Growth Response of Newly Planted Valley Oak Trees to Supplemental Fertilizers[1]

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Abstract

Growth of Valley Oak (*Quercus lobata* Neé) trees was not improved by slow-release or soluble fertilizers applied at planting time, nor by a single application of soluble fertilizer one year after planting. The native soil, with nutrient levels typical of newly developed residential and park areas in the region, provided adequate nutrition for good tree growth over the term of the 3-year study.

Index words: Shade trees, plant nutrition, *Quercus lobata*

Significant to the Nursery Industry

Recommendations for fertilizing landscape trees, based on scientific studies, are lacking in the literature. In particular for newly transplanted trees, recommendations range from no fertilizer the first growing season to a complete fertilizer mixed in the planting hole. More specific information on landscape tree fertilization is needed, considering the wide range of soil types and native fertility levels, as well as the wide range of available fertilizers. The results of this study indicate that nursery grown oak trees, transplanted into soils of moderate fertility, may not need added nutrients for the first 2 to 3 years.

Introduction

It is generally acknowledged that fertilizers usually improve the growth of young landscape trees, and that mature trees need little, if any, additional fertilizer (5). In soils deficient in a particular nutrient, the addition of fertilizers containing this nutrient is necessary for successful plant growth. Extensive work by van de Werken showed that on phosphorus deficient soil, applications of complete fertilizers enhanced the growth of several landscape tree species (16).

Harris (4) reports that 2 applications of ammonium nitrate at 125 g N per application (0.25 lb N) significantly improved the growth of newly planted *Magnolia grandiflora* and *Zelkova serrata* in a turfed area. Likewise, Meskimen (9) found that monthly applications of 6N-2.6P-5.0K (6-6-6) fertilizer at 80 g N per application (0.18 lb N) improved the growth of newly planted *Eucalyptus camaldulensis* in a turfed area. However, van de Werken (15) reports that yearly applications of ammonium nitrate did not significantly affect the growth of sugar maple, yellow poplar and pin oak planted in turfgrass in the first three years after planting.

Following a four-year study of well-established trees (10–11 years old), Neely (10) reported that in soils where nutrients were not a major limiting factor for plant growth, the addition of nutrients did not improve tree performance and was not a suitable cultural practice. Additionally, Shoup et al. (12) stated that in "good soils," the addition of 1.8 kg N/9 m^2 (4 lb N/1000 ft^2) of dry fertilizer had little effect on vegetative plant growth in apple, pear, peach and Arizona ash.

Other studies indicate that landscape trees may not require high levels of soil nutrients for satisfactory growth. One year after fertilizing newly planted trees with various fertilizers, Corley et al. (1) reported "few significant growth increases" in four landscape species (white flowering dogwood, red maple, Chinese pistache and sycamore). The trees were planted in a soil which had low to moderate fertility.

Laboratory tests have shown that landscape plant species differ in maximum growth response to nitrogen solution concentrations. However, when applications cause soil nitrogen to exceed plant needs, additional fertilizer is wasteful and does not contribute to improved growth (2, 6, 7, 11). In fact, Wright and Hale (17) reported that increasing N levels from 168 to 329 kg N/ha (148 to 290 lbs N/A) did not result in an increase in height or trunk diameter of landscape trees at the end of three years.

Unnecessary or excessive fertilization may also have adverse effects on trees. McClure (8) reports that certain sucking insect pests of trees and shrubs are actually favored by nitrogen fertilization. Harris (3) states that unnecessary fertilizer applications waste both time and money and can lead to salt build-up in the soil and to water pollution.

From the available literature, it appears that a knowledge of soil fertility at the planting site is important in order to avoid unnecessary fertilizer applications. The purpose of this trial was to determine the growth response of newly planted, container grown *Quercus lobata* to applied nitrogen fertilizer in a planting site of known natural fertility.

Materials and Methods

Forty-eight *Quercus lobata* (Valley Oak) trees were transplanted from 57 L, 44.5 cm h × 37.5 cm diam (15 gal, 17.5 in h × 14.75 in diam) containers on January 13, 1989. The trees were 16–17 mm (0.63–0.67 in) in diameter at breast height, 2.7–3.2 m (8.9–10.6 ft) tall, and were approximately 2 years old at time of planting. Fertilizer treatments consisted of applications of a slow release 20N-4.4P-4.2K (20-10-5) fertilizer at planting time (Agriform Planting Tablets, Sierra Chemical Company), a soluble 12N-2.6P-14.9K (12-6-18) fertilizer at planting time (Tree and Vine, J.R. Simplot Company), the soluble 12N-2.6P-14.9K (12-6-18) fertilizer applied 12 months after planting, and an

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untreated control. Each treatment was replicated 12 times in a randomized complete block design. Planting holes approximately 76 cm (30 in) wide and 38 cm (15 in) deep were dug. Trees were positioned in the planting holes and backfilled with unamended native soil to within 15 to 20 cm (6 to 8 in) of soil surface. For the first treatment, ten 21-gram slow release tablets (42 g N, 0.09 lb N) were placed in the partially-filled planting hole, evenly spaced around the root ball, about 2.5 cm (1 in) from the root tips, in accordance with the manufacturer's label directions. The planting hole was then completely backfilled. For the second treatment, 75 grams (9 g N, 0.02 lb N) of the soluble 12N-2.6P-14.9K (12-6-18) fertilizer was uniformly placed in the partially-filled planting hole, approximately 2.5 cm (1 in) from the root tips. Complete backfilling followed. A third treatment, made on January 19, 1990, consisted of a surface application of soluble 12N-2.6P-14.9K (12-6-18) fertilizer at the rate of 280 grams (34 g N, 0.08 lb N) per tree. The fertilizer was uniformly placed on the soil surface within the tree's dripline, and lightly raked into the soil to approximately 2 cm (3/4 in) deep. The rates of soluble fertilizer used fall within the wide ranges that are generally recommended (3). The fourth treatment was an untreated control. Each tree was watered with 19 liters (5 gal) of water following planting and fertilizing. Irrigation basins were built around each tree to hold water.

