ILLUSTRATED CONCEPTS IN TROPICAL AGRICULTURE

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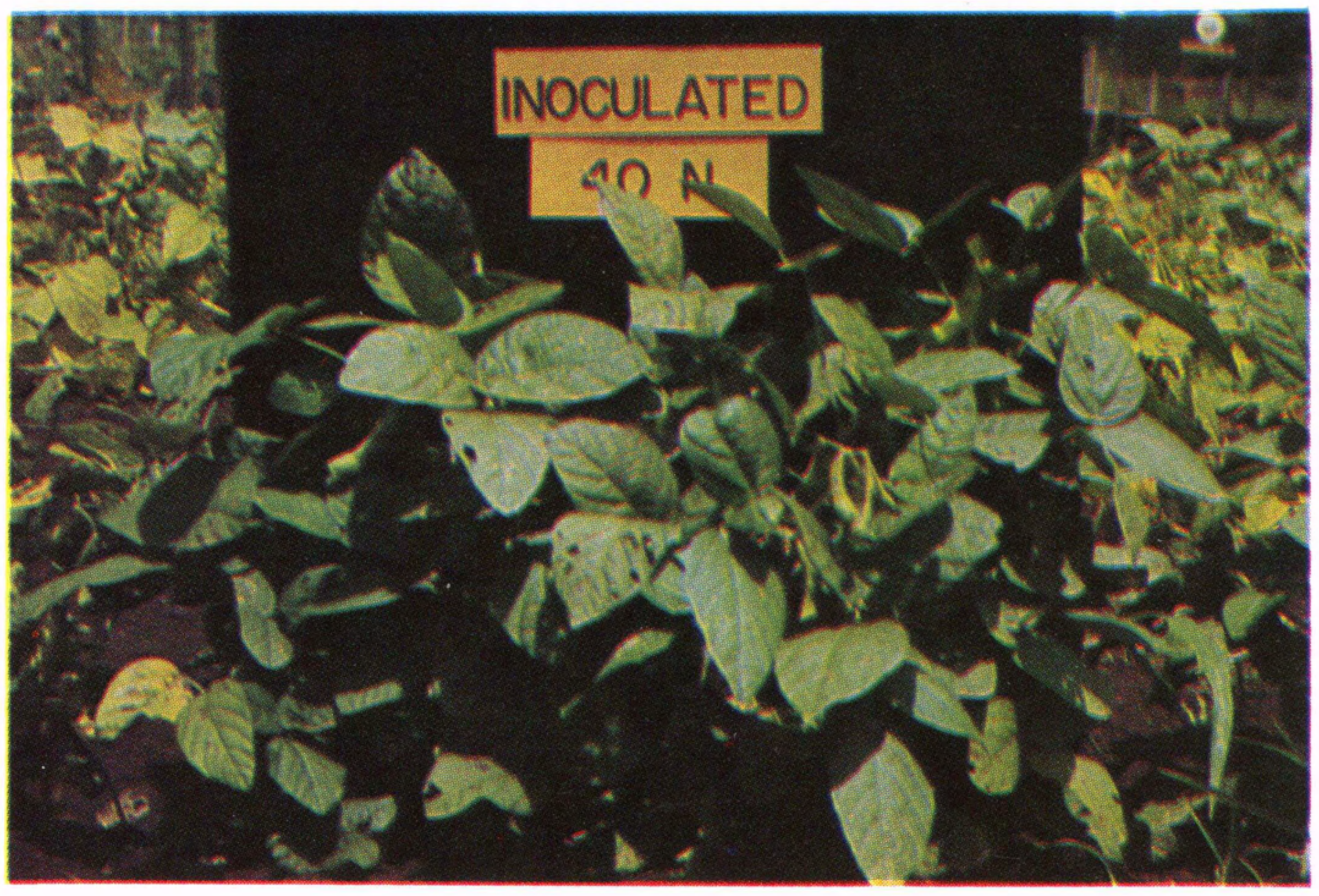
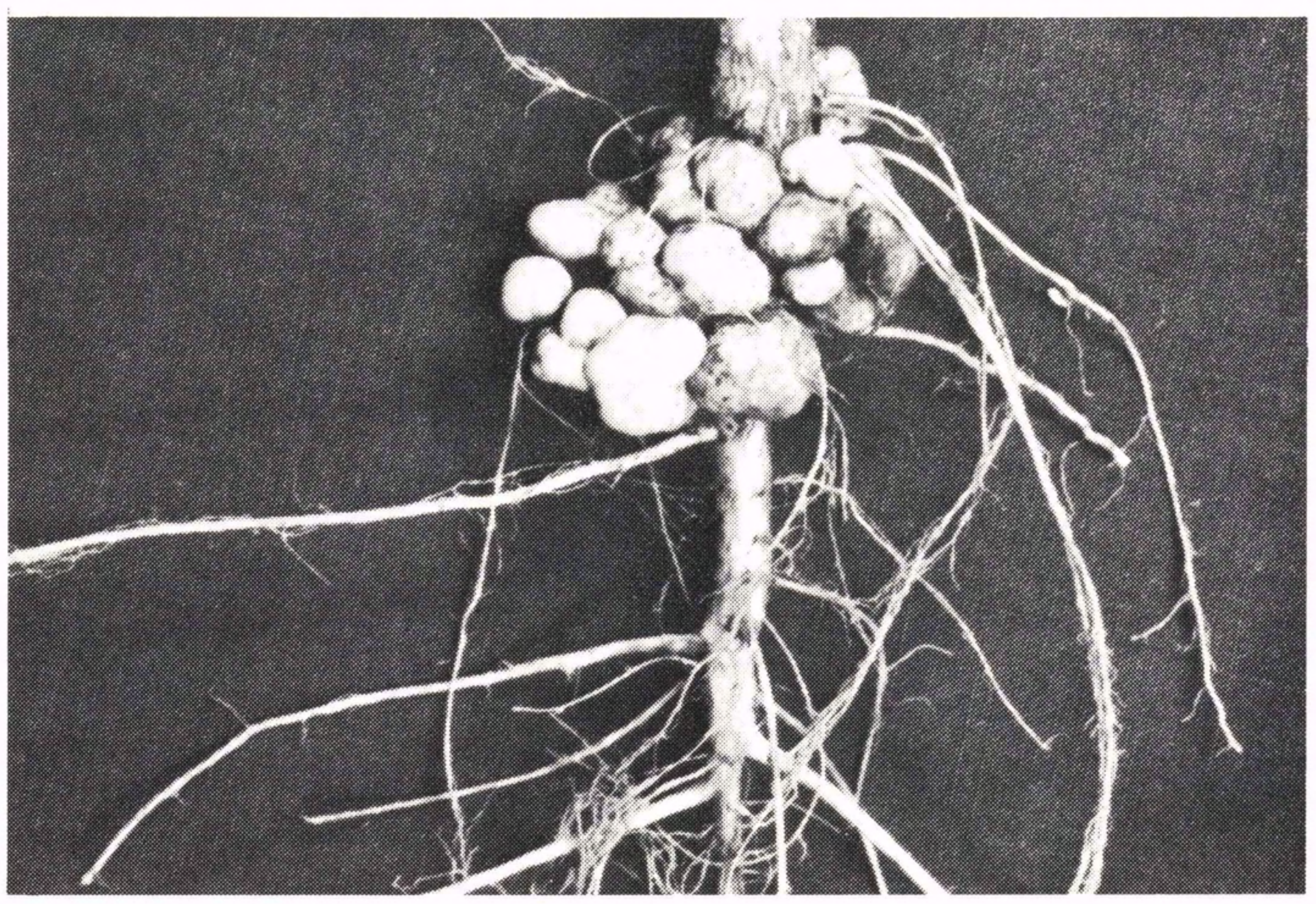
MOLYBDENUM DEFICIENCY INHIBITS NITROGEN FIXATION BY LEGUMES





