

Oil Palm (*Elaeis guineensis* Jacq.)

French: Palmier à l'huile; Spanish: Palma de aceite; Italian: Palma da olio;
German: Oelpalme

Crop data

Perennial with a generic life of over 200 years, but the economic life is 20-25 years, (nursery 11-16 months, first harvest 32-38 months from planting, peak yield 5-10 years from planting).

Most widely used planting material consists of Dura x Tenera hybrids. Clonal palms are expected to come into commercial use in the late 1990s.

Harvested part: Fruit (Fruit bunch). Oil is obtained from fleshy mesocarp of fruit (45-55 % oil) and from kernels (50 % oil). Oil extraction rate (from mature fresh fruit bunches = FFB) 20-24 %.

Highest yield attained to-date (1990) 46 t/FFB = 10.6 t/ha crude palm oil/ha.

Planting density: 128-148 palms/ha, depending on planting material, soil and climate. Most common spacing 9m x 9 m triangular (= 143 palms/ha).

Grown in lowlands of the humid tropics, 15° N - 15° S with evenly distributed rainfall of 1 800-5 000 mm/year. Adapted to a wide range of soils and to low pH, but sensitive to high pH (above 7.5) and to stagnant water.

Nutrient demand/uptake/removal

Nutrient demand is highly variable, depending mainly on the yield potential determined by the genetic make-up of the planting material and on the yield limit set by climatic factors (water, effective sunshine, temperature). Yield and nutrient uptake are much higher, for example, in Malaysia than in Nigeria (see table). More important, however, is the fact that the efficiency of nutrient use (uptake/ton FFB) is much higher in Malaysia, the main reason being the heavy climatic stress in Nigeria (a long dry season, and limited hours of sunshine during the wet season). The response to most stress factors is a reduction in fruit output, while vegetative growth is little affected.

Nutrient uptake is low during the first year (transplanting shock!), but increases steeply between year one and year three (when harvesting commences) and stabilizes around years five to six.

Recognition of this fact has resulted in increased early applications of fertilizer, which combined with improved other agronomic practices (better planting material, higher nursery standards, more rigid culling etc.) has led to a dramatic increase in early yields (in third to sixth years from planting). In regions without any serious climatic constraint yields of over 25 t/ha FFB have been achieved in the second year of harvesting, largely as a result of higher early rates of fertilizer application.

Nutrient removal, immobilization and recycling in adult oil palms								
	Malaysia (24 t FFB/ha)				Nigeria** (9.7 t FFB/ha)			
	kg/palm/year				kg/palm/year			
	N	P2O5	K2O	MgO	N	P2O5	K2O	MgO
Removal in harvested fruit	0.49	0.18	0.76	0.23	0.20	0.09	0.28	0.05
Immobilized in palm tissue	0.27	0.05	0.56	0.12	0.18	0.06	0.13	0.17
Recycled	0.53	0.17	0.83	0.32	0.63	0.17	0.46	0.42
Total nutrient uptake	1.29	0.40	2.15	0.66	1.01	0.32	0.87	0.63
	%				%			
Removal as % of total uptake	38	44	35	35	20	29	31	8
	kg/ha				kg/ha			
Uptake per hectare (148 palms/ha)	191	62	318	98	149	48	236	93
	kg/t FFB				kg/t FFB			
Uptake per ton FF	8.0	2.5	13.2	4.2	15.5	5.0	13.3	9.6

Source: *Malaysia: Ng and Tamboo, 1967; ** Nigeria: Tinker & Smilde, 1963.

Plant analysis data

Producing, as it does, leaves (and fruit) throughout the year at a relatively uniform rate, the oil palm is better suited to leaf analysis than most other crops. The reference tissue for adult palms is the centre part of the pinnae (without midrib) from the seventeenth frond.

