ALABAMA COOPERATIVE Extension SYSTEM

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Environmental Safety Of Forestry Herbicides

Forestry herbicides are a cost-effective tool for the control of undesirable vegetation in forest stands. They can be used by landowners in several ways to increase forest productivity. Forestry herbicides help prepare sites for tree planting by reducing unwanted vegetation and providing conditions for prescribed fire. They also reduce competition from herbaceous weeds so that newly planted trees are given a boost in survival or early growth. They may also be applied to improve the growth rates in established stands by selective removal of non-crop trees. The vast majority of herbicides are used for growing pines, although some are applied for herbaceous weed control and timber stand improvement in hardwood forests.

The practice of chemical vegetation control in forestry has progressed significantly in the last decade. Research and development efforts have produced new compounds that are more effective and more environmentally sensitive. Better application techniques have increased the efficiency of chemical weed control by forest managers. And, recent emphasis on applicator training by state regulators and professional organizations has helped to ensure that these chemicals are safely and effectively applied.

Even though herbicides may be effective and safely applied, some people have concerns as to the long-term environmental effect of using these chemicals in forest management. Unfortunately, much of the information the public sees regarding silvicultural herbicides is misleading and inflammatory. Some view all herbicides as indestructible toxic compounds that are applied at high rates over vast acreages, inevitably finding their way into the food chain and water supplies to become a threat to the general public. Such extreme views should not be simply dismissed. Everyone, particularly those who are most directly dependent upon the health and productivity of our forests, must be sure that our management techniques are environmentally sound. In this publication let us examine the case for using herbicides in forestry.

Herbicide Use In Forestry

First of all, what quantities of herbicides are used in forest management and at what intensity? The U.S.D.A. Forest Service has completed a number of Environmental Impact Statements (EIS) that are excellent references in regard to the environmental effect of using silvicultural herbicides. In their EIS for the southeastern Coastal Plain and Piedmont, the Forest Service stated that approximately 0.5 percent of its total land base in the Southeast is treated with herbicides annually. At this rate, it would take 200 years for the Forest Service to spray all of the national forests only once. The forest industry, on the other hand, usually manages their forests more intensely than the Forest Service and may use herbicides more frequently. Even so, an intensively managed plantation will receive a maximum of three herbicide applications over a rotation, which may be anywhere from 20 to 60 years in the Southeast. Regardless of the management philosophy, herbicide use in forestry does not approximate the intensity of chemical use in agriculture.

Not only are forestry herbicides used infrequently, but they are generally applied in very small amounts. Specific application rates will vary with herbicide, vegetation, and soil type but range from 24 ounces to a maximum of 3 gallons of product per acre for chemical site preparation. Even lower rates of chemicals are used for herbaceous weed control in young plantations, ranging from as little as 1 ounce of product per acre to a maximum of 1 gallon per acre. These low application rates indicate the efficiency of existing vegetation control products under forestry field conditions where plant biomass and diversity are considerable.

Toxicity

Many people have the misconception that all compounds whose name end in "cide," such as insecticide, rodenticide, or fungicide, can be lumped together as dangerous, highly toxic chemi-

cals, and unsafe at any application level. This is simply not the case for the vast majority of agricultural pesticides and is certainly not true of forestry herbicides. Table 1 provides the acute toxicity of the active ingredient in several forestry herbicides for comparison to some other common chemicals. The table lists the LD50, which is a rating system for chemical toxicity. A low LD50 indicates that a small amount of chemical is toxic and is a more dangerous substance. Likewise, the larger the LD50 the less toxic the chemical. All of the forestry herbicides have active ingredients that are less toxic than caffeine. And, the active ingredient is diluted to make the herbicide product sold on the market. All over-the-counter formulations of the products listed in Table 1 have LD50s above 1,700 mg/kg (milligrams of chemical per kilogram of body weight) and so are therefore less toxic than aspirin!

Table 1. The Relative Toxicity Of Commonly Used Silvicultural Herbicides.

Trade Name	Active Ingredient	LD50* of the Active Ingredient mg/kg
Arsenal	imazypyr	5,000
Garlon	triclopyr	630
Oust	sulfometuron methyl	5,000
Roundup	glyphosate	4,320
Tordon	picloram	8,200
Velpar	hexazinone	1,690
Weedone	2,4-D	375
For Comparison:	Table Salt	3,750
	Aspirin	1,700
	Malathion (insecticide)	370
	Caffeine	200

*LD50 is the dose that is lethal to 50 percent of a test animal population, expressed as milligrams (mg) of chemical per kilogram (kg) of body weight.

