Management of Phosphorus, Potassium and Magnesium in Mature Oil Palm

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Phosphorus

Function

Phosphorus (P) is an essential element for plant growth and is particularly important for root growth during the establishment and early growth stages. The chemistry of P in soil is complex and is influenced by many factors, making the interpretation of soil analysis difficult.

Stunted palm due to P deficiency.

The amount of 'available' P in soil depends on the method used to extract P from the soil for measurement. Therefore, where different methods have been used, soil test results should not be compared.

Soil P analysis is best interpreted by referring to a response curve which shows the relationship between the amount of available P in the soil and crop response to applied fertilizer P.

Deficiency Symptoms

- Unlike nitrogen (N), potassium (K) and magnesium (Mg), there are no easily recognizable leaf P deficiency symptoms in oil palm. However, P deficient plants may be stunted with short fronds, and the palm trunk may have a pronounced pyramid shape.
- Other species act as proxy indicators for P deficiency. For example:
    a) A purplish discoloration on the leaf blade of *Imperata cylindrica* (alang-alang) indicates P deficiency. Leaves of legume cover crops (*Pueraria phaseoloides*) are small, plants are difficult to establish, and root nodulation is sparse when P is deficient.
    b) When *Melastoma malabathricum* and *Dicranopteris linearis* exclude other inter-row species by their competitive advantage, soil P status may be low.
- In general, a response to P fertilizer is likely when the amount of available P in the soil is less than 15 mg/kg (Bray II method).

Common Causes of P Deficiency

- Areas where topsoil has been removed or lost due to soil erosion (e.g., hill tops, exposed slopes).
- Insufficient phosphate fertilizer applied, especially in plantations that

(At left) On steep land, platforms should be installed to reduce the loss of P fertilizer due to surface run-off and erosion. (At right) The fertilizer should have been sprinkled evenly over the edge of the palm circle.

have produced large yields in the past.

- Applied fertilizer P is fixed by aluminium (Al) and iron (Fe) compounds in low pH (acid) soil and is not available to palm roots for uptake.

Prevention of P Deficiency

- Apply phosphate fertilizer in the nursery, at transplanting, and throughout the immature phase to build up soil P reserves.
- Maintain soil and palm P status with annual applications according to leaf and soil analysis results.
- Install erosion control measures such as bunds, platforms and terraces to reduce losses of native and applied phosphate in surface run-off water and eroded soil.
- Soil P status can be improved by applying large amounts (up to 1 t/ha) of rock phosphate (RP) to legume cover crops during the immature phase.
- A yield of 25 tonnes fresh fruit bunches (FFB)/ha contains about 11 kg P. This is equivalent to 84 kg RP/ha or 0.5 to 0.7 kg RP/palm.

Treatment

- On acid (pH less than 5.5) oil palm soils, P is usually applied in the form of RP. More readily available sources such as triple superphosphate (TSP) and diammonium phosphate (DAP) may be used where a rapid response is required (e.g., where acute deficiency symptoms have been identified).
- Indicative P fertilizer recommendations are given below.

Condition of palms	Application rate, kg/palm	
	P_2O_5	RP
Replacement of nutrients removed	0.15 to 0.2	0.5 to 0.7
Deficiency symptoms observed	0.5 to 0.75	1.7 to 2.5

Fertilizer Management for Efficient Use

- Spread single and compound P fertilizers evenly over the outer edge of the weeded circle and the inter-row space. Most of the fertilizer is applied over the inter-row, but some is applied inside the weeded circle to allow for easy field checking.
- Phosphorus is not mobile in the soil. Therefore, little applied P is lost due to leaching, except in very sandy soils. However, surface-applied P fertilizers are easily lost in run-off and erosion. The installation of

soil erosion controls such as platforms, terraces and bunds increases the efficiency of P fertilizer use. It may be more efficient to apply single P fertilizers over the frond stack where the soil is protected from erosion and the oil palm root density is large.

Application Frequency

- One to 2 rounds/year.

