Auburn University Southern Forest Nursery Management Cooperative

RESEARCH REPORT 98-5

RESULTS OF 1996 IRRIGATION WATER QUALITY SURVEY

by
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INTRODUCTION

Poor quality irrigation water can detrimentally affect seedling growth and development. Sodium (Na), chlorine (Cl), and boron (B) can be directly toxic to foliage if found at high enough concentrations. Moreover, water with abnormally high levels of Na can cause soil crusting and lack of permeability because it breaks down the normal flocculating tendency of clays resulting in micropore blockage. Excessively high irrigation water pH can affect soil properties and fertility. Finally, government regulations set acceptable limits on the presence of specific compounds in drinking water. While nursery irrigation water is usually not a drinking water source, inappropriate levels of certain compounds, specifically nitrates (NO_3) might indicate a contamination problem. Therefore, keeping a watch on irrigation water quality is well justified.

The objective of this study was to determine the quality of water used to irrigate seedling crops by members of the Auburn Nursery Cooperative. Secondly we wanted to compare the results of this water survey to an earlier survey completed in 1986 to determine if any detectable changes have occurred.

METHODOLOGY

All 53 member nurseries in the Auburn Coop were contacted by telephone in the spring of 1996 and were requested to participate in the survey. Plastic bottles and instructions were mailed to all 53. We requested samples be taken from the irrigation system and not directly from surface sources such as ponds or creeks. Samples were mailed to Auburn and immediately frozen upon reception. When it was determined that we had received samples from all nurseries willing to participate, the samples were sent to the Auburn University Soil Testing Laboratory for analysis. The full range of water quality parameters were tested based using a standard methodology. (Specific methodology for each test can be provided upon request.)

RESULTS

A total of 62 water samples were received for analysis, representing 34 of the 53 nurseries contacted. The analysis results are presented in Table 1.

pH

The average pH from the 62 samples was 7.0, with the lowest value at 4.3 and the highest at 10.1. Most were in the 5 to 7 range. While it is probably safe to assume the majority of Coop nurseries should not have a problem with acidic irrigation water, there are some that have alkaline or high pH water that may be a problem. Some literature indicates that plant production problems do not begin until irrigation water goes above pH 7 ((Southern Nursery Association 1997). Eighteen nurseries had a pH value between 7.0 to 7.5, twelve with values between 7.5 and 8.0, and 4 nurseries had irrigation water above a pH of 8. It is important to remember, however, that the potential effect of irrigation water on soil pH is mitigated by the buffering capacity of the soil. Nevertheless, soils with low buffering capacity, such as very sandy soils low in organic matter, may see an increase in pH. Increasing soil pH can result in a decrease in the availability of plant nutrients, iron (Fe) and Manganese (Mg) in particular become less available as pH increases. Availability of both phosphorus (P) and Boron (B) decreases between a pH of 7.5 to 8.5. In addition, pathogenic fungi tend to increase with higher pH. Previous work by the Nursery Coop indicates that pines should be grown at pH 4.8 to 5.5.

NO_3

Many nurseries are concerned with nitrate levels in their well water because of potential groundwater contamination. Nitrate levels (NO_3) in this survey ranged from 0 to 17.59 ppm. The drinking water standard mandated by EPA is 10 ppm nitrogen *in the nitrate form* (NO_3-N). This is often a confusing point. Because NO_3 is only 22.6% nitrogen, the NO_3 level would have to reach 45 ppm before the drinking water standard of 10 ppm NO_3-N would be exceeded. None of the nurseries sampled had NO_3-N levels above the drinking water standard of 10 ppm.

As a point of interest, calculating an average of .06 ppm of NH_4 and 1.62 ppm of NO_3 in irrigation water, applying 1 inch of water on one acre would also apply approximately one tenth of a pound of nitrogen per acre.

Na and SAR

Sodium averages 10 ppm across all nurseries sampled. The recommended toxic threshold for Na in tree seedling irrigation water is 50 ppm (Landis 1989). Above this level, foliar toxicity symptoms may appear. Only two coop samples exceeds this limit.

