SODIUM

To Cuttings

ROBERT D. RAABE J. VLAMIS

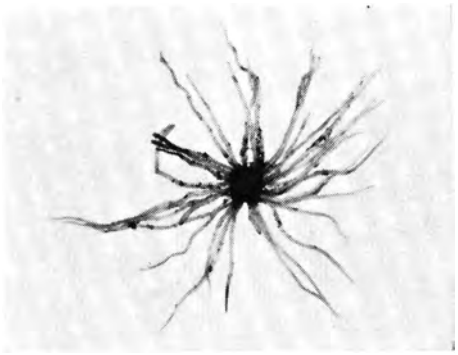

Photo 1. Bottom view of chrysanthemum cutting which has been rooted in a medium containing a low level of sodium. The early red root symptoms appear as gray areas in the photo. The more severely diseased areas, which turn red to brown, appear black.

Photo 2. Effect of three rates of sodium (one, two and three tons per acre) on the rooting of three different varieties of chrysanthemum. The plants on the left are checks.

FOLLOWING A CHANGE in the water supply used for irrigation and misting—from a shallow well (400 ft) to a deeper well (800 ft)—a large California chrysanthemum producer experienced extreme difficulty in rooting the cuttings. Early symptoms appeared as a loss of root hairs and small rootlets, and as a reddening of portions of the roots (photo 1). As severity increased, the tips beyond the reddened areas died and the number of roots increased. These failed to elongate so that in the most severely injured cuttings, only a tuft of short, reddish-brown roots was produced (photo 2). Except for the failure to elongate, there were no symptoms on the above-ground portions of most varieties.

In experiments to determine the cause of the trouble, no disease-producing organisms could be found in the roots. Analyses of water samples from the two wells showed that the old well was much higher in total salts but most of them were calcium and magnesium. The new well was low in total salts but of those present, most were sodium. The pH of the new well was slightly higher but not enough so that it could have been the cause of the problem.

Rooting media

Tests were started with cuttings rooted in different media including sand, wood chips, vermiculite, or perlite, each with and without peat—to which a number of different salts were added. Results showed that whenever sodium and peat were found in combination, the red root disease (the name by which it became known) appeared.

Further tests showed that when sodium salts were added to the rooting medium at the rate of 1 ton per acre, only slight injury resulted. With an added increase in sodium, however, there was an increase

INJURY

of Chrysanthemum

JOSEPH H. HURLIMANN J. QUICK

in injury, the most severe appearing at 4 tons of sodium per acre. The symptoms produced in these tests were identical with those found when the disease first appeared.

Experiments were also started to determine the effect on different chrysanthemum varieties. It was found that all of the 119 varieties tested showed some degree of red root though some varieties were more severely affected than others. No correlation between color, type or rooting ability of the different varieties and the degree of injury could be found in these tests.

Potassium

Inasmuch as potassium is an alkali like sodium, it was also tested and the results were found to be quite similar to those resulting from sodium, though not as severe. However, calcium added to the rooting medium did not injure the cuttings but instead promoted large, healthy root systems.

The type of sodium or potassium compounds added were also found to make a difference. Bicarbonates, carbonates and hydroxides resulted in the injury whereas chlorides, nitrates and phosphates did not, even at the same rates. This was found to be related to the ratio of sodium to calcium or potassium to calcium in the rooting medium. Sodium or potassium added as bicarbonates, carbonates or hydroxides favored a buildup of the sodium or potassium portions of these compounds adsorbed by the peat portion of the rooting medium, and resulting in a high ratio of sodium or potassium to calcium. When sodium or potassium was added as chlorides, nitrates or phosphates, the ratio of sodium or potassium to calcium increased only slightly and the disease did not occur.

Sodium-calcium ratio

The ratio of sodium to calcium also explained the appearance of the problem with the change of wells. In the old well, the ratio was 5.0 to 6.9 whereas in the new well, the ratio was 4.3 to 0.6. There were almost 10 times as many equivalents of sodium for each one of calcium in the new well, as in the old well. Thus, the water from the old well, though higher in total salts, was allowing a buildup of calcium in the rooting medium, while sodium had little or no chance to accumulate. However, water from the new well built up the sodium level in the peat very rapidly and an unfavorable rooting environment resulted.

Since the high ratio of sodium to calcium caused the problem, the answer was found by adding calcium to the rooting medium. Either lime or gypsum at the rate of two tons of calcium per acre, added between each crop of cuttings, has given complete control (photo 3). Gypsum was used primarily because it is cheaper.

Robert D. Raabe is Associate Plant Pathologist, Department of Plant Pathology, Berkeley; J. Vlamis is Plant Physiologist, Department of Soils and Plant Nutrition, Berkeley; Joseph H. Hurlimann is Laboratory Technician II, Department of Plant Pathology, Berkeley; and J. Quick is Associate in Agricultural Extension Service, Davis.

Photo 3. Effect of the addition of gypsum on the rooting of chrysanthemum cuttings at the rate of two tons per acre in the presence of sodium at the rate of one, two, three, and four tons per acre. Note that in the presence of calcium, the rooting is better than in the check.