A NOTE ON EFFECTS OF SEWAGE EFFLUENT IRRIGATION ON SPECIFIC GRAVITY AND GROWTH RATE OF WHITE AND RED OAKS[1]

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ABSTRACT

A 2.5-acre forested terrace of mixed hardwoods (predominately oak) in southern Missouri was sprinkler-irrigated with treated sewage effluent. Ninety-two oak trees were sampled (increment cores) at breast height. There were 41 white oaks and 52 red oaks. Growth rate increased significantly for white oaks and specific gravity increased significantly for red oaks.

Keywords: *Quercus* Spp., fertilization, sewage effluent treatment, specific gravity, growth rate, irrigation.

INTRODUCTION

As man expands his occupancy and use of the land, disposal of wastes—both industrial and domestic—is becoming a major concern. Because of growing ecological awareness, waste disposal systems that cause further degradation of the environment are no longer acceptable, aesthetically or, in many cases, legally. New methods of waste disposal must be developed that return our waste products to the environment in a manner that will have minimal effect on the natural order.

The disposal of sewage is one problem that might be turned to our advantage because treated sewage contains materials that can be returned to nature with beneficial results. Irrigation of crop and forest land with treated sewage effluent may prove to be an efficient means of disposal as well as a benefit to the plants through the addition of nutrients and water to the soil. Murphey et al. (1973), for example, found a significant increase in growth of red oak after irrigation with treated sewage effluent.

Fertilization and irrigation have proved to be beneficial silvicultural treatments (Paul and Marts 1931; Erickson and Lambert 1958; Williams and Hamilton 1961; Broadfoot 1964). While many have reported increased radial growth, there is considerable variation in tree response with regard to specific gravity and springwood/summerwood percentages. Reviews by Klem (1968) and Van Buijtenen (1969) indicate that the effect of fertilization is strongly affected by tree species, climate, soil conditions, and genetic differences. Silvicultural treatments, such as thinning, also affect results of fertilizer application. In a recent study of nitrogen fertilization of pole-size loblolly pine plantations, Wells et al. (1976) found that small variations in initial basal area could mask responses to fertilization. In short, different trees will probably react differently to the same treatment.

The present study was undertaken to determine the effects of four years of irrigation with treated sewage effluent on white and red oaks in southern Missouri.

EXPERIMENTAL

The study area is a 2.5-acre forested terrace of mixed hardwoods (predominately oak) in southern Missouri. The site

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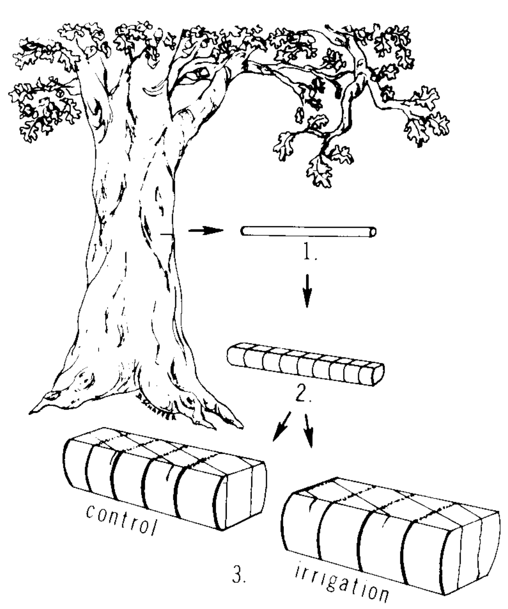


FIG. 1. Sampling technique showing subdivision of increment core into 4-year irrigation segment and 5-year control segment.

was sprinkler-irrigated with treated sewage effluent from a three-cell facultative oxidation pond system. Irrigation plus precipitation (average 53.34 cm) averaged 193.04 cm during the four-year study—1972–1975. The proportions of the major constituents of the effluent—18 N, 23 P_2O_5, and 46 K_2O pounds per acre—approximate a 9-11-23 commercial fertilizer. The soil is classed as a Clarksville loam.

The species sampled were scarlet oak (*Quercus coccinea* Muenchh.), black oak (*Q. velutina* Lam.), white oak (*Q. alba* L.), and post oak (*Q. stellata* Wang.). Data for black and scarlet oak were combined, as were white and post oak data, and presented as "red" oaks and "white" oaks, respectively. A total of 92 trees were sampled by removing increment cores at breast height, which were later subdivided into treatment and control segments as shown in Fig. 1. The 92 sampled trees were composed of 41 "white" oaks ranging from 30–89 in ring count and from 10.16–45.72 cm at breast height. Corresponding data for the 51 "red" oaks are 20–40 rings and 10.16–50.80 cm. All trees were sampled in 5.08-cm-diameter classes ranging from 10.16–15.24 cm up to 40.64–45.72 cm, based on diameter distribution in the plot.

