Iron Deficiency of Oil Palm in Sumatra

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Symptoms of iron (Fe) deficiency in oil palm are described and a level of 50 mg Fe/kg dry wt. in leaf (frond) 17 is stated as critical for oil palm growth. Absorption of ferrous sulfate solutions through one root tip per palm was tested as an efficient and lasting means to overcome Fe deficiency in oil palm and is reported as applicable in oil palm estates of Riau, Sumatra, Indonesia.

Introduction

Iron deficiency is a worldwide problem in crop production on calcareous soils (Marschner, 1986). However, Fe deficiency is very rare in oil palm grown on acid tropical soils.

A growth disorder was observed in nine-year-old oil palms grown on a histic tropaquept with a 40 cm layer of peat over a thick sand underlay (40 to 150 cm) in two estates in Riau, Sumatra. This disorder was subsequently identified as severe Fe deficiency. These soils are acidic (pH H_2O: 4.5), very sandy (80 to 90 percent sand), and have very low levels of available plant nutrients [(e.g., available phosphorus (P), Bray II: <6 mg/kg; exchangeable calcium (Ca), magnesium (Mg) and potassium (K) <1.0, <0.4 and <0.2 cmol/kg, respectively]; and very low content of total Fe (0.05 percent). It was also noted that palms grown on peat soils (typic troposaprist) in adjacent areas were not affected.

Photo 1. (Left) At the beginning, interveinal chlorosis is observed on the leaflets of the youngest fronds. At a later stage, the whole frond becomes white.
Photo 2. (Right) Chlorosis is at first shown by the three youngest fronds and is later shown by older fronds below them.

Description

The earliest visible symptom is interveinal chlorosis of the usually normal sized and shaped youngest fronds (leaves 1 to 3). At a later stage, the youngest fronds turn completely white, while many of the older fronds are yellow. This chlorosis is followed by breakage and drying up of the fronds, arrested plant growth, and death. The process above is

Photo 3. (Left) Severe symptoms of Fe deficiency indicated by chlorosis on over nine of the youngest leaves.
Photo 4. (Right) The youngest leaves break at the base and dry up. At the final stage of Fe deficiency, the plant dies.

usually concluded within one year of the appearance of the first symptoms (**Photos 1** to **4**).

As a simple test, totally chlorotic young leaflets were painted once daily for three consecutive days using a 0.5 percent solution of ferrous sulfate. The result was a complete re-greening of the leaflets within seven days. Similar tests with other micronutrients such as copper (Cu) and zinc (Zn) as sulfate produced negative results.

Table 1. Total leaf Fe concentration of affected, treated and non-affected palms.

Category of palms		mg/kg oven dried matter Frond 3	Frond 9	Frond 17
Affected palms	(a)	21	40	48
Treated palms	(b)	32	68	59
Non-affected palms	(c)	39	83	64

(a) Sick (Fe-deficient) palms
(b) Recovered palms (three months after Fe root absorption-treatment)
(c) Healthy palms

Table 2. Total Fe concentration in frond 17 of two groups of palms.

Group	mg/kg oven dried matter Mean ± Std Dev	Range
Fe-deficient	44 ± 8	35 - 53
Non-affected	71 ± 16	47 - 119

Critical level

Leaf analysis confirmed the diagnosis of Fe deficiency in affected palms (**Table 1**).

After comparing analytical results from Fe-deficient and non-affected palms, the critical deficiency level of total Fe in frond 17 was found to be around 50 mg per kg dry weight (**Table 2**).

Table 3. Effect of various $FeSO_4 \cdot 7H_2O$ treatments on the severity of Fe deficiency of oil palm at 0, 3, 6, and 12 months after Fe application (MAA), presented as a rated scale from 0 to 100 percent.

