REGROWTH RESPONSE OF LONDON PLANE INJECTED WITH DIKEGULAC AT DIFFERENT STAGES OF TREE DEVELOPMENT

by S.C. Domir, D.E. Wuertz and W.F. Kwolek[1]

Abstract. Three-year-old London plane *(Platanus acerfolia)* trees pruned at 5 different stages of plant development were injected with dikegulac [2,3:4,6-bis-0)1-methylethylidene)-0(-L-xylo-2-hexulorfuranosonic acid)]. At the end of the growing season, sprout length, number of new sprouts, and phytotoxicity were determined. Maximum growth reduction with minimum foliar damage was obtained on injected trees pruned at half-leaf development stage. Even though greater growth reduction was obtained on injected trees pruned at full-leaf development stage, the phytotoxicity was unacceptable.

Vegetation management along the utility rights-of-way is of considerable importance to communities located in urban areas. Mechanical pruning at present is extensively used as means of controlling growth, but there are certain distinct disadvantages with this technique (Abbot, 1977; Creed, 1975). Studies carried out during the last several years have shown that application of growth-regulating chemicals can provide an effective alternative to mechanical pruning (Domir, 1978). Investigations conducted with aqueous growth regulators suggest existence of significant regrowth variability among tree species pressure injected with any concentration of a plant growth-regulating chemical (Domir et al., 1982; Roberts et al., 1979). There may be several reasons for lack of uniform regrowth among chemically treated trees, including heredity, physiological vigor of the tree canopy, size of the tree, uneven distribution of chemical among limbs of trees, and stress influences such as air-pollutants and moisture deficits (Domir, 1982; Roberts and Domir, 1981 and 1983). The timing of chemical application may be another critical factor in achieving consistent growth retardation without causing adverse damage to the trees. Factors influencing the effectiveness of time of treatment include species, treatment techniques, climatic conditions, and stage of plant development (Sachs et al., 1972).

Whether applied to the foliage, soil, bark or tree wound, chemicals must be absorbed into the transport system of the tree and translocated to growing regions before they can be effective (Foy, 1964). Factors influencing absorption include temperature, humidity, dosage, and formulation (Smith et al., 1959). Annual growth variations among species in the same climatic zone are too great to depend on calendar dates of application or reliance on a single species in determining growth retardation effectiveness of chemicals. Sachs et al. (1970) indicated that foliar application of maleic hydrazide (MH) to deciduous species before new leaves had expanded, resulted in excessive damage to the trees. Treatment after leaf expansion resulted in inhibition of growth without damage. Applications made late in the growing season were ineffective in controlling the growth of deciduous species because current year's growth may have been completed (Sachs et al., 1972). Deciduous trees, if treated with MH at bud-break showed excessive phytotoxicity (Sachs, 1969). In a study with injected growth retardants, the greatest effect was reported for trees treated during the spring (Domir et al., 1982).

This study was conducted to determine the effect of regrowth of London Plane *(Platanus acerfolia)* trees pruned and treated with dikegulac-sodium at various times during the growing season.

1. Dr. Kwolek is located at the USDA-ARS, Northern Regional Research Center, Peoria, Illinois 61064.

Materials and Methods

Three hundred 'Bloodgood' London plane whips, approximately 2 m in height were planted at the nursery in Delaware, OH in April, 1980. The whips were spaced 3.7 m apart. In March 1981, 100 trees were randomly selected and divided into 10 separate groups of 10 trees per group for treatment at later dates. On dates representing different stages of plant development, trees from two groups of trees were pruned to a single terminal shoot approximately 2.1 m tall. This reduced the chances of any effects that different canopy sizes may have on regrowth (Domir, 1982). Trees were pruned just prior to treatment. One group was treated by injecting 2 ml of 2.5 g/l dikegulac-sodium into the trunk 1 m above the ground level using the technique described by Sterrett and Creager (1977). The other group was a control. Treatment dates were April 3 (before bud-break), April 16 (immediately after bud-break), May 29 (leaves approximately half-developed), June 19 (leaves fully developed), and July 9 (post leaf-development stage). On each injection date, 10 trees were treated with chemical and 10 trees were used as controls. Following treatment, phytotoxicity was rated every two weeks on a numerical scale from 0 to 5 where 0 = no phytoxicity; 1 = slight phytotoxicity; 2 = phytotoxicity more severe, but acceptable; 3 = phytotoxicity at an unacceptable level; 4 = extensive phytoxicity-major portions of seedlings affected; and 5 = seedlings dead. In early-October at the end of growing season, data for number of new sprouts and length of each new sprout were recorded.

Data were examined by determining analyses of variance in a completely randomized experimental design and fitting polynominal equations to various measurements as the dependent variable, and day of the year at the time of injection as the independent variable. The least significant difference (LSD) at the 0.05 level is shown for comparison of control and treated means.

