Plate 142: The young plant on the right displays the early stages of sulphur deficiency as a pale yellow chlorosis of younger leaves. The healthy plant on the left is an overall green colour.

Plate 143: Chlorotic young sulphur-deficient leaves. The yellow chlorosis is uniform across the leaf blade and veins (compare with iron deficiency).

Plate 144: Newly developing leaves on a sulphur-deficient plant. As the deficiency progresses, new leaves are pale green to yellow as they emerge, giving the whole plant a general chlorotic appearance. In (a) the sulphur-deficient plant is in the middle.

Plate 145: In young, recently developed leaves, the distal leaflets are more chlorotic than the proximal leaflets

Plate 146: Even within a leaflet, the distal region is more chlorotic than the proximal region.

Plate 147: By contrast, some older leaves are uniformly chlorotic.

Plate 148: As the deficiency progresses, some of the older leaves develop necrotic tips whilst the oldest leaves may die and drop off.

Iron (Fe) Deficiency

Symptoms

The symptoms of iron deficiency appear rapidly, although the seedlings may initially show no slowdown in growth. As the severity of the deficiency increases, growth of the young plant slows and the stem becomes spindly.

Iron deficiency affects younger leaves more than older leaves. The pale yellow chlorosis is quite uniform across the leaf blade and includes the veins. This pattern is not typical of iron deficiency found in other species.

Occurrence likely

- Alkaline or calcareous soils with high pH (7.4–8.5) where levels of soluble iron are low.
- Waterlogged or compacted (wet) calcareous soils (including roads made from coral rubble).
- Coarse-textured soils low in total iron (eg bleached white sands).
- Peat soils where organic matter ties up soluble iron.
- Acid soils with very high levels of soluble manganese, zinc, copper (either natural or from excessive applications of copper-based fungicides), or nickel (eg serpentine soils) which depress the uptake of iron by plants.

Occurrence highly unlikely

- Acid to neutral mineral soils that are not high in soluble manganese, zinc, copper or nickel.
- Flooded non-calcareous soils.
- Mineral soils high in organic matter (but not peat soils).

Plate 149: Young seedling showing how the whole plant is generally a pale yellow with younger leaves slightly more chlorotic than older leaves.

Plate 150: Young leaves from an iron-deficient plant. Note the general yellow chlorosis of leaves including the veins. This is in contrast to the more typical symptom of iron deficiency in which the interveinal regions of the leaf (leaflet) are quite chlorotic with the veins remaining green.

Manganese (Mn) Deficiency

Symptoms

The symptoms of manganese deficiency are more severe in young leaves than in old leaves. The whole plant develops a general pale yellow chlorosis which is more noticeable on the younger leaves. Within the leaflet, the chlorosis is localised rather than general over the whole leaflet. In young leaves, the youngest leaflets sometimes develop an abnormal shape when they become chlorotic. Eventually, the chlorosis develops into a diffuse brown necrotic patch.

Occurrence likely

- Strongly alkaline soils, especially those with free lime, eg calcareous soils, where manganese is converted into forms less available to plants.
- Strongly acidic peat soils where total manganese is low.
- Peaty soils overlying calcareous subsoils.
- Poorly drained soils with a high content of organic matter where manganese is tied up in forms less available to plants.
- Acidic sandy mineral soils where manganese has been removed by leaching.
- Soils derived from parent material low in manganese (eg acid igneous rocks).
- Soils that fluctuate regularly between well-drained and waterlogged, where the manganese can be reduced to water-soluble forms that are then readily leached.
- Soils over-limed with lime or dolomite.
- Soils over-fertilised with copper, iron or zinc that inhibits plant uptake of manganese.

Occurrence highly unlikely

- Flooded soils where the level of total manganese is adequate.
- Acid mineral soils, especially those formed from parent materials rich in manganese (eg basic igneous rocks such as basalt).

Plate 151: Young seedling suffering from manganese deficiency. The whole plant is slightly chlorotic with younger leaves more chlorotic than older leaves.

Plate 152: Close-up of a young leaf showing that the chlorosis is localised rather than across the entire leaf.

Plate 153: Close-up of a developing young leaf showing that the localised chlorosis is also noticeable in the newly emerging leaves. Also note the abnormal shape of the youngest leaves.

Plate 154: Close-up of the leaflets on an older leaf. The chlorosis develops into a diffuse necrotic patch.

Boron (B) Deficiency

Symptoms

A number of different symptoms are associated with boron deficiency. As boron becomes deficient, seedlings stop growing and become stunted with stout stems. Death of the terminal leaflet is common, as is abscission of newly emerged leaves. To a lesser extent lobed chlorosis and small white necrotic patches are also seen on some older leaves. On some leaves a brown 'corkiness' near the midrib of the leaflet is apparent.

Occurrence likely

Boron deficiency is more likely to occur in highly weathered soils in high rainfall areas, with increasing distance from oceans, and in acid peat soils.

Typical sites for boron deficiency include:

- Coarse-textured soils formed from parent materials low in boron such as acid igneous rocks (eg granites), metamorphic rocks, and freshwater sandstones and shales.
- Acid sandy soils (eg podsolic soils) from which boron has been leached by rainfall.
- Alkaline, or calcareous soils, especially those with free lime.
- Soils low in organic matter.
- Acidic soils rich in aluminium oxides.
- Soils derived from pumice and volcanic ash rich in allophane.
- Peat soils, especially after liming.

A temporary deficiency of boron can occur under drought conditions when uptake of boron is inhibited by the isolation of available boron in a dry soil horizon.

Occurrence highly unlikely

- Soils formed from marine sediments.
- Soils close to oceanic coastal influences.
- Fine-textured soils with high clay content (eg from basalts or shales) unless highly weathered.
- Soils of naturally high pH that have no free lime.