(vii) OILPALM

CLIMATE REQUIREMENT

T_Max°C	T_Min°C	Optimum °C	Rainfall mm	Altitude m MSL
33 - 38	10 - 15	24 - 29	2000 – 4000	up to 900

Tropical and subtropical climate. Cannot tolerate drought and need 80% RH.

INTRODUCTION

Oil palm requires evenly distributed annual rainfall of 2000 mm without a defined dry season. In areas with dry spell, a deep soil with high water holding capacity and a shallow water table augmented with copious irrigation will satisfy the water requirement of the palm. Temperature can be a limiting factor for oil palm production Best oil palm yields are obtained in places where a maximum average temperature of 29-33 C and minimum average temperature of 2-24 C are available. Higher diurnal temperature variation causes floral abortion in regions with a dry season.

The crop requires 1800-2000 sunlight hours annually, more than 300 cal/cm^2 / per day, constant sunlight of atleast 5 hours per day for better oil palm yield.

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

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 large sized polybags. Raising seedlings in large polybags without a pre-nursery stage is also being practiced.

The potting mixture is made by mixing top soil, sand and well decomposed cattle manure in equal proportions. Smaller polybags of 250 guage and 23 x 13 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. The seedlings are to be watered daily. Application of a fertilizer 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 at 15 g at one month stage, 45 g at three months stage and 60 g 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

The germinated seeds can be directly planted into large black polybags with the advantage of avoiding the pre-nursery stage. At present the single stage polybag nursery is recommended in India. Since the plants are to remain in these polybags for more than one year, good quality polybags of 500 gauge and 40 x 45 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.

The water requirement for different stages of growth of seedlings are as follows: 0 - 2 months at 4 mm/day, 2 - 4 months at 5 mm/day, 4 - 6 months at 7 mm/day and 6 - 8 months at 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. Application of 9 - 18 lit. of water per seedling per week according to the stage of growth and soil type.

FIELD PLANTING

Prepare the land for oil palm plantings at least 3 months before transplanting the seedlings to the main field. In soils with low permeability, drainage channels are to be constructed to prevent water stagnation in upper layer of soil

AGE OF SEEDLINGS AT TRANSPLANTING

It is advisable to plant well grown seedlings of 12 - 14 months old. 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 maintain.

TIME OF TRANSPLANTING

Transplanting to the main field has to be done during the onset of rainy season. In very impermeable soils and where there is chance for the seedlings to suffer severely during rainy season, proper drainage has to be ensured.

SPACING AND METHOD OF PLANTING

The optimum planting density for oil palm is the density of population that gives maximum production from unit area. Triangular system of planting with 9 x 9 x 9 m spacing accommodates 143 palms/ha. is being recommended. 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.

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. Rock phosphate is applied at 200 g per planting pit. Nitrogen is not usually applied in the planting pits as the application of fertilizers 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 at 100 g as anhydrous $MgSO_4$ or 200 g 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 plantations. 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.

FERTILIZER REQUIREMENT

Based on the 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 oilpalm

Age	Nutrients (gram/palm/year)		
	N	P	K
First year	400	200	400
Second year	800	400	800
Third year onwards	1200	600	270

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 especially where the soil is poor in organic matter content. Mg deficiency can be corrected through the application of 500 g of $MgSO_4$ palm/year. Borax @ 100 g per palm also recommended.

Urea is found to be the most economic nitrogen source if losses by volatilization and leaching are minimised. Rock phosphate and muriate of potash are the best source 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 sloppy 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.

a) Nitrogen: In oil palm, characteristic yellowing symptoms are developed under N deficiency conditions. 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 inflorescence and decreases female inflorescence thereby reducing the sex ratio.

b) 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.

c) **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 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 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 exchangeable 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.

d) **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'. While the lower most 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 secondary nutrients, calcium and sulphur, and probably chlorine, may not pose much problems to oilpalm cultivation in the country.

e) **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 showing 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 - 200 g borax, per palm, depending on age, and severity of symptoms is practiced for correcting the malady.

WATER REQUIREMENT

Continuous soil moisture availability encourages vigorous growth and increased yield of oil palm. Adequate supply of water, good soil depth and water holding capacity contribute to water availability. In oil palm as water deficiency increases, stomata will remain closed and the development and opening of spear will be inhibited. Water deficiency adversely affects flower initiation, sex differentiation and therefore, results in low sex ratio due to production of more male inflorescences. It is established that oil palm needs 120 - 150 mm of water to meet its monthly evapo-transpiration needs. In areas where 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 to keep four drippers per palm in the weeded palm circle to supply atleast 90 litres of water per palm per day during summer months which will vary according to the ETP values in a locality.

FERTIGATION

Drip fertigation with the recommended dose of fertilsers at bimonthly interval was found to increase the yield.

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 upto 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 recommended 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. Pre-emergence Atrazine @ 1.0 kg/ha for the control of grasses and sedges and POE Paraquat 10 ml / litre of water.

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.

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 initial 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 that palms aged 4 - 7 years should retain 6 - 7 leaves per spiral (48 - 56), those aged 8 - 14 years 5 - 6 leaves 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 so that leaf base that is retained on the palm is as short as possible or 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 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.

INSECT POLLINATION IN OIL PALM

The oil palm, hitherto though to be wind pollinated, has been now proved to be an a insect pollinated species. From West Africa, the original home of oil palm, eight species of pollinating weevils were reported. Occurence of ***Eldeidobius 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 feed on the anther filament. Eggs are deposited inside the male flowers and larva feeds on the spent flowers. Life-cycle 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 are receptive female inflorescences. The weevils carry maximum pollen during the third day of antheses. Antennae, rostrum, thorax, legs etc. are the main sites of pollen land. *E.Kamerunicus* a fairly good searching ability. It can survive in dry as well as in wet seasons.

