MANAGEMENT

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Introduction

Oil palm requires evenly distributed annual rainfall of 2000 mm without a defined dry season since it is continuously growing and yielding all through the year. In areas with dry spell, a deep soil with high water holding capacity and a shallow water table can however, satisfy the water requirement of the palm. Though the crop can withstand 3 to 4 months of dry period, continued moisture stress affects the yield adversely, unless augmented with copious irrigation.

Temperature can be a limiting factor for oil palm production as it influences inflorescence production, initiation of flower primordia, sex differentiation, anthesis, floral abortion and growth rate of palm. Prolonged cooler temperature with less than 19°C reduces the growth rate and leaf production considerably in oil palm. More number of male inflorescences are produced under low minimum temperatures. Best oil palm yields are obtained in places where a maximum average temperature of 29-33°C and minimum average temperature of 22-24°C are available. Higher diurnal temperature variation causes floral abortion in regions with a dry season.

The crop requires 1800-2000 sunlight hours annually for producing good yield. The oil palm growth and yield will be drastically reduced when solar radiation levels fall below 350 Langleys (cal/cm^2/day). Constant sunlight of at least 5 hours per day is required for better oil palm yield.

Though oil palm is considered as a humid tropical crop, it can tolerate a wide range of pedo-ecological conditions. It is found to grow well on a variety of soils. However, moist, deep and well drained medium textured soils rich in humus content are considered ideal. Gravelly and sandy soils, particularly the coastal sands, are not ideal for oil palm cultivation. Heavy clay soils with poor drainage properties may pose problems of aeration during rainy seasons.

Nursery and its management

Direct planting of the germinated seedlings into the mainfield is not advocated mainly due to the anticipated damage of seedlings by rodents and also due to the expected uneven stand in the field. Therefore, a nursery is raised by planting germinated sprouts initially in a pre-nursery bed or in polybags in a primary nursery and transplanting them at five leaf stage to a secondary nursery of larger sized polybags. Raising seedlings in large polybags without a pre-nursery stage is also being practised.

In India the potting mixture is made by mixing top soil, sand and well decomposed cattle manure in equal proportions. Smaller polybags of 250 guage and 23x13 cm size, preferably black, are used for raising primary nurseries. These bags are filled with the potting mixture leaving one cm at the top of the bag. A healthy germinated sprout is placed at the centre at 2.5 cm depth. While placing the sprout, care must be taken to keep the plumule of the sprout facing upwards and the radicle downwards in the soil. It is better to plant sprouts soon after the differentiation of radicle and plumule. Mulching is beneficial for better growth in the nursery (Gunn *et al.*, 1961). Mulching with palm shell, finely divided bunch refuse, saw dust, groundnut husk or other fibrous material has been found to conserve moisture, prevent compaction of soil and provide certain amount of nutrition to the growing seedlings. Shading is also found beneficial at early stage especially when they are raised under higher temperature conditions in certain parts of India. Adequate supply of water is to be ensured to these seedlings by installing permanent irrigation facility. The seedlings are to be watered daily. Response of seedlings to nitrogen and phosphorus was reported from Nigeria and Malaysia. Application of a fertiliser mixture containing one part of ammonium sulphate, one part of super phosphate, one part of muriate of potash and two parts of magnesium sulphate is recommended @ 15g at one month stage, 45g at three months stage and 60g at six months stage per seedling. This has to be applied 6-8 cm away from seedlings during the first application, 10-12 cm away during second and 15-20 cm away during the third application in primary nursery. Surface soil is slightly scratched at the time of fertilizer application.

Single stage poly bag nursery and secondary nursery

Bevan and Gray (1966) demonstrated that germinated seeds can be directly planted into large black polybags with the advantage of avoiding the pre-nursery stage. Experimental trials conducted in Malaysia have shown that planting of germinated seeds directly into large polybags gives more vigorous larger seedlings than those obtained by raising pre-nurseries. At present the single stage polybag nursery is recommended in India. Since the plants are to remain in these poly bags for more than one year, good quality polybags of 500 guage and 40x45 cm size are to be used. On the lower half of the bag, perforations are made at an interval of 7.5 cm for drainage. A bag can carry 15-18 kg of nursery soil depending on the type of soil mixture used.

Germinated seeds are planted in the same way as described under primary nursery. It is important to provide shade until seedlings attain two leaf stage. This can be done by staking palm leaflets in each bag so as to cover the bag like an umbrella over the developing seedlings. Though the single stage nursery is more labour intensive, it is compensated by the reduction in the overall time for transplanting by about two months. Where two stage nursery system is practised, eight week old pre-nursery seedling (five leaf stage) from smaller bag with its ball of soil is transplanted as such into the larger polybag.

Quencez (1982) suggested water requirement for different stages of growth of seedlings as follows : 0-2 months @ 4mm/day, 2-4 months @ 5 mm/day, 4-6 months @ 7mm/day and 6-8 months @ 10 mm/day. It is better to supply if feasible the daily requirement in two halves to prevent overflow and wastage caused by one time application. Bevan and Gray (1966) suggested application of 9-18 l of water per seedling per week according to the stage of growth and soil type.

