

COLORADO FLOWER GROWERS
ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY

Dorothy Conroy, Executive Secretary
901 Sherman Street, Denver, Colorado 80203

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People You Should Know



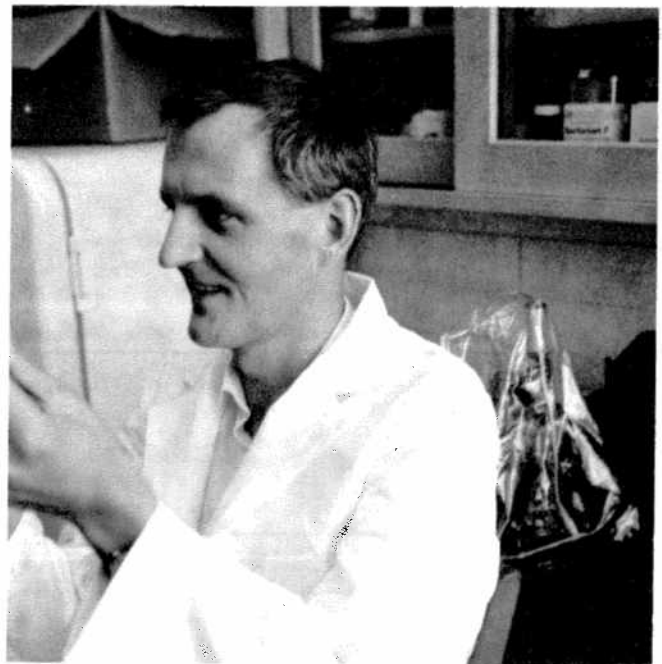
Jane Aldrich is now handling the shoot-tip program and starting research on tissue culture and projects related to our clean stock. She will be working toward the Ph.D. degree

Jane was born in Atchison, Kansas, and grew up in Tulsa. She received the B.S. degree in microbiology at the University of Oklahoma and an M.S. in Genetics at Kansas State. She has worked in the microbial genetics lab at C.U. Medical Center in Denver.

While at O.U. the experience working with fungal pathogens while she was lab assistant was most interesting to Jane and probably has most to do with her coming to CSU to work with carnation diseases. It's rather interesting since it was almost an accident

that she took the job at Oklahoma. Call it fate, if you will!

Jane loves to ski. She is learning to play the guitar. Maybe this is the reason Tex Baker hired her? We certainly are enjoying working with Jane. Your clean stock program is in good hands!



Dr. Gösta Nilsson, a native of Sweden, took his undergraduate training in horticulture and botany. From 1957 to 1960, Gus worked as a quarantine in-

spector for the Swedish government. Between 1960 and 1964 he completed his M.S. and Ph.D. degrees under Watt Dimock at Cornell. His theses were on *Phialophora* wilt of carnation.

After finishing at Cornell Gus worked a year in Sweden as governmental plant pathologist and two years for DCK (Danish Chrysanthemum Culture) in Denmark. The past year he was in Botswana (formerly Bechuanaland) in southern Africa making a survey on plant diseases for the Botswana government as a FAO (United Nations) plant pathologist.

During his work in Sweden and Denmark he initiated two meristem programs for development of virus-free carnation and chrysanthemum, and worked with steaming for the eradication of wilt diseases.

Gus will only be with us through the March Meeting of ACS and then must go back to Botswana for a follow-up on work he started there. Many of you have already met him and know he exudes enthusiasm. He has brought many new ideas with him and is most helpful in planning facilities for the new Tissue Culture Lab and research to be done in it.

Mrs. Nilsson and two little tow-headed boys accompany Gus in his wanderings. His oldest son is learning American slang and football at a rapid pace.

Colorado Water Analyses

Joe J. Hanan, Kurt Schekel and
W. D. Holley

During September, 1968, water samples were obtained from a number of shallow and deep wells used by greenhouses in the Denver Metropolitan area. The region included both sides of the South Platte River valley between Brighton and Littleton, the Cherry Creek Basin, north from Parker, and the Clear Creek area, north from Arvada. The samples were analyzed for electrical conductivity (EC), osmotic pressure (OP), acidity (pH) and concentration of individual components of the solutions. These data were combined with information obtained from analyses made about four years ago, and they are presented in Tables 1 and 2.

