Influence of Fertilization Practices on Live Oak Wound Closure

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Abstract. **A 2-year study was conducted in southwest Florida to evaluate the effects of quick vs. slow-release nitrogen sources commonly used in landscapes on wound closure in live oak [*Quercus virginiana* (Mill.)]. Fertilized trees displayed nonsignificant shoot growth and leaf color when compared to nonfertilized ones. Neither fertilizer type, nor rate of application appeared to affect wound closure rates over the two year measurement period. This study showed increased replication will be needed when studying landscape trees, since trends in known primary growth response to fertilization were present but were not statistically significant. Fertilization effects on secondary growth including diameter increase and wound closure rate, were correspondingly not significant. Secondary growth responses may be difficult to demonstrate in live oak when using landscape trees especially at lower nitrogen rates currently being recommended in the industry.**

Tree pruning in landscapes, nurseries and on newly planted trees is one of the most common cultural practices used in the production and maintenance of trees. However, there have been no studies to link the effects of soil fertility, especially nitrogen fertilization, to the rate of wound closure after pruning. Rapid wound closure on both young and old trees is important in minimizing the amount of time that wounds are potentially exposed to infection by canker and wood decay fungi.

Many studies have been conducted over the past several decades to evaluate the effects of fertilizers on plant growth and establishment. Other studies have investigated the effects of various fertilizers on plant response to insect/disease pressure (Waring and Cobb, 1992). A recurrent problem one encounters when reviewing the literature is the lack of qualification of the specific fertilizers used. Consequently, many authors have made conclusions such as "…fertilizers result in…," or "….fertilizers cause….," without actually specifying a quick- or slow-release nitrogen type of product. A recent symposium was organized to clarify some of these issues and to reach a consensus among academics and the industry regarding the present state of knowledge and future research needs (Siewert et al., 2000).

No studies appear in the literature which specifically address the effect of fertilization on wound closure. Neely (1988) studied the wound closure rates of ten species of plantation-grown trees. He concluded that closure rates correlated positively with trunk growth, but varied among the different species. However, he did not elaborate on the role of fertilization in this process. Neely (1973) also studied wound healing on American elm [*Ulmus americana* L.], white ash [*Fraxinus americana* L.], honeylocust [*Gleditsia triacanthos* L.], tuliptree [*Liriodendron tulipifera* L.] and pin oak [*Quercus palustris* Muench]. He determined that large wounds, 7.5 cm wide closed (sealed) more quickly than small wounds, 2.5 cm wide. In addition, wounds on faster growing trees, such as pin oak and tulip tree, sealed faster than the other species. Again, neither study elaborated on the role of fertilization in the wound sealing process.

This study was conducted in 2002–03 to investigate the effects of quick- and slow-release nitrogen as a component of common fertilizer sources on the ability of trees to seal pruning wounds. Even though quick-release nitrogen fertilizers such as urea or ammonium nitrate result in fast green-up and growth flush; they do possess the potential for leaching and resultant ground water contamination if misapplied or if applied in excessive amounts (Funk, 2003). Slow-release nitrogen fertilizers on the other hand, have a reduced leaching potential and may provide a more attractive alternative when considering both tree health as well as environmental concerns (Tisdale and Nelson, 1975; Petrovic, 1990; McCarty et al., 1993). Further, since trunk growth and wound closure are secondary growth characteristics, there may be important differences in how quick- and slow-release sources of nitrogen affect primary and secondary growth.