As indicated, one of the most detrimental effects of high sodium content in irrigation water is a possible detrimental effect on soil structure and permeability. The concentration of Na in irrigation water in and of itself is not a good indicator of this potential. A better indicator is reflected in the Sodium Adsorption Ratio (SAR) which is calculated as:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$ (expressed in meq/liter)

SAR therefore gives an indication of how much of the soil exchange surfaces will be taken up by sodium as opposed to Calcium and Magnesium. Most soils have preferential adsorption of the double charged ions (Calcium and Magnesium) and therefore a straightforward measure of sodium content on a concentration (ppm) basis may overestimate the potential effect on soil properties. Moreover, fine textured soils will be more sensitive to possible sodium affects. Crusting and loss of permeability resulting from Na related deflocculation, is difficult in coarse textured soils with low clay content and relatively few micropores. An SAR of 3 or less is considered acceptable (Landis 1989). There was only one sample that had an unacceptably high SAR.

Boron and Other Elements

The foliar toxicity threshold for boron is 0.75 ppm (Landis 1989). No sample came close to this level. Analysis included several elements not listed in Table 1. These were Barium (Ba), Cobalt (Co), Copper (Cu), Chromium (Cr), Iron (Fe), Lead (Pb), Magnesium (Mn), Molybdenum (Mo), and Zinc (Zn). With the possible exception of iron, no sample indicated an unsuitable level of this element for plant production. Maximum recommended iron levels for conifer seedling nurseries is 0.1 ppm. Ten samples were above this threshold with a maximum of 0.15 ppm. Since the effect of excess Fe is cosmetic in that it may stain seedlings and decrease customer preference, it is doubtful these levels of Fe would cause any problem.

Changes Since 1986

Table 2 compares the results for NO_3 and Na analysis for the two years 1980 and 1996. These samples were taken from the same 13 nurseries both years. The average NO_3 concentrations increased by 0.93 ppm while Na increased by 2.45 ppm. Neither increase proved significant when using a paired t test comparison.

MANAGEMENT IMPLICATIONS

Nursery coop members generally have high quality irrigation water. Some caution may be needed on the part of specific nurseries regarding any influence on soil pH. Nitrate contamination of well water does not seem to be an issue. There does not appear to be a significant change in irrigation water quality over time in respect to fertilizer and Na element concentrations.

Literature Cited:

Landis, T. D., R.W. Tinus, S.E. Mc Donald, and J.P. Barnett. 1989. Seedling Nutrition and Irrigation, Bol. 4, The Container Tree Nursery Manual. Agric. Handbk. 674. Washington, DC, U.S. Department of Agriculture, Forest Service 119pp.

Southern Nursery Association. 1997. Best Management Practices Guide for Producing Container-Grown Plants. Southern Nursery Association, Marietta, GA. 69pp.

Table 1. Results of the Nursery Coop 1996 irrigation water survey.

