Forest Herbicides: Benefits, Environmental Considerations, Testing, and Risks

MISSISSIPPI STATE UNIVERSITY EXTENSION

To many, the use of herbicides in forest management is an assumed practice. To others, a lack of familiarity may make such use questionable. Often, both groups lack firsthand knowledge of the management benefits of herbicides. The goal of this publication is to provide facts about forest herbicide benefits, environmental considerations, the regulation and testing process for new herbicides, and risks associated with exposure to herbicidal compounds.

Forest Herbicides Are Beneficial

Forest herbicides can be used at several points throughout a forest's rotation (period of time over which a forest stand is managed), including site preparation, release, and intermediate applications, to increase forest production. Increases in production result from increased seedling survival due to reduced competing vegetation as well as greater volumetric growth of trees as the stand matures. Herbicides are often the least expensive means of controlling competing vegetation, and seedling survival of 90 percent or greater has become normal in plantings that are treated with herbicides at establishment. See **Figure 1**.

Using herbicides in pine silviculture can shorten a stand's rotation by as much as 5–10 years while increasing wood quality and yields. Removing hardwood competition from young pine stands often increases volumetric growth and ensures continued survival of greater numbers of pine crop trees. Some studies have reported volume increases of as much as 45 percent in treated versus untreated pine stands.

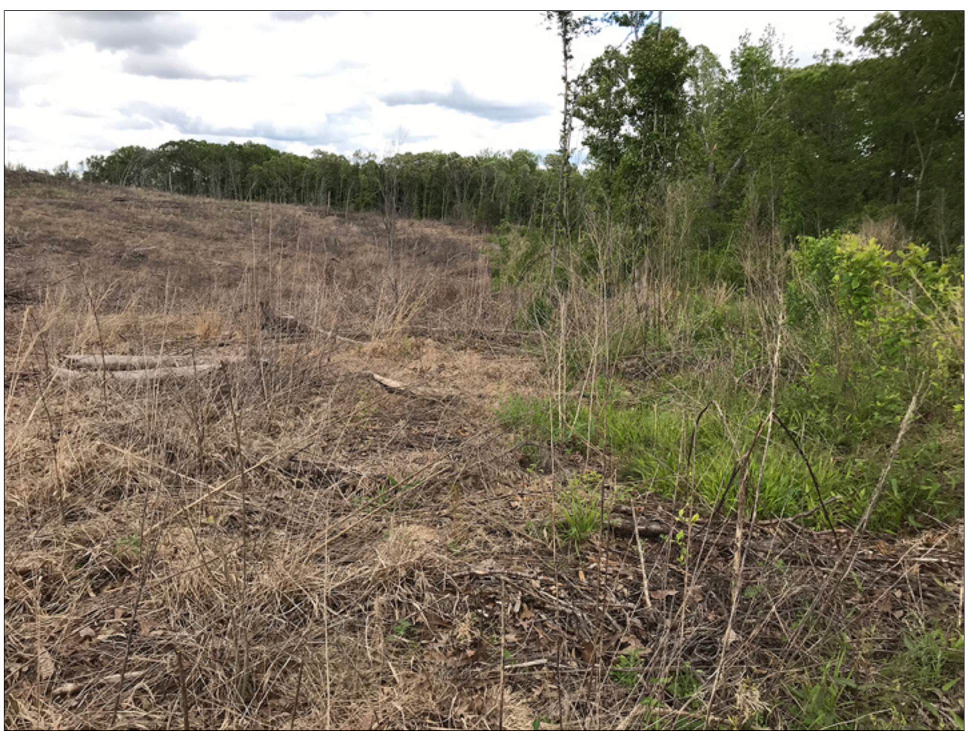

Figure 1. Planted cutover that received a herbicide application at site preparation. Notice the lack of vegetation inside the sprayed area (left) versus the vegetation immediately outside of the sprayed area (right).