The cores were placed in a Soxhlet apparatus and cycled with water for 48 h to bring them to maximum moisture content. Both transverse faces were microtomed smooth, and the cores were divided into samples: one containing the last four years of growth—the irrigation sample, and one containing the previous five years—the control sample.

This sampling method was chosen because it would allow a comparison of wood properties within trees between the "irrigation" and "control" samples eliminating variation attributable to that between trees (if a separate control area was sampled). This same technique was used by Murphey et al. (1973) in a study of northern red oak.

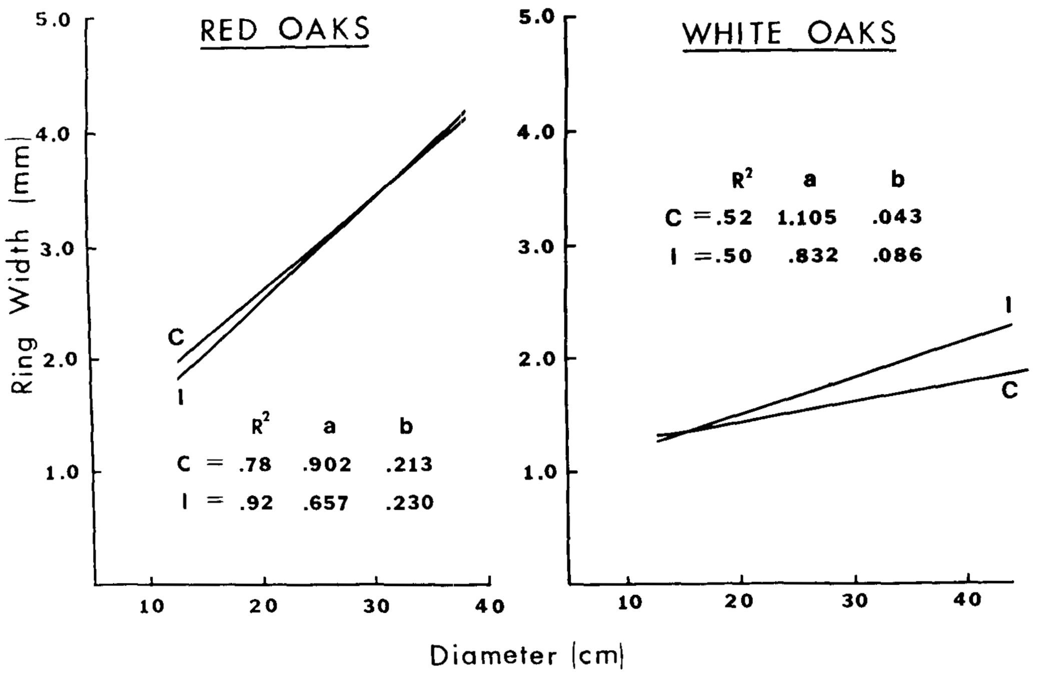
Photographs of one transverse face of each sample were taken with a 35-mm camera equipped with bellows attachment and reverse-mounted 50-mm macro lens. A millimeter scale was included in each photograph for growth rate measurement and a sample number for identification. Growth rate was measured directly from the photographs.

Specific gravity was calculated using Smith's (1954) formula.

RESULTS AND DISCUSSION

Growth rate and specific gravity data are presented in Table 1. Growth rate increased significantly for white oaks but not for red oaks; whereas specific gravity increased significantly only for the red oak group. It appears that white oak trees of the larger diameter classes (presumably representing the more vigorously growing trees) respond more favorably to treatment than trees in the smaller diameter classes. Regression analyses presented in Figs. 2 and 3 support this observation. Red oak response appears to be independent of diameter class for specific gravity data.