Materials and Methods

A cohort of live oak trees [*Quercus virginiana* (Mill.)], ranging from 20 to 30 cm Diameter at Breast Height (DBH) was used. The trees were growing along the entrance to Franklin Locks on the Caloosahatchee River in the eastern part of Lee County, Fla. The soil type was Caloosa Fine Sand and the texture was loamy sand (85% sand; 12% silt; 3% clay) with a pH of 7.6. The oaks had not been fertilized in the past. Two types of fertilizers were evaluated. A quick-release form of nitrogen as urea (46N–0P–0K; Lesco, Rocky River, Ohio), and a slow-release nitrogen in the form of ureaformaldehyde (Arbor Green, 30N–4.4P–5.8K, The Davey Tree Expert Co., Kent, Ohio). There were five fertilization treatments as follows: 1) Urea active ingredient N at 1.36 kg/91 m^2; 2) Urea active ingredient N at 2.72 kg/91 m^2; 3) Ureaformaldehyde active ingredient N at 1.36 kg/91 m^2; 4) Ureaformaldehyde ingredient N at 2.72 kg/91 m^2; and 5) Untreated Control. The rates of fertilizers chosen were representative of those used in the industry. All fertilizers were applied through hydraulic root injection to a depth of 15 to 20 cm in a grid pattern 1 m on center in the drip zone, maintaining a distance of 1 m away from the base of the trunk (Funk, 2000). One-half gallon of solution was injected in each hole. Treatments within a replication were assigned at random to the trees. Every treated tree was separated by an untreated buffer tree on each side. Fertilization was conducted on 24 Jan. 2002 and on 22 Jan. 2003.

Two limbs were pruned (mechanically removed) at random from each tree at a height of 1.3-1.5 m from the ground on 21 Jan. 2002. The resulting wounds ranged in size from 2.5 to 5.7 cm, with means per treatments as follows: 1) 4.0 cm, 2) 3.7 cm, 3) 4.1 cm, 4) 3.2 cm, and 5) 3.0 cm. The diameter of each wound was recorded and the width of the opening measured at 3, 6, 9, 12, 15, 18, 21, and 24 month intervals. Other growth parameters monitored included DBH, twig elongation and leaf color. Diameter at Breast Height was measured at 3, 12, and 24 month intervals. Twig elongation was evaluated by measuring the annual growth from 3 twigs selected at random from each cardinal direction on the tree (resulting in 12 data points per replication) at 12 and 24 month intervals. Leaf color was evaluated by measuring the optical density from 3 leaves selected at random from each cardinal direction on the tree (resulting in 12 data points per replication) at 12 and 24 month intervals. A SPAD optical density meter (OD meter SPAD 502, Minolta Corp., Japan) was used for leaf color evaluations.

There were four replications per treatment. A tree comprised an experimental unit or replication. Data were analyzed via Analysis of Variance procedure and mean separation via Student-Newman-Keuls test at p=0.05 (ARM 6, Gylling Data Management, Inc., Bookings, S.Dak.).

