WATER QUALITY AND MIST PROPAGATION

J. L. PAUL
Department of Environmental Horticulture
University of California
Davis, California

The concentration and composition of dissolved mineral salts in irrigation water determine the water quality. Agricultural scientists have developed classifications of irrigation waters based on kind and quantity of salts contained in the waters. The principal indices for classification are total salt content, proportion of sodium and boron concentration. These standards apply mainly to field conditions, but it is questionable that the same criteria are suitable for the special conditions of mist propagation. To gain a more thorough understanding of environmental factors which effect rooting it seems appropriate that water quality be studied for conditions of mist propagation.

The major cations contained in natural waters are sodium (Na), calcium (Ca) and magnesium (Mg). Major anions are chloride (Cl), sulfate (So_4) and bicarbonate (HCO_3). The cation of chief concern is sodium. Waters with a high sodium hazard rating are unsuitable for irrigating purposes since they can cause alkali or sodic soils. Considerable data from laboratory and field observations have shown that excess sodium is detrimental to soil physical properties, particularly with regard to air and water permeability. There is insufficient data to conclude that these waters would be injurious to rooting although a recent investigation by Raabe and Vlamis (1) suggested that a high sodium water was the cause of poor rooting in chrysanthemum. The absolute sodium concentration is not used as a measure of sodium hazard but rather its relation to calcium and magnesium (2). Calcium and magnesium are not considered injurious and are viewed as counteracting the effects of sodium.

Major anions are usually not considered when classifying waters. Certain classifications, however, utilize the bicarbonate and carbonate concentrations in sodium hazard.

Of the minor constituents, boron is importent since at 1 ppm or greater it can be toxic to crops. Since toxicity is accentuated by transpiration, it is not anticipated a problem under mist even at concentrations greater than 1 ppm. On the contrary boron may promote rooting. Nitrates are another minor component which have gained attention in recent years mainly because of health reasons. Some waters contain high levels of nitrate and can add significantly to the nitrogen requirement of the crop being irrigated. These waters would behave as nutrient mists.

In addition to specific ion effects, total salt content may be important. It is generally accepted that irrigation waters having a total salt content of 10 meq/l (640 ppm) or greater are salinity hazard waters and should be carefully managed.

Preliminary experiments in this laboratory showed that mist waters with a total salt level of 20 meq/l did not reduce rooting of chrysanthemum, and since most irrigation waters do not exceed 15 meq/l, salinity should not be a problem. It is of interest though to know the salt level of the mist water which reduces rooting. For a thorough discussion of water quality the reader is referred to "Agricultural Handbook No. 60" (2).

The following are brief descriptions and summaries of some experiments which have been performed to evaluate the influence of mist water solute composition on rooting. Results are applicable only to chrysanthemum.

RESULTS

To dispense a particular mist water, a special reservoir — pump arrangement was designed. Five of these combinations were used in a single experiment so that five waters varying in composition could be studied at one time. Media consisted of one flat of sand and one flat of sphagnum peat for each water. Each flat contained 25 cuttings of *Chrysanthemum morifolium* 'Princess Anne' which had received a quick dip in 2000 ppm IBA in 50:50 ethanol water. After two weeks under mist cuttings were harvested and root length and numbers estimated.

Table 1 Influence of total salt concentration in mist on rooting of chrysanthemum

Salt concentration in mist water meq/l	Root length per cutting — cm	
	Sand	Peat
10	44	68
30	51	63
50	52	71
90	56	55
140	8	18

Total Salt. Equal concentrations (in meq/l) of NaCl and $CaCl_2$ were added to tap water to give 10, 30, 50, 90 and 140 meq/l total salt concentrations. Rooting data are given in Table 1. Although there is a difference in root length per cutting between peat and sand, rooting was considered good in both media from 10 through 90 meq/l salt. Rooting was sharply reduced at 140 meq/l. Rooting in chrysanthemum does not appear to be sensitive to salinity. Under most conditions salt derived from mist water should not pose a problem especially since few waters contain as much as 20 meq/l total salt. Leaves were more sensitive to the salt treatments. At 10 and 30 meq/l leaves were normal but at the higher salt levels leaves were necrotic and deformed. The most severe damage occurred in the 140 meq treatment.

Magnesium. Although magnesium is not given separate consideration in water quality classifications, there is reason to believe that it may be harmful to cuttings under mist. To study the influence of magnesium on rooting, $MgCl_2$ and/or $CACl_2$ were added to tap water to give a total salt concentration of 15 meq/l. Mg concentration was varied to give Mg percentages of 20, 40, 50, 60 and 70. Mg% is defined as Mg 100/Mg+Ca+Na, where each ion is expressed in meq/l. Results of the experiment are given in Table 2. Root lengths were similar in peat and sand from 20 through 60% Mg. At 70% Mg root length was reduced in both media. In this treatment the roots were dark brown and the base of the stem appeared rotted. Leaves in the 70% Mg water also exhibited severe Ca deficiency symptoms. The data indicate that waters having 70% or more of their cations present as magnesium

Table 2. Influence of magnesium in mist on rooting of chrysanthemum

Mg% in Mist	Average root length — cm	
	Sand	Peat
20	1.48	1.18
40	1.36	1.15
50	1.22	1.23
60	1.00	1.14
70	0.24	0.50

may be detrimental to rooting. Few waters are high magnesium waters, and therefore, this should not be considered a serious problem.

