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Phosphorus Requirement of Three Sweet Potato Cultivars

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Sweet potato cultivars Tib 3, Tib 4, and Tis 2534 were grown in a Shante soil series at seven levels of phosphorus concentrations in a soil solution ranging from 0.01 to 1.6 ppm P.

Differential response and external P requirement were apparent between the cultivars. At 0.01 ppm P, over 70% of the maximum yield was obtained with the three cultivars. Yields of 95% occurred at 0.05, 0.10, and 0.15 ppm P, respectively, for the cultivars Tib 3, Tib 4, and Tis 2534.

Tissue phosphorus concentrations of 0.22% in the blade and 0.08% in the petiole of the index leaf at 9 weeks after planting appeared to be sufficient for 95% yield for the three cultivars.

The phosphorus response of sweet potato has generally been reported as small or insignificant; however, in some instances, large responses of 50% and above have been observed. Soil data are usually not included in these reports, so meaningful generalization is difficult.

Fox et al. (1974) attempted to determine more generally applicable parameters, basing their experiments on soil solution criteria, rather than on rates of fertilizer applied. They observed that sweet potato yielded 75 and 95% of the maximum yield with 0.003 ppm P and 0.1 ppm P in the soil solution concentration, respectively.

The work presented here uses the soil solution criteria to determine the phosphorus requirement of three sweet potato cultivars in a pot experiment.

Materials and Methods

The experiment was conducted as a randomized complete block design with three replications. Three sweet potato cultivars Tib 3 (early maturing, relatively low yielding), Tib 4 (intermediate maturing), Tis 2534 (late maturing, high yielding), and 7 external phosphorus concentrations were studied in the experiment.

Twenty kilograms of a Shante soil series (Quartzsipsamment, USDA) was used per pot. The soil has the following properties: loamy sand texture; pH 5.8; Org. C 1.2%; CEC 3.04 meq/100 g; Bray P 3.3 ppm. Phosphorus (finely ground single superphosphate) was applied at planting at rates of 0, 3, 6, 8, 12, 15, and 28 ppm P. These rates were based on the phosphorus absorption isotherm of the soil to provide equilibrium soil solution concentrations of 0.01, 0.025, 0.05, 0.1, 0.2, 0.4, and 1.6 ppm P. Each pot also received before planting 100 ppm N, 10 ppm S, 150 ppm K, and 2 ppm Zn as NH_4NO_3, $(NH_4)_2SO_4$, KCl, and Na_2 EDTA. A further 25 ppm N as NH_4NO_3, 50 ppm K as K_2SO_4, and 10 ppm Mg as $MgSO_4$ were added 10–12 weeks after planting (WAP).

Six plants were planted per pot and watered with deionized water. At 4 WAP plants were staked. One plant was harvested from each pot at 3, 5, 7, and 11 WAP. For each treatment, plants of the three replications were combined, separated in leaf blades, petioles, and stems,

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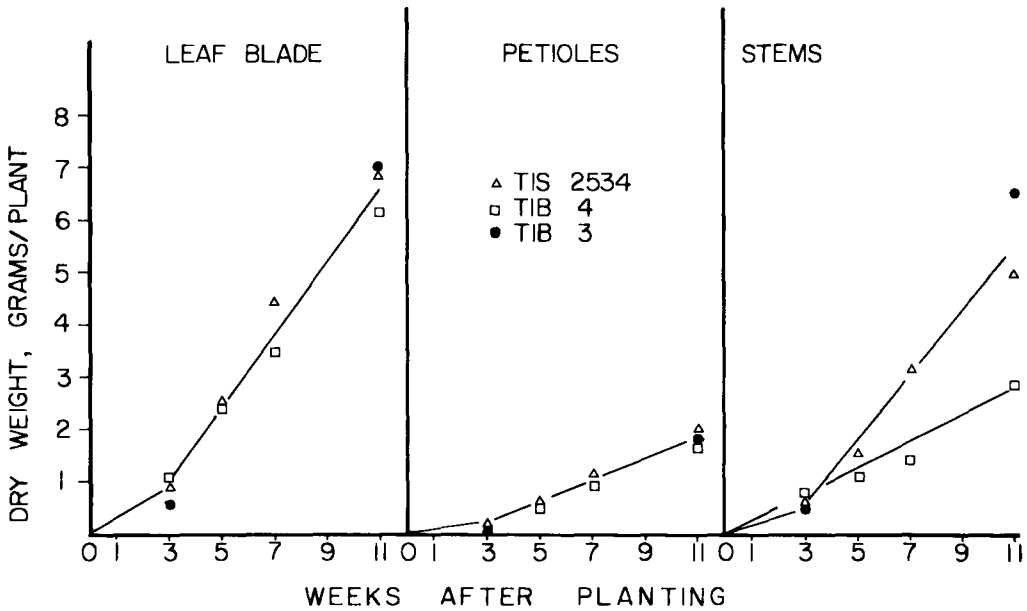

Fig. 1. Average dry matter weight of various plant parts of the three cultivars at various stages of growth.

and dried at 65 °C for dry weight phosphorus determination. At 9 WAP, index leaves consisting of the 4th fully expanded leaf from the top were collected from 8 vines per pot. They were separated in leaf blades and petioles, and dried at 65 °C. The remaining two plants per pot were harvested at 19 WAP. Leaf blades, petioles, stem, and tubers were separated. Subsamples were taken and dried at 65 °C for dry weight and phosphorus determination.