Symbiotic nitrogen fixation by legumes involves the mineral nutrition of two kinds of individual organisms—the host plant and the associated rhizobia. Thus, the nutritional requirements of the rhizobia-host combination are determined by the organism that has the higher individual requirement. In several respects, requirements for the bacteria are more stringent than for the host plant. A case in point is the requirement for molybdenum. In plants, Mo is an essential mineral nutrient involved in the reduction of nitrate. In rhizobia, it is a part of the enzyme nitrogenase that is responsible for N fixation. Levels of Mo that may be adequate for a legume supplied with N, either as fertilizer or from the soil, may not suffice when that same legume is dependent on symbiotically fixed N.

The Mo status of soils has not been intensively studied in the tropics, but the studies that have been made suggest that many highly weathered soils are deficient. Molybdate is sorbed by soil—apparently by mechanisms much like phosphate sorption. However, molybdate sorption is much more sensitive to soil pH than phosphate sorption is. Therefore, liming is an effective means of increasing Mo availability to plants.

Requirements for Mo fertilizer in Hawaii seem to be high in comparison with recommendations reported from Australia. This can be explained if Hawaii soils sorb molybdate in proportion to their capacity to sorb phosphate and sulfate.

The photographs above illustrate some of these concepts. The soil, a manganiferous Oxisol, Wahiawa series, has a high capacity to sorb P (standard P sorption was 870 μg P/g soil) and is known to be Mo-deficient for alfalfa. Furthermore, the soil required a large application of Mo ($>$2 kg/ha) to sustain maximum alfalfa production.[1]

Upper left: Soybean growing without Mo fertilizer on a Mo-deficient soil. Note the apparent N-deficiency symptoms exhibited by the leaves.

Upper right: Soybean without Mo but with N fertilizer. Soybeans were a normal green color, indicating adequate N.

Lower left: Soybean growing with Mo and without N resulted in effectively nodulated soybean plants and superior growth.

Lower right: Nodulated soybean roots from plants growing on Mo-fertilized soil.

[1]Younge, O. R., and M. Takahashi. 1953. Response of alfalfa to molybdenum in Hawaii. Agron. J. 45:420–428.

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