Results and Discussion

Pruning wounds started to partially produce wound wood (initial callus) as early

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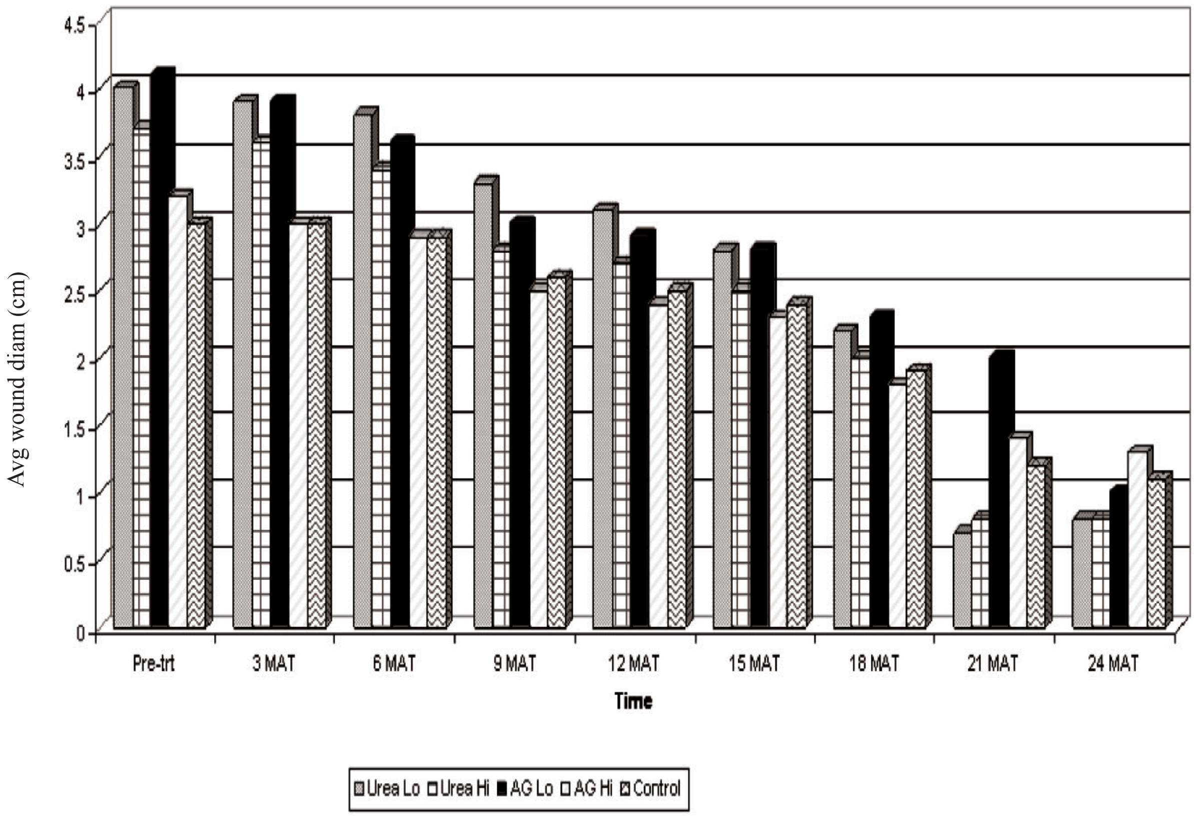

Fig. 1. Live oak wound closure as influenced by various fertilizers, 2002–03, Lee County, Fla.

Table 1. Influence of various fertilizers on live oak [*Quercus virginiana* (Mill.)] twig elongation and leaf color, 2002–03, Lee County, Fla.

	Rate	12 MAT[z]		24 MAT	
Treatment	(a.i. N at kg/91 m^2)	Twig length (cm)	Leaf color[y]	Twig length (cm)	Leaf color
Urea low	1.36	15.6	44.0	11.4	43.5
Urea high	2.72	16.3	46.0	15.7	45.3
Ureaformaldehyde low	1.36	16.8	43.1	15.8	45.1
Ureaformaldehyde high	2.72	21.0	41.2	14.8	43.8
Untreated control	---	11.2	37.5	9.4	38.9

[z]Months after treatment.
[y]Measured with an optical density meter (SPAD 502; Minolta).
Means within a column are not significantly different ($P \leq 0.05$) by Student-Newman-Keuls test.

as 3 months after treatment (MAT). Wound closure was comparable in all treatments (Fig. 1). Trees receiving the urea treatments closed their wounds by about 80% at 24 MAT. Over the same period, trees receiving the ureaformaldehyde treatments closed their wounds by an average of 68% and the Control trees by an average of 65%. Wound closure was not statistically different among treatments at any of the measurement periods.

Even though live oaks have a moderately rapid growth rate (Gilman, 1997), pruning wounds did not completely close. In a previous, preliminary study, the authors observed complete wound closure on green ash [*Fraxinus pennsylvanica*] within 6 months. The latter being a rapid growth rate species.