Notes

- Phosphorus may contribute to the eutrophication of waterways and algae blooms when P fertilizer is applied on slopes where soil conservation has not been implemented.
- Rock phosphate applied in the palm circle helps to counter the acidifying effect of N fertilizers (e.g., ammonium sulfate and urea) and replaces calcium (Ca), which has been leached due to past large applications of K and Mg fertilizers.

Potassium

Function

Potassium is an essential element for plant growth. It is important for proper stomata function in the leaf. Therefore, K-deficient palms are more susceptible to drought conditions.

Potassium is also important for the transport of assimilates from photosynthesis, enzyme activation, and oil synthesis. It is difficult to predict the response to applied K based on the amount of exchangeable K in the soil.

Potassium affects bunch size, bunch number, and is an important factor in disease resistance.

Potassium deficiency is common on peat and sandy soils and is usually the largest single nutritional factor that determines yield.

A frond on a mature palm showing severe K deficiency symptoms.

Deficiency Symptoms

- Potassium deficiency appears in oil palm as orange spotting, confluent orange spotting, diffused mid-crown yellowing, and white stripe.
- Diffuse or mid-crown yellowing occurs on acid sands and peat soils, particularly after prolonged periods of dry weather. In severe cases, old fronds will suddenly become desiccated and die.
- White stripe is probably caused by an imbalance involving excess N and insufficient K and boron (B).
- Potassium deficiency first appears on older leaves because K is remobilised from the older to younger fronds. Small, initially rectangular spots appear on the frond pinnae and turn bright orange as the spots join to form a reticulate mass. The spots transmit light when held up to a bright light source.
- Chlorotic spots frequently become necrotic and may become the site

of secondary pathogenic infection before frond desiccation.

- Potassium deficiency has been associated with the occurrence of vascular wilt disease, cercospora leaf spot, ganoderma basal stem rot, and the physiological disorders which cause bunch and plant failure.
- Excess K may induce B and Mg deficiency and is reported to decrease the oil to bunch ratio.

Correct application of K fertilizer to the edge of the palm circle.

Common Causes of K Deficiency

- A concentration of exchangeable K in the soil less than 0.15 cmol/kg.
- Potassium deficiency is common in palms planted on:
  a) Peat soils.
  b) Sandy soils (low pH) derived from sandstone and granite.
  c) Acid soils with small, pH-dependent cation exchange capacity.
- Inadequate application of mineral K fertilizer to balance the removal of K from a large yield of fruit bunches over a period of several years. Potassium deficiency may be a problem when insufficient fertilizer K is applied to high yielding clonal oil palms.
- Potassium deficiencies often appear in high yielding progenies when full fruiting begins if insufficient K fertilizer is applied during the immature phase.

Prevention of K Deficiency

- Apply sufficient K fertilizer.
- Recycle K contained in empty bunches or bunch ash (if empty bunches are incinerated).
- Apply empty bunches to sandy soil to build up soil nutrient retention capacity.
- A large amount of K is removed from the field in fruit bunches. A yield of 25 tonnes fresh fruit bunches (FFB)/ha contains about 93 kg K. This is equivalent to 186 kg muriate of potash (MOP)/ha or 1.2 to 1.5 kg MOP/palm.

Treatment

Indicative K fertilizer recommendations are given below.

Condition of palms	Application rate, kg/palm	
	K_2O	MOP
Replacement of nutrients removed	0.7 to 0.9	1.2 to 1.5
Deficiency symptoms observed	1.8 to 3.0	3.0 to 5.0

Fertilizer Management for Efficient Use

- Single and compound K fertilizers are evenly spread over the outer rim of the circle and the surrounding inter-row space. Single K fertilizers can be applied irrespective of weather conditions.
- The large application rates required on sandy textured soils should be

applied in several rounds (e.g., 5 kg MOP/palm in four applications of 1.25 kg/palm).

Application Frequency

- Two to 3 rounds/year (3 to 4 rounds/year on sandy and peat soils).