It is possible that the difference in age between the red and white oaks may be an



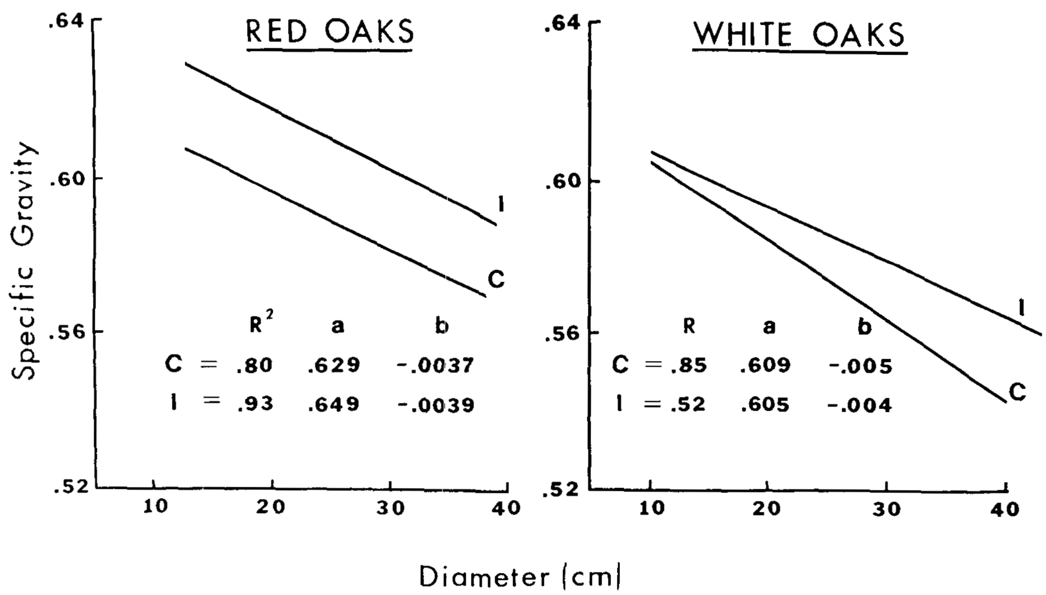


FIG. 2. Plot of ring width vs. diameter at breast height for red and white oaks. C = control and I = irrigated samples.

FIG. 3. Plot of specific gravity vs. diameter at breast height for red and white oaks. C = control and I = irrigated samples.

TABLE 1. *Effects of sewage effluent irrigation on specific gravity and growth rate of white and red oaks*

Species Group	Diameter Class and Number of Samples (cm)	Age[a]	Specific Gravity			Ring Width (mm)		
			Contr.	Irri.	Diff.	Contr.	Irri.	Diff.
White Oaks	10.16-15.24 (6)	75	0.59	0.59	0.00	1.43	1.37	-0.06
	15.24-20.32 (4)	---	0.56	0.56	0.00	1.18	0.82	-0.36
	20.32-25.40 (8)	42	0.56	0.59	+0.03	1.72	2.16	+0.44
	25.40-30.48 (7)	---	0.55	0.55	-0.01	1.53	1.85	+0.32
	30.48-35.56 (7)	71	0.55	0.57	+0.02	1.43	1.83	+0.40
	35.56-40.64 (5)	---	0.53	0.55	+0.02	1.86	2.34	+0.48
	40.64-45.72 (4)	79	0.52	0.53	+0.01	1.87	2.07	+0.20
	combined (41)	---	0.55	0.56	+0.01	1.57	1.78	+0.21*
Red Oaks	10.16-15.24 (11)	24	0.61	0.62	+0.01	1.49	1.55	+0.06
	15.24-20.32 (11)	---	0.61	0.63	+0.02	2.60	2.55	-0.05
	20.32-25.40 (11)	32	0.59	0.61	+0.02	2.80	3.44	+0.64
	25.40-30.48 (10)	---	0.59	0.61	+0.02	3.13	3.34	+0.21
	30.48-35.56 (4)	31	0.59	0.60	+0.01	3.85	3.15	-0.70
	35.56-40.64 (4)	---	0.57	0.59	+0.02	3.90	4.20	+0.30
	combined (51)	---	0.59	0.61	+0.02**	2.96	3.04	+0.08

[a] Average ring count at breast height

* Difference significant at 5% level

** Difference significant at 1% level

important factor in observed treatment effects. An additional study on both young and old white oaks could answer this question. From Table 1, the youngest white oak group had the greatest increase in specific gravity coupled with the second largest increase in growth rate.

The differences (Table 1) noted as statistically significant may not be all that real. In this study, considerably less irrigation and sewage effluent were added as compared to the investigation of red oaks by Murphey et al. (1973); this may be one reason that the treatment effects are not as pronounced. The results for growth rate of red oaks would also show a significant increase if data of one group of four trees were removed; however, results were checked and no valid reason for eliminating them could be found.

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