How can this be so? How can a chemical with such low toxicity be so effective at killing plants? Imazapyr, for example, has an LD50 above 5,000 mg/kg, making it practically non-toxic. Yet this compound is a very effective herbicide and can control many of the largest trees. The secret to understanding this apparent contradiction comes from realizing that herbicides work on biochemical pathways that are specific to plants. For example, only plants photosynthesize (produce food from carbon dioxide and water), so, if a compound inhibits one or several of the steps in the long biochemical pathway that is photosynthesis, that compound is then toxic to plants. At the same time, this compound may have no effect on animal systems because the biochemical pathway for photosynthesis does not exist in animals. As another example, some herbicides work on amino acid pathways that are specific to plants and not found in animals. All of these types of compounds can be very effective herbicides yet are safe for animals because the biochemical basis for toxicity does not exist.

Effect On Wildlife

Given the low toxicity and application rates of forestry herbicides, game or non-game animals would have to consume a great deal of treated biomass for a toxic effect. In an area sprayed with hexazinone, for example, a deer weighing 150 pounds would have to ingest **all** the chemical applied to an area 54 feet by 54 feet to consume enough herbicide to reach the LD50 level (application rate of 2 gallons of product per acre). This consumption would have to occur within a few hours and before natural elements begin to breakdown the herbicide. This is assuming, of course, that the deer would consider herbicide-treated foliage to be palatable.

Not only are silvicultural herbicides very nontoxic to wildlife, they also do not bioaccumulate (accumulate in the food chain). These chemicals pass very quickly through the body when ingested and are eliminated through urine and feces. Laboratory studies have shown that 95 percent of ingested glyphosate is eliminated within 5 days, 93 percent of hexazinone is eliminated in 24 hours, and 93 percent of 2,4-D is eliminated within 2 hours. In this respect, forestry herbicides are substantially different from some of the older pesticides, such as the insecticide DDT, which would accumulate in fatty body tissue. Silvicultural herbicides belong to a class of compounds that do not remain in the body and are eliminated within a short period of time. So, herbicides show no tendency to accumulate in the food chain.

Although the danger to wildlife from toxic herbicide effects are virtually non-existent, there is a real—although indirect—effect on wildlife through habitat modification. A large diversity of plant and animal species quickly move in to occupy the site after a forest tract is harvested. Herbicides are used to delay plant succession so crop trees can get a good start and effectively compete with the many other plant species present. Chemical site preparation normally increases the amount and diversity of herbaceous plants (forage) like grasses and forbs, because residual pine and hardwood sprouts are reduced. And, when larger hardwoods are killed and left in place they may improve habitat for bird species that nest and feed in dead standing trees. While herbaceous weed control

results in a significant reduction in wildlife forage and cover species during the first growing season after application, research has shown that this effect is temporary, and many species begin to reappear in the first year. By the end of the second growing season, the diversity and quantity of herbaceous plants are comparable to untreated areas.

Environmental Fate And Water Quality

What happens to silvicultural herbicides when they are released into the environment? Do they perpetuate and remain in the ecosystem, slowly accumulating over time until reaching hazardous levels? Forestry herbicides neither move very far nor do they survive very long. The Forest Service, for example, in its "Federal Environmental Impact Statement for Vegetation Management in the Coastal Plain/Piedmont," gave the half-life of picloram as 63 days, of 2,4-D as 28 days, and of triclopyr as 46 days. This means that for picloram, one-half of the applied amount decomposes during the first 63 days after application, followed by one-half again in the following 63 days. One year after application, less than 2 percent of the original picloram applied, less than 0.01 percent of the 2,4-D, and 0.4 percent of the triclopyr will remain in the soil. Although the actual environmental persistence of a chemical depends upon the application rate, application method, soil type, weather, and characteristics of the chemical, all these herbicides are subject to the relentless and effective process of biological decomposition.

In addition, silvicultural herbicides do not move very far from where they are placed. The same EIS calculated leaching fractions for several forestry herbicides when applied to a sandy loam soil. For nine of the most commonly used chemicals, five had "non-significant" leaching fractions. As for the remaining four chemicals on the list, the highest leaching potential would still be less than 12 percent of the total amount applied 90 percent of the time.