Shading the nursery is not a usual practice and is not recommended except under high temperature conditions. In West Africa shaded plants though found taller in the nursery, were slower in growth than unshaded plants (Gunn *et al.*, 1961). Hand weeding is recommended at monthly intervals both in polybags and the intervening ground (Bevan and Gray, 1969). Mulching is practised in certain regions of Central America but not commonly in Asia and Africa.

Field planting

It is necessary to prepare the land for oil palm plantings at least 3 months before transplanting the seedlings to the main field. In the case of forest land chosen for oil palm plantation, the major activities involved are, felling of existing vegetation and piling up and burning of the residue. In soils with low permeability, drainage channels are to be constructed to prevent water stagnation in upper layer of soil. On steep slopes, circular platforms are cut with a diameter of 3-4 m and a slope back to the hill side of 7-8°. However, in very steep slopes of over 20° terracing is required. Clearing paths are constructed in the centre of every other avenue.

Age of seedlings at transplanting

In places with no distinct dry season, it is advisable to plant well grown seedlings of 10-16 months old. In Malaysia, polybag seedlings of 13 months or more gave significantly higher yields in the first three bearing ages than those transplanted at younger ages (Hew Choy Kean and Tam Tai Kin, 1971). From trials conducted in other oil palm growing countries, it was observed that seedlings of 12-14 months of age are the ideal ones for transplanting to mainfield. At this stage, a well developed *tenera* seedling will have a height of 1-1.3 m from base and will have more than 13 functional leaves. These seedlings were found to maintain higher leaf production, bear earlier, produce heavy bunches, give higher fruit/ bunch ratio and a higher oil to mesocarp in the first year of harvest.

Selection of seedlings

All deformed, diseased and elongated seedlings are to be discarded. Differences in the height of healthy seedlings ranging from 90 to 159 cm tend to even up after 14 months of transplanting to mainfield in Malaysia.

Time of transplanting

Transplanting to the mainfield has to be done during the onset of rainy season so that the seedlings can establish under favourable conditions. Most suitable time for transplanting seedlings into mainfield in India is with the on set of monsoon by which time the seedlings are to be at least 12-14 months in the nursery. Accordingly, raising nursery has to be planned well in advance for timely supply of the seedlings.

In very impermeable soils and where there is chance for the seedlings to suffer severely during rainy season, proper drainage has to be ensured. In Kuttanad region of Kerala, oil palm is being successfully grown on raised bunds or terraces which are surrounded by standing water during the rainy season.

Spacing and method of planting

The optimum planting density for oil palm is the density of population that gives maximum production from unit area. When density is less than the optimum level, though individual palm yield increases to a certain extent, the total production per unit area will be lesser. Population above optimum level will also lead to reduced production of individual palms due to competition for water, nutrients and sunlight thus reducing the total yield per unit area. Yields of individual palms are adversely affected due to increased density of planting causing mutual shading of leaves. Although closer spaced palms gave higher yields initially, as the palms grow, mutual shading affects the yield adversely.

Under more favourable conditions a population of 127 - 135 palms per hectare was found to be optimum whereas under less favourable conditions as in India, higher densities of 138 - 150 palms per hectare are recommended.

Dense shade affects sex ratio in oil palm. Close planting induces more male inflorescence (Sparnaij, 1960). A very regular planting arrangement with largest possible number of similarly spaced surrounding palms is desirable and triangular spacing fulfils this requirement best (Hartley, 1988). Triangular system of planting with 9x9x9m spacing accommodates 143 palms/ha.

For efficient utilization of solar energy the rows are to be oriented in the North-South direction. Equilateral triangular system of planting with 9 m spacing between palms will allow each plant to occupy the centre of a hexagon thus allowing better use of the area. Different methods of marking planting points are discussed below:

(a) In flat or gently sloping lands the stakes are placed in base line 'B' taken in E-W direction at every 46.8m. (space for 7 rows = 7.8x6). Palm rows are marked at 9 m spacing on those two rows A_1, A_2 in N-S direction by putting stakes. The stakes are placed for remaining palm rows in between these two rows by use of a chain on which marks are made at 9 m spacing. The first mark of this chain is placed on first stake of line A_1 and the seventh mark of the chain on the other end is placed on fourth stake of line A_2. (Fig. 1). Then the stakes are placed on all the marks on chain thus filling the entire area of the block.

(b) Another method is to mark a base line A in N-S direction in one end of a block and put the stakes at 9m spacing on this line (Fig. 2). From this base line another line B_1. in E-W. direction is made with the corner stake on left hand corner remaining the same and stakes are placed at 7.8 m in this line. Similarly, another line B_2 is made after 54m (6x9) from line A. Now a chain is used on which marks are made at every 4.5m with two different colours so that the distance between similar coloured marks is 9m. Thus the marks on even numbered positions have one colour and odd numbered positions have another colour.

