USE OF A TREE GROWTH REGULATOR

TO MANAGE VEGETATION NEAR

OVERHEAD POWER LINES

By

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INTRODUCTION

Power outages increase substantially when trees are present, and in fact, trees are the leading cause of power interruptions in Oklahoma (Personal Communication, PSO). Trees typically contact power lines through either increased annual growth or tree failure. Utility companies spend millions of dollars annually to control vegetation in their rights-of-way (ROW) (Personal Communication, PSO). Aggressive tree trimming cycles are becoming very common for electric utilities, and may become mandated in the near future. Utility foresters are exploring tools and techniques to extend the time interval between trim cycles. A study was conducted to determine the effect of paclobutrazol on the annual growth rates of the five predominant tree species present along an Oklahoma corporate utility's ROW. American elm (*Ulmus americana*), hackberry (*Celtis occidentalis*), silver maple (*Acer saccharinum*), post oak (*Quercus stellata*), and sycamore (*Platanus occidentalis*) were treated with paclobutrazol as a soil injection. Sampled trees received one treatment during their respective year of treatment and then they were trimmed approximately four months later. Ten trees were observed for each species per year of treatment covering a five-year period (2001, 2003, 2004, 2005, and 2006) for a total of 250 sample trees. Sampled trees were located in a range of soil types throughout the Tulsa, OK metropolitan area. Visual inspections were conducted at each individual sample plot to determine whether paclobutrazol had lost its effectiveness, allowing the tree to resume normal growth.

A variety of growth retardants became available to the agriculture, ornamental horticulture, and floriculture industries during the 1950's. Soon after growth retardants became available, utility arborists pondered the potential of growth regulators as a tool for tree maintenance. The first tree growth regulators were painted onto the surface of wounds from cut branches. This was an effective method to control re-growth, but not very cost effective because of the labor time involved in treating individual cut surfaces (Chaney, William R. 2003). In the 1970's, new tree growth retardants and more economical treatment methods were sought. Two groups of growth retardants were identified: Type I - cell division inhibitors; and Type II – cell elongation inhibitors (Chaney, William R. 2003). Type I inhibitors were applied directly to the bark of the tree and often resulted in deformed shoot growth and unattractive bark discoloration and damage (Chaney, William R. 2003). The Type II compounds, paclobutrazol and flurprimidol were more effective at reducing growth with fewer negative effects. Flurprimidol was pressed into tablets for insertion into shallow holes drilled in tree trunks. Concern about drilling holes into trees and the apparent compartmentalization around the tablets preventing continued release of flurprimidol into the transpiration stream resulted in limited use (Sterrett, J.P., and Tworkoski, T.J. 1987). The confusing and frequent flux in ownership and licensing agreements among chemical companies resulted in the removal of flurprimidol from the market in 2002 (Chaney, William R. 2003); hence, paclobutrazol is currently the only growth retardant for use on trees. Paclobutrazol, formulated as Cambistat 2SC or Profile 2SC, is applied as a water suspension. Use of paclobutrazol provides a variety of benefits in utility line clearance operations. The most obvious response in trees is reduced shoot growth and consequently, an extended trimming cycle (Redding et al. 1994: Mann et al. 1995). The use of paclobutrazol by utility arborists lengthens the time between trimming cycles, and lessens the amount of time at the jobsite by reducing the amount of biomass removed during trimming for many species; thus costs associated with vegetation management are decreased. (Redding et al. 1994; Burch et al. 1996).

Reduction of the re-growth rate after pruning in trees treated with paclobutrazol is due to inhibition of gibberellin biosynthesis (Burch, RL., et al.1996). Gibberellins affect several physiological functions in plants but are principally responsible for the control of cell elongation and resulting annual growth. Paclobutrazol inhibits three steps in the metabolic pathway leading to gibberellins, all of which are catalyzed by cytochrome P 450 dependent enzymatic reactions (Rademacher 1991). Paclobutrazol is thought to attach to the central iron atom of cytochrome P 450 making it inactive (Sugavanam 1984: Lurssen 1988). Cytochrome P 450 also plays a direct role in phototropism as a part of the blue light receptor system (Galland and Senger 1988: Salisbury and Ross 1992); hence, paclobutrazol not only disrupts the production of gibberellin, but also appears to alter the photoreceptor system that controls phototropic response in plants (Ruter 1994; Burch et al. 1996; Hensley and Yogi 1996; Arron et al. 1997). The inner branches in canopies of trees that are side-trimmed or V-trimmed for utility line clearance are exposed to increased light intensity due to the removal of branches surrounding utility equipment. This exposure to light within the crown increases the likelihood of phototropic curvature and enhanced re-growth of shoots toward the power lines centered in the light-rich environment created by pruning. Although paclobutrazol has been more widely used in recent years, little data exists to establish the length of time that tree growth is controlled following treatment. This study was designed to investigate the effect of tree species, tree diameter, years since application, and soil type on tree response to paclobutrazol in north central Oklahoma.