Sodium. Five experiments have been conducted in much the same way that the magnesium study was conducted. Instead of $MgCl_2$, NaCl was added with $CaCl_2$ to a tap water to give a total salt concentration of 10 meq/l and Na percentages of 36, 47, 58, 69 and 79. Na% is defined as Na 100/Na+Ca+Mg where each ion is in meq/l. In each experiment rooting in sand was independent of Na%; i.e. rooting was good at all Na percentages. Rooting response in peat gave a less consistent pattern: In two experiments rooting was reduced at 69% and 79%; in two experiments rooting was reduced only in the 79% treatment; in the remaining experiment rooting was good at all Na levels. Work is underway to determine the reason for this rooting behavior in peat, but it is thought to be due to exchangeable ions held by the peat.

Results of these experiments illustrate clearly that salts in mist water can influence rooting, and that there are limits beyond which rooting or foliage are injured. The data are limited to chloride salts and a single species. Further experiments are planned with other species and with salts of bicarbonates and sulfates.

LITERATURE CITED

1 Raabe, R D, and J Vlamis 1966 Rooting failure of chrysanthemum cuttings resulting from excess sodium or potassium *Phytopath* 56.713-717
2 Richards, L A (Editor) 1954 Diagnosis and improvement of saline and alkali soils U S D A Handbook No 60 pp 160

MODERATOR LEISER: Thank you Jack. We've kept well within our time limit and have 15 minutes for questions.

BRUCE BRIGGS: Andy, did you also run a check to determine if Panogen itself might have aided or retarded rooting?

ANDY LEISER: We did not have a non-Panogen check. All treatments received the same concentration and the same length of treatment with Panogen, so if it affected rooting in one it should have affected rooting in the other unless there was an interaction. There didn't appear to be any damage from Panogen. The browning for example was not through a whole species. It was related definitely to the percentage of calcium in the peat.

BRIAN GAGE: Was the browning due to the calcium leaching distinguishable from browning from excess water.

ANDY LEISER: There is no way that I know to distinguish one from the other. It does not appear to be anything pathogenic; there is no sluffing of the bark or sliminess that you associate with diseased tissue. In our experiments we don't feel that we had excess water.

UNIDENTIFIED SPEAKER: What is the cation exchange capacity of vermiculite and perlite?

JACK PAUL: Perlite has a very small cation exchange capacity. It would behave much like sand. There is a rather significant exchange capacity in vermiculite. Vermiculite that we buy usually has a lot of calcium in it. Therefore if you are passing sodium over it, it would be very difficult to displace this calcium. So it is in a good chemical state when we buy it. It does have exchange capacity.

MODERATOR LEISER: This may be why we have had such good rooting results in vermiculite.

RALPH MOORE: Were the peats thoroughly saturated with water before sticking the cuttings?

JACK PAUL: All of these media were steam sterilized before they were used for rooting so they were thoroughly saturated with water.

AUSTIN KENYON: Dr. Raabe. At what ratio of sodium to calcium would damage to cuttings begin to appear?

BOB RAABE: Where the ratio was 2 to 1, if you will remember the chart, we began to get injury. So I would say at anything over a 1 to 1 ratio you would begin to get some injury.

AUSTIN KENYON: Do you use gypsum to saturate the peat with calcium?

JACK PAUL: If you use gypsum you probably won't get 100% saturation with calcium. If you want to saturate it to 100%, you would add lime.

WALTER KRAUSE: Our next speaker this morning is Mr. Duane Sherwood, Northwest Nursery Distributor, Boring, Oregon. He will speak to us on the subject "Rooting of Blue Spruce from Cuttings."

ROOTING OF BLUE SPRUCE FROM CUTTINGS

DUANE SHERWOOD
Northwest Nursery Distributor
Boring, Oregon

There is a high demand for Colorado Spruce plants that are all blue. Colorado spruce are generally fuller with a better shape than Koster blue spruce, the old standby.

Presently, most Colorado spruce plants are raised from seed. If the seed is collected from blue parents, the offspring may vary from 10% to 60% with 20% blues considered a very good result.

Grafting is frequently used for strains of Colorado blue spruce such as Koster blue spruce. Grafting has advantages of generally quicker results and uniform plants. Many people feel that a seedling understock will give a better plant. The disadvantages are that it takes experienced help to do this grafting and this experiencd help is usually hard to get. Conditions where these grafted plants are kept are also quite critical.

The next way of reproducing plants is by cuttings. In talking to most nurserymen, Colorado spruce are very difficult to root from cuttings, and when they do root, roots are typically poor and claims are that the top will be lopsided. With this in mind, we have gone ahead and tried rooting cuttings.

Oregon is probably an ideal place to grow Colorado spruce, as we have acid soil which is well drained, and we have plentiful water. We also have a very mild temperature where the temperature rises above 90 degrees for less than a total of seven days a year and the minimum temperature is below 32 degrees for only one or two weeks out of the year. We are located in the general Willamette Valley, 20 miles east of Portland. The Willamette Valley is located between two mountain ranges which probably has a great bearing on our mild climate.

A little later we will show you pictures of the type of stock plants we are looking for. We are looking for shape, plus beautiful blue color. But this is only part of the problem. We also need a stock plant that has a high percentage of rooting with a good root system and uniform top. We do all of our rooting in an unheated structure covered with polyethylene. The air temperature is very similar to outside temperatures