The first (odd) mark is placed on the 2nd stake of B_1 and last mark on second stake of B_2. Now mark palm positions by placing the stakes on the other colours (even). Remove the chain and place it on 3rd stake of B_1 and B_2 and mark the positions by putting stakes on other coloured mark (odd) and continue till the block is completed.

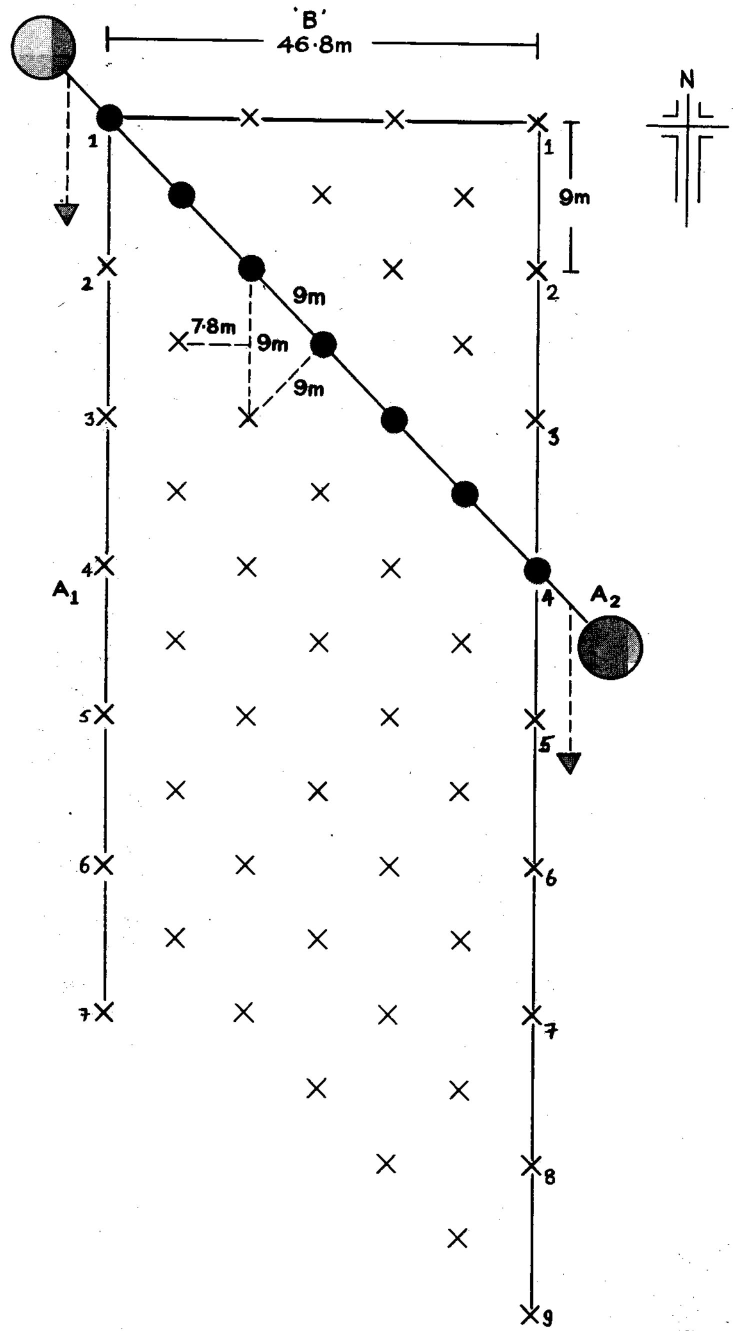

Fig. 1 : Equilateral triangular system of planting - Method 'A'