For phosphorus determination, plant samples were wet digested in a nitric-perchloric acid mixture. The digests were analyzed for phosphorus content using reduced molybdovanadate complex.

Results and Discussion

Dry Weight of Tops

There appears to be no distinct relationship between the phosphorus treatments and the leaf blade, petiole, and stem weights of the three cultivars sampled at 3, 5, 7, 11, and 19 WAP (data not presented). Although there is a tendency for the dry weight of the plant parts to increase with phosphorus application, no significant differences were observed between the treatments due to the high variability of the results.

The dry weights of the plant parts as averaged for the various phosphorus treatments are shown in Fig. 1. The dry weights of the leaf blades and petioles and their increases with time are similar for the three cultivars. The lower stem weight of cultivar Tib 4, in comparison with the other two, reflects the shorter growth habit of this cultivar.

Dry Weight of Tubers

The relationship between external phosphorus concentration and tuber dry weight is shown in Fig. 2. Cultivar Tis 2534 gave the largest response to phosphorus, only 73% of maximum yield was obtained from the control, compared with 78 and 88% for cultivars Tib 4 and Tib 3, respectively. All these responses are relatively low, and are in agreement with the findings of Fox et al. (1974). The 95% yield levels for cultivars Tib 3, Tib 4, and Tis 2534 occur at fertilizer levels designed to give external phosphorus concentrations of 0.05, 0.1, and 0.15 ppm P, respectively.

Although some caution should be exercised in extrapolating these results to field conditions, it seems clear, however, that there are

