RECOGNITION OF WEED-KILLER INJURY TO TREES

by Robert Hibbs

Abstract. Increased usage of herbicides means increased injury to sensitive plants. Signs of chemical injury include cupped, chlorotic leaves, lack of apical dominance, enlarged bud size, parallel leaf venation, stem lesions, abnormal stem coloration, and nastic growth. Identification of weed-killer injury is difficult, requiring knowledge of individual species as well as detailed investigation and research.

Since the mid-1950's the use of weed-killers has increased significantly. U.S. herbicide production in 1950 totaled 26 million pounds. In 1960, this figure had increased to 63 million pounds, and by 1970 it had increased to 370 million pounds (CEQ, 1972). In 1975 over ten percent of the tree and shrub specimens sent to the diagnostic laboratory of the Illinois Natural History Survey showed definite symptoms of chemical injury, suggesting that herbicide injury is an important problem.

Injury to desirable plants is most likely to occur when using the family of chemicals known as phenoxy herbicides. Butoxone, 2,4-D, MCPA, 2,4,5-T, silvex and Banvel are in this group.

Damage to sensitive plants (Table 1) can occur in three ways: drift of spray particles, movement of volatiles, and root absorption (Meade, 1977). Signs of air pollution damage to trees via ambient drift (spray particles or volatiles) have been described by Phipps (1963), Sherwood, *et al*, (1970), Otta (1972), and Hibbs (1976). Susceptible species mentioned by these authors include boxelder (*Acer negundo*), elm (*Ulmus* spp.), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis occidentalis*), Amur maple (*Acer ginnala*), paper birch (*Betula papyrifera*), redbud (*Cercis canadensis*), pin oak (*Quercus palustris*), and sugar maple (*Acer saccharum*).

In an urban environment, damage to desirable plants is most apt to result from misapplication of combination fertilizer and herbicide products, or from drift of neighborhood sprays. In a rural environment, damage is most apt to be caused by agricultural chemical applications. Banvel injury to soybeans has been observed up to 2 miles from the point of application (ISU, 1975). Additionally, leaf damage from volatiles can be observed near chemical production, packaging, and storage facilities.

Signs of Injury

"Sensitivity should not be confused with pronounced distortion after sufficient exposure, since some plants eventually respond and may even exhibit dying or damaged tissue at sustained 2,4-D levels lower than those which appreciably affect tomatoes or roses." (Sherwood, *et al*, 1970).

The more common expressions of herbicide injury include parallel leaf venation on normally net-veined leaves, cupped leaves, chlorosis, nastic growth, and wavy or curled leaf margins. Grape and redbud are known to be good indicator species and exhibit these common signs of herbicide injury. Other signs are not so obvious.

Purple stem coloration may indicate herbicidal root inhibition. Whether absorbed through the leaves or the roots, 2,4-D and other phenoxys can restrict root development. Sugars produced in the leaves then build up in the stem, causing a purple coloration. This herbicide-induced sign has been observed on pin oak, hard maple, ash, and walnut wood generally less than four years old.

Tough, leathery, or weather-beaten leaves also indicate phenoxy injury (Sherwood, *et al*, 1970). Hard maple exhibits a pebbled leaf; pin oak retains its normal shape but becomes quite leathery. Sherwood also cites enlarged bud size and more obvious lenticels on stems as signs of 2,4-D injury.

Loss of apical growth is typial of phenoxy herbicide injury. This sign has been observed on hard maple, boxelder, hackberry, redbud, walnut, ash, cherry, poplar, willow, and birch. Affected trees suffer a gradual crown dieback, leading to eventual tree mortality. This may be related to winter injury, in that chemical exposure reduces winter hardiness. With winter-weakened buds, trees tend to leaf out later to coincide with peak herbicide conditions the following spring, increasing the likelihood of repeated herbicide drift injury (Hibbs, 1976). Concomitant with the loss of apical growth is restricted lateral leaf development (Phipps, 1963). Sherwood, *et al*, (1970) reported fewer normal leaves, flowers, and fruits produced by plants exposed to 2,4-D drift. The resultant "thin crown" characteristic typifies hackberry response to phenoxy herbicides.

Leaf scorch can indicate chemical injury, particularly in instances of gross exposure. Ash, cherry, and cottonwood have exhibited scorched leaves without expressing more common signs of herbicide injury.

Weed-killers also cause stem lesions and bark abnormalities. Otta (1974) reported bark abnormalities of Siberian elm at 2,4-D exposure levels of 25 ppm, with injury persisting one year after treatment. Walnut, poplar, and Russian olive will show 2 mm to 5 mm stem splits on wood less than 3 years old. Black lesions of this size occur on the mid-vein of walnut leaves exposed to 2,4-D. Hard maple and cottonwood injected with phenoxy herbicides develop abnormal callous tissue at the point of injury.

Though evergreens are somewhat resistant to phenoxy herbicide injury, instances of such injury have been suspected. Fir occasionally exhibits curled leader growth, "burned" needle tips, and needle cast. Spruce will show a loss of terminal growth and needle cast. Pine is most susceptible during the May to June period of active growth, and will exhibit nastic growth of the candles if exposed to phenoxy herbicides.