Although it is very unlikely that properly applied forestry herbicides move through the soil and into ground and surface water, a possibility exists for their movement on top of the ground during heavy storms that move soil and debris into streams. This could occur if a heavy rain came immediately after application, something an effective and conscientious applicator might prevent by monitoring weather forecasts. In fact, when comparing the use of chemicals to the use of large machines for site preparation, herbicides positively affect water quality by reducing sedimentation rates. Chemical site preparation normally results in less runoff, since there are more roots, stems, and leaves left on the site to slow water flow and physically hold the soil in place, particularly if the site is not burned prior to planting.

The Issue Of Risk

One of the most discussed aspects of forestry herbicides is whether or not they pose a long-term health risk to the public. Some feel that exposures to even infinitesimal amounts of these chemicals will eventually result in adverse health effects, particularly cancer. This is a complicated and often emotional issue. Even though we are living longer and healthier lives than at any period in our country's history, much of the public has come to believe that the use of agricultural pesticides has introduced hazardous chemicals into the environment at unacceptable levels. Forestry herbicides have been caught up in this debate and are viewed by some segments of the public as posing a hazard. But, there are several things we should keep in mind when reviewing the potential health hazard of herbicides.

First, there is nothing we do that is totally risk free. We could, if desired, calculate the risk of the building falling in on us as we read this publication. While the possibility of such an occurrence is extremely small, the risk is not zero, as some buildings do occasionally fall on their occupants. Common activities like driving a car, climbing a ladder, or getting an X-ray all have associated risks. An X-ray, for example, carries a 7 in 1 million chance of causing a cancer. Those who would expect zero risk for any human activity are not living in the real world.

Second, calculations of cancer risk to the public have shown forestry herbicides to be an extremely low risk. The Forest Service calculated cancer risk to the general public from herbicide use on Forest Service lands in the Southeast to be 1 in 10 million. These estimates are based on an extremely conservative approach, which assumed that the herbicides were carcinogenic (cancer causing) and exposure levels were high over long periods of time—70 years. The fundamental assumption of carcinogenicity is subject to much debate and to date no forestry herbicide has been conclusively shown to be carcinogenic.

Finally, when evaluating a perceived risk we cannot assume that its elimination will result in a higher margin of public safety. The cure can often be worse than the disease. We use fewer manual methods of vegetation control because we have herbicides that are much safer for workers than long hours of swinging brush axes or machetes

through uneven terrain and thick vegetation. The use of chain saws and bulldozers for vegetation control would likely increase the consumption of hydrocarbon fuels, whose effect on the environment are well known and documented. In addition, machinery requires considerable capital investment, which could increase the cost of forest regeneration and therefore decrease its implementation. The issue of risk evaluation is complex and should be based on a review of the health risks of the activity in question and compared with an accurate evaluation of the costs and risks of the alternatives.

Summary

All of us should be aware and concerned about the long-term environmental wisdom of our forestry management practices, including the use of forestry herbicides. But, after reviewing the use pattern, chemical properties, and safety associated with these chemicals, we must conclude that their continued use in forest management not only improves forest productivity but does so in an environmentally sound manner. The following five statements summarize the environmental safety of silvicultural herbicides.

1. Small amounts of forestry herbicides are used on a very small percentage of forest land, a maximum of two or three applications over a 20- to 30-year period.

2. Forestry herbicides are very low in animal toxicity, and they are significantly less toxic than most insecticides and other chemicals commonly found in the home and environment.

3. Forestry herbicides do not bioaccumulate and are quickly eliminated from animal tissue.

4. Forestry herbicides biodegrade relatively fast after field application.

5. Potential public health risks from using forestry herbicides are negligible and are most certainly less risky than their alternatives.

Although these statements make a strong case for the use of silvicultural herbicides, this logic can be entirely undone if these chemicals are used in an irresponsible or unlawful manner. Forest managers and landowners have an obligation to use this important tool properly to ensure its continued availability. It is wise to remember, "if you abuse it, you lose it." The single most important thing to remember about the use of forestry herbicides is to **always read and follow the label instructions.** The label is a legal document and to disregard it may result in penalties under the law. Disregarding label recommendations could also reduce application effectiveness. Chemical companies have invested considerable time and effort into developing label recommendations that maximize the effectiveness of their product.

Another management technique important to the proper use of silvicultural herbicides is to leave streamside management zones (SMZs) along permanent streams. These are buffer strips that are neither harvested nor sprayed. The utility of these zones for protecting water quality is well documented and all forest managers should employ them around permanent bodies of water. Most states have written Best Management Practices (BMPs) for silvicultural operations that include SMZs. By following BMPs, the label, and a conscientious approach to forest management, silvicultural herbicides will continue to be an effective and environmentally sound forestry management tool.

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