Environmental Considerations

Forest herbicides are not applied indiscriminately; their use is based on need. Factors like crop tree species, climate, geography, and targeted vegetation species all play a role in determining what herbicide should be used. Low rates are used for most forest herbicide applications. These rates range from as low as 1 or 2 ounces to as much as 5 or 6 quarts per acre. While 5 or 6 quarts may seem high, remember that, in most cases, only one herbicide application will be used before or just after planting. Often this is the only treatment that a forest will receive until the next harvest occurs (30–40 years in pines and 70–80 years in hardwoods). In addition, the active ingredient in most herbicides is a small percentage of the formulated product and is further diluted with water before application. Typically, forest herbicides are diluted to concentrations of at least 14-to-1, with most being diluted to much lower concentrations.

One of the misconceptions about herbicide use in forest management is that wildlife habitat is always destroyed, leaving no cover or food. In reality, many herbicides are effective only on specific plant species and can be used to promote growth of desirable forbs, legumes, and brambles (all food supplies for deer and other species). Quality vegetation management (QVM) is an example of this type of management technique. In QVM, the herbicide imazapyr is used in conjunction with prescribed fire to improve the quality of habitat for deer, turkey, and quail after the first thin in pine stands (see **Figure 2**). Other techniques involving forest herbicides can be used to improve food sources for deer, turkey, quail, rabbits, small mammals, birds, and other wildlife species. Forest herbicides have low toxicity and do not bioaccumulate in animal tissues. When ingested, they pass very quickly through the body and are excreted in urine and feces.

Forest herbicides often provide longer control of undesirable species than treatments such as prescribed burning. Because herbicides do not disturb soils, they can be used on steep slopes, fragile soils, or other sites with limiting conditions without endangering equipment operators, soil, or wildlife. In addition, most forest herbicides are not mobile in the soil and adhere to soil particles within the top foot of the surface. This severely limits contamination of ground water.

Most forest herbicides have relatively short half-lives (the time required for a herbicide to decrease by one-half of its concentration), generally ranging from a few days to a few months. Thus, they do not remain in soils or vegetative material for long. While microbial breakdown is the primary means by which herbicides decompose, photodecomposition (breakdown of molecules by radiant energy in the form of light), hydrolysis (decomposition due to reacting with water), adsorption to soil, metabolism by plants, and chemical decomposition all serve roles in breaking down herbicides in the environment.

Figure 2. The vegetation in a QVM-treated area (left) is within reach of deer and comprised of desirable herbaceous species, compared to the primarily woody species, ground-level vegetative complex in a prescribed fire-only treatment area (right).

Herbicide Testing and Registration

Herbicides must be environmentally safe and must meet strict standards before they can be registered for use. The Environmental Protection Agency (EPA) evaluates herbicides for safety during the registration process. Manufacturers must conduct extensive testing before the EPA will grant registration for new herbicides. This testing may take up to a decade and costs an estimated $200 million to $250 million. Products submitted for registration undergo more than 140 tests to successfully navigate the registration process. These tests assess factors such as product efficacy (whether the product works on targeted vegetation and what rates are needed), potential for plants to develop resistance, storage stability, toxicity, lifetime feeding effects (high daily dose of herbicide that approximates an equivalent dosage in humans from infancy to 70 years of age), birth defect potential, reproductive effects, herbicide decomposition expectations, amount of residue present in food sources, cost/benefit ratio, patentability, and many more. After data is compiled from these tests, the manufacturer submits a registration packet to the EPA for a decision.

If the EPA grants label approval for a new herbicide, the product can then be marketed. The label defines the herbicide's allowable use, which is enforceable by law. It specifies active ingredient information, instructions for use, protective equipment requirements, reentry intervals, safety considerations, plant species controlled, crops the product can be applied to, and other such information. Deviating from the label information is illegal and can subject the user to penalties. While the EPA plays the primary role in herbicide regulation, several other entities and federal acts impact the process and/or provide other regulations dictating the way herbicides may be used. Some of these include the Occupational Safety and Health Administration (OSHA); the Endangered Species Act (ESA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and state and local regulatory agencies. Herbicidal compounds are extremely well screened, with approximately only 1 in 140,000 tested chemicals reaching the market as registered products.