Critical ranges of concentration of nutrient elements in oil palm leaves					
Age of trees	Range	% of dry matter			
		N	P	K	Mg
Young palms (under 6 years)	Deficiency	< 2.50	< 0.15	< 1.00	< 0.20
	Optimum	2.60-2.90	0.16-0.19	1.10-1.30	0.30-0.45
	Excess	> 3.10	> 0.25	> 1.80	> 0.70
Old palms (over 6 years)	Deficiency	< 2.30	< 0.14	< 0.75	< 0.20
	Optimum	2.40-2.80	0.15-0.18	0.90-1.20	0.25-0.40
	Excess	> 3.00	> 0.25	> 1.60	> 0.70

Critical ranges of concentration of nutrient elements in oil palm leaves(ctd.)						
Age of trees	Range	% of dry matter			ppm	
		Ca	S	Cl	B	Cu
Young palms (under 6 years)	Deficiency	< 0.30	< 0.20	< 0.25 < 8 < 3		
	Optimum	0.50-0.70	0.25-0.40	0.50-0.70	15-25	15-2
	Excess	> 1.00	> 0.60	> 1.00	> 35	> 15
Old palms (over 6 years)	Deficiency	< 0.25	< 0.20	< 0.25	< 8	< 3
	Optimum	0.50-0.75	0.25-0.35	0.50-0.70	15-25	5-8
	Excess	> 1.00	> 0.60	> 1.00	> 40	> 15

Optimal levels can vary widely with factors such as moisture regime, nutrient balance, type of planting material, spacing, etc., so it is advisable to think in terms of critical or optimal "ranges" rather than absolute "values".

Variations in K and Mg are generally greater than those of N and P, due to larger errors in field sampling as well as to greater sensitivity to climatic (moisture/sunlight) factors.

Nutrient deficiencies

N deficiency is usually associated with conditions of water-logging, heavy weed infestation and topsoil erosion. Symptoms are a general paling and stiffening of the pinnae which lose their glossy lustre. Extended deficiency will reduce the number of effective fruit bunches produced as well as the bunch size.

P deficient leaves do not show specific symptoms but frond length, bunch size and trunk diameter are all reduced. Most soils on which oil palms are grown are very low in P, but it appears to be very efficient in utilizing soil and fertilizer P.

K deficiency is very common and is the major yield constraint in sandy or peaty soils. The most frequent symptom is "confluent orange spotting". Pale green spots appear on the pinnae of older leaves; as the deficiency intensifies, the spots turn orange or reddish-orange and desiccation sets in, starting from the tips and outer margins of the pinnae. Other symptoms are "orange blotch" and "mid-crown yellowing". In soils having a low water holding capacity (sands and peats) K deficiency can lead to a rapid, premature desiccation of fronds.

Mg deficiency is a frequent problem in light textured soils and in acid soils where the topsoil has been eroded. Symptoms are a yellowing of leaflets of older fronds, with leaflets exposed to sunlight showing more severe yellowing than do shaded leaflets.

S deficiency has not (yet) reached levels of significance in any of the major growing areas. Current sources of N (Ammonium Sulphate) and Mg (Kieserite) appear to be sufficient to meet the S needs of the crop.

Outright Ca deficiency is rare and the largest benefit from applied Ca (lime or dolomite) is probably due to better growth of legume covers and improved P availability.

Although Cl is a micronutrient for most crops, oil palm (and coconut palms), for optimum growth and yield, require Cl in concentrations that bring it well into the range of a secondary nutrient. No clear deficiency symptoms have been observed so far, other than pronounced signs of water stress during dry spells.

B is so far the only micronutrient of general significance. Deficiency first appears as retarded growth of young tissues. Deficient leaves are misshapen, wrinkled, brittle, and dark green in color. Specific to oil palms are: "frond shortening", "blind leaf", "crinkle leaf", "hook leaf" and "fishbone leaf".

Cu deficiency is a common problem on peat soils and on highly leached sandy soils in high rainfall areas. Symptoms are severely stunted growth, chlorosis (starting from the tips or upper part of the youngest pinnae), shortening of internodes and desiccation.