Electrical conductivity

According to the U.S. Salinity Laboratory (3), irrigation water with conductivity up to 2.250 millimhos/cm (2,250 reading on a Solu-Bridge) has been used successfully in field irrigation. None of the samples in this survey approached this level. However, if a complete fertilizer solution is injected the conductivity might be more than doubled over the original value. Readings up to 3.0 mmhos/cm after nutrient injection should not be troublesome, even in soils, if benches are leached sufficiently at each watering. Irrigation water with a salt reading less than 0.5 mmhos/cm is very good. The Denver domestic water supply (samples 15 and 16) fall well within this limit. Water with conductivity above 3.0 should probably not

be used unless carnations are grown in inert media such as Idealite. The general conclusion is that total soluble salts as measured by electrical conductivity is not a problem in the Denver area water.

Osmotic pressures

The osmotic pressure of the solution is an indication of the force which must be exerted by the plant in removing water. The higher the osmotic pressure, the "drier" the solution. Magistad (2) states that salt sensitive plants may succumb at solution concentrations below 2.5 atmospheres (atm) (one atm. = 14.7 psi). On the other hand, salt tolerant plants may survive at concentrations exceeding 6 atmospheres. There has been work in Israel, purporting to use sea water for irrigation of some plants with good results (1). For an average composition of sea water, the osmotic pressure is computed to be about 26 atm. It is not known just where carnations lie in respect to resistance to high osmotic pressure. Preliminary observations indicate that pressures much above 4.0 atm. causes extreme growth reduction in carnations. There appears to be a gradual reduction in growth as pressure increases. The dividing point where this reduction becomes uneconomical has not been determined, nor is it known how much increased salinity may be offset by manipulating the nutrient solution. None of the samples in this survey exceeded 1.0 atm. ($\neq 0.5$). Injection of fertilizer into the watering line will increase the pressure, but it should not reach dangerous levels in any of the Denver water sources.

Acidity

pH of the samples varied from slightly more than 7.0 to about 8.4. As far as availability of nutrients in the soil, this does not appear to be important, although potassium and nitrate become less available, manganese is unavailable in significant amounts above 7.5 and aluminum is released above 8.5. More important is the effect of pH on solubility of calcium and phosphorous in solution, particularly in the concentrate barrel prior to injection. For example, calculations by Dr. Willard Lindsay showed that pH of the water would have to be 4.36 if concentration of calcium was about 10 meq/l (Sample 9, Table 2) and phosphorous concentration was 0.5 meq/l. At higher pH's, calcium phosphate (CaHPO_4) begins to precipitate. The concentration of phosphorous would be many times higher in the concentrate tank, and significant amounts of phosphorous would be lost. At CSU, the problem is avoided by injecting phosphorous or calcium and magnesium on alternate weeks, or by using a double injector whereby phosphorous is kept separate. However, where the water already contains significant amounts of calcium at pH much above 6.0, the only safe method is to apply phosphorous dry. Magnesium phosphate precipitation may also occur to a lesser degree. It is probably not important in the final nutrient solution at any of the magnesium concentrations found in the Denver water sources, but likely occurs in concentrate tanks.

Total hardness-total dissolved solids

Total hardness is seldom used as a criterion for determining suitability of a supply for irrigation. It is generally stated that total dissolved solids should not exceed 550 ppm in domestic water supplies. If the total solids are divided by the electrical conductivity, the numerical result should be about 0.64 (3). Accord-

ing to this value, samples 1 and 16 (Table 1) come close with values of 0.63. Samples 9, 11, and 12 equalled or exceeded 0.90. This does not appear to be a particularly good indication of suitability since sample 9 water has been used successfully in carnation production for a number of years. Sample 1 water, with its high sodium content, causes severe problems in soils.

