B

Plate 155: Close-up of the leaf showing how the terminal leaflet and its rachis have died. There is also some corkiness on the main rib of the leaflet on the right (arrowed).

Plate 156: Close-up of the surface of some leaflets that have became mottled with white and green. The white areas appeared to suffer the complete death of small patches of leaf epidermal (surface) cells.

Plate 157: Older leaves showing how the chlorosis advances inwards from the margins and between the secondary veins. The white patches seen in Plate 156 are also apparent on the non-chlorotic parts of the leaf.

B

Plate 158: Close-up of a leaf showing brown areas of corkiness next to the midrib.

Plate 159: Close-up of the growing point showing loss of young leaves soon after emergence (arrowed). An axillary bud (arrowed) has 'burst' indicating a possible loss of apical dominance.

Molybdenum (Mo) Deficiency

Symptoms

Molybdenum-deficient seedlings grow slower and develop a general pale green to pale yellow overall chlorosis that is more evident in the new growth although the whole plant is slightly chlorotic. On young leaves, a pale yellow general chlorosis develops in the basal part of the leaflet and extends to cover the whole leaflet as the deficiency becomes more severe. Small brown specks may develop within the leaf tissue. However, even when the deficiency is severe, the veins remain slightly greener than the surrounding tissue. The chlorosis that develops on older leaves is often weakly interveinal.

Occurrence likely

- Acid soils ($pH < 6.0$) where soil colloids may strongly absorb the molybdate ion.
- Highly podsolised soils that are low in total molybdenum.
- Soils with a low molybdate retentive capacity, such as certain well-drained calcareous soils and soils derived from serpentine.
- Acid soils with high levels of hydrous oxides of iron and aluminium.

Occurrence highly unlikely

- Peat soils recently limed for the first time.
- Alkaline soils.

Plate 160: Young seedlings suffering from molybdenum deficiency. Note the general pale yellow chlorosis present in all leaves.

Plate 161: Close-up of the growing point of a molybdenum-deficient seedling. The new growth is particularly chlorotic.

Plate 162: Older leaves from the plant in Plate 161. Note the development of a general basal chlorosis across the whole leaf tissue.

Plate 163: Close-up of the developing leaflet from a molybdenum-deficient plant. Note the general basal chlorosis but with the veins remaining slightly greener than the surrounding tissue. Also evident are small brown specks within the leaf tissue. The white specks are insects, probably mites, and are not a nutritional disorder.

Manganese (Mn) Toxicity

Symptoms

Cedrela appears to be extremely susceptible to manganese toxicity; seedlings stop growing soon after being exposed to high levels of manganese in culture solutions and often die rapidly. Seedlings that are less susceptible develop a strong deep yellow chlorosis on all leaves. The chlorosis is sometimes interveinal but rapidly spreads over the entire leaf. Brown spots often develop in the chlorotic tissue across the entire surface of the leaf and remain visible even after the leaf dies.

Occurrence likely

- Waterlogged acid soils where poor aeration causes the unavailable manganic ions to be reduced to manganous ions that can be taken up by plants.
- Strongly acid soils formed from parent material high in manganese (eg basic igneous rocks); in acidic conditions there is an increase in the solubility of manganese and its concentration in the soil solution may reach levels that are toxic to plants.

Occurrence highly unlikely

- Strongly alkaline soils, especially those with free lime, eg calcareous soils, where manganese is converted into forms less available to plants.
- Strongly acidic peat and muck 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.

Plate 164: Young seedlings of *Cedrela* seem to be particularly sensitive to high levels of manganese, with some plants dying quickly.

Plate 165: Close-up of a leaflet suffering from severe manganese toxicity. Chlorosis is common and mainly, but not always, interveinal. Brown spots are also present over the leaf surface.

Mn
Tox

Plate 166: Close-up of different leaflets of the plant shown in Plate 165. The brown spots remain even after the leaves die.

Aluminium (Al) Toxicity

Symptoms

When aluminium becomes toxic, the young seedlings grow more slowly and stems become thin and spindly. The whole plant develops a general pale yellow chlorosis which may be weakly interveinal in the younger leaves.

Occurrence likely

- Any soil with a pH less than 4.5.
- Highly leached, highly weathered, non-calcareous soils.

Occurrence highly unlikely

- Soils with a pH greater than 4.5.

Plate 167: Young seedling showing symptoms of aluminium toxicity. All the leaves develop a general pale yellow chlorosis.

Plate 168: Close-up of some of the younger leaves showing a chlorosis that is slightly interveinal.