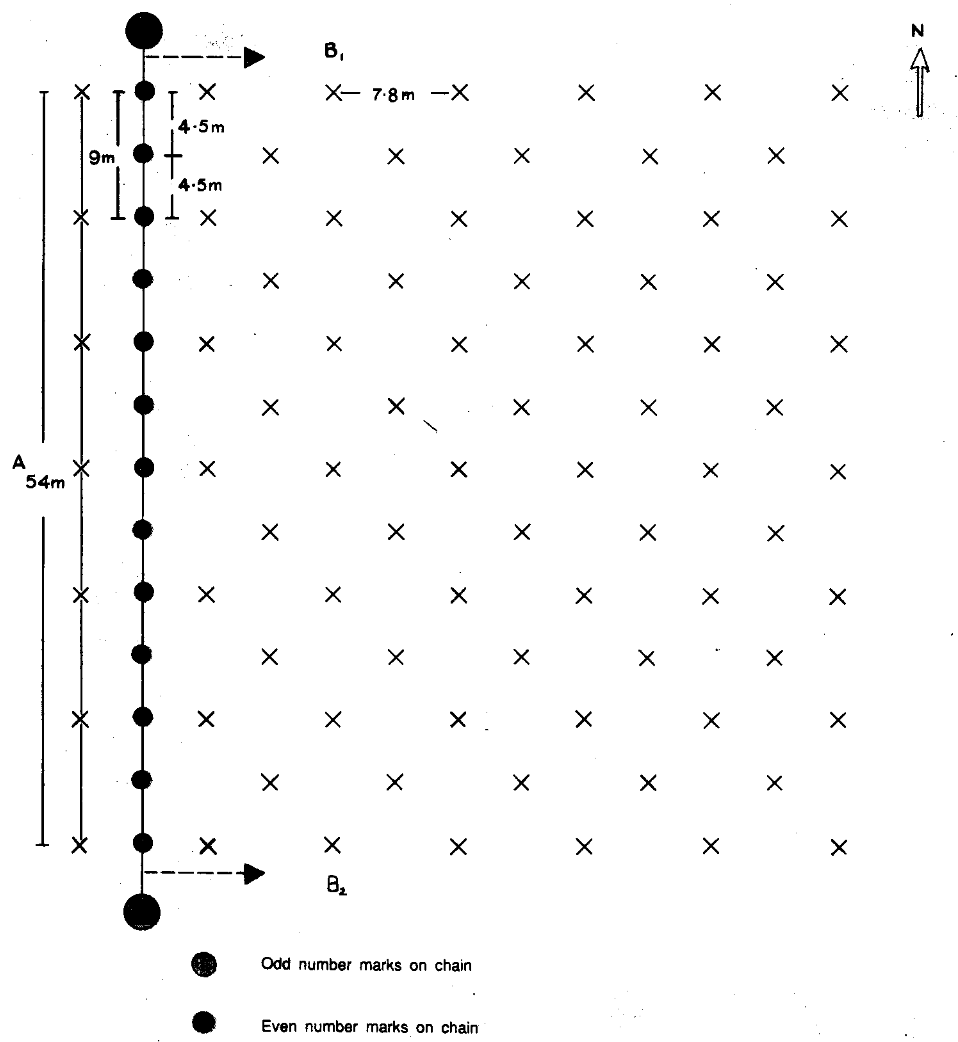

Fig. 2 : Equilateral triangular system of planting - Method 'B'

Transporting seedlings and preparing pits

While transporting seedlings to the planting site one hand is placed at the bottom of the bag while holding the plant collar with the other one. Leather gloves can be used to avoid injury with spines of the leaves.

Pits of 60 cm^3 are taken prior to planting, and filled with surrounding top soil and allowed to settle. In the refilled and root zone soil, a depression sufficient to cover the ball of earth is made at the time of planting.

After removing the bag by cutting edges, the plant is carefully placed in the depression with the ball of earth. The surface of the ball of earth must be at the soil level as planting below or above the soil level is not congenial for the later development of the seedlings. The space in between the ball of earth and the hole is filled and compacted.

Protecting the seedling by placing wire net around the base of the seedling at the time of planting is practised in areas where wild boar or rodents are prevalent. Rock phosphate is applied @ 200g. per planting pit. Nitrogen is not usually applied in the planting pit as the application of fertilizer may damage the root system and affect survival of the plants if there is a dry period soon after planting. Nitrogen and Potassium are usually applied 4-6 weeks after planting. In Mg deficient soils magnesium is applied @ 100g anhydrous $MgSO_4$ or 200g epsum salt per seedling.

Replacement and gap filling

Field inspection is carried out one to two months after planting to gap fill dead plants. Replanting is carried out during the onset of next monsoon. These palms are to be given special care so that they can catch up with the rest of the plantation. Yeow *et al.*, (1981a) observed that early production of more female inflorescences in the initial 30 months, is an indication of high yielders and all those that fail to produce female bunches will remain as poor yielders. However, replacements are found to be affected to some extent by the vigorous growth of the neighbouring palms which will shade the replanted palms.

Establishment and management of cover crops

The more commonly used cover crops that can establish very well in oil palm plantation in India are *Pueraria phaseoloides, Calopogonium mucunoides, Centrosema pubescens* and *Mimosa invisa*. *Pueraria* is found to establish very well and spread fast in the oil palm plantations of Kerala and Andhra Pradesh. *Pueraria* seeds require treatment with concentrated sulphuric acid (scarification) or soaking for 12-24 minutes and subsequent heat treatment for one hour at 39-40°C. Inoculation of the seeds with specific Rhizobium species has to be carried out for better nodulation and rock phosphate has to be applied at the time of planting. *Calopogonium mucunoides* seeds are soaked in conc. H_2SO_4 for 15-20 minutes and the acid is repeatedly washed out with hot water. Maintenance of these covers consists of cutting back the adventitious growth to 30 cm by cutlassing sometimes as many as six times a year. Rings around the palms need frequent clearing to keep the palm basin clear so that the palms are not covered by the creepers especially the young palms. As the palms grow and shade the area, ground cutlassing can be reduced to one or two ring cutlassing depending on the growth of the cover crops. Cutlassing of *Pueraria* is carried out twice in young plantations and once in adult plantations in Cote d' Ivoire (Surre and Ziller, 1963).

Mixture of three cover crops viz. *Calopogonium, Centrosema* and *Pueraria* are also successfully raised in oil palm plantations in Asian countries.

