icity. This is probably the mechanism involved in root damage in the field experiments following the application of high rates of superphosphate.

In this experiment, roots were not noticeably damaged due to periodic applications of non-ammoniated phosphate compounds to the grove soil. Probably the copper was not sufficiently active, and most of these phosphate compounds did not greatly affect the soil pH at the relatively low rate of application. The only exception was Treatment 6, in which 50 percent of the P_2O_5 was added as phosphoric acid. In this case, feeder root growth was restricted, especially in the surface foot of soil. Soil salinity remained at relatively low levels in all treatments throughout the experiment.

Figure 2 is a composite photograph of root systems showing treatment differences. In pots which received high amounts of acid or acid-forming fertilizers applied to a grove soil high in copper, the surface soils were practically devoid of feeder roots. It is apparent that similar results could have been obtained with any other acidifying agent that sufficiently reduced the pH in the presence of this amount of copper.

The manganese, copper, and phosphorus content of leaves and roots varied widely with treatment (Table 12). Seedlings growing in the grove soil which received the ammonia-containing phosphate compounds were very high in both manganese and copper. A comparison of Treatments 44, which received copper, with 45, which received copper plus superphosphate, indicates that copper is extremely high in both cases, although there was no root damage in the former treatment. This would indicate that root analysis for copper probably is not a good guide to use in ascertaining potential toxic levels of copper. Liebig et al. (13) studied copper toxicity with orange and lemon cuttings and reported very little difference in copper content between copper-injured and healthy roots.

Manganese did not appear to be toxic to citrus roots and did not depress the growth of citrus seedlings in any treatment. In Treatment 38, the root manganese level was above 13,000 ppm with no apparent detrimental effects.

Dry matter production and root growth were not affected by the application of fluoride or arsenate compounds in this experiment. Apparently these compounds, in concentrations present in superphosphate materials, do not adversely affect citrus seedlings.