MATERIALS AND METHODS

Two hundred and fifty trees were inspected during this study throughout the Tulsa metropolitan area. American elm, common hackberry, silver maple, post oak, and sycamore were chosen because they represent the majority of large tree species located along utility easements and rights-of-way in Tulsa, Oklahoma. Paclobutrazol was applied by Advanced Applicators Incorporated in 2001, 2003, 2004, 2005, and 2006 to numerous trees located along these utility easements. Each tree received one treatment of paclobutrazol during the course of this study. All visual observations and data collection were conducted in late summer 2006. Fifty trees (ten from each species) were observed for each year of treatment (e.g., 2001: 5 year post-treatment; 2003: 3 year post-treatment; 2004: 2 year post-treatment; etc.) The trees were located on various soil types (Urban land (0-8 % slope, very high runoff, silty clay loam), Kamie-Urban land complex (0 to 12% slope, high runoff, fine loamy), Choska-Severn-Urban land complex (0 to 2% slope, low runoff, very fine sandy loam), Urban land-Dennis complex (0-20% slope, very high runoff, clay loam), Coweta-Urban land-Eram complex) (0 to 6% slope, moderate runoff, loam, gravely loam) to gauge the significance, if any, soil type made on the effectiveness of paclobutrazol. Diameter classes varied across treatments, but a minimum 4” diameter at breast height (DBH) was established for each species. All trees were treated prior to trimming with the manufacturers recommended amount of paclobutrazol, within their respective treatment years. Different tree species differ in their response to paclobutrazol; therefore, dosage amounts are determined by the DBH and crown size of the tree (Personal Communication, Advanced Applicators Incorporated, 2006).

A visual inspection of annual growth was performed on each individual sample tree to gauge the effectiveness of paclobutrazol in controlling growth rates. Terminal bud scale scars were utilized as indicators of annual branch growth. Branches were observed in the inner and outer portion of the lower canopy of treated trees and then compared to non-treated trees of the same species located on the same site to determine treatment effects on branch growth. Statistical comparisons were made with the use of contingency tables. In the case where sample sizes were sufficiently large, chi square tests were performed. For small samples, Fisher's Exact Tests were used as a small sample alternative (Agresti 2002). A significance level of P=0.05 was used for all determinations of significance. PC SAS version 9.1 (SAS Institute, Cary, NC) was used for all statistical analysis.

RESULTS

Paclobutrazol reduced branch growth of all trees for three years (treated in 2003, 2004 and 2005) (Table 1). Five years after treatment, most trees had resumed normal growth rates. Species did not differ in their response to paclobutrazol (Table 2). Five year post-treatment, 100% of sycamore trees resumed branch growth at a pre-treatment rate as did 70-80% of trees within the other species tested (Table 2).

Trees treated in 2006 (four months before observation) showed little response to paclobutrazol (Tables 1 and 2). Branch growth was reduced in only 20% of the post oak and hackberry trees and 10% of American elm trees. None of the branches of silver maple or sycamore trees had reduced growth four months after treatment. Soil type did not affect branch growth of any species treated with paclobutrazol on any date compared to non-treated control trees (Table 3). Also, no direct relationship between tree diameter and growth reduction was apparent, as all samples exhibited the same trend of growth reduction regardless of size.

DISCUSSION

The focus of this research was to evaluate the effectiveness of paclobutrazol in reducing annual growth rates of trees situated along utility rights-of-way. Reductions in shoot growth have been reported from a low range of 20% to a high of 90% among a broad spectrum of species including hardwoods, conifers, shrubs, and palms (Ruter 1994; Burch et al. 1996; Hensley and Yogi 1996; Arron et al. 1997).