Ablation

The bunches produced initially will be very small and have low oil content. Removal of such inflorescences is called ablation or castration. Removal of all inflorescences during the inititol three years is found to improve vegetative growth of young palms so that regular harvesting can commence after three and half years of planting. Ablation is done at monthly interval by pulling out the young inflorescence using gloves or with the help of devices such as narrow bladed chisels. Ablation improves drought resistance capacity of young palms by improving shoot and root growth especially in low production areas where dry condition exists.

Pruning of leaves

In oil palm two leaves are produced per month. Therefore, it becomes necessary to prune excess leaves so as to gain access to bunches for harvest. Severe pruning will adversely affect both growth and yield of palm, cause abortion of female flowers and also reduce the size of the leaves. It was suggested by Yeow *et al.*, (1981 b) that palms aged 4-7 years should retain 6-7 leaves per spiral (48-56), those aged 8-14 years 5-6 per spiral (40-49) and those above 15 years should have 4-5 leaves per spiral (32-40). Leaf pruning is carried out in India using chisels (Fig. 3) so that leaf base that is retained on the palm is as short as possible for otherwise it may catch loose fruits, allow growth of epiphytes and the leaf axils form a potential site for pathogens. The leaf petioles are removed by giving a clear cut at a sufficient distance from the base of the petiole using a sharp chisel for young palms and with the long sickle in taller palms.

Pruning is preferably carried out at the end of the rainy season. It is also better to carry it out during the low crop season when labourers are also available. Pruning is

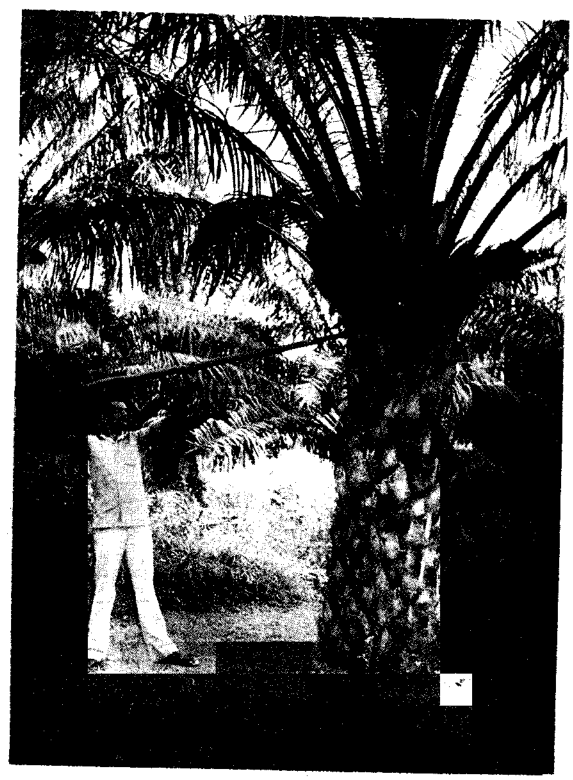

Fig. 3 : Leaf pruning

confined to only lower senile leaves during initial harvests but when canopy closes in later years, leaves are cut so as to retain two whorls of fronds below the ripe bunch. (Turner and Gillbanks, 1974).

Weed control

The basin area of oil palm is kept free of weed growth through ring weeding. It is more important for young palms, roots of which are to be kept free from competition from weed. Depending on the extent of weed growth and rainfall, hand weeding is carried out even up to four times in a year during early years of the plantation which is progressively reduced to two rounds a year.

Herbicide application has become common in recent years. Care must be taken in the choice of herbicide and its application to prevent the damage of young palms. It is recommeded to preferably apply contact herbicides rather than translocated herbicides. Translocated herbicides like paraquat which is inactivated when contacted with soil are also used. Herbicides such as 2,4-D, 2,4,5-T, halogenated aliphatic acids dalapon and TCA are found to produce abnormalities in oil palm seedlings and are to be avoided (Hartley, 1988). Herbicide mixtures of 2kg ai of paraquat with 3-4 kg atrazine monuron and diuron per ha of sprayed ground applied twice a year has been found to give control of weeds in young palms in Nigeria (Sheldrick, 1968).

Maintenance of paths

In young plantation, the maintenance of paths is important for inspection and in later years for harvesting. This is carried out by timely weed control as done in the case of ring weeding.

Water requirement

Continuous soil moisture availability encourages vigorous growth and increases yield of oil palm. Adequate supply of water, good soil depth and water holding capacity contribute to water availability. In oil palm as water deficit increases, stomata will remain closed and the development and opening of spear will be inhibited. Water deficit adversely affects flower initiation, sex differentiation and therefore, results in low sex ratio due to production of more male inflorescences. Relationship between water deficit and bunch yield were reported by IRHO.

Irrigation experiments conducted in Grand Drevin and La Me (Ivory Coast), Benin (Dahomey) and Malaysia have all indicated the positive effects of irrigation on leaf production , sex ratio, reduction in inflorescence abortion and overall bunch yield and oil yield. (Desmarest, 1967; de Taffin and Daniel, 1976; Corley and Hong Theng Phong, 1981). From irrigation trials conducted in West African countries where several months of dry period exists, it has been reported that with irrigation, yield levels as high as that of far east could be obtained. In India, oil palm planting programmes are envisaged in relatively dry regions of Karnataka, Andhra Pradesh and Tamil Nadu with assured water supply. The growth of palms so far is very encouraging and the palms have started yiedling after three years.

