

Manganese (Mn) Toxicity

Symptoms

The first foliar symptom to appear is the development near the main and secondary veins of small light brown spots with a slight yellow chlorosis surrounding the spot on the surface of the older mature leaves. This symptom is followed rapidly by the development of a general yellow chlorosis throughout the blade of the younger mature and newly expanding leaves. This chlorosis is similar to that developed on the younger leaves of nitrogen-deficient plants.

As the toxicity becomes more severe, the older leaves develop a marked yellow chlorosis with the main veins remaining green. The brown spots now are easily distinguished on the older leaves where they occur more frequently near the veins, and also on the petioles.

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 93: Older mature leaf from a seedling showing the first signs of manganese toxicity. Note the appearance of small brown spots with a slight yellow chlorotic halo.



Plate 94: Seedling showing a general chlorosis of the youngest leaves caused by manganese toxicity. This symptom is very similar to the yellow chlorosis seen in nitrogen-deficient plants.



Plate 95: Manganese toxicity in a young mature leaf showing the brown spots and slight, general yellow chlorosis (a). The brown spots develop mainly along the main and secondary veins (b). A slight yellow chlorosis has also developed generally over the entire leaf.



Plate 96: Older mature leaf from plant in Plate 95 showing similar brown spots (a and b), but not as prolific as seen in the younger mature leaf.



Plate 97: Leaves separated from a seedling displaying manganese toxicity to show the change in colour from pale green to yellow younger leaves and the dark deep green older leaves (a). Close-up of younger mature leaf (b; top) and older mature leaf (b; bottom); note the more prolific brown spotting on the older leaf and the more general chlorosis on the younger leaf.

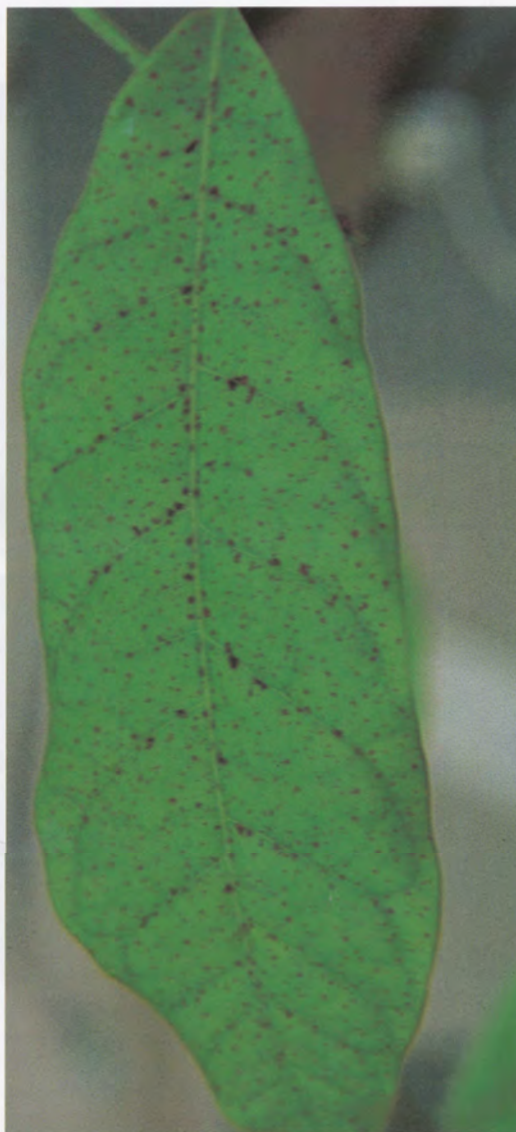


Plate 98: An older mature leaf showing the development of small brown spots near the main and secondary veins from manganese toxicity.



Plate 99: Older mature leaves from a seedling showing severe manganese toxicity. Note the development of a general yellow chlorosis with the main and secondary veins remaining green. The brown spots are more frequent near the major veins, and can also be seen on the petiole. Soon after this stage, the older leaves drop off.