Only isolated cases of Fe, Zn and Mn deficiency have been detected.

Fertilizer recommendations

Fertilizer recommendations must take into account environmental (soil and climate) and economic (fertilizer price and produce price) constraints. Actual fertilizer use should be further modified by the level of agronomic management. Responses tend to be most vigorous from the first to the sixth year in the field.

Nursery programme

Fertilizer recommendations - Nursery programme			
Age of seedlings (weeks from planting)	Quantity g/seedling	Frequency	Compound fertilizer (N - P2O5 - K2O - MgO)
Weeks 8 and 10	3.5	bi-weekly	15 - 15 - 6 - 4
Weeks 12 - 24	7 - 10	bi-weekly	12 - 12 - 17 - 2 with micronutrients alternating with 15 - 15 - 6 - 4
Weeks 26 - 32	12 - 16	bi-weekly	12 - 12 - 17 - 2 with micronutrients alternating with 15 - 15 - 6 - 4
Weeks 34 - 48	25 - 36	bi-weekly	12 - 12 - 17 - 2 with micronutrients alternating with 15 - 15 - 6 - 4
Week 50 to field planting	30 - 40	every 3 weeks	12 - 12 - 17 - 2 with micronutrients alternating with 15 - 15 - 6 - 4

Healthy, well selected seedlings are a pre-condition for early and sustained high yield. In most cases granular multinutrient compound fertilizers (NPK Mg + micronutrients) are the preferred nutrient source for seedlings in the nursery. Where sub-soil is used to fill the polybags, extra dressings of Kieserite may be required (10-15 g every 6 to 8 weeks). Where compound fertilizers are not available, equivalent quantities of straight materials should be used.

Field Programme

N rates range from 1.5-8 kg/palm of ammonium sulphate (AS) or its equivalent, depending on the yield potential as affected primarily by the total rainfall and its distribution and the intensity of solar radiation.

P rates range from 0.5-2 kg/palm/year of triple superphosphate (TSP) or its equivalent.

K rates range from 1 to 5 kg/palm of KCl, depending on soil and yield potential.

Malaysia - Fertilizer input for maximum exploitation of the genetic Yield potential									
Soil series and taxonomy	Annual rainfall (mm)	Annual water deficit (mm)	kg/ha/year						
			N	P2O5	K2O	MgO	B2O3	CuSO4	CaO
Sagomana (Oxic Paleuquult)	2582	97	Immature plants:*						
			60-120	75-110	65-105	12-20	4-8	-	20-40
			Mature plants:*						
			170-230	70-90	220-310	25-35	8-12	-	40-60
Peat soil (Tropofibrist)	2638	83	Immature plants:*						
			50-100	65-80	140-260	-	6-12	1-2	140-280
			Mature plants:*						
			120-160	50-70	550-700	0-10	13-18	3-5	300-400
Holyrod (Oxic Distropept)	2921	99	Immature plants:*						
			50-100	80-120	120-200	20-40	6-12	-	40-60
			Mature plants:*						
			170-200	100-130	400-500	45-60	12-16	-	60-80

* Immature plants = up to 3 years; Mature plants = 4 to 7 years.

To maintain good fertilizer response and high yields in older palms (selective) thinning is often necessary where inter-palm competition has become a problem as a result of initial high density planting in combination with a high fertility regime and good rainfall.

Recent pioneering work on maximum exploitation of genetic yield potentials (MEGYP) in Malaysia (Ng et al. 1990) has demonstrated that through a combination of good overall agronomic husbandry and intensive and well balanced use of fertilizer, productivity of oil palms can be enhanced by as much as 30 to 40 %.

With good management and proper fertilizer use, differences between soils of widely different inherent fertility largely disappear, so long as moisture deficit does not become a limiting factor.

