which may be a factor in Florida citrus groves since phosphate has an effect on aluminum available.

Data from Experiment P-III showed that the lethal effects of the very high rates of phosphate application reported by Rasmussen and Smith (18) were due to salt toxicity and not to free acids in the superphosphate. Fertilizer-grade triple super or ordinary superphosphate usually contain less than 5 percent free acid. In Experiment P-II the application to a virgin soil low in copper of phosphoric acid equivalent to 10 and 50 percent of the P_2O_5 had no detrimental effect on root growth. However, when phosphoric acid equivalent to 50 percent of the P_2O_5 was applied to the grove soil containing copper, root growth was decreased in the surface foot of soil. The use of phosphoric acid as the only source of phosphorus to young trees in Experiment 4 with no detrimental effect on root growth further substantiates the fact that free acid itself applied to soils in moderate amounts is not toxic to citrus roots.

Data on residual effects of phosphate and limestone applications in Experiment 6 indicated that the concentration of roots in the surface foot of soil remained lower in the phosphate-treated plots three and a half years after the last phosphate application. However, young trees interplanted in all plots following the last application of phosphate produced the best root systems in plots with high pH levels regardless of past phosphate treatment. Pot Experiment P-I also showed that soils which received heavy rates of phosphate in combination with limestone in Field Experiment 6 were no longer toxic to citrus feeder roots. This would indicate that the soil toxicity factor is no longer present in the phosphated plots. The fact that the concentration of roots is still lower in the Ruby Red grapefruit trees which received the high rates of phosphate can be accounted for by injury of the root system during the period of phosphate and copper application. In other words, the present root pattern is a reflection of the root system established during 1951-58, when high rates of superphosphate and copper were being applied.

The same mechanism—mobilization and toxicity of copper—was probably responsible for the reported detrimental effects of high rates of nitrogen on root development (10) and tree condition and yields (32). Acidity resulting from nitrogen fertilizers would increase copper in the soil solution in the same manner as acid phosphates. The results of Experiment P-II, in which ammonia-containing phosphate compounds greatly re-