It is established that oil palm needs 120-150 mm of water to meet its monthly evapotranspiration needs. In areas where sufficient perennial water source is available, basin irrigation is possible. But where the terrain is undulating and water is scarce during summer months, drip irrigation is recommended which has the advantage of water economy and limiting the loss. It is recommended to keep four drippers per palm in the weeded palm circle to supply at least 90 litres of water per palm per day during summer months which will vary according to the ETP values in a locality.

Fertilizer requirement

Based on fertilizer experiments conducted under rainfed conditions in India, the following fertilizer schedule is recommended for oil palm until specific results are derived from multilocational fertilizer trials.

Fertilizer recommendation for oil palm

Age	Nutrients (gram/palm/year)		
	N	P_2O_5	K_2O
First Year	400	200	400
Second Year	800	400	800
Third Year and onwards	1200	600	1200

Method of fertilizer application

The fertilizers are preferably applied in two equal split doses during May-June and September-October by uniformly spreading them within a 2 metre circle around the base of the palm and forking to incorporate them into the soil. Supply of sufficient quantity of green leaves or compost is advantageous

Fig. 4 : Fertilizer application

especially where the soil is poor in organic matter content. Mg deficiency can be corrected through the application of 500g $MgSO_4$ palm/year magnesium sulphate.

Urea is found to be the most economic nitrogen source if losses by volatilisation and leaching are minimized. Rock phosphate and muriate of potash are the best sources for phosphorus and potassium respectively. During the initial years, fertilizers may be applied within the area covered by the crown canopy. In the case of older palms, fertilizers are applied depending on the concentration of roots and are usually applied in the weeded circle. Appropriate soil conservation methods such as growing cover crops and platform cutting (on slopy lands) enhance the efficiency of fertilizers by preventing losses through run off.

Nutrients - Functions and deficiency symptoms

The effect of major nutrients on growth and yield of oil palm has been studied in most of the oil palm growing countries in Asia and Africa (Nair and Sreedharan, 1982.)

Nitrogen In oil palm, characteristic yellowing symptoms are developed under N-deficiency conditons. Nitrogen is found to be essential for rapid growth and fruiting of the palm. *It increases the leaf production rate*, leaf area, net assimilation rate, number of bunches and bunch weight. Excessive application of nitrogen increases the production of male inflorescences and decreases female inflorescences thereby reducing the sex ratio.

Phosphorus In oil palm seedlings, P-deficiency causes the older leaves to become dull and assume a pale olive green colour while in adult palms high incidence of premature desiccation of older leaves occurs. Phosphorus application increases the bunch production rate, bunch weight, number of female inflorescences and thereby the sex ratio. However, lack of response to P due to P-fixation in soils is very common in the tropics. Eventhough the main effect of phosphorus on the productivity of the palm has not been significant in most studies, it gives a positive interaction with nitrogen and potassium.

Potassium When potassium is deficient, growth as well as yield is retarded and it is translocated from mature leaves to growing points. Under severe deficiency, the mature leaves become chlorotic and necrotic. Confluent orange spotting (Bull, 1954; Hartley, 1988) is the main K-deficiency condition in oil palm in which chlorotic spots, changing from pale green through yellow to orange, develop and enlarge both between and across the leaflet, veins and fuse to form compound lesions of a bright orange colour. Necrosis within spots is common, but irregular. Mid crown yellowing (Chapas and Bull, 1956; Hartley, 1988) is another prominent K-deficiency condition of the palm in which leaves around the 10th position on the phyllotaxy become pale in colour followed by terminal and marginal necrosis. A narrow band along the midrib usually remains green. There is a tendency for later- formed leaves to become short and the palm has an unthrifty appearance with much premature withering.

Potassium removal is large compared to the normal exhangeable K content in most top soils. It is mostly required for the production of more number of bunches, maximum number of female inflorescences, increased bunch weight and also for increasing the total dry matter production and yield.

Magnesium In adult oil palm and in seedlings in the field, severe Mg-deficiency symptoms are most striking and have been named as 'orange frond' (Hartley, 1988). While the lowermost leaves are dead, those above them show a gradation of colouring from bright orange on the lower leaves to faint yellow on leaves of young and intermediate age. The youngest leaves do not show any discolouration. The most typical Mg-deficiency symptom is the shading effect in which the shaded portion of the leaflet will be dark green while the exposed portion of the same leaflet is chlorotic. Heavy rates of K applications induce Mg-deficiency, particularly on poor acid soils.

Among the major nutrients, calcium and sulphur, and probably chlorine, may not pose much problems to oil palm cultivation in the country.