Preferred nutrient forms and methods of applications

N: the preferred source is ammonium sulphate (AS), but urea is expected to become a dominant source. To avoid N losses due to volatilization, urea must be applied at times of assured rainfall.

Other N sources include ammonium chloride (AC) and ammonium nitrate (AN).

With young palms N should be evenly distributed over the weeded circle; in older palms inter-row application is also possible if there is no competition from a ground cover. In no case should N be applied in a narrow band around the base of the palms, as this will increase losses and may cause severe root damage. High N rates should be split into several dressings. In areas with an extended dry period, the last N application should be at least 3-4 months before the beginning of the dry season (high N levels in leaves result in more water consumption).

P: water-soluble sources (TSP, DAP and NPK compounds) are preferred during the immature phase. Thereafter phosphate rocks (preferably of high reactivity) can be used, applied up to year 4 in the circle, and thereafter alternating between circle and inter-row or inter-row only (where surface erosion is a problem).

K: potassium chloride (KCl) is the sole K source of significance. Potassium chloride has the added benefit of supplying chloride - an element found to be often deficient in oil palms. With young palms (up to year 4) it should be spread evenly over the circle; with mature palms it should be broadcast in the inter-row.

Mg: Kieserite ($MgSO_4 \cdot H_2O$) is the main Mg source for oil palms. Other sources include sulphate of potash magnesia and dolomite (suitable for acid soils only).

Kieserite should be spread over the circle while dolomite should be applied to the inter-rows.

Cl: potassium chloride is the main Cl source. In high K soils ammonium chloride can be used as an efficient alternative Cl source.

B: Sources are mainly various forms of sodium borate ($Na_2 B_4 O_7 \cdot 10H_2O$, $Na_2 B_4 O_7 \cdot 5H_2O$).

Placement of B should be into the weeded circle. Axillary application, though effective, is not advisable as it may result in uneven B distribution in the palm and cause B toxicity.

Cu: a one time soil application of 50 g/palm of copper sulphate is usually sufficient to correct Cu deficiency. On some peat soils repeated applications may be required.

Present fertilizer use in major growing areas for young, mature palms (4-10 years old)						
Country	Yield level (t/ha FFB)	Soil	kg/palm/year			
			N	P ₂ O ₅	K ₂ O	MgO
Malaysia	26-32	Alluvial	0.90-1.35	0.33-0.50	1.80-3.00	0.135
	22-28	Inland (Sedentary)	0.84-1.25	0.50-0.65	2.40-3.30	0.27-0.40
	20-26	Peat*	0-0.45	0-0.35	2.40-3.00	-
Indonesia	22-30	Volcanic	0.90-1.35	0.46-0.70	1.70-1.80	0.35-0.40
	20-26	Podzolic (Sedentary)	0.90-1.35	0.70-0.90	1.50-3.00	0.35-0.40
Thailand	14-18	Sedentary	0.84-1.05	0.50-0.66	1.80-3.00	0-0.14
Papua New Guinea	20-28	Volcanic**	0.60-0.80	0.23-0.46	0-1.20	0-0.14
	18-26	Alluvial	0.40-0.60	0-0.23	1.80-2.40	-
West Africa	10-18	Sedentary sands	0.20-0.50	0.23	0.60-1.80	0-0.27
Latin America	16-24	Volcanic**	0.45-0.68	-	-	0.20-0.27
	17-25	Alluvial	0.45-0.68	0.45-0.68	0.60-1.20	0-0.27
	15-22	Sedentary	0.30-0.60	0.45-0.68	0.90-1.80	0.20-0.27

Borate is now commonly applied to young palms (up to year 6) at rates starting from 50 g/palm/year and increasing up to 150 g/palm/year. * During the immature phase finely ground limestone is applied twice at a rate of 6-8 kg/palm. ** When no potash (KCl) is used on K-rich, young volcanic soils, ammonium should be the preferred N source in order to provide adequate chloride.

Further reading

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