Results and Discussion

Numbers of new sprouts were increased significantly by the injection of dikegulac at half and full leaf development stages (Table 1). At half leaf development stage increase was almost 50% and at full leaf stage it was more than 100%. Most of the new sprouts were observed developing above the point of chemical injection. Growth of the longest sprout was effectively retarded by injections made at all 5 stages (Table 1). Mean sprout length of treated trees was significantly reduced between 30 to 85% for treatments carried out at all development stages except the

Table 1. Mean sprout measurements for control (C) and treated (T) sycamore trees with dikegulac at various development stages[a].

Development stage	*Date*	*Day*	*Number of sprouts*		*Longest sprouts*		*Sprout length*		*Phytotoxicity*	
			C	*T*	*C*	*T*	*C*	*T*	*C*	*T*
Pre bud-break	April 3	93	8.00	8.43	68.1	47.0*	46.4	29.6*	0.4	2.0
Bud-break	April 16	106	8.89	11.75	83.2	31.0*	58.6	17.0*	0.0	2.1
Leaves half-developed	May 29	149	5.56	8.63*	86.2	33.3*	66.7	19.3*	0.4	2.1
Leaves full-developed	June 19	170	4.60	11.29*	88.8	11.7*	43.9	6.8*	0.4	3.8
Post-leaf development	July 19	190	6.33	8.63	71.4	45.6*	35.4	27.4	0.8	2.0

[a] Data are means of 10 trees. All trees were pruned prior to chemical treatment.

* Significant difference between control (pruned) and treated (pruned and dikegulac injected) tree (LSD at 0.05 level).

post-leaf development stage. Growth of trees was most effectively controlled when injected at full-leaf development stage. Reduction in growth was more than 80% of control. However, the phytotoxicity of 3.8 was found to be unacceptable (Table 1).

Using a simple polynomial model Y = b + btbt, equations were computed for both the controls and treated trees with a measurement as Y and t as the day of injection (e.g. April 3rd is 93rd day since January 1). The predicted measurements Y as related to t the day of the year for the pair of equations for control and treated trees are plotted in Figures 1 to 3.

The analysis indicates that the time that pruned trees are injected has a significant effect on sprout growth but not on sprout numbers (Table 2, Figure 1). In addition to chemical treatment, time of pruning also may be an important factor in determining the amount of growth achieved during the growing season. An analysis of the untreated control trees shows that a gradual increase in sprout length and a decrease in sprout number would occur for trees pruned between bud-break (day 93) and half-leaf development stages (day 150) (Figures 1, 2, and 3). The sprout regrowth of untreated trees pruned after this stage begins to decline. Such a decline is expected since there is less time left in the growing season. However, significant differences in sprout regrowth were not detected between trees pruned on day 93 (bud-break) and on day 190 (post-leaf development) (Figures 1-3). This finding is also observed in case of trees treated with dikegulac.

These results may be attributed to the differences in physiological processes that trees undergo when trimmed at different times during the year (Marini et al., 1982). Figure 1 also shows that dikegulac-sodium injection made either before day 120 or after day 180 would not cause

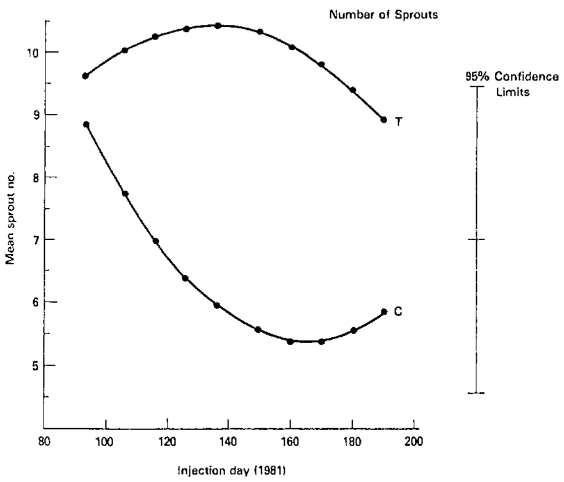

Figure 1. New sprout formation of control (C) and dikegulac-injected (T) trees at various times during the growing season. Least significant difference (LSD) is for comparison between C versus T.

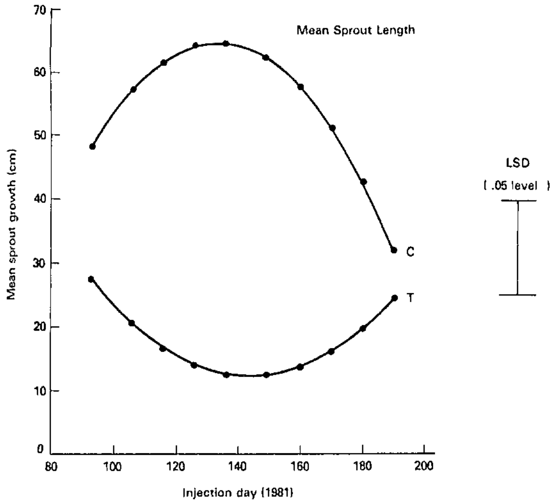

Figure 2. Predicted mean sprout length of control (C) and dikegulac-injected (T) trees treated at various stages of plant development. LSD is for comparison between C versus T.