Micronutrients Micronutrient elements, iron, manganese, copper and zinc are not generally found limiting in the nutrition of oil palm on acid soil conditions. Boron deficiency is occasionally found on young palms in the field being; a reduction of leaf area in certain leaves producing incipient 'little leaf', advanced "little leaf' with extreme reduction of leaf area and bunching and reduction in the number of leaflets and 'fish-bone' leaf. The 'fish -bone' leaves are abnormally stiff with leaflets reduced to projections. Leaf malformations including 'hook leaf' and corrugated leaflets are some other associated symptoms. Soil application of 50—200g borax decahydrate, depending on age, and severity of symptoms, is practised for correcting the malady. (Rajarathnam, 1972; Hartley, 1988).

Multiple cropping

Though intercropping is not a normal practice in oil palm plantations, there is ample scope for intercropping in the initial years of the plantations. Growing food crops in oil palm plantation is common in Africa. In American Plantations, grazing of cattle or sheep is also practised in oil palm plantation. During the early years of the plantation, maize, cassava and yams (*Dioscorea sp.*) which require more light and during later years shade tolerant crops like *Colocasia* and *Xanthosoma* are successfully grown along with oil palm. Both the main crop and intercrop have to be separately manured to reduce competition for nutrients. It is better to confine intercropping to strips 4-5 m width between rows and down the avenues instead of intercropping the whole area.

Intercropping with tropical tubers is possible in India. Annuals like tobacco and chillies are being successfully grown in young plantations of Andhra Pradesh and Karnataka. Mixed cropping experiments with shade loving bushy perennials were also conducted in oil palm plantations. From trials conducted at CPCRI Palode, cacao was found to come up very well in oil palm plantations without any adverse effect on yield of oil palm. Robusta coffee is also found to be a successful mixed crop in Africa and Far East. Vanderweyen (1952) recommended planting of cacao when the palms are 7-8 years old and attain a height of 1.8 m in two rows between normally spaced palms at 9 m triangular spacing. Marynen (1960) from trials in Zaire suggested that

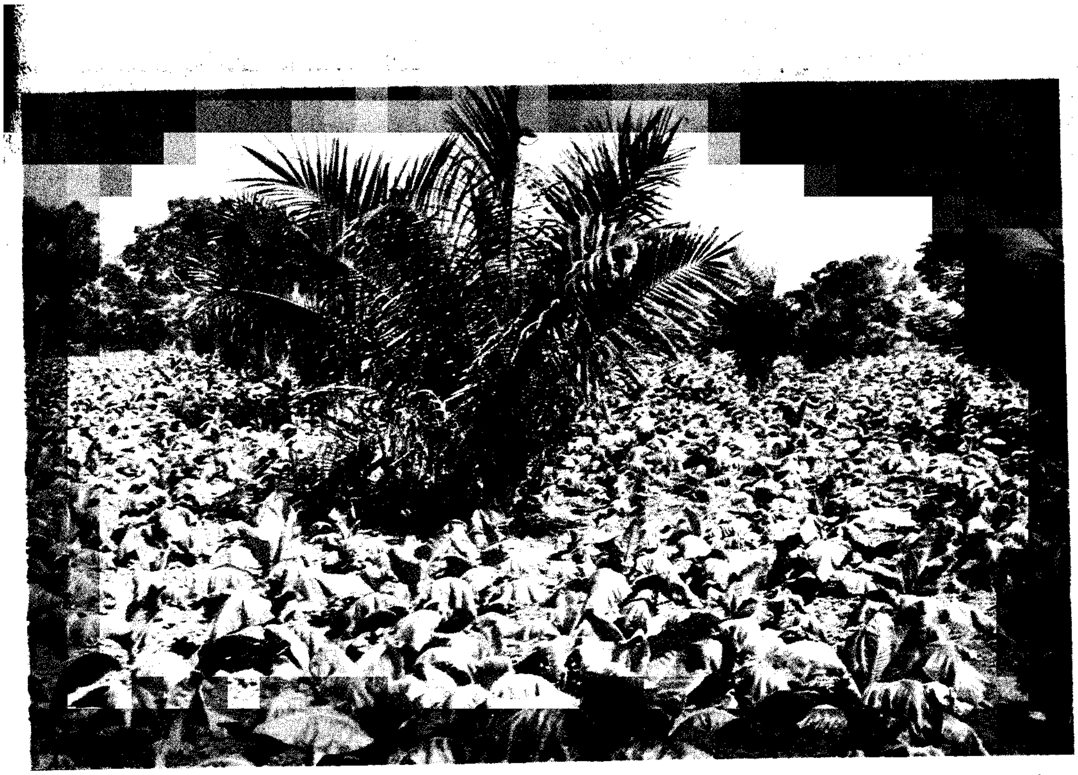

Fig. 5 : Intercropping with tobacco

coffee can be planted along with oil palm and may be removed after seven years. More field trials are necessary to find out the advantages of various cropping systems during different stages of oil palm growth.

