THE CRUSH AND SPRAY

a patented design for herbicide application with less waste

| Cherie LeBlanc Fisher and Adam H Wiese

ABSTRACT

The USDA Forest Service recently patented an equipment design to deliver herbicides more efficiently and cost-effectively. Towed by a standard all-terrain vehicle, the Crush and Spray can access out-of-the-way or wet locations. An adjustable roller first knocks down the unwanted plants. A low-set spray boom with wide angle sprayer nozzles then provides precise, close-to-the-ground application of herbicide along the length of each plant. The operator can easily control the flow of chemicals using a pressurized pumping system with a simple on–off switch. This Crush and Spray system treats targeted plants without wasting herbicides or creating overspray and chemical drift. In field trials over the course of 2 y, the Crush and Spray was used successfully to treat quackgrass (*Elymus repens* (L.) Gould [Poaceae]) and Canada thistle (*Cirsium arvense* (L.) Scop. [Asteraceae]). On average, more than 96% of the plants treated in the Crush and Spray plots were successfully eliminated with just one application of herbicides. In comparison plots, the same chemicals delivered without the Crush and Spray effectively treated an average of 87% of the grasses and 77% of the broadleaf plants. An unexpected finding from the field trials was that plots treated with the Crush and Spray in year one had very low regrowth of weeds in year two even though no additional chemicals were applied.

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KEY WORDS
weed treatment, mechanical application, herbicide

NOMENCLATURE
USDA NRCS (2008)

Herbicides are widely used to control the growth of unwanted plants in agriculture, timber production, tree farming, ecological restoration work, and landscaping. For small-scale operations, a person wearing a backpack-style herbicide sprayer can readily move through an area selecting and spraying individual plants. But for larger operations, a mechanical spraying machine or vehicle may be needed.

Traditional herbicide application with mechanical equipment has a number of drawbacks. Large ride-on machines or vehicles may be heavy, cumbersome, and difficult to maneuver. They may not be able to reach out-of-the-way locations because of uneven terrain, slippery ground conditions, or inadequate roadways. Even accessible locations may be difficult to treat at some times of the year because of wet conditions.

The equipment itself also poses a number of challenges. Continuous spray mechanisms that are not easily

switched on and off may waste chemicals by spraying unnecessarily while the machine is idling or being turned around at the end of a row. Spray booms or nozzles set too high or at the wrong angle can overspray plants and spread herbicides outside of the targeted area. These stray, wasted chemicals may damage desirable native plants and nearby plants under cultivation. When using chemicals that pose a potential health risk to wildlife or humans, it is especially important to prevent overspray that could run off into nearby water bodies or seep into soil or groundwater.

A number of factors may also lead to incomplete herbicide treatment of an area using mechanical equipment. Improperly adjusted spray nozzles can miss the targeted plants. Nozzles spread too far apart or spaced unevenly can cause "striping," in which rows of treated plants alternate with rows of missed plants. Short plants growing beneath taller ones can be shielded from the chemical spray and be missed entirely. Any of these incomplete treatment results may require repeated applications of chemicals in the same area.

THE CRUSH AND SPRAY SOLUTION

An apparatus design recently patented by the USDA Forest Service addresses all of these issues. The basic design includes a sprayer arm with adjustable nozzles, a roller mechanism with crimping bars for knocking down targeted plants, and a pressurized pump system with a simple on–off switch. The patent was awarded for the overall design, not the individual elements (many of which already existed).

The Crush and Spray apparatus is meant to be towed by a 4-wheel all-terrain vehicle (ATV). This eliminates the maneuverability and rough terrain access problems that larger machines may face. It also keeps investment costs down for agencies or companies that already have ATVs because they will not need to purchase specialized vehicles with which to pull the Crush and Spray. (Or, if they don't have an ATV, purchasing one is typically a smaller investment than a number of other pieces of agricultural equipment.) And, of course, when ATVs are not in use for herbicide application, they can be put to many other work-related uses.

The Crush and Spray's roller assembly is one key piece of the patented design. The roller is dragged immediately behind the ATV, knocking down plants in its path to prepare them to receive the herbicide application. The roller system hugs the ground over uneven terrain and vegetation while crimping bars on the roller force the plants to the ground, which will facilitate even spray coverage. The flattened plants are sprayed along their length, leading to more complete and effective treatment in one pass. Roller extensions can be used to widen the treatment path.

The specifications for the herbicide spray boom are also important. Any number of commercially available spray booms with wide-angle nozzles can be used as long as the boom height is adjustable. With the Crush and Spray, the boom height can be set very low to the ground since the plants are knocked down before they are sprayed. This helps prevent overspray or spray drift of chemicals to the sides of the treatment row. The low boom and wide-angle spray nozzles together provide a precisely aimed chemical spray. The herbicide application is more likely to be effective in this scenario as it will be delivered with uninterrupted accuracy along the length of each flattened plant.

The final key element of the design is a rear-mounted CO_2-based pump system with a chemical-resistant hose; many types are available on the market. The CO_2 pumping system keeps herbicide flowing to the spray arms at a steady rate. A simple on–off switch within easy reach allows the operator to stop and start the chemical spray with precision as needed. This prevents wasteful spraying of chemicals when the machine is idling or being turned around between rows. Some CO_2 pumping systems can hold multiple tanks allowing the operator to spray different chemicals or combinations of chemicals in the same treatment pass.