No.	State	Nursery	Sample		ppm								SAR[+]
				pH	NH_4	NO_3	NO_3-N	P	K	Ca	Mg	Na	B	(meq/L
1	Alabama	A	1	7.6	0	1.16	0.26	0.15	1.25	42.72	6.15	3.24	0.015	0.12
2			2	7.3	0	0.47	0.11	0.19	0.92	34.74	6.54	1.67	0.016	0.07
3		B	1	6.5	0	0	0	0.05	0.58	1.23	0.33	1.75	0.009	0.36
4			2	6.7	0	0	0	0.14	0.71	1.70	0.39	1.81	0.009	0.33
5		C	1	6.8	0	0	0	0.10	1.55	5.63	0.94	2.25	0.009	0.23
6			2	6.6	0	0	0	0.08	1.72	5.64	0.94	1.96	0.015	0.20
7			3	7.1	0.07	0	0	0.69	2.00	14.17	1.60	5.30	0.013	0.36
8		D		7.2	0	5.10	1.15	0.14	1.91	3.37	4.40	1.94	0.016	0.16
9		E	1	6.2	0.03	9.10	2.06	0.28	3.19	3.81	7.53	3.28	0.016	0.22
10			2	7.0	0.01	0	0	0	0.93	1.05	0.48	3.34	0.009	0.68
11			3	5.9	0.02	1.50	0.34	0.13	0.45	0.89	0.82	3.32	0.009	0.61
12		F		7.3	0	0	0	0.12	6.07	14.4	1.93	15.20	0.013	1.00
13		G		7.3	0.02	0.29	0.07	0.09	1.05	2.57	1.47	4.11	0.009	0.51
14	Arkansas	A		7.0	0	0.99	0.22	0.16	1.24	1.76	0.68	2.36	0.016	0.38
15	Georgia	A	1	7.7	0	0	0	0.10	2.07	27.11	6.82	7.94	0.021	0.35
16			2	8.0	0	0	0	0.10	1.81	29.60	6.03	7.60	0.019	0.33
17			3	8.3	0	0.02	-	0.24	2.31	32.70	6.85	7.46	0.028	0.31
18		B		4.5	0	0	0	0.15	0.87	3.35	0.46	1.71	0.013	0.23
19		C	1	7.8	0	0.01	-	0.28	2.39	29.11	18.22	21.29	0.050	0.76
20			2	8.0	0	0	0	0.20	2.40	27.18	18.03	21.07	0.052	0.77
21		D		7.3	0	0.17	0.04	0.06	1.32	3.88	1.11	2.22	0.009	0.26
22		E	1	7.9	0	0	0	0.14	2.36	15.41	7.21	16.66	0.031	0.88
23			2	7.9	0	0	0	0.16	2.81	13.41	8.03	15.77	0.036	0.84
24			3	8.1	0	0	0	0.11	2.35	9.17	5.45	33.35	0.039	2.16
25		F	1	7.5	0	0	0	0.11	3.06	33.46	2.00	2.47	0.018	0.11
26			2	7.4	0	0	0	0.09	3.21	30.50	2.05	2.51	0.012	0.12
27		G		7.7	0.03	0	0	0.29	3.00	15.97	7.85	11.47	0.028	0.59

Table 1 Continued

No.	State	Nursery	Sample		ppm								SAR[+]
				pH	NH_4	NO_3	NO_3-N	P	K	Ca	Mg	Na	B	(meq/L
28	Louisiana	A	1	7.3	0	0	0	0.22	2.46	17.16	2.32	14.53	0.039	0.87
29			2	7.2	0.05	0	0	0.11	2.75	26.00	3.29	15.71	0.034	0.77
30			3	7.3	0	0.02	-	0.25	2.46	21.79	2.66	14.80	0.034	0.80
31		B		6.9	0	0	0	0.10	1.72	6.29	1.92	11.12	0.019	1.00
32		C	1	7.0	2.12	0	0	0.11	4.14	5.49	1.33	4.65	0.021	0.46
33			2	7.7	0	0.41	0.09	0.29	16.31	12.69	2.66	165.16	0.092	11.01
34	Mississippi	A	1	5.9	0.01	7.55	1.71	0.22	2.30	3.75	5.97	3.27	0.018	0.24
35			2	6.0	0	1.05	0.24	0.22	0.70	1.22	0.85	2.16	0.012	0.37
36			3	6.2	0	0.63	0.14	0.14	0.34	1.11	0.54	2.00	0.009	0.39
37		B	1	7.4	0.01	0	0	0.07	5.45	16.75	6.18	7.79	0.022	0.41
38			2	7.3	0.21	0	0	0.10	5.72	14.32	6.32	8.04	0.021	0.44
39	N. Carolina	A		9.3	0	1.88	0.42	0.22	3.02	17.13	0.19	6.51	0.022	0.43
40		B	1	6.9	0	0.03	-	0.07	1.13	2.55	1.12	3.24	0.009	0.42
41			2	6.9	0	6.79	1.53	0.07	1.29	3.05	1.28	3.70	0.007	0.45
42		C	1	4.3	0	14.89	3.37	0.14	1.74	7.89	13.07	4.98	0.021	0.25
43			2	4.5	0.01	17.59	3.98	0.20	2.48	10.22	12.37	4.18	0.024	0.21
44			3	6.8	0	0	0	0.04	2.18	2.94	0.39	5.97	0.015	0.87
45		D		7.5	0	0.07	0.02	0.07	1.50	50.22	2.14	6.21	0.021	0.23
46	S. Carolina	A		7.7	0	1.09	0.25	0.12	3.52	2.58	1.56	9.59	0.028	1.16
47		B	1	5.8	0	0.06	0.01	0.07	0.36	0.59	0.12	1.57	0.003	0.49
48			2	5.7	0	3.38	0.76	0.12	0.35	0.59	0.48	2.15	0.006	0.50
49			3	5.8	0	3.73	0.84	0.12	0.68	1.23	2.03	2.56	0.009	0.33
50		C	1	6.9	0.02	1.23	0.34	0.06	0.62	9.33	2.95	10.43	0.025	0.76
51			2	6.6	0	0.79	0.18	0.12	2.38	5.95	3.30	4.27	0.052	0.35
52		D		6.6	0.03	2.97	0.67	0.09	1.33	4.72	1.42	3.32	0.009	0.34
53		E	1	6.7	0	0.13	0.03	0.04	0.64	2.15	0.30	2.37	0.009	0.40
54			2	10.1	0.13	9.66	2.18	0	2.24	31.53	0.06	3.21	0.004	0.16
55			3	5.4	1.07	2.07	0.47	0.04	0.81	0.91	2.00	1.87	0.009	0.25
56			4	6.2	0	0	0	0.13	0.42	0.41	0.27	1.47	0.007	0.44

