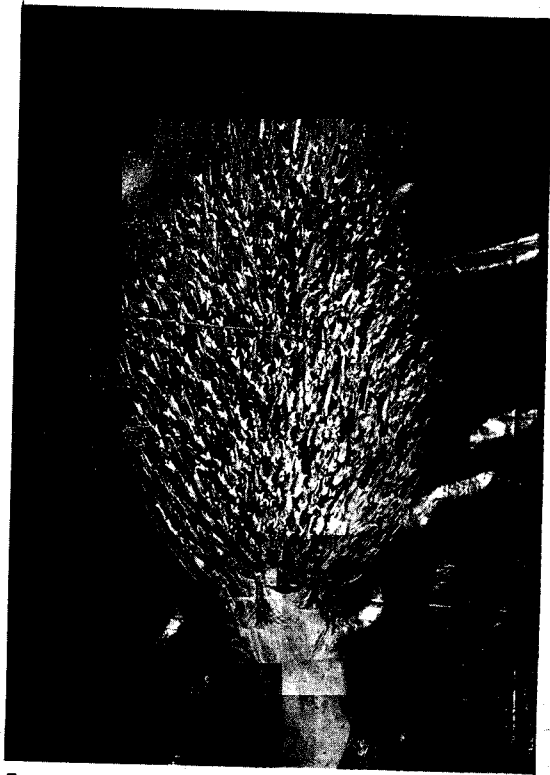


Fig. 4. Female inflorescence

the axils of spinous bracts (Fig. 4). The flowers are arranged spirally around the rachis of the spikelets. Each flower is housed in a shallow cavity and is subtended by a bract which is drawn up into a spine. At the end of the spikelet also there is a spine. An average inflorescence from a mature palm may have more than 110 spikelets with over 4000 flowers. Each female flower has a protection bract, two floral bracts and two whorls of three perianth each. All these bracts enclose a tricarpellary ovary. The two accompanying male flowers are abortive. At anthesis the trifid stigma curves outward. The stigmatic lobes when receptive are white to pale yellow in colour. Later on a red stripe develops along those lobes as the flower turn purplish indicating the end of receptivity.

The male inflorescence is borne on a longer peduncle than that of the female. The spikelets are long finger-like and not spiny (Fig. 5). Each spikelet is about 10-20 cm long arising from a central stalk bearing between

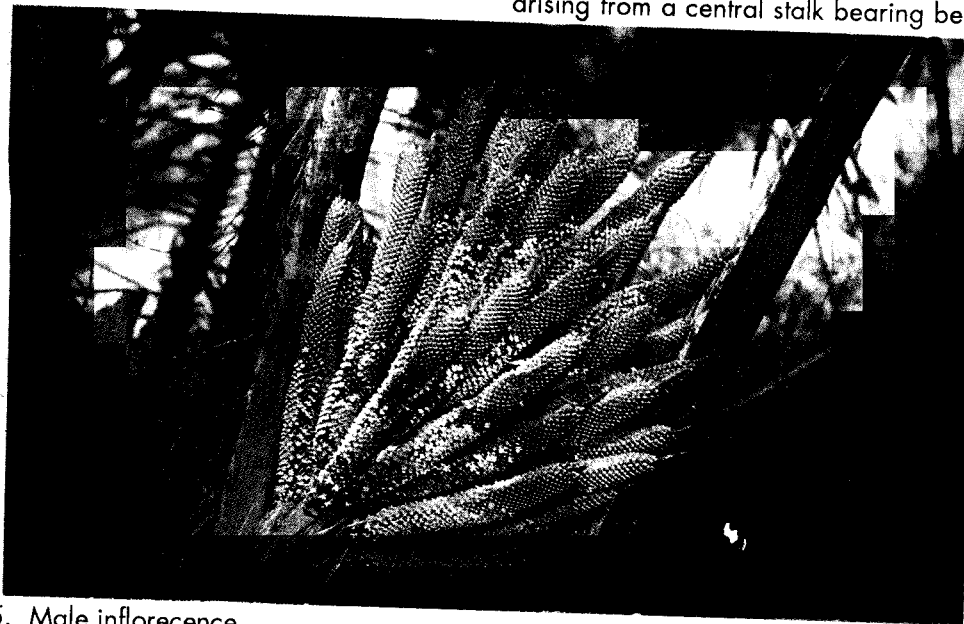


Fig. 5. Male inflorescence

600-1200 male flowers which are yellow in colour having a distinct aroma and mature from bottom to top. A mature flower is 3-4 mm long and 1.5 to 2.0 mm wide and is completely enclosed in a triangular tract. It has an outer whorl of three hard and an inner whorl of soft perianth together with six stamens fused to form a tube in the centre. The anthers are bilobed and release pollen grains through the lateral slits. The amount of pollen produced by a single inflorescence is upto 50 g. and liberated over a period of 2-3 days.

Male and female inflorescences are produced in cycles. In young palms a great variety of hermaphrodite inflorescences are produced. This consists of male, female and mixed spikelets on the same inflorescence. Young palms occasionally produce a peculiar type of inflorescence known as andromorphic. Here the male flowers are replaced by small solitary female flowers arranged in the same manner as that of the male flowers.