Table 1. Denver water analyses

Site	Remarks	EC ¹	OP ²	pH	Total hardness ³	Total solids ⁴	Ca	Mg	Na	K	Cl	SO ₄	NO ₃	CO ₃	HCO ₃	TDS ¹⁰ EC
1	Deep well ⁵	1.319	0.5	8	16	826	0	4	319		44	8	0	24		0.63
2	Shallow well ⁶	1.073	0.5	8	302	790	4	71	126		83	259	51	0	0	0.68
3	Shallow well	0.560	0.5	8	268	378	80	17	15		9	83	0	0	0	0.68
4-a	Shallow, 1968	0.517	0.7	8	278	442	80	19	46		15	132	0	0	0	0.85
4-b	Shallow, 1964			8	369	502	118	18	51	-- ⁷	32	210	0	--	264	
5-a	Deep, 1968	0.258	0.2	8	46	158	18	8	40		2	26	0	0	0	0.61
5-b	Deep, 1964			8	43	116	17		42	--	7	14	--	3	126	
6	Shallow	1.200	0.5	8	458	918	136	29	94		110	234	106	0	0	0.77
7-a	Shallow, 1968	1.100	0.7	8	488	966	146	31	148		85	239	90	0	0	0.87
7-b	Shallow, 1964			7	460	924	149	25	120	1	85	247	72	0	459	
8	Shallow	1.521	1.0	7	336	1048	98	22	226		76	316	95	0	0	0.69
9	Shallow	1.397	1.0	8	618	1286	183	39	162		57	542	0	0	0	0.92
10	Shallow	1.162	0.7	7	454	902	106	46	84		63	221	95	0	0	0.78
11	Shallow	1.343	1.0	8	630	1216	190	38	162		123	374	42	0	0	0.91
12	Deep	0.357	0.4	7	4	322	0	1	80		1	27	0	0	0	0.90
13	Shallow			7	625	1194	192	35	181	1	82	554	21	0	353	
14	Deep			8	78	558	24	4	162	--	14	268	--	12	171	
15-a	Denver, 1967 ⁸	0.255		8	110	188	31	8	13		25	44	--	0	75	0.74
15-b	Denver, 1964 ⁸			8	181	308	48	15	39	--	52	89	3	0	122	0.59
15-c	Denver, 1968 ⁸	0.364	0.2	8	116	214	23	14	25		30	58	0	0	0	
16	Denver, 1967 ⁹	0.093		8	40	59	11	4	1		4	15	--	0	27	0.63

Ft. Collins water supply: EC = 0.056, OP = 0.1, pH = 7

Ft. Collins water after fertilizer injection: EC = 1.379, OP = 0.7

¹ EC, electrical conductivity, millimhos/cm. ² OP, osmotic pressure dtr. by freezing point depression, atmospheres.

³ ppm CaCO₃. ⁴ Total dissolved solids as ppm, all others in ppm. ⁵ Deep wells in excess of 500 feet. ⁶ Shallow wells less than 100 feet. ⁷ -- indicates trace. ⁸ Denver water system, the South Platte source. ⁹ Denver water system the Moffat tunnel source. ¹⁰ $\frac{\text{Total dissolved solids}}{\text{Electrical conductivity}}$ should = 0.64

Individual ions

Analysis of the individual components showed considerable variation (Table 1). Bicarbonate (HCO₃) was not analyzed for all samples, but the close electrical balance shown for those samples which did have HCO₃ analyses (Table 2), indicated that bicarbonate is probably a major constituent of a number of water sources in the Denver area. The highest quality water is represented by samples 16, 15, 5 and 12 in descending order. Sample 1 is noted for excessive sodium content, followed by 13, 9, 11, 14 and 7-a in descending order. Problems with soil structure and maintenance of calcium and boron might be expected in such water. Apparently, the carnation is relatively insensitive to high sodium and sulfate - or at least these may be offset by appropriate nutrient solution modifications. There are indications that high sulfate (Samples 9 and 13) may inhibit calcium uptake in a number of plants (3). The breakdown of soil structure by excessive sodium, leading to problems of percolation and aeration, can be eliminated by using inert media such as Idealite.

Samples 13, 9, 7 and 6 are characterized by high calcium and magnesium. In some samples, the concentrations exceeded any that we have employed in

nutritional studies at CSU. It is obvious that calcium and magnesium need not be added to the injection solution. However, calcium phosphate precipitation will probably occur, even at the final nutrient dilution, when phosphorous is added. Only in samples 1, 2, 5, 12, 14, 15 and 16 does it appear possible to place phosphorous directly in a concentrate tank. Sample 2 had high magnesium content. Such levels have not been examined for effect on growth. Magnesium phosphate precipitation would likely occur if phosphorous was placed in the concentrate tank for injection, using sample 2 water.

It appears that chloride reduces growth of carnations progressively as concentration increases (CFGA Bull. 221). Those samples with chloride in excess of 35 ppm would probably show easily observable growth reduction when compared with plants grown at lower chloride levels. It appears that the carnation is particularly sensitive to chloride, especially in inert media, and its use as a carrier for potassium should be avoided.