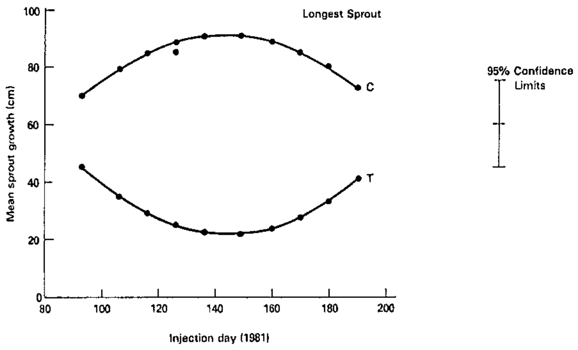

Figure 3. Predicted growth of the longest sprout of control (C) and dikegulac-injected (T) trees treated at various stages of plant development. LSD is for comparison between C versus T.

Table 2. Prediction equations for growth measurements Y ($Y = b_0 + b_1t = b_2t^2$) versus injection time in days.

Measurement = Y	b_0	b_1	b_2
Number of sprouts			
Control	23.83	−0.2244*	+.0006
Treated	1.80	+0.1286	−.0004
Longest sprout			
Control	− 79.65	+2.3871	−.0083*
Treated	207.66	−2.5764	+.0089*
Sprout length			
Control	−116.19	+2.7126	−.0101**
Treated	135.60	−1.7166	+.0059**

*Coefficient significantly different from zero at .05 level (*): at .01 level (**).

a significant change in new sprout formation; however, a treatment between these two dates would result in increased sprout formation. The effect of dikegulac-sodium treatment on reducing sprout length increases until day 150 and then declines (Figures 2 and 3). These data suggest that to obtain the maximum growth reduction, the trees should be trimmed and treated when the leaves have attained the half-leaf development stage. At this stage the trees may be undergoing certain physiological and biochemical changes and dikegulac-sodium seems to interfere with these processes at the cellular level to retard the growth of trees.

The results of this study corroborate the works by others that the development stage of tree at treatment time can affect its growth and development (Sachs et al., 1970). Also, it is evident that time of pruning during the year can also play an important role in determining the growth of trees. Studies conducted to determine the effect of chemicals on tree growth have shown that significant regrowth variability exists among treated trees. Time of treatment is one of the several factors responsible for such variability. Thus to achieve the goals for which injection technique is applied, the user must consider all the parameters that will reduce the variability, and thus maximize the efficiency of growth retardants.

Literature Cited

1. Abbot, R.E., 1977. *Commercial arboricultural practices in North America.* J. Arboric. 3: 141-145.
2. Creed, L.D., 1975. *Tree injection method to control tree regrowth.* J. Arboric. 1: 75-77.
3. Domir, S.C., 1978. *Chemical control of tree height.* J. Arboric. 4: 145-153.
4. Domir, S.C. and D.E. Wuertz, 1982. *Retardation of tree growth by injection of plant growth regulators.* Plant Growth Regulation 1: 107-111.
5. Domir, S.C., 1982. *Influence of canopy size on regrowth response of dikegulac injected American sycamore seedlings.* HortScience 17: 204-205.
6. Foy, C.L., 1964. *Review of herbicide penetration through plant surfaces.* J. Agric. Food. Chem. 12: 473-476.
7. Marini, R.P. and J.A. Barden, 1982. *Net photosynthesis, dark respiration, transpiration, and stomatal resistance of young and mature apple trees as influenced by summer or dormant pruning.* J. Am. Soc. Hort. Sci. 107: 170-174.
8. Roberts, B.R., G.K. Brown, and C.L. Wilson, 1979. New methods and chemicals to control regrowth in trees. EPRI publication EL-1112, 95 p., Palo Alto, CA.
9. Roberts, B.R. and S.C. Domir, 1981. *Influence of SO fumigation on regrowth of American sycamore seedlings treated with MH.* HortScience 16: 84-85.
10. Roberts, B.R. and S.C. Domir, 1983. *Effect of plant water stress on regrowth of American sycamore seedlings injected with maleic hydrazide.* For E. and Mgnt. 7: 291-296.
11. Sachs, R.M. 1969. *Growth control of trees — anatomical and physiological aspects.* Proc. Int'l. Shade Tree Conf. 45: 60-78.
12. Sachs, R.M. and W.P. Hackett, 1972. *Chemical inhibition of plant height.* HortScience 7: 440-447.
13. Sachs, R.M., W.P. Hackett, G.M. Maire, T.M. Kretchen, and J. DeBie, 1970. *Chemical control of plant growth in landscapes.* Calif. Agric. Exp. Sta. Bull. 844: 19 p.
14. Smith, A.E., J.W. Zukel, G.M. Stone, and T.A. Riddell, 1959. *Factors affecting the performance of maleic hydrazide.* J. Agric. Food Chem. 7: 341-344.
15. Sterrett, J.P. and R.A. Creager, 1977. *A miniature pressure injector for deciduous woody seedlings and branches.* HortScience 12: 156-158.

USDA-ARS
Nursery Crops Research Laboratory
359 Main Rd.
Delaware, Ohio 43015