Insect pollination in oil palm

The oil palm, hitherto thought to be wind pollinated, has been now proved to be an insect pollinated species. From West Africa, the original home of oil palm, eight species of pollinating weevils were reported by Syed (1979). They belong to the order Coleoptera (Family - Curculionidae, subfamily - Derelominae). Weevils on oil palm in Cameroon include, *Elaeidobius kamerunicus* Fst., *E. plagiaus* Fah., *E. singularis* Fst., *E. bilineatus* Fst., *E. subvittatus* Fst. and rarely *E. spatulifer* Mshl. The only species found in South America is *E. subvittatus*. Occurrence of *E. kamerunicus* in the oil palm plantations of Kerala was introduced during 1985 from where it was introduced and got established in Little Andamans during 1986.

The weevils are dark brown in colour. Adult weevils chew the anther filament. Eggs are deposited inside the flowers and larva feed on the spent flowers. Lifecycle is completed within 11 to 13 days. Males live longer than females. The activity of the insects is in accordance with the receptivity of the male and female inflorescences. It was roughly estimated that 40 palms in a grove might be the minimum to sustain a sufficiently high continuous population of pollinators to pollinate all receptive female inflorescences. The weevils carry maximum pollen during the third day of anthesis (Dhileepan, 1991). Antennae, rostrum, thorax, legs etc. are the main sites of pollen load. *E. kamerunicus* has a fairly good searching ability. It can survive in dry as well as in wet seasons. Their host range is limited to the genus *Elaeis* and even at this level it cannot survive for more than two or three generations, on the most closely related species like *Elaeis oelifera*

E. kamerunicus was introduced in Malaysia during 1981 and was well established over a radius of more than 5 km from the release site within six months. Total yield was 20 per cent higher in Peninsular Malaysia and 53 per cent higher in Sabha, with higher increase in kernel yield (Syed, 1982). Introduction of the weevil in India increased the fruit set from 36.8 per cent to 56.1 per cent resulting in 40 per cent increase in FFB weight and 11 per cent increase in F/B ratio. The maximum attainable pollination potential was as much as 70 per cent with 57 per cent increase in FFB weight. Introduction of *E. kamerunicus* into the oil palm plantations at Little Andamans increased the FFB weight from 5 to 12 kg.

For introduction, male flowers cut from

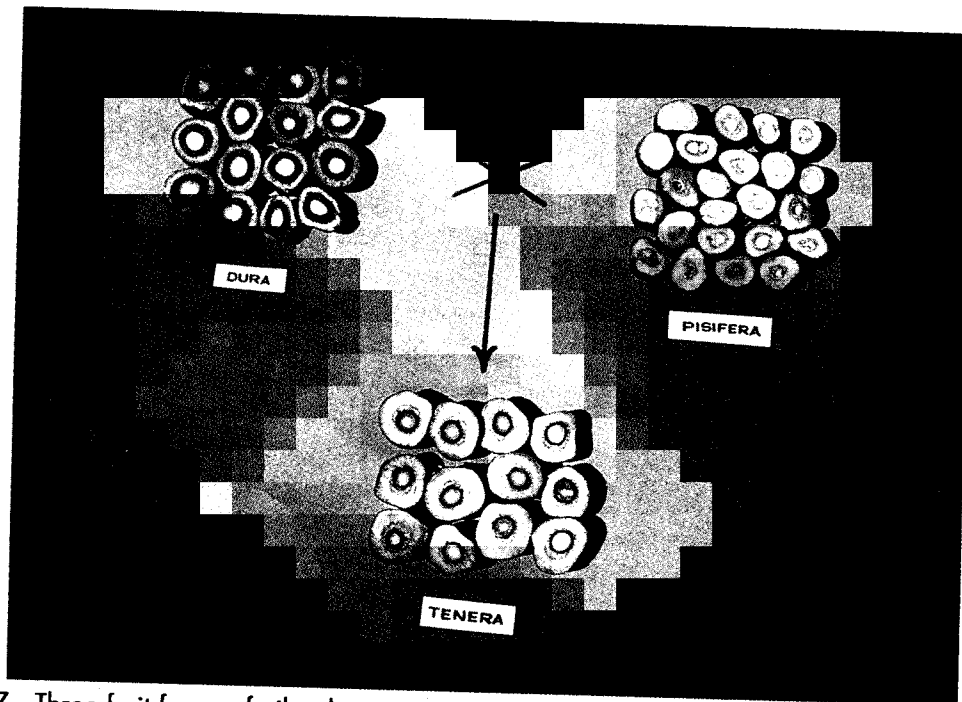


Fig. 7. Three fruit forms of oil palm

b) *Pisifera* - this fruit type is characterised by the absence of a shell, the vestiges of the shell being represented by a ring of fibres around the kernel, the latter being quite small. In the absence of shell, there is a high ratio of mesocarp to total fruit size and the mesocarp oil content is also high. *Pisiferas* are usually described as female sterile since the majority of bunches abort at an early stage of development. Therefore, *Pisifera* material cannot be used for commercial plantings but is used as the male parent in breeding programmes. By crossing the *dura* and *pisifera* types, the third

type *tenera* is produced.

c) *Tenera* - this type which is currently planted on an estate scale, combines the characteristics of the parent material. Shell thickness ranges from 0.5 mm to 4 mm around which a ring of fibres, is present. The ratio of mesocarp to fruit is comparatively high, usually within the range 60-96 per cent. *Tenera* palms generally produce more fruit bunches than *dura* palms, although mean bunch size is usually smaller. The ratio of oil to bunch is about 22-24 per cent.

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