Twig elongation and leaf color data are shown in Table 1. Overall, twig elongation/growth rate was higher in 2002 than in 2003. This may be explained in part by greater precipitation in 2002 with 2,105 mm than in 2003 with 1,819 mm as shown in Fig. 2. There were no statistical differences in twig elongation or colorimetric readings at 12 or 24 MAT. Since the response of primary growth to fertilization was not significant statistically, it is then unlikely that secondary growth responses, including wound closure, would result. This is illustrated in Table 2 where the increase in trunk diameter was comparable in all treatments. The addition of nitrogen containing fertilizers usually results in greater primary growth (increased leaf production) rather than secondary growth (Wareing and Patrick, 1975). However, this study failed to show a statistically significant response to either N source even at the relatively high rate of 2.72 kg/91 m^2.

Despite the common practice of fertilization of ornamental trees, there are no studies that demonstrate a reliable response to fertilization on secondary growth characteristics of maturing or mature trees. As in this study, the ability to obtain adequate replication to demonstrate even known responses (e.g., primary twig elongation), using trees in the landscape where practices such as fertilization are used, can be problematic. The trends in primary growth and chlorophyll content of leaves, although not statistically significant, were in line with established responses for fertilized trees.

This research is of benefit to the industry in that future research effort on this or related topics will be known to require additional increases in replication if landscape trees will be investigated. In this study, even though soil type, tree species and age were relatively consistent within the treatment population, four replications were not adequate to demonstrate a known primary growth response to fertilization. Further, the recommended trend in the industry is to lower nitrogen rates applied to ornamental trees based on field evaluation of the tree's growth (ANSI, 2004; Siewert et al., 2000). Given our lack of response to even a relatively high rate of N using two fertilizers, it may be unlikely that a consistent secondary growth response in live oak in ornamental situations can be relied upon at lower use rates of nitrogen.

Literature Cited

American National Standards Institute. 2004. American National Standard for tree care operations—Tree, shrub and other woody plant maintenance—Standard practices (*Fertilization*). Tree Care Ind. Assn., Inc., Manchester, N.H.

Funk, R.C. 2000. The effect of fertilizer source and placement on tree growth, p. 83–86. In: Siewert et