Treatment	0 MAA	3 MAA	6 MAA	12 MAA
Control	67	78	93	100
Soil application (3,000 g)*	67	63	59	70
Foliar spraying (3 rounds of 6L)**	67	56	63	100
Root abs. (11.0 g $FeSO_4 \cdot 7H_2O$)***	67	0	0	0
Root abs. (16.5 g $FeSO_4 \cdot 7H_2O$)***	67	0	0	0
Root abs. (22.0 g $FeSO_4 \cdot 7H_2O$)***	67	0	0	0

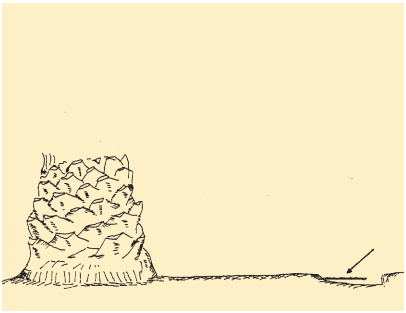
• Score 0 (0 percent): "Healthy" = no chlorosis on any leaves
• Score 1 (33 percent): "Light" = chlorosis on fronds 1 to 3
• Score 2 (67 percent): "Moderate" = chlorosis on fronds 1 to 9, white color of the three youngest fronds
• Score 3 (100 percent): "Severe" = chlorosis on more than 9 youngest leaves, breakage and drying up of the leaves
* Two applications of 1,500 g, monthly intervals
** 0.53 percent $FeSO_4 \cdot 7H_2O$ solution during the first 3 weeks (weekly intervals)
*** per 50 ml (stabilized with 0.6 g citric acid), 1 root per palm

Causes

Iron deficiency has been reported so far only in immature oil palm on deep peat in Sarawak, east Malaysia (Turner, 1981) and on the east coast of Riau (authors' observations, unpublished). This study suggests that the nature of the organic topsoil and absence of Fe in the sandy underlay of the histic tropaquept contributed to the insufficient Fe uptake by the affected palms.

Treatment

Three methods of Fe application were tested in a field trial with six treatments (control, soil application, foliar spraying, and three rates of root absorption), each with nine



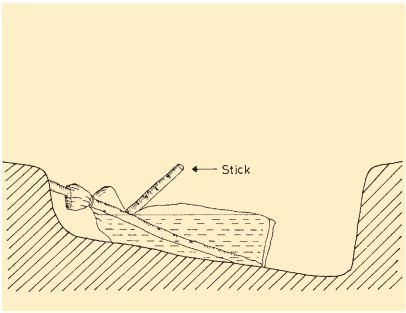


Figure 1a. (Left) To use the root absorption method, select one healthy primary root around the stem. Cut perpendicularly. Clean the root. The root should be hanging horizontally.

Figure 1b. (Right) After inserting the root into a plastic bag filled with the treatment solution, tie up the mouth of the bag. Then incline and place the root in a way that all the treatment solution can be absorbed very slowly.

Fe deficient palms selected as replicates using a completely randomized design. Industrial grade ferrous sulfate ($FeSO_4 \cdot 7H_2O$) containing 19 percent Fe was applied as the corrective agent (**Table 3**).

All root absorption treatments (50 ml per palm solutions contained in a plastic bag were applied to one pre-selected active root tip) were effective in correcting and preventing Fe deficiency for at least 12 months (**Table 3**).

Foliar sprayings during the first three weeks of the trial caused a re-greening of chlorotic leaves 2 to 4 weeks after the first application. However, foliar application of Fe could not prevent the recurrence of chlorosis on newly emerging leaves, thus indicating that sprayings would have to be repeated regularly to ensure success.

Soil application by broadcasting $FeSO_4 \cdot 7H_2O$ on the palm circle was completely ineffective. Most likely the applied Fe (II) was transformed by oxidation and/or strongly adsorbed in the organic and mineral layers of the soil and thus became as unavailable for plant uptake as any inherent soil Fe.

The successful Fe applications through root absorption confirmed that Fe is "intermediately mobile" in plants, meaning that it is translocated to a certain degree in the phloem. Iron application on just one root tip resulted in the complete recovery of palms over a 12-month period and maintained Fe contents in leaves at levels of sufficiency.

Following the satisfactory results in the trials, the root absorption technique was used to apply 15 g $FeSO_4 \cdot 7H_2O$ + 1 g citric acid in 50 ml solution per palm (one time application on one root tip) on all the affected palms in the two estates. Observation one year thereafter showed that Fe deficiency symptoms had disappeared in all formerly affected palms, indicating that root absorption is an effective and lasting means to treat Fe deficiency in oil palm plantations. **BCI**

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