THE EXTERNAL PHOSPHORUS REQUIREMENTS OF PLANTS

Fig. 1. Growth of lettuce (above) and Chinese cabbage (right) in relation to the concentration of P established in the soil solution by fertilization. Soil was an Oxisol, Wahiawa series, Poamoho Experimental Farm, Oahu. Maximum yields were 850 g per head for lettuce and 2770 g per head for Chinese cabbage.

The immediate source of phosphorus for plant use is the soil solution. Phosphorus in the soil solution equilibrates with labile P in the solid phase. This important aspect of P nutrition can be diagrammed:

\[ \text{Labile P} \rightarrow \text{Solution P} \rightarrow \text{Plant Root} \downarrow \]

For all practical purposes, P moves from solution to active plant roots along a "one-way path." Plants are effective sinks for solution P.

The quantity of P absorbed by plants in a unit of time—a rate factor—is closely related to soil solution P concentration—an intensity factor. The quantity of labile P in the soil, in relation to the capacity of the soil to retain P in the labile pool, is an important factor determining the concentration of P in soil solutions. Thus, the intensity of P nutrition is governed by the quantity of available soil P in relation to the capacity of the soil to sorb P. Adequate P nutrition is attained when the flux of P to roots matches the plant requirement for P uptake. The required concentration to sustain an adequate P flux is called the external P requirement. The external P requirement is an intensity factor and should not be confused with the internal P requirement, which is the quantity of P required in the plant for a specified quantity of growth or production.

For most conditions, and for near maximum potential yield, the external P requirement is reasonably constant for a specific crop and a given yield potential. The external P requirement does vary with soil temperature, however. Plants growing in cold soils have high requirements.

The external P requirement also varies among plant species, as is clearly evident from Fig. 1. The pictorial graphs represent growth response curves for head lettuce (Lactuca sativa) and Chinese cabbage (Brassica pekinensis). These crops grew in plots that had been fertilized to adjust P in the soil solution to the concentrations given on the abscissa. Lettuce growth was near maximum when P in the soil solution was about 0.4 ppm (Fig. 1). Chinese cabbage required less P, about 0.2 ppm for near maximum growth. Under suboptimal P levels, lettuce grew relatively much less than Chinese cabbage. For example at 0.025 ppm P, lettuce achieved only 15% of its potential yield, while Chinese cabbage achieved 60%.