Introduction of weevil in India increased the fruitlet from 36.8 to 56.1 percent resulting in 40 per cent increase in F/B ratio. The maximum attainable pollination potential was as much as percentage with 57 percent increase in FFB weight.

For introduction, male flowers cut from palms which have the weevils are transferred to a plantation where one wishes to introduce. In order to make sure that they are not carrying any plant pathogens to other area/countries, we have to breed them under laboratory conditions for seven or eight generations before introduction.

Pest Management

In India, since the import of germplasm is in the form of seeds/sprouts, possibilities for introduction of the pest species from other countries are limited. But many of the pest species of related palm species such as coconut and areca palm, have got adapted to oil palm. Among the 49 species of insects infesting adult oilpalms, 14 species are known pests of coconut and 19 species are known pests of areca palms. Insect pests of oilpalm in India are more or less same as those reported from Malaysia and other South-East Asian countries.

PESTS OF ADULT PALMS

The rhinocerous beetle

The rhinocerous beetle is primarily a serious pest of coconut palm, and in recent years has attained the pest status in oilpalm also. The adult beetle which bores through into the spear leaves, resulting in snapping of the fronds at the feeding sites. In oil palm plantations failed female inflorescences, dead palm trunks, persistent leaf axils and empty bunch heaps, act as breeding sites for the pest.

The red palm weevil

Infestation by the red palm weevil (Chynchophorus ferrugineus) was noticed in majority of oil palm plantations resulting in the death of the palms. Damage is due to the feeding activity of the grubs, usually 12-87 per palm, which bore through and feed on the softer tissues of stem and meristem. Palms infested by R.ferrugineus show gradual wilting and drying of outer whorl of fronds. In some cases roofing of spear was also noticed.

Biological control

In nature, the rhinocerous beetle is suppressed by entomophogens like *Baculovirus orystus virus* and *Metarhizium anisopliae*. Release of *Baculovirus orystus minimise* the pest incidence.

Cultural control

i) Field sanitation and elimination of breeding sites like dead palm trunks, empty bunch heaps etc., within the plantations are essential for the management of both red palm weevil and rhinocerous beetle.

ii) When the infestation by rhinocerous beetle is very high, especially in young plantations, Hand picking of the adult beetles using hooks is very effective.

iii) For red palm weevils, use of attractants incorporating fermented sugarcane juice, acetic acid, yeast etc., to collect and kill the adult weevils is recommended.

Chemical control

i) For rhinocerous beetles, placing 3-4 napthalene balls in the youngest spear axils at weekly intervals is recommended.

ii) For palms with advanced stage of infestation by red palm weevil, stem injection of 5-8 ml of monocrotophos is advised.

Fruit bunch covering against avian pests

Covering the bunches with different materials such as noirenets, reed baskets, plaited coconut leaf baskets and senile oil palm leaf are effective in preventing the fruit damage. But senile oil palm leaf covering is more practical and economical as the material is readily available and involves only the labour charges and cost of rope bits.

Rodent control

Among rats, the burrowing type is more serious which tunnel into the bole of the seedlings. Different baits such as acute poison baits (Zinc phosphide, Aluminium phosphide etc.) anticoagulants (warfarin, fumarin, bromadiolone) and traps such as iron traps, snap traps, deathfall trap, boro trap etc. may be used as an integrated approach to minimise the rodent damage to the crop.

Disease

Oil palm, a new crop to the country is reported to be affected by a number of diseases and disorders. Among these, bud rot causes considerable economic losses.

Bud rot

- Higher disease incidence is noticed in young plantations. Rotting initiates at the basal portion of the spear closure to the meristem and extends to the whole spear. The spear could be easily pulled off.
- Cleaning the affected tissues and drenching the crown with carbendazim 0.1 percent cures the disease.
- The leaves emerging immediately after the application of fungicides are shorter and successively emerging ones are normal.

Leaf spots

- Leaf spots caused by *Curvularia* noticed on the inner whirl and young leaves. The fungal spots enlarge with a yellow ring around spots. As these spots enlarge the leaf will be scorched.
- *Pestalotiopsis* fungal spots are irregular with grey to brown centre. Numerous black dots, the acervuli of the fungus, are seen on the lesions.

Management

Affected leaves must be cut and burnt Spray Mancozeb @ 0.2%.

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 increase 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 practiced. Other factors determining 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 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.

Yield of Oilpalm

In well maintained garden the yield of oilpalm will be as furnished below :

Age of oilpalm (Years)	Yield (Ton/ha/year)
3-4	5
4-5	12
5-6	25
6-25	30

ECONOMICS

A detailed account of the economics of oilpalm cultivation in India has been furnished. 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. This excludes the cost of land as we expect government owned land, leased land, or already owned property will be used for oilpalm 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 system. 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 22 FFB per hectare can be expected from the tenth year onwards.

TABLE 1 - COST OF PRODUCTION AND (Rs.) PER HECTARE

S. No.	Particulars	Cost of production (Rs.)
1	Labour cost for 200 Nos. @ Rs.120/- per day as casual labour	24,000
2	Fertilizer cost	5000
3	Plant Protection cost	500
	Total cost of production	**29,500**

TABLE 2 : INCOME FROM OILPALM GARDEN DEPENDING UPON THE BUNCH PRODUCTION

S.No.	No. of Bunches/ kg/tree/year	FFB yield t/ha/year	Gross Income Rs./ha/year	Net income (Gross income cost) Rs./ha/year
1	10	14.3	1,02,960	73,460
2	12	25.7	1,85,040	1,55,540
3	12	34.3	2,46,960	2,17,460