Discussion

Signs of chemical injury should not be confused with other plant deficiencies related to site conditions, nutrient availability, or the presence of insects and diseases. Careful examination is necessary prior to attributing injury to any one causal agent. It is also possible that a primary causal agent has been disguised by invasion of secondary pathogens. Pimentel (1976) found corn leaf aphids, European corn borers, and southern corn leaf blight more abundant on corn exposed to 2,4-D than they were on unexposed corn.

Expression of herbicide injury need not be restricted to the exact time of exposure, nor even to the same year of exposure. Data from Otta and Sherwood indicate recurring signs of 2,4-D injury for 6 months to 2 years following exposure. Klepper (1974) found that phenoxy herbicides interfere with plant nitrite reduction. This supports the conclusion that signs of injury can occur after the herbicide has dissipated. If the injured plant is unable to reduce nitrite, then the effects of repeated exposures become cumulative, eventually leading to plant toxicity.

Chemical injury symptoms are most evident in June, subsequent to the time of maximum weed-killer usage. Trees situated near agriculturally active lands, railroad rights-of-way, roadside ditches, or fence rows receiving shrub control materials are particularly subject to chemical injury. Foliage browning and abnormal plant growth in these areas can indicate the likelihood of plant injury on adjacent lands. Noticeable chemical odors followed by plant maladies can also be indicative of herbicide pollution.

When attempting to assess the cause of injury to plants, rapid and simplistic diagnoses should be avoided. All possibilities must be considered. With chemical injury, two or more signs are frequently present. Knowledge of these signs coupled with inspection of known sensitive plants (grape, boxelder or redbud) can confirm the presence of weed-killer injury.

Table 1: Sensitivity of various tree species to broadleafed weed-killers.

Sensitive	*Intermediate or unknown*	*tolerant*
boxelder	mulberry	catalpa
elm	honeylocust	linden
ash	soft maple	
hackberry	oak	
Amur maple	cottonwood	
hard maple	cherry	
Ailanthus		
hickory		
apple		
sycamore		
redbud		
walnut		
Amur cork tree		
willow		
birch		
horsechestnut		

Literature Cited

Council on Environmental Quality. 1972. Integrated pest management. U.S. Govt. Printing Office. 41 pp.

Hibbs, R.H. 1976. *Decline of hackberry attributed to ambient herbicide drift.* Proc. Ia. Acad. Sci. 72(3-4): 187-190.

Iowa State University. 1975. Insect, weed, and plant disease newsletter. *IC* 421 *(15)*: 4.

Klepper, L. 1974. A mode of action of herbicides: Inhibition of the normal process of nitrite reduction. U. of Neb. Res. Bul. 259. 42 pp.

Meade, J.A. 1977. *Herbicide injury to trees.* Jour. of Arboriculture 3(9): 167-168.

Otta, J.D. 1974. *Effects of 2,4-D herbicide on Siberian elm.* For. Sci. 20: 287-290.

Phipps, H.M. 1963. *The role of 2,4-D in the appearance of a leaf blight of some plains tree species.* For. Sci. 9(3): 283-288.

Pimentel, D. 1976. *Herbicide (2,4-D) increases insect and pathogen pests on corn.* Science 193: 239-240.

Sherwood, C.H., J.L. Weigle, and E.L. Denisen. 1970. *2,4-D as an air pollutant: Effects on growth of representative horticultural plants.* Hort. Sci. 5(4): 202, 211-213.

District Forester,
Iowa Conservation Commission,
Marshalltown, Iowa

A NEW YORK CITY SAFETY PROGRAM

by Charles E. Speiser, Safety Director

Municipal tree workers performing their skills in a hostile environment face the plight that most people know . . . Forestry is a dangerous job.

In an effort to balance the scales to offset the relentless pile of horrendous accident statistics (injury frequency rates for Parks & Recreation employees published by the National Safety Council were 35.51 in 1973), the Department of Labor in 1971 designated five industries with the highest injury rates as target industries. Logging was among the five. Many of the same type hazards are confronting municipal tree workers as in the Logging Industry, i.e. bucking, falling, power saw injuries, etc.

After the near fatality of a Park treeworker two years ago, the New York City Department of Parks, Climber & Pruner Local 1506, AFSCME, AFL-CIO Safety Committee embarked in an "all out" safety program. The committee's goals were to reduce or eliminate the dangers they know about, i.e. powerlines, noise, and vibration, and to learn about others they did not know of, seeking to eliminate those too.

Eager for education, they took advantage of the New York City Employee Safety Program which taught them to be skilled instructors as alluded in the June 1975 Safety Newsletter article *Training the Trainer—An Approach to Safety Training.* Furthermore, the group attended numerous occupational safety and health courses and conferences sponsored by the Union and Universities. At the seminars it was shocking to learn some of the chemicals that the spray applicators were using can have adverse health affects causing cancer or destroying the nervous system.

Conmingled with these problems, the Forestry Division had antiquated tools and vehicles, no protective equipment, lack of training and poor morale.

With the perserverance of the Safety Committee and the cooperation of Park Management, we provided the following:

Training

Spray applicators participated with foreman; representatives from management, chemical companies, and the Union; and medical scientists by attending an in-house four day chemical seminar.

In-house forestry instructors developed and prepared lesson plans and taught courses in work-area protection, improving climbing techniques and safety skills, New York State Industrial Rule Code 3 (working in and about power