Another ratio which may be used to check irrigation water, is the numerical result of dividing electrical conductivity by the total cations in solution (meq/l). The result should be close to 100 (3). Sam-

ples 4, 5, 7, 9 and 11 showed markedly high values, supposedly indicative of proportionally high sodium and chloride content (Table 2). Ratios less than 100 indicate sulfate and bicarbonate water in which calcium and magnesium are proportionally high. Only two samples (15-c and 16) had ratios less than 100. All others, for which data was available, had 100 or more. It is doubtful that the ratio is useful other than to indicate trends. For example, sample 1 showed very high sodium, but the ratio was only 108.

With the exception of samples 4 and 8 all of the sources from which the samples were taken have been, and are being, used to irrigate carnations with varying degrees of success. Despite high salts, high calcium, etc., one of the "least desirable" waters

(sample 9) has been used for about 6 years with outstanding success and high productivity. The general observation has been made that where the environment is properly controlled in conjunction with a suitable fertilizer program, none of the water sources analyzed in Tables 1 and 2 are completely unusable.

Your editor,



Table 2. Denver water analyses: Conversion to milliequivalents per liter (meq/l)

Site	Ca	Mg	Na	K	Total cations	$\frac{Ec^1}{CaT}$	Cl	SO ₄	NO ₃	CO ₃	HCO ₃	Total anions	Discrepancy ² C-A
1	0	0.33	13.87		14.20	108	1.24	0.17	0	0.80		2.21	11.99(A) ³
2	0.2	5.82	5.48		11.50	107	2.34	5.40	0.82	0		8.56	2.94(A)
3	4.0	1.39	0.65		6.04	108	0.25	1.73	0	0		1.98	4.06(A)
4-a	4.0	1.56	2.00		7.56	146	0.42	2.75	0	0		3.17	4.39(A)
4-b	5.9	1.48	2.22	0.15	9.75		0.90	4.38	0	--	4.33	9.61	0.14(A)**
5-a	0.90	0.66	1.74		3.30	128	0.06	0.54	0	0		0.60	2.70(A)
5-b	0.85	--	1.83	---	2.68		0.20	0.29	--	0.1	2.06	2.65	0.03(A)**
6	6.8	2.38	4.09		13.27	111	3.10	4.88	1.71	0		9.69	3.58(A)
7-a	7.3	2.54	6.39		16.23	148	2.39	4.97	1.45	0		8.81	7.42(A)
7-b	7.45	2.05	5.22	0.03	14.75		2.39	5.14	1.16	0	7.52	16.21	1.50(C)**
8	4.9	1.8	9.83		16.53	109	2.14	6.58	1.53	0		10.25	6.28(A)
9	9.15	3.20	7.04		19.37	139	1.60	11.29	0	0		12.89	6.48(A)
10	5.3	3.77	3.65		12.72	109	1.77	4.60	1.53	0		7.90	4.82(A)
11	9.5	3.11	7.04		19.65	146	3.46	7.79	0.68	0		11.99	7.72(A)
12	0	0.08	3.48		3.56	100	0.03	0.56	0	0		0.59	2.97(A)
13	9.6	2.87	7.87	0.03	20.37		2.31	11.54	0.34	0	5.79	19.98	0.39(A)**
14	1.2	0.33	7.04	--	8.57		0.39	5.58	--	0.40	2.80	9.17	0.60(C)**
15-a	1.55	0.66	0.56		2.77	109	0.70	0.92	--	0	1.23	2.85	0.08(C)**
15-b	2.40	1.23	1.70	--	5.33		1.46	1.85	0.05	0	2.00	5.36	0.03(C)**
15-c	1.15	1.15	1.08		3.38	93	0.84	1.21	0	0	--	2.05	1.33(A)**
16	0.55	0.33	0.04		0.92	99	0.11	0.31	--	0	0.44	0.86	0.06(A)**

¹ Electrical conductivity should = 100 total cations

² The total cations should equal the total anions for electrical neutrality. C-A indicates the discrepancy. Those samples in which HCO₃ was determined come close and are marked with an asterisk.

COLORADO FLOWER GROWERS ASSOCIATION, INC.
 OFFICE OF EDITOR
 W. D. Holley
 Colorado State University
 Fort Collins, Colorado 80521

FIRST CLASS