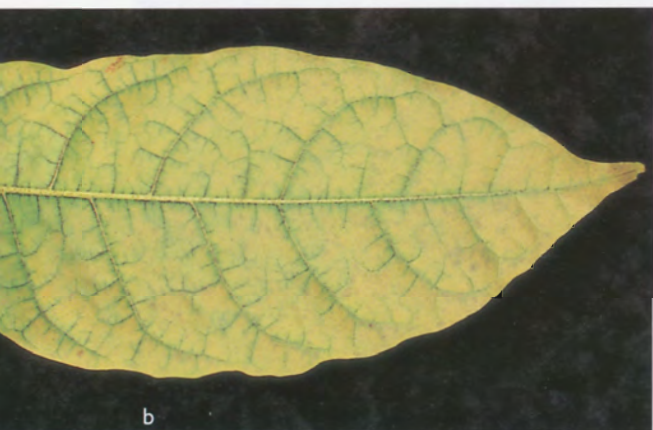
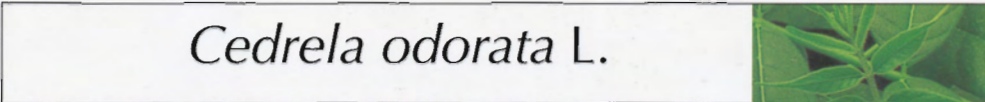



Plate 100: Older leaves that have fallen from a manganese-toxic seedling showing marked chlorosis and brown spotting that is more visible on the upper surface (a) than the lower surface (b).



Plate 101: Seedlings severely affected by manganese toxicity can lose much of their foliage except for a few newly developing leaves, leaving the stems almost leafless.



Cedrela odorata L.



cedar
cedarwood
cederwood
cedro
cedro amargo
cedro colorado
cedro real
cigar box cedar
culche
Spanish cedar
stinking mahogany
suren
surian
West Indian Cedar
yom-hom

Symptom Key

Symptoms based on

- Leaf colour Key pages 109-113
- Leaf shape and condition Key pages 114
- Stems and growing point Key pages 115-116

Symptoms based on leaf colour: chlorosis pattern

Veins green;
interveinal area
strongly
chlorotic



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Veins green;
interveinal area
mildly chlorotic



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Veins green;
interveinal area
weakly chlorotic



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Veins and
interveinal areas
are uniformly
chlorotic



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Symptoms based on leaf colour: chlorosis position

Basal



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Distal



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Marginal



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Symptoms based on leaf colour patterns

Lobed



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Uniform over
leaf



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Symptoms based on leaf colour: necrosis

Pattern:
Interveinal



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Veins and
interveins
uniformly
necrotic



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Position:
Basal



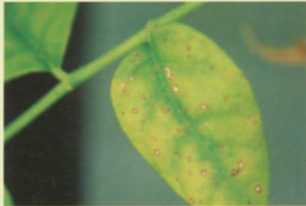
N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Distal



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Body of leaf



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

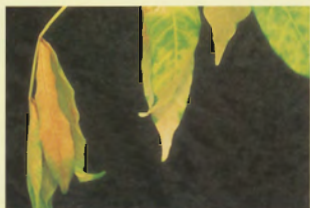
Uniform over leaf



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Symptoms based on leaf shape and condition

Flaccid



N P K **Ca** Mg S Fe Zn Cu Mn B Mo $\frac{\text{Mn}}{\text{Tox}}$ $\frac{\text{Al}}{\text{Tox}}$

Distorted shape



N **P** K **Ca** Mg S Fe Zn Cu **Mn** B Mo $\frac{\text{Mn}}{\text{Tox}}$ $\frac{\text{Al}}{\text{Tox}}$

Corkiness of main rib



N P K Ca Mg S Fe Zn Cu Mn **B** Mo $\frac{\text{Mn}}{\text{Tox}}$ $\frac{\text{Al}}{\text{Tox}}$

Symptoms based on stems and growing point

Short and stout



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Thin/spindly/
leggy



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Death of
growing point or
meristem



N	P	K	Ca	Mg	S	Fe	Zn	Cu	Mn	B	Mo	Mn Tox	Al Tox
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Abscission of leaves



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Death of terminal leaflet



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Rapid death of whole plant



N P K Ca Mg S Fe Zn Cu Mn B Mo Mn Tox Al Tox

Healthy Seedlings

A healthy seedling usually has an unbranched stem that grows rapidly to reach about 30 cm in 12 weeks. Plants are light green and leaves have a dull or matt appearance. The young emerging leaves may be brown with a soft texture to begin with, but they quickly turn a light green. As the young leaf matures, it remains a bright green.

The roots of a healthy seedling are extensively branched, the younger roots being pale brown to white while the older roots are dark brown. The root tips have no signs of malformation, such as being club-shaped or with brown or black necrotic lesions.