Putting Herbicide Risks in Perspective

One of the more common arguments against herbicide use in general is that they are detectable in the tissues of various biological organisms. In the 1950s, substances could be detected in quantities as small as parts per million (1×10^{-6}). Smaller quantities of a substance could not be detected and were considered zero residue or undetectable. By the mid-1960s, improvements in scientific technology made detection of parts per billion (1×10^{-9}) possible and, by 1975, parts per trillion (1×10^{-12}). It is possible to detect substances at levels as small as 1 in 1 quadrillion (1×10^{-15}) currently. Clearly, herbicides are detectable at levels unachievable historically; with advanced technology, we can see that herbicide molecules are present in many substances.

The amount of a substance (not merely its presence) determines whether a health risk exists. For proof of this concept, consider the toxic nature of many substances to which humans are constantly exposed. Nicotine, caffeine, aspirin, table salt, and vitamins A and D all possess LD50 ratings (the concentration of a substance required to kill half of the test population) higher than forest herbicides. In the case of these products, as well as that of forest herbicides, it is not the presence of a compound, but rather its quantity that determines its ultimate risk level. For more information on forest herbicide toxicity, please read MSU Extension Publication 1874 *Forest Herbicide Safety: Environmental Concerns and Proper Handling*.

Opponents of herbicide use often point to the prevalence of cancer in humans as a direct correlation with herbicide use in the agriculture, landscaping, and natural resources fields. While it is true that the incidence of cancer has increased slowly over the past few decades, other factors are believed to have driven this change. One of the most important factors is increased life expectancy. About 77 percent of cancer incidences occur in people over 55 years of age, which is more than the average life expectancy before the 1920s. According to the National Cancer Institute, seniors have an average life expectancy of approximately 79 years, while the median age of cancer-related mortality is 73.

Obesity is another factor that contributes to cancer prevalence in today's population. The rate of obesity in the United States has been steadily increasing from around 13 percent in 1960 to more than one-third of all adults currently. Obesity is associated with post-menopause breast, colon and rectal, esophageal, endometrial, pancreatic, kidney, thyroid, and gallbladder cancers.

Additionally, other cancers have become more common as lifestyles evolve. Human papillomavirus (HPV) is a sexually transmitted disease that has become more common over the past several decades. Head, neck, throat, and reproductive system cancers are often attributed to HPV. Gastrointestinal cancers (cancers of the stomach, gallbladder, liver, pancreas, intestines, and colon) have also risen over the past several decades. While obesity can play a role in these cancers, changes in diet are thought to have increased their prevalence. Skin cancers have also increased. The CDC reports the rate of melanoma skin cancer has doubled over the last 30 years as a result of tanning. Finally, while the negative effects of tobacco use are well known, according to the CDC, cancers linked to its use account for approximately 40 percent of all cancer and 80 percent of all lung cancer diagnoses in the United States.

The Take-Home

Forest herbicides are an important and necessary tool in forest management. When applied correctly, their use is both beneficial and has little negative environmental impact. Herbicide testing during the EPA's registration process is both stringent and thorough, with the vast majority of tested compounds being rejected. The dangers of forest herbicides to human health are negligible when registered products are properly applied in forest management.

Suggested Reading

Self, B. 2019. Forest herbicide safety: Environmental concerns and proper handling. Mississippi State University Extension Publication 1874. 4p.

Silvicultural Excellence Council. 1995. Herbicide use in forestry. PE-11361 5K MA5/95. 14p.

Walstad, J. D., and P. J. Kuch (Eds.). 1987. Forest vegetation management for conifer production. John Wiley and Sons, NY.

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