Notes

- Larger applications may be required on peat soils, sandy soils, and replant areas where little fertilizer has been applied previously.
- The most commonly used K fertilizer is MOP, but langbeinite ($K_2SO_4 \cdot 2MgSO_4$) may also be used where a supply of both K and Mg is required. Langbeinite (Sul-Po-Mag/K-Mag)...22 percent K_2O, 18 percent MgO, 22 percent sulfur (S)...provides a source of K, Mg and S.

Magnesium

Function

Magnesium is the central element in chlorophyll and is therefore essential for efficient photosynthesis. It is also important in phosphate metabolism, plant respiration, and the activation of enzymes.

Deficiency Symptoms

- Initial symptoms appear as olive green to ochre patches on the distal end of the older frond pinnae, particularly those exposed to full sunlight.

A young field palm showing Mg deficiency on lower fronds.

- Newly emerged fronds do not normally exhibit deficiency symptoms.
- In cases of more severe deficiency, the fronds become ochre to bright yellow and may eventually become desiccated.
- **A clear diagnostic feature of Mg deficiency is the absence of chlorosis on sections of pinnae shaded from direct sunlight.**
- Chlorotic areas may be invaded by secondary fungal infection (e.g., *Pestalotiopsis gracilis*), which produces purplish spots on the margins and distal ends of frond pinnae.

Common Causes of Mg Deficiency

- Magnesium deficiency symptoms may be caused by insufficient availability and/or uptake of Mg, but may also be caused when there is an imbalance between Mg, and other cations, e.g., K^+, NH_4^+.
- Magnesium deficiency is often detected in very high rainfall areas (greater than 3,500 mm/year).
- Magnesium deficiency is likely when the amount of soil exchangeable Mg is less than 0.3 cmol/kg.
- Palms planted on sandy textured soils with shallow topsoil (e.g., erod-

ed areas on sloping land).
- Inadequate application of Mg to high yielding palms or to palms on Mg-deficient soils.

Magnesium deficiency in mature frond. Symptoms have not appeared on shaded pinnae.

Prevention of Mg Deficiency

- Check the ratio of exchangeable Ca:Mg and Mg:K in soil analysis data. Nutrient imbalances are likely where the Ca:Mg ratio exceeds 5:1 (e.g., volcanic soils) or Mg:K ratio exceeds 1.2:1.
- A yield of 25 tonnes FFB/ha contains about 20 kg Mg. This is equivalent to 123 kg kieserite ($MgSO_4 \cdot H_2O$)/ha or 0.75 to 1.0 kg $MgSO_4 \cdot H_2O$/palm, or 184 kg $K_2SO_4 \cdot 2MgSO_4$/ha or 1.2 to 1.5 kg $K_2SO_4 \cdot 2MgSO_4$/palm.

Treatment

Indicative recommendations for Mg fertilizer are given below.

Condition of palms	Application rate, kg/palm		
	MgO	$MgSO_4 \cdot H_2O$	$K_2SO_4 \cdot 2MgSO_4$
Replacement of nutrients removed	0.20 to 0.27	0.75 to 1.0	1.1 to 1.5
Deficiency symptoms observed	0.54 to 0.81	2.0 to 3.0	3.0 to 4.5

- On very acid soils, dolomite may be used to provide the basic requirement for Mg. However, kieserite and Sul-Po-Mag/ K-Mag are the preferred sources of more readily plant available Mg.

Fertilizer Management for Efficient Use

- Split large applications of soluble Mg fertilizer (kieserite, Sul-Po-Mag/K-Mag).
- Apply single and compound fertilizers containing Mg over the outer edge of the weeded circle. Dolomite is more effective when dusted over the frond stack to maximise the contact between the particles of dolomite and the soil.
- Response to the application of fertilizer Mg may be increased by an application of empty fruit bunches (EFBs)...30 tonnes EFB/ha; particularly where topsoil has been eroded.

Application Frequency

- Two to 3 rounds/year (3 to 4 rounds/year in sandy soils).

Notes

- Sul-Po-Mag/K-Mag (22 percent K_2O, 18 percent MgO, 22 percent S) provides a source of K, Mg and S.
- Kieserite (27 percent MgO, 23 percent S) provides a source of Mg and S. **BCI**

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