Sunflower response to acid soil factors

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The main sunflower production in the world occurs on neutral to alkaline soils, but with the increasing importance of this oilseed crop, acid soils are also being utilized. Acid soil infertility may result from toxicities and deficiencies. Toxic conditions may result from low pH per se, soluble aluminium, or excess manganese. In acid soils, deficiencies of phosphorus, calcium, magnesium, molybdenum, or boron may occur also.

Sunflower response to acid soil factors was studied in a number of field and glasshouse studies. Using the flowing solution culture technique, sunflower was shown to tolerate solution pH maintained at > 4.0. A marked reduction in top and root growth was observed at pH 3.5. In field and glasshouse experiments, sunflower was shown to be very sensitive to Al toxicity. In the field, sunflower responded to liming on soils with A1 saturation > 5%. In solution culture, Al concentrations as low as 5 ?M reduced dry matter yields by 44%. By contrast, sunflower is one of the most tolerant crops to excess Mn. Sunflower was found to tolerate high concentrations of Mn in the root environment (90% of maximum yield at 65 ?M Mn) all in its tops, the critical concentration for Mn toxicity being 5300 pg g . The mechanism whereby sunflower is able to tolerate high Mn concentrations appears to involve the concentration of Mn around the base of the leaf hairs.

With regard to deficiencies of R, Ca and Mg, sunflower does not appear to differ greatly from many other dicotyledons. P deficiency symptoms first appeared as a non-specific growth reduction followed by appearance of grey-green necrotic areas particularly on the lower leaves. Ca deficiency symptoms first appeared on the youngest emerging leaves. These leaves were wrinkled and eventually wilted with severe Ca deficiency. A black necrosis developed on the petioles and large veins of the oldest leaves. Magnesium deficiency symptoms first appeared on the older leaves as an interveinal chlorosis accompanied by a marked downward cupping of the leaves. Sunflower was sensitive to Mo deficiency in the field. Young Mo-deficient seedlings developed general chlorosis plus a marked upward cupping of the leaves. A rapid recovery of seedlings was observed when they were sprayed with a sodium molybdate solution (50 g in 100 litres of water). Sunflower was very sensitive to boron deficiency which first affected the apical meristem. The bud became hard and leathery, and the stem was brittle with a corky appearance. The leaves developed a yellow to bronze mottling, and heads were commonly deformed.

The large differences in sunflower sensitivity to Al and Mn toxicities are interesting from an evolutionary point of view. Since sunflower originated in the south western U.S.A., an area with neutral to alkaline soils, particular tolerance to acid soil factors would not be expected. This would be true of A1 toxicity, but Mn toxicity is a problem both of acid soils and of soils subject to waterlogging. It is possible that the tolerance of sunflower to excess Mn developed in response to intermittent waterlogging of soils high in easily-reducible Mn.

Provided A1 toxicity effects are minimized by ensuring Al saturation < 5X, it should be possible to correct other limitations to production on acid soils by fertilizer application.