The trees were planted in a non-turfed area, in a newly developed City of Modesto park. The test site was approximately 0.8 hectare (2A) in size. The soil type was a Bear Creek clay loam of moderate native fertility (14), and typical of soils developed as parks in the Central Valley of California. The soil was uniform throughout the area of the trial. Six pre-plant soil samples from surface to 0.6 m (2 ft) deep were collected, and a composite sample submitted to the University of California Diagnostic Laboratory for analysis. The analysis results were as follows: pH-5.6, NO_3-N-25.5 ppm, total N-490 ppm, P-39 ppm and K-530 ppm.

After planting, a drip irrigation system was installed, with a single 1-gallon per hour emitter placed in each irrigation basin. The trees were irrigated once every 7 to 14 days, from March to November, throughout the duration of the trial. The trees were irrigated at full evapotranspiration of 119.4 cm (47 in) per year in order to ensure good growth and avoid moisture stress. Weeds growing in the tree watering basins were controlled by hand.

Tree growth measurements were taken at 6, 12, 18, 24, 30 and 36 months after planting. Measurements included tree height and trunk diameter at 0.3 m (1 ft) above the ground. The data were analyzed using One-Way Analysis of Variance. Duncan's Multiple Range Test was used for analysis of mean separation.

Results and Discussion

Growth of the oak trees in this 36-month trial was not improved by a slow-release fertilizer or a soluble fertilizer at time of planting, nor by a single application of a soluble fertilizer one year after planting (Table 1). There was a steady increase in tree size within all treatments over the trial period. Average tree height increased by 68 percent (1.2 m or 3.9 ft) and trunk diameter at 0.3 m (1 ft) above ground by 67 percent (58 mm or 2.3 in). No observable differences in leaf color or size were observed 6, 18 and 30 months after planting. From these data, it appears that the native fertility of the soil at the planting site was adequate, as non-fertilized trees grew as well as fertilized trees.

To verify that the soil at the test site was representative of soils in the area that may be developed as residential or park areas, soils were sampled in four other locations. These sites were previously grape and fruit tree farms, and were being developed as residential subdivisions. Soils were analyzed for nitrate nitrogen, total nitrogen, phosphorus and potassium concentrations. Compared to most of the sites sampled, the soil at the test site is not substantially more fertile, especially in nitrate nitrogen (Table 2).

Foliage tissue samples were collected from the test trees in October 1989 and submitted to the University of California Diagnostic Laboratory for analysis. Although the fertilized trees had higher foliage tissue concentrations of N, P and K compared to the untreated check trees (Table 3), growth was not significantly improved. Nutrient levels in the untreated check trees were adequate to support growth. Little information is available regarding critical nutrient levels in landscape tree foliage. Harris (3) states that P is deficient in both conifers and broadleaved plants if the level in current season's foliage is below 0.1 percent. In the current test, levels of P were well above 0.1 percent, even in control trees. In a study comparing fertilizer application techniques in willow oaks (*Quercus phellos*), Smiley et al. (13) states that N deficient trees may start with foliage levels of 1.4 percent N and need to be raised to 2.0 percent N. Trees in the current study, including controls, had foliar N concentrations well above 2.0 percent.

Table 1. Effects of fertilization on oak tree height and trunk diameter at intervals following treatment.

	Months											
	6		12		18		24		30		36	
Treatments	Height (m)	Diameter[z] (mm)	Height (m)	Diameter (mm)	Height (m)	Diameter (mm)	Height (m)	Diameter (mm)	Height (m)	Diameter (mm)	Height (m)	Diameter (mm)
Slow Release 20-10-5 (at planting)	2.7[y]	28.8	2.7	31.0	2.9	43.6	3.4	57.3	3.7	75.8	3.9	85.1
Soluble 12-16-18 (at planting)	3.0	29.7	3.0	32.8	3.2	46.4	3.9	67.2	3.8	77.7	4.3	87.5
Soluble 12-6-18 (1 year post plant)	3.2	30.3	3.3	32.9	3.3	45.1	4.0	61.8	4.1	73.9	4.2	80.5
Control	3.0	28.3	3.0	29.9	3.1	41.9	3.6	56.5	3.6	72.4	4.1	85.6

[z]Measurement taken at 0.3 m (1 ft) above ground level.

[y]Treatment differences were not significant for height or diameter at 0.3 m at any of the measured intervals.

Table 2. Soil nutrient levels of comparison sites.

Soil type	NO_3N ppm	N ppm	P ppm	K ppm
Greenfield sandy loam	14.9	800	37.0	100
Hanford sandy loam	22.3	200	21.3	156
Hanford fine sandy loam	25.4	240	46.0	199
Dinuba fine sandy loam	60.0	580	55.0	181
Mean	30.7	455	39.5	159

Table 3. Percent foliar nutrient concentrations in Valley Oaks, 9 months after fertilizer treatment.

Treatment	N	Percent P	K
Slow Release 20-10-5 (at planting)	2.62	0.19	1.54
Soluble 12-6-18 (at planting)	2.52	0.18	0.71
(at planting)			
Control	2.42	0.17	0.62

This study indicates that additional fertilizer may not be necessary for many newly planted landscape trees if natural soil fertility levels are nearly equivalent to those found in this study.

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