Figure 1. A Crush and Spray prototype developed by R & D Sprayers of Louisiana. Photo by Linzay Nezat

Figure 2. The wheel assembly can be flipped down for transporting the apparatus while not in use. Photo by Linzay Nezat

FIELD TESTING

The Crush and Spray design was rigorously field-tested at a poplar (*Populus* L.

[Salicaceae]) tree plantation in Minnesota over the course of 2 y. Detailed descriptions of the field test methods and findings are available in Wiese and others (2006); the highlights are provided here. Two aggressive nonnative plant species were targeted for control with herbicide: quackgrass (*Elymus repens* (L.) Gould [Poaceae]) and Canada thistle (*Cirsium arvense* (L.) Scop. [Asteraceae]). In the first year of the field trials, a wet spring season had left the ground too muddy for access with traditional herbiciding equipment. As a result, the 2 weed species dominated the test plots, and individual plants had grown to more than 1 m (3 ft) tall.

During the field tests, a Crush and Spray device distributed herbicides to the weed plants between rows of poplar trees on half of the test plots. The other plots received the same chemicals delivered by traditional means (that is, herbicides were delivered via a spray boom but without the Crush and Spray roller). Untreated plots were also included as controls. The primary herbicide, Accord (glyphosate), was applied alone in 2 different concentrations and in combination with Milestone (azafeniden), Scepter (imazaquin), and Squadron (imazaquin + pendimethalin).

In July, scientists estimated the percentage of weeds that had been successfully treated on each plot. These data were used to assess the effectiveness of the different chemicals and the different application methods. The main finding was that all of the chemical combinations were more effective if delivered using the Crush and Spray apparatus. On average, about 97% of the plants in each plot were controlled with the Crush and Spray, no matter which chemical or combination of chemicals was used. By comparison, about 85% of the plants within a given plot were successfully

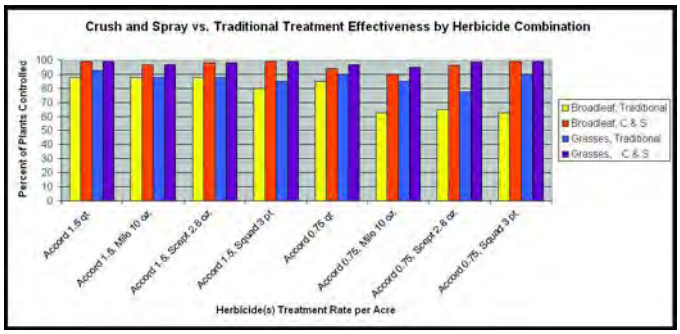

Figure 3. Treatment results for the Crush and Spray versus traditional herbicide application.

Figure 4. A row of plants treated using traditional herbicide application methods during field trials. Photo by Adam Wiese

Figure 4. A row of plants treated with the Crush and Spray. Photo by Adam Wiese

treated by the traditional chemical application method. The Crush and Spray was particularly successful at treating broadleaf plants; about 97% of broadleaf plants in the test plots were controlled by the Crush and Spray method as compared with 77% on the plots not using the Crush and Spray. In the second year, no additional herbicide was applied to the plots but the Crush and Spray plots had little weed growth. This alone could translate into cost savings for users, because weeds are controlled beyond the initial herbicide application without additional labor or chemicals.

To test the larger effect of using the Crush and Spray, scientists also monitored the growth of poplar trees in the test plots. The hypothesis was that even with the precise delivery of chemicals to the target plants afforded by the Crush and Spray, nearby trees might grow more slowly if herbicide soaked into the soil and reached the tree roots. This proved to be untrue: the effects of the treatment and the interaction between the treatments and sampling date were negligible for diameter breast height (DBH) (P = 0.3270 and P = 0.9999, respectively). In total, 3 DBH measurements have been collected for each tree near the test plots (recall that these are plantation trees that are all the same size and were planted at the same time). No matter how close they are to the testing plots, all of the measured trees (n = 360) had a DBH of 3.6 ± 0.1 cm (1.4 in) at the beginning of the field trials and grew to 5.6 ± 0.1 cm (2.2 in) and then 7.3 ± 0.1 cm (2.9 in) in the next 2 y.

The field tests suggest that the Crush and Spray could be used effectively to target unwanted plants in a variety of settings and conditions without harming nearby crops or other desirable plants. For example, roadside weeds could be treated without damaging seed production fields on adjacent land. At small-scale farming operations, orchards, or gardens, the apparatus could target weeds between rows of crops, trees, or cutting beds. Also, the Crush and Spray could be used to treat larger areas during site clearing or site preparation work.

Currently, the USDA Forest Service is working with a manufacturer interested in licensing the patent for the Crush and Spray. Contact patent holder Adam Wiese for more information.

REFERENCES

[USDA NRCS] USDA Natural Resources Conservation Service. 2008. The PLANTS database. URL: http://plants.usda.gov (accessed 3 Oct 2008). Baton Rouge (LA): National Plant Data Center.

Wiese AH, Netzer DA, Riemenschneider DE, Zalesney RS Jr. 2006. A weed compaction roller system for use with mechanical herbicide application. Northern Journal of Applied Forestry 23(1):66–69.

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