Harvesting

Proper and timely harvesting of fruit bunches is an important operation which determines the quality of oil to a great extent. The yield is expressed as fresh fruit bunches (FFB) in kg per hectare per year or as oil per hectare per year. The bunches usually ripen in six months after anthesis. Unripe fruits contain high water and carbohydrate and very little oil. As the fruit ripens oil content increased to 80-85% in mesocarp. Over ripe fruit contains more free fatty acids (FFA) due to decomposition and thus increases the acidity. Usually the ripe fruits attached to the bunches contain 0.2 to 0.9 % FFA and when it comes out of extraction plant the FFA content is above 3%.

Ripeness of the fruit is determined by the degree of detachment of the fruit from bunches, change in colour and change in texture of the fruit. Ripening of fruits start from top downwards, nigrescens fruits turning reddish orange and the virescens (green) to reddish brown. Fruits also get detached from tip downward in 11-20 days time. Ripeness is faster in young palms than in older palms for the bunches of equal weight.

The criteria used in determining the degree of ripeness based on the fruit detachment are as follows:

a) fallen fruits : 10 detached or easily removable fruits for young palms and 5 for adult palms.

b) number of fruits detached after the bunch is cut : 5 or more fruits/kg of bunch weight.

c) quantity of detachment per bunch : fruit detachment on 25% of visible surface of bunch.

These criteria could be applied with flexibility.

Frequency of harvesting

Harvesting rounds should be made as frequent as possible to avoid over-ripening of bunches. A bunch which is almost ripe but not ready for harvest for a particular harvesting round should not be over-ripe by next round. In lean period of production, harvesting can be made less frequent and it should be more frequent in peak periods. Harvesting rounds of 7-14 days are generally practised. Other factors determining the harvesting frequency are, extraction capacity of the mill, transportation facilities, labour availability and skill of the workers. In India, harvesting is usually carried out with a chisel of 6-9 cm wide attached to a wooden pole or light hollow aluminium pipe. Bunches are cut without damaging the petiole of neighbouring leaves and trying not to eliminate the leaf that supports it. Use of narrow chisel is usually carried out till the palm reaches two meters above the ground. For taller palms upto 4 meters , a wider chisel of 14 cm is used. The curved knife is attached to a long bamboo or aluminium pole with screws or steel wires to harvest from taller palms. In uneven stands, an adjustable, telescopic type of pole is in use.

Economics

A detailed account of the economics of oil palm cultivation in India has been furnished by Varghese and Nampoothiri (1988). The data furnished therein is modified using current labour charges and oil price and the details on various investments and returns from one hectare adult plantation is furnished in the Table 1, 2. This excludes the cost of land as we expect government owned land, leased land, or already owned property will be used for oil palm cultivation. From the fourth year, the yield of bunches increases upto tenth year and a stabilized bearing is attained thereafter. The investment during first year under irrigation will be almost three times of that under rainfed conditions mainly on account of the initial expenditure required to install the drip irrigation systems. With irrigation the annual returns will exceed the annual expenses from the first harvest itself i.e. during the fourth year after planting. By the end of sixth year the total returns will be more than total investments including all the expenditure for installing pumpset and the drip irrigation system. A minimum of 22t FFB per hectare can be expected from the tenth year onwards.

1. Labour cost is calculated @ Rs. 40/- per day.
2. Yield of 15t under rainfed and 22t under irrigated condition are the actual average yield obtained at Palode from 10th year onwards. This can go up to 30t/ha with high yielding genotypes and added management practices as is estimated from the initial growth of palms in Andhra Pradesh and Karnataka.
3. Capital investments such as cost of land, cost of pumpset and irrigation system, etc. has not been included.
4. Intercropping is also possible in oil

palm plantations with annual crops during the initial 5 years and again after 10 years. Profitability from intercropping has not been taken into account.

Table 1. Income from one hectare of oil palm plantation - pure crop - after yield stabilization (10th year onwards)

Produce	Rainfed - average yield obtained at Palode		Irrigated - average yield obtained at Palode		Irrigated - anticipated yield with high yielding Genotype and added inputs.	
	Quantity and Rate	Amount Rs.	Quantity and Rate	Amount Rs.	Quantity and Rate	Amount Rs.
FFB Yield/ha Oil 20%	15t 3t @ Rs. 20,000/-t	60,000	22t 4.4t @ Rs. 20,000/-t	88,000	25t 5t @ Rs. 20,000/-t	1,00,000/-
Kernel oil	300kg @ Rs. 35/- kg	10,500	440 kg @ Rs. 35/- kg	15,400	500 kg @ Rs. 35/- kg	17,500/-
Fronds (firewood)	24 frondsx 140 @ Rs. 3/24.	420	24 fronds x 140 @ Rs. 3/24 fronds	420	24 fronds x 140 @ Rs. 3/24 fronds	420/-
Total income		70,920/-		1,03,820/-		1,17,920/-

Table 2. Cost of production and extraction charges (Rs.) per hectare

	Rainfed	Irrigated
Labour cost 150xRs. 40/-	6,000	8,000 *
Fertilizer cost	2,000	2,000
Plant protection cost	200	200
Total cost of production	8,200	10.200
Oil extraction charges	7,000	8,000
Total expenditure	15,200	18,200

* 200x40

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