ILLUSTRATED CONCEPTS IN TROPICAL AGRICULTURE
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THE EXTERNAL PHOSPHORUS REQUIREMENTS OF PLANTS

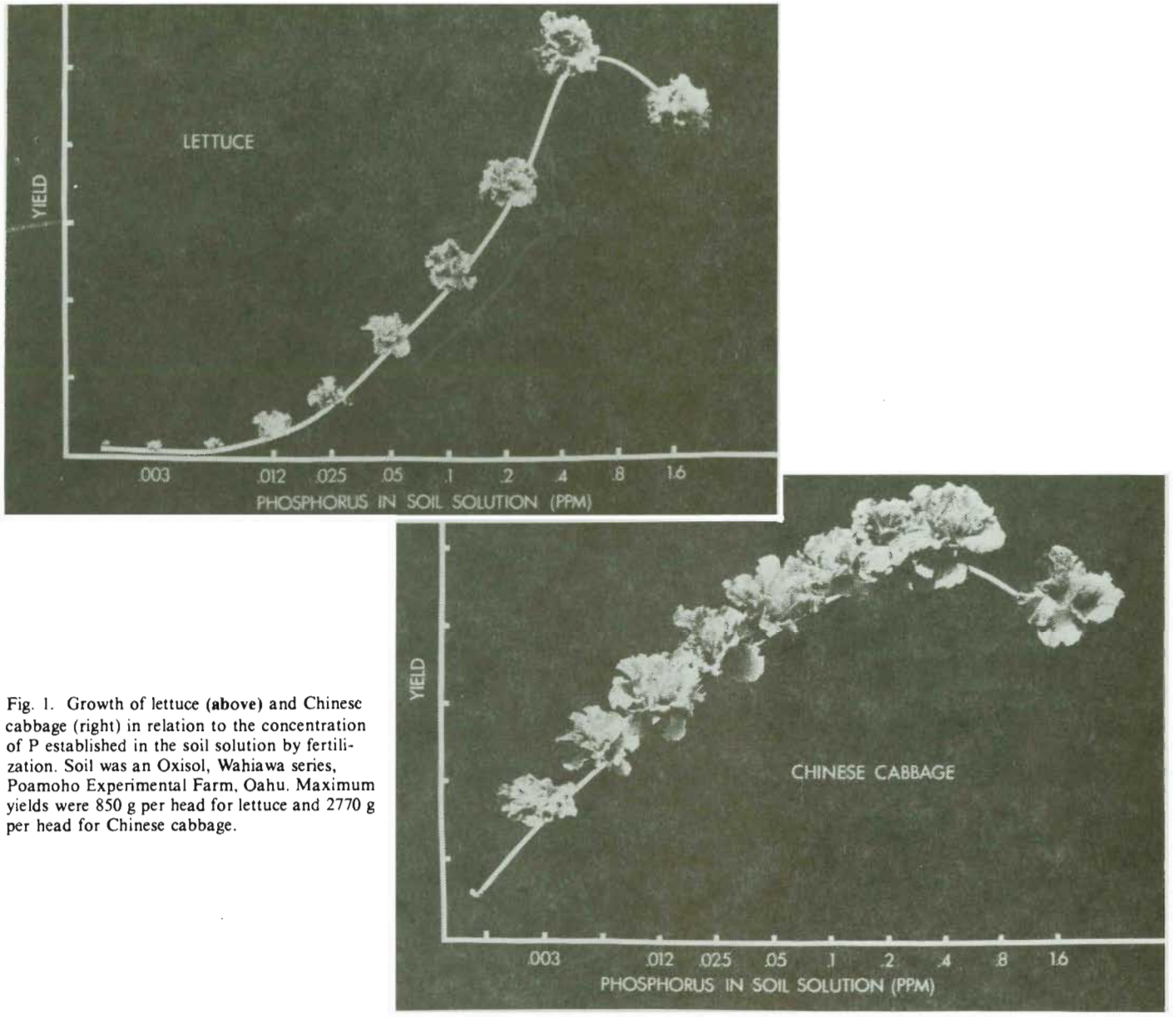

Fig. 1. Growth of lettuce **(above)** and Chinese cabbage (right) in relation to the concentration of P established in the soil solution by fertilization. Soil was an Oxisol, Wahiawa series, Poamoho Experimental Farm, Oahu. Maximum yields were 850 g per head for lettuce and 2770 g per head for Chinese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

Labile P ⇄ Solution P → Plant Root ↓

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%.

Robert L. Fox and Roy K. Nishimoto, No. 16, 1980