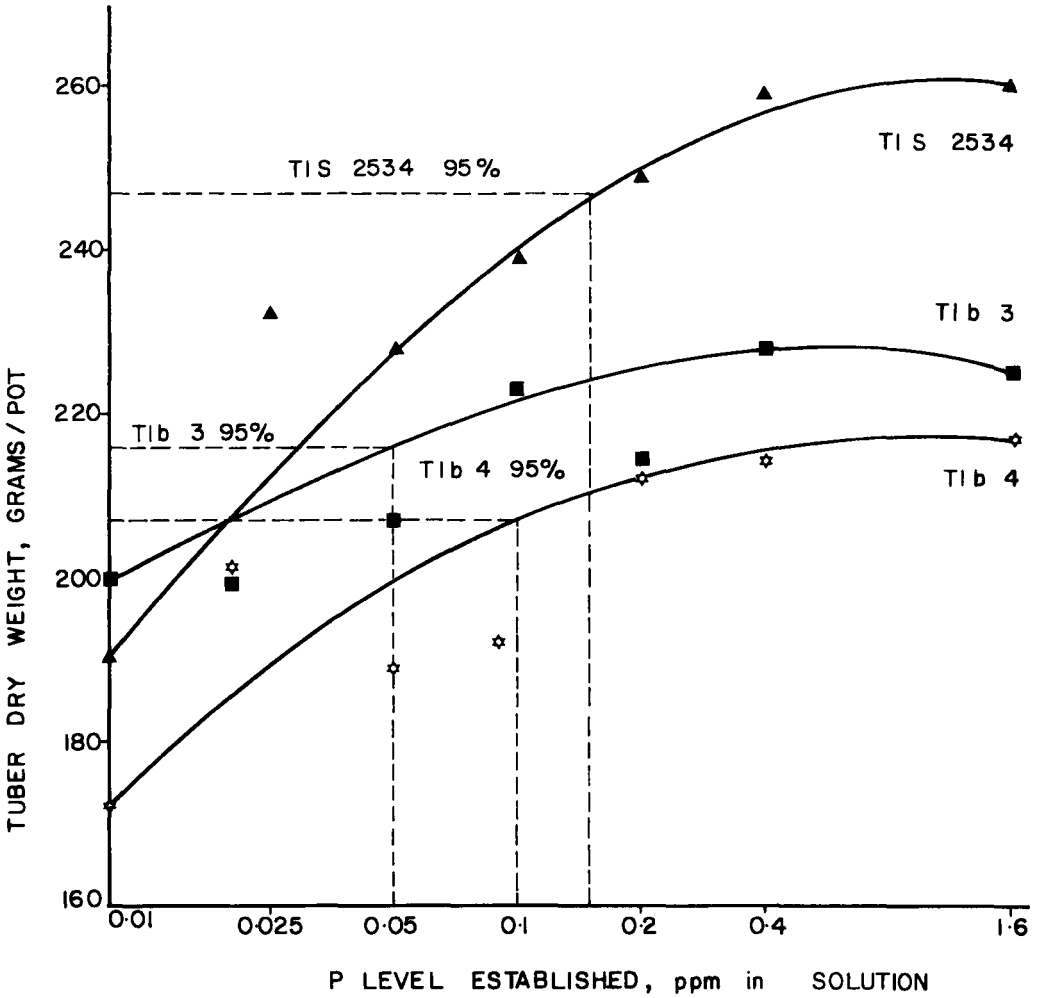

Fig. 2. Relationship between external phosphorus concentration and tuber dry weight of three sweet potato cultivars.

differences in the phosphorus external requirements and responses between the three cultivars. The observed range of soil solution concentrations, required to give 95% yields of 0.05 to 0.15 ppm P, falls close to the 0.1 ppm P level reported by Fox et al. (1974) for field conditions.

Dry Matter Percentage of Tubers

There was no significant effect of phosphorus treatment on the dry matter percentage of the tubers. Large differences existed between cultivars. The average dry matter percentage of the early maturing Tib 3 tubers was only 20%, while that of each of the other two cultivars was 30%.

Phosphorus Concentration in Plant Tissue

No distinct relationship was observed between the phosphorus content of the leaf blades and petioles at the various harvesting dates for the three cultivars and tuber yield. However, data for phosphorus content for index leaves collected at 9 WAP, shown in Fig. 3 and 4, showed significant relationship with the relative tuber yields as well as with the external phosphorus concentrations. From data presented in Fig. 3 it appears that the phosphorus content

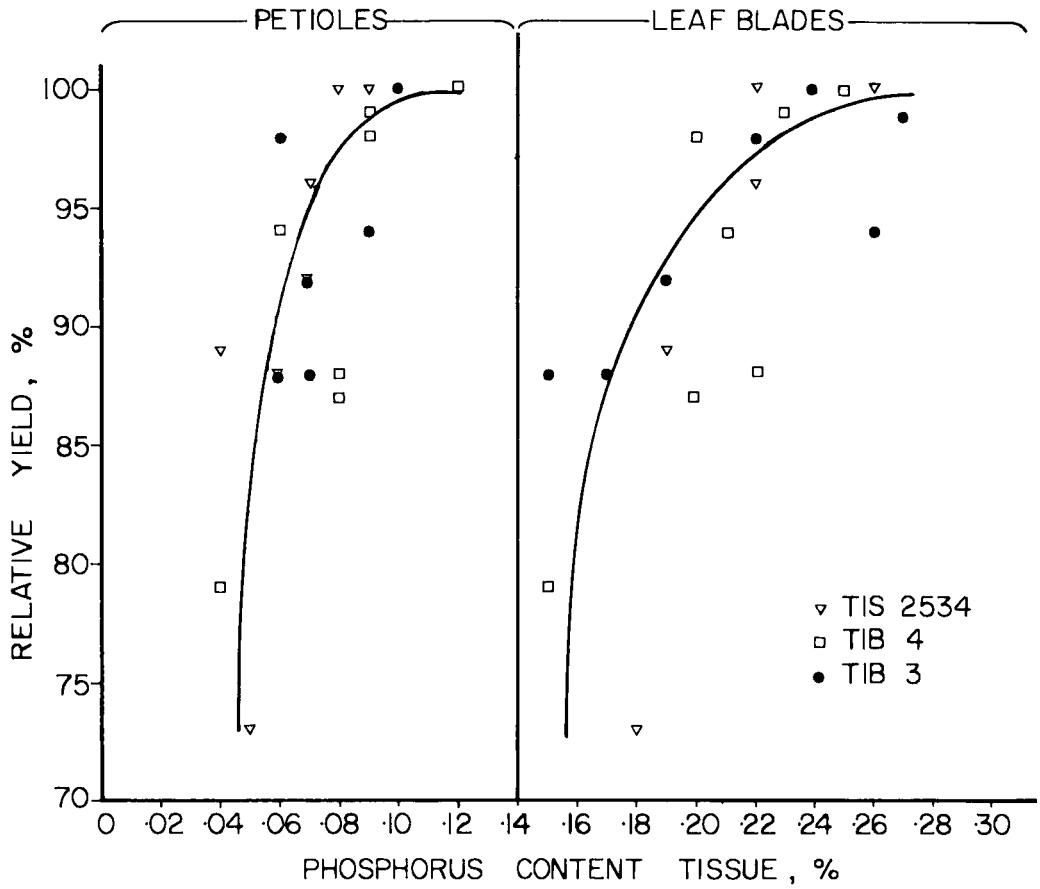

Fig. 3. Relationship between relative tuber yield and phosphorus concentration in petioles and leaf blades of index leaves.