Table 1 Continued

No.	State	Nursery	Sample	pH	ppm NH_4	ppm NO_3	ppm NO_3-N	ppm P	ppm K	ppm Ca	ppm Mg	ppm Na	ppm B	SAR† (meq/L
57			5	5.8	0	0.42	0.09	0.09	0.26	0.39	0.19	1.89	0.004	0.62
58	Tennessee	A		6.5	0	0	0	0.11	3.28	2.81	1.46	5.40	0.012	0.65
59	Texas	A		7.3	0	3.68	0.83	0.13	3.45	8.73	4.57	9.90	0.027	0.68
60		B		7.5	0	0	0	0.17	5.13	57.41	5.11	52.20	0.059	1.77
61		C		7.3	0.01	0.03	0.01	0.16	4.37	11.05	3.85	15.79	0.033	1.04
62	Virginia	A		7.4	0	1.46	0.33	0.27	2.66	25.64	10.64	7.24	0.025	0.30
Average				6.97	.06	1.62		.14	2.3	12.8	3.70	10.04	.021	
Range				4.3-10.1	0 - 2.12	0 - 17.59		0-.69	0.26-16.31	0.59-57.4	0.12-18.22	1.47-165.2	.004-.092	

† Sodium Adsorption Ratio

Table 2. Comparison of 1986 Nitrate and Na values to 1998 values for 13 nurseries

		ppm			
		NO3		Na	
Nursery†	State	1980	1996	1980	1996
3	Alabama	0.85	0	1.2	1.80
8		0.92	5.12	1.0	1.94
9		2.97	9.07	4.7	3.28
14	Arkansas	1.17	0.99	1.8	2.36
19	Georgia	1.70	0.01	3.6	21.29
29	Louisiana	1.32	0	3.5	15.71
34	Mississippi	1.25	7.55	1.7	3.27
37		0.75	0	4.7	7.79
39	N. Carolina	1.17	1.88	12.0	6.51
47	S. Carolina	1.00	0.06	3.7	1.57
50		1.17	1.23	8.6	10.43
55		0.85	2.07	1.4	1.87
60	Texas	0.80	0	50.3	52.2
	Average	1.22	2.15	7.55	10.00
	Difference	+ 0.93 ns		+ 2.45 ns	

† Numbers correspond to those in Table 1.