ILLUSTRATED CONCEPTS IN TROPICAL AGRICULTURE

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SYMPTOMS OF PLANT MALNUTRITION–MULTIPLE DEFICIENCIES AND "THE LAW OF THE MINIMUM"

In 1843 Justus von Liebig wrote "....by the deficiency or absence of one necessary constituent, all others being present, the soil is rendered barren for all those crops to the life of which that one constituent is indispensible". In other words, the growth of plants is limited by the nutrient present as the lowest percentage of its optimum requirement. This "law of the minimum" cannot be rigidly applied. For example, if several factors are low, but none too low, increasing one factor may increase yield. However, the concept is useful for understanding plant nutrition in highly weathered soils of the Humid Tropics where severe, multiple deficiencies are commonplace. Eliminating a deficiency may avail little unless other deficiencies are corrected also.

The photographs illustrate the law as expressed in corn growing on a highly leached volcanic ash soil (Hydrandept, Honokaa Series) of Hawaii. This soil is severely depleted of calcium because it has little permanent negative charge to hold positively charged nutrients. It has a very large capacity to immobilize phosphate because the soil particles are very reactive with phosphate.

Upper left: No lime or phosphate. Typical calcium deficiency symptoms. Note the torn margins of leaves, the tendency of leaf tips to stick together and necrosis (death) of the whip-like, unrolled central whorl of leaves.

Upper right: Phosphate at 75 pounds P per acre as calcium phosphate. Symptoms of calcium deficiency have disappeared as a result of adding calcium with the phosphate. Note purple leaves–a symptom of severe phosphate deficiency. The added phosphate was mostly fixed by the soil.

Lower left: Phosphate at 300 pounds P per acre. Phosphorus deficiency symptoms are no longer evident except as purpling on lower leaf sheaths.

Lower right: Phosphate at 600 pounds P per acre. Growth was increased by further increasing the phosphate supply even though a new deficiency developed. Note yellow streaks (chlorosis) between the veins and the broad chlorotic band in some leaves which is typical of zinc deficiency.

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