Testing for Calcium Carbonate Precipitation in Irrigation Waters

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Irrigation water often contains adequate concentrations of calcium for carnation growth (3, 5). However, most also contain bicarbonate (HCO_3) ions. Loss of calcium (CA) from irrigation waters can occur if HCO_3 is present (1,4). Insoluble calcium carbonate is precipitated:

$$Ca^{++} + 2HCO_3 \quad CaCO_3 + H_2O + CO_2 \qquad (1)$$

The problem increases as water is lost from the growing medium, thereby concentrating the soil solution (1). $CaCO_3$ precipitation not only reduces the concentration of Ca in the soil solution, but also increases the ratio of exchangeable sodium (Na) to Ca (4). Relatively high concentrations of Na in the soil solution can lead to poor drainage and poor aeration in the growing medium (6). This is more of a problem in soils than in inert media.

A means of evaluating irrigation waters has been devised by Bower et al. to determine the possibility of $CaCO_3$ precipitation (2). All of the necessary values for the calculations can be obtained from the accompanying graphs. The term given this measurement is the saturation index (SI). SI is defined as the actual pH of the water (pH_a) minus the theoretical pH (pH_c) that the water would have if it were in equilibrium with $CaCO_3$:

$$SI = pH_a - pH_c \qquad (2)$$

Positive values of SI mean that $CaCO_3$ will precipitate from the irrigation water.

The pH_c can be calculated from the accompanying graphs if Ca, total cation, and total (HCO_3 + CO_3) concentrations are known from the irrigation water in question. All three vlaues can be obtained from the usual CSU water analysis. For example, suppose a sample has the following analysis:

Ca - - - 8 meq/1   Total cations = 8 + 3 + 6 = 17 meq/1

Mg - - - 3

Na - - - 6

SO_4 - - - 8

Cl - - - 2

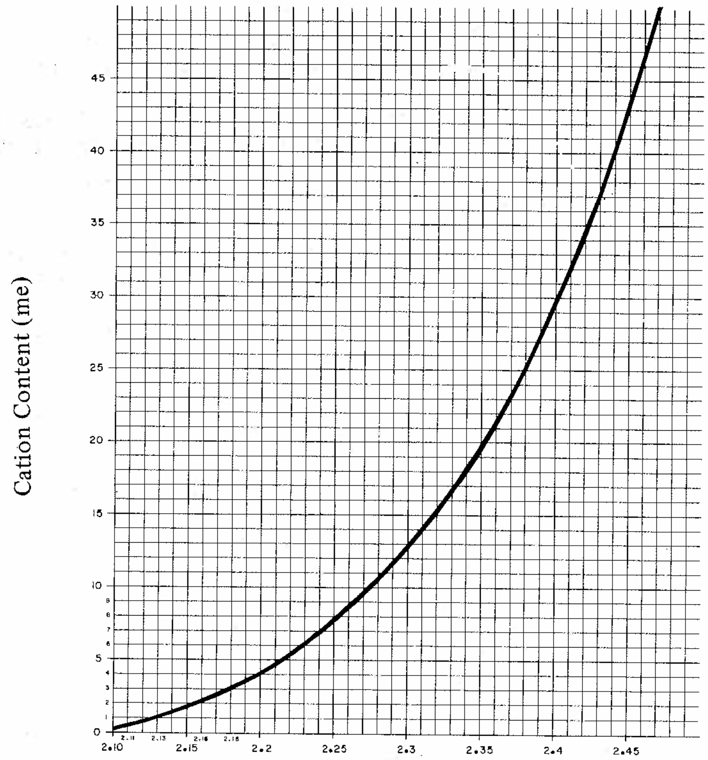
HCO_3 - - 6

CO_3 - - - 1

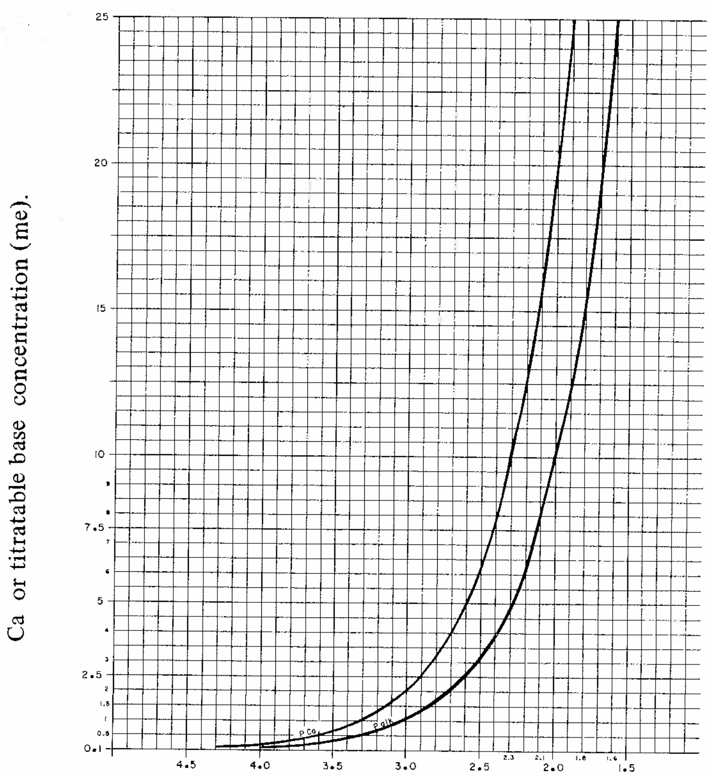
pH - - - 7.8

From graph A, determine $pK_2 - pK_c$ by reading the total cation concentration on the vertical, left-hand axis, moving to where the line intersects the total cation level, and then reading the value directly below the intersection. Since total cations equal 17, the $pK_2 - pK_c$ value is 2.33. The total calcium concentration is 8 meq/1. From graph B, determine the pCa and pAlk values in the same manner as in graph A. In this case, the values are 2.40 and 2.15. Add the three values, i.e. 2.33 + 2.40 + 2.15 = 6.88. This value is pH_c. Subtract from the pH_a--or, 7.8 – 6.88 = +0.92. The positive value, 0.92, means that Ca CO_3 will precipitate.

Since $CaCO_3$ precipitation is correlated with the actual pH of the water (pH_a), a lower pH_a–by adding acid–will prevent precipitation. Calculation of SI will indicate if loss of Ca from the solution is likely to occur, and should be calculated on all water analyses.



Graph A: For determining $pK_2 - pK_c$.



Graph B: For determining pCa and pAlk

Table 1. Possibility of $CaCO_3$ precipitation in Denver area irrigation waters, using water analyses given in Tables 1 and 2 CFGA bulletin 222, November, 1968. Values rounded to nearest tenth.

Site	Depth type	Concentration[1] Ca	Total cations	pH_a	pH_c	Precipitation? (yes/no)
1	Deep	0	14.3	8	---	NO
2	Shallow	0.2	11.5	8	10.6	NO
3	Shallow	4.0	6.1	8	7.3	YES
4-a	Shallow	4.0	7.6	8	7.4	YES
4-b	Shallow	5.9	9.8	8	7.1	YES
5-a	Deep	0.9	3.3	8	8.5	NO
5-b	Deep	0.9	2.7	8	8.5	NO
6	Shallow	6.8	13.3	8	6.9	YES
7-a	Shallow	7.3	16.2	8	6.8	YES
7-b	Shallow	7.5	14.8	7	6.8	YES
8	Shallow	4.9	16.5	7	7.2	NO
9	Shallow	9.2	19.3	8	6.7	YES
10	Shallow	5.3	12.8	7	7.2	NO
11	Shallow	9.5	19.6	8	6.7	YES
12	Deep	0	3.6	7	---	NO
13	Shallow	9.6	20.4	7	6.7	YES
14	Deep	1.2	8.5	8	8.6	NO
15-a	Denver	1.6	2.9	8	8.1	NO
15-b	Denver	2.4	5.3	8	7.7	YES
15-c	Denver	1.2	3.5	8	8.5	NO
16	Denver	0.6	0.9	8	8.8	NO

[1]Concentrations in milliequivalents per liter.

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