Of the five species observed in this study, all had reduced growth when paclobutrazol was applied at least six months prior to observation. Under these conditions, branch growth was reduced for three years following treatment. The lack of branch growth reduction observed in 2006 to paclobutrazol applied in 2006 may have been due to insufficient time for the compounds to become metabolically active in stimulating gibberellin biosynthesis.

There was no evidence to suggest that soil type affected growth reduction in any of the species tested. Various slopes (0 to 20%) and soil profiles (sand, silt, clay, loam) were present on the sample locations. This would suggest paclobutrazol does not leach and is not affected by runoff.

The interval between trimmings (i.e., the trim cycle) can be extended if the initial flush of growth that occurs after trimming can be controlled, thus saving money and time spent on tree trimming during the following maintenance cycle.

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Table 1. Effect of Paclobutrazol in controlling branch growth of five hardwood species by years since application (all observation made in 2006).

YEARS SINCE APPLICATION	**R[1]**	**NR[2]**	**% REDUCED**
5	9	41	18 b
3	50	0	100 a
2	50	0	100 a
1	50	0	100 a
0	5	45	10 b

R[1]= branch growth reduced, NR[2]= branch growth not reduced
Percents with similar letters are not significantly different using pair-wise contingency tables and chi square tests at a $p=0.05$ level.

Table 2. Effectiveness of paclobutrazol by species in controlling branch growth by years since application (all observations made in 2006).

	YEARS SINCE APPLICATION									
	5		**3**		**2**		**1**		**0**	
SPECIES	R[1]	NR[2]	R[1]	NR[2]	R[1]	NR[2]	R[1]	NR[2]	R[1]	NR[2]
Post Oak	2a	8	10a	0	10a	0	10a	0	2a	8
Hackberry	2a	8	10a	0	10a	0	10a	0	2a	8
Silver Maple	3a	7	10a	0	10a	0	10a	0	0a	10
American Elm	2a	8	10a	0	10a	0	10a	0	1a	9
Sycamore	0a	10	10a	0	10a	0	10a	0	0a	10

R[1]= branch growth reduced, NR[2]= branch growth not reduced
Comparisons of species for the number of trees with reduced branch growth were made with Fisher's Exact Tests. Counts within the same column with the same letter are not statistically significant at the p=0.05 level.

Table 3. Influence of soil type on the effectiveness of paclobutrazol in controlling branch growth in five hardwood species (observations made in 2006).

	YEARS SINCE APPLICATION									
	5		**3**		**2**		**1**		**0**	
Soil Type [3]	R[1]	NR[2]	R[1]	NR[2]	R[1]	NR[2]	R[1]	NR[2]	R[1]	NR[2]
CULEC	3a	26	11a	0	-	-	-	-	0a	4
ULDC	0a	6	-	-	2a	0	50a	-	-	-
KULC	5a	8	22a	0	32a	0	-	-	5a	41
UL	1a	1	17a	0	3a	0	-	-	-	-
CSULC	-	-	-	-	13a	0	-	-	-	-

R[1] = branch growth reduced, NR[2] = branch growth not reduced

[3] Soil types are Coweta-Urban land Eram complex, Urban land Dennis complex, Kamie-Urban land complex, Urban land, and Choska-Severn Urban land complex.
Comparisons of species for the number of trees with reduced branch growth were made with Fisher's Exact Tests. Counts within the same column with the same letter are not statistically significant at the p=0.05 level.
Dashes indicate no samples were present on individual soil types.

VITA

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Scope and Method of Study: The intent of this study was to determine if paclobutrazol could effectively reduce the growth rate of trees interfering with overhead power lines. American elm, hackberry, silver maple, post oak, and sycamore were observed on 250 different locations to determine the effect paclobutrazol had in reducing annual growth. The trees were located on five different soil types to gauge any discrepancies. Visual observations were made on all trees treated with paclobutrazol and compared to untreated trees of the same species on the same locations to determine annual growth reduction.

Findings and Conclusions: Paclobutrazol was effective in reducing annual growth of all trees for up to three years after the treatment date. Trees treated within four months of observation did not show any response to paclobutrazol. Soil type did not affect branch growth of any species treated with paclobutrazol. Also, no direct relationship between tree diameter and growth reduction was apparent.

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