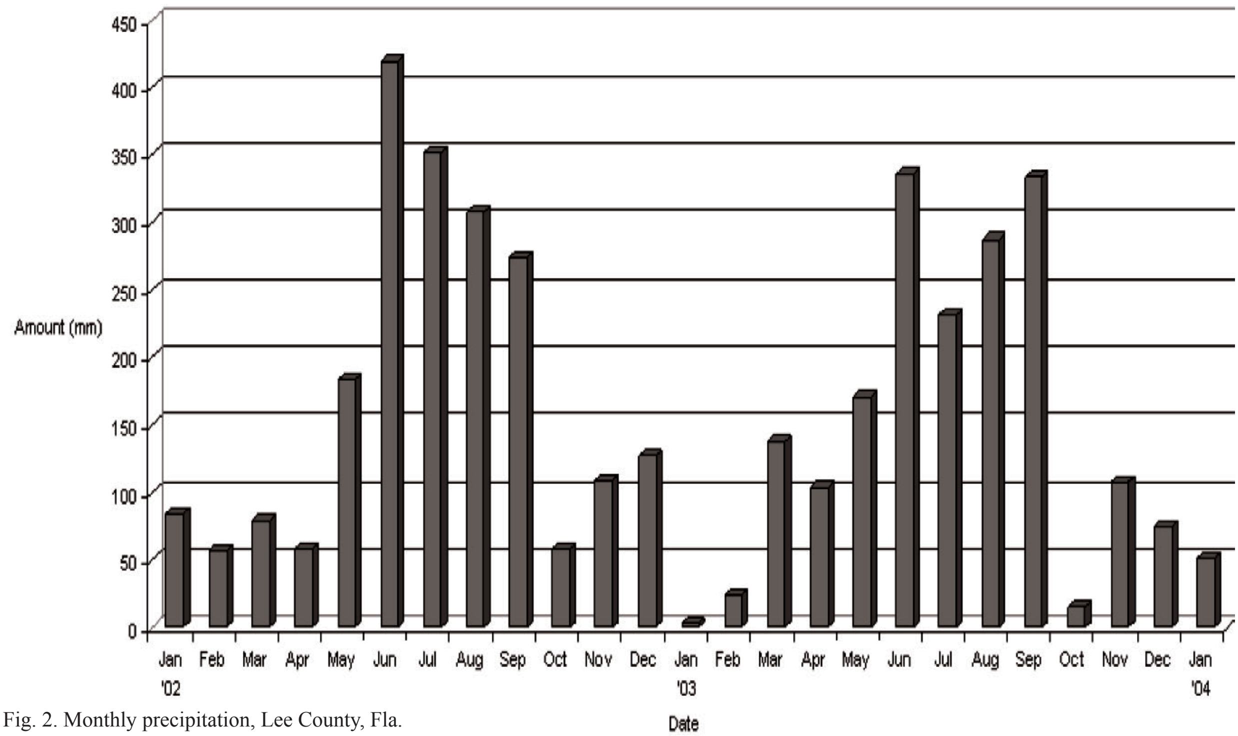

Fig. 2. Monthly precipitation, Lee County, Fla.

Table 2. Influence of fertilizers on live oak [*Quercus virginiana* (Mill.)] trunk growth, 2002–03, Lee County, Fla.

Treatment	Rate (a.i. N at kg/91 m^2)	DBH[z] (cm) 3 MAT[y]	12 MAT	24 MAT
Urea low	1.36	27.3	31.3	34.0
Urea high	2.72	21.8	24.7	27.8
Ureaformaldehyde low	1.36	31.5	34.2	36.2
Ureaformaldehyde high	2.72	22.2	25.0	28.7
Untreated control	---	27.5	31.1	33.0

[z]Diameter at breast height, measured approx. 1.4 m above ground level.
[y]Months after treatment.
Means within a column are not significantly different ($P \leq 0.05$) by Student-Newman-Keuls test.

al. (eds.). Tree and shrub fertilization. Proc. Intl. Conf. Tree Shrub Fert., Fairlawn, Ohio.

Funk, R.C. 2003. 2003 Fertilizer nitrate leaching trial, p. 1–8. In: 2003 Research update manual. The Davey Tree Expert Co., Kent, Ohio.

Gilman, E.F. 1997. Trees for urban and suburban landscapes. Delmar, New York.

McCarty, L.B., J.B. Sartain, G.H. Snyder, and J.L. Cisar. 1993. Plant nutrition and turf fertilizers, p. 50–64. In: L.B. McCarty and M.E. Elliott (eds.). Best management practices for Florida golf courses. Univ. Fla., IFAS, Gainesville.

Neely, D. 1973. Tree wound healing and radial growth correlations. HortScience 8(5):384–385.

Neely, D. 1988. Wound closure rates on trees. J. Arboricult.14(10):250–254.

Petrovic, A.M. 1990. The fate of nitrogenous fertilizers applied to turfgrass. J. Environ. Qual. 19:1–14.

Siewert, A., A. Siewert, B. Rao, and D. Marion (eds.). 2000. Tree and shrub fertilization. Proc. Intl. Conf. Tree Shrub Fert., Fairlawn, Ohio.

Tisdale, S.L. and W.L. Nelson. 1975. Soil fertility and fertilizers. 3rd ed. Macmillan, New York.

Waering, R.F. and J. Patrick. 1975. Source–sink relations and the partition of assimilates in the plant, p. 481–499. In: H.P. Cooper (ed.). Photosynthesis and productivity in different environments. Cambridge Univ. Press, New York.

Waring, G.L. and N.S. Cobb. 1992. The impact of plant stress on herbivore population dynamics, p. 167–226. In: E.A. Bernays (ed.). Insect–plant interactions, CRC Press, Boca Raton, Fla.