in the petioles is better correlated with tuber yield than with those in the leaf blades. This suggests that petiole phosphorus concentration makes the most useful index. This is also in agreement with results obtained from field trials conducted at IITA (de Groot et al., unpublished data). In general, the phosphorus content of the petioles of cultivar Tis 2534 is lower than those of the other two cultivars for the same external phosphorus concentration indicating that the critical phosphorus concentration in the petiole may be independent of cultivar (Fig. 4). From the data presented in Fig. 3, it is estimated that about 0.08% P in the petiole and about 0.22% P in the leaf blade is sufficient for 95% yield, but these figures may be slightly higher than the critical levels. Spence and Ahmad (1967) quote 0.1% P as the deficiency threshold for sweet potatoes. However, they used whole shoots to the ninth node for their analyses, and their threshold was the appearance of visible deficiency symptoms rather than yield reduction as used here.

Conclusions

Differential responses to phosphorus were observed among the three cultivars. The responses, however, were relatively small, between 73 and 88% of the maximum yield being obtained in the unfertilized, low phosphorus soil for the three cultivars.

The external phosphorus concentrations required for 95% of the maximum yield were in the range of 0.05–0.15 ppm P, close to the 0.1 ppm P level found by other workers. A level of 0.08% P in the petioles and 0.22% P in the

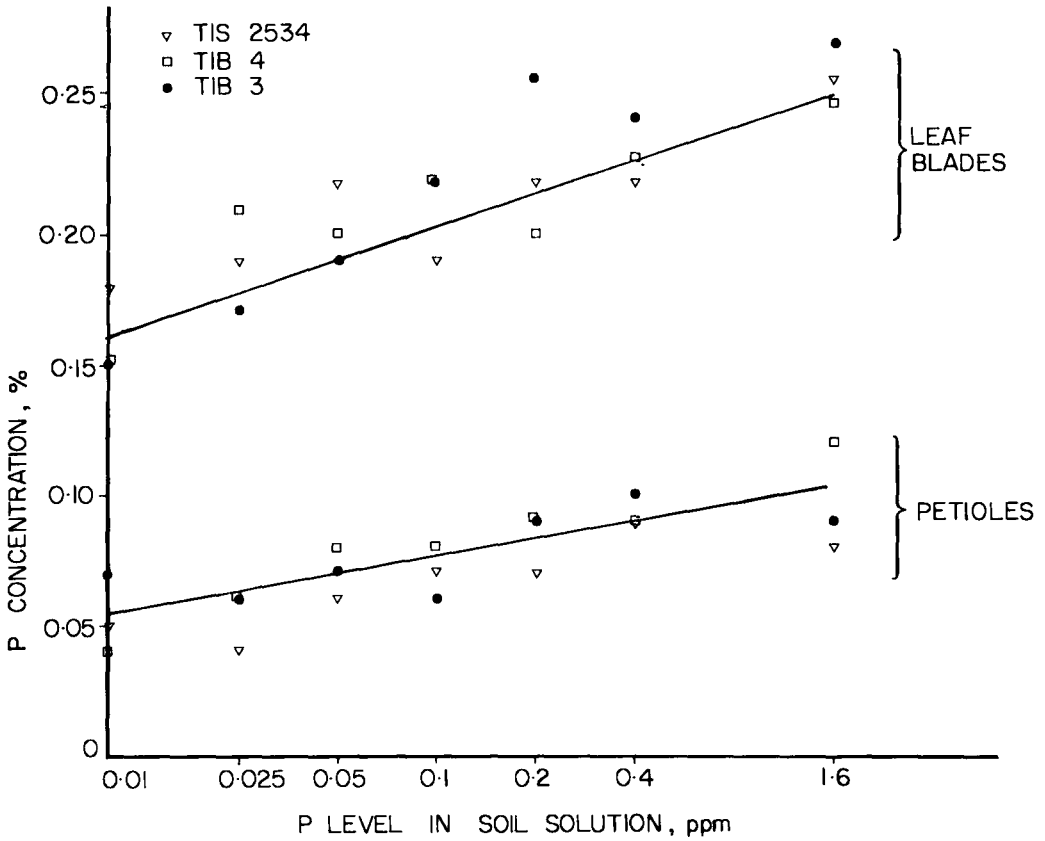

Fig. 4. Relationship between external phosphorus concentrations and phosphorus concentrations in petioles and blades of index leaves.

blades of index leaves at 9 WAP indicates that phosphorus is not limiting, though a slightly lower value may be sufficient. The petiole is suggested as a better index than the leaf blade for monitoring phosphorus status by tissue analysis.

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