The Brush Roller—an Experimental Herbicide Applicator with Potential for Range Weed and Brush Control

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One of the best examples of progress in the search for more effective weed control practices is the recent development of equipment which directly applies nonselective herbicides to weeds. Implements such as the recirculating sprayer and rope-wick applicator have successfully been used to remove tall, hard-to-control weeds like johnsongrass *(Sorghum halepense)* from cotton, soybeans, and other crops for several years. More recently, efforts to improve upon this approach have resulted in applicators which utilize a carpeted surface to wipe herbicide solutions onto weeds growing above crop canopies, without damaging the crop plants.

The rapid acceptance of these new herbicide applicators by farmers has underscored the advantages of this concept, and sparked interest among those who are concerned with weed and brush control on rangeland and pastures. A few researchers at widely scattered locations are currently evaluating both rope wick and carpet applicators for control of locally important weeds. For instance, scientists at North Dakota State University have demonstrated that levels of control of leafy spurge *(Euphorbia esula)* obtained with herbicides wiped on with a carpeted-roller applicator were equal to those obtained with broadcast sprays. Use of the roller applicator reduced the amount of herbicide applied by 50 to 70%, compared to conventional spraying.

Such a reduction in the amount of herbicide used, with no comparable reduction in weed control, is an important economic advantage. Broadcast sprays are relatively inefficient, with as little as 30 to 50% of the herbicide actually reaching the target plants. Since the roller is operated just above the grasses, herbicide is deposited only on taller weeds and brush. Other advantages of applying herbicides without spraying include the reduction of drift and potential herbicide residue problems. Timing of spray applications to correspond with certain weed growth stages or growth conditions is often critical to the success of foliar sprays, but timing may not be as important if herbicides are applied with a roller. Nonselective herbicides which are effective against undesirable plants but also damage forage species cannot be applied as broadcast sprays, but they can be used with a roller applicator.

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Description of the Machine

Design of the brush roller under evaluation in Texas began when former Extension Specialist, Dr. Richard Hoverson, observed another plant physiologist developing ways of introducing experimental chemicals into cotton seedlings to control root rot. One of the techniques involved a small applicator which abraded the stem bark and simultaneously applied a fungicide solution to the exposed conductive tissue responsible for downward translocation, the phloem. Dr. Hoverson recognized the applicability of this idea to brush control; poor control with hormone-like herbicides such as 2,4,5-T is often attributed to a lack of sufficient translocation to resprouting roots and crown buds, after absorption by leaves. He then constructed a tractor-mounted roller applicator fitted with hacksaw blades to scrape the bark off brush plants at the height encountered by the 8-inch diameter roller. The results of field trials with this initial prototype were encouraging, and its effectiveness has hopefully been improved by changes incorporated into the implement described here. It should be noted that this version of the roller was solely designed and constructed so that the effectiveness of this concept could be experimentally evaluated in the field. Simplicity, sturdiness, and economy were of primary importance, rather than the development of a refined, finished product.

The roller itself is 10-inch (I.D.) polyvinyl chloride (PVC) pipe with a wall thickness of 3/8 inch, about 6 feet in length. It is fitted with milled, half-inch thick end-plates to which 1-inch shafts are welded to facilitate mounting in block bearings. The roller is suspended 32 inches in front of a light farm tractor, on a parallel-linkage support. A hydraulic cylinder on the linkage allows adjustment from ground level to a height of 4.5 feet. During use, the roller is usually operated at a 1 to 2 foot height, depending on the height of the weeds or brush.

The roller is continuously rotated during use with a hydraulic motor and chain drive. The direction of rotation at the lower edge of the roller is against the direction of travel. Rate of rotation can be varied, but the cylinder is usually rotated at about 40 revolutions per minute.

The carpet used to cover the PVC cylinder is common household carpet about 0.75 inch thick, with a heavy nap to hold as much solution as possible. The carpet is held in place with adjustable steel or nylon straps (hose clamps). This allows the carpet to be changed easily, as must be done when evaluating different herbicides or herbicide concentra-

A herbicide solution is applied to small honey mesquite trees with an experimental applicator. The herbicide is wiped on by the carpeted surface of the rotating cylinder mounted in front of the tractor.

tions during installation of experiments.

The scraping edge is mounted 20 inches in front of the roller. Although its height is adjustable, relative to the height of the roller, it is usually set at the same height as the lower edge of the roller. The scraper consists of hacksaw blades mounted end-to-end, or a sicklebar, fastened to a 2-inch iron pipe. The hacksaw blades are used when treating small (1 to 4 feet high), multistemmed shrubs, and the sicklebar is mounted when treating taller woody brush such as honey mesquite. The depth and severity of bark abrasion can be regulated by changing the angle of the scraping edge. Wide, shallow scrapes are best obtained by pointing the edge down and back about 30 degrees, relative to the direction of travel.

Herbicide solutions are mixed in plastic 5-gallon jugs. These are secured to a platform on the main mounting frame. A high-volume electric pump delivers the solution at low pressure (8 pounds per square inch) to a spray boom mounted just above the roller. The pump is switched on at will by the tractor driver to occasionally rewet the carpet as needed during use. About 1 minute is required to fully wet a dry carpet with 2 gallons of solution. Although the spray system works well on this experimental machine, it is not considered the best way to keep the carpet wet because of the possibility of drift. Brush- and weed-infested pastures commonly occur adjacent to herbicide-susceptible crops in Texas, so a less hazardous method of wetting the carpet should be used if development of the machine continues. Similarly, automated systems using moisture sensors are available which could rewet the carpet whenever needed.

Retail cost of materials used to construct the brush roller would total about $800.00. The hydraulic system, including a speed control valve for varying rate of roller rotation, currently costs $475.00. Approximately 60 hours of labor were required for construction and fitting.

Our brush roller is mounted on a relatively inexpensive, 27-horsepower tractor. Any farm tractor with hydraulic fittings that is capable of bearing a front-mounted implement weighing about 500 pounds will suffice. Operation on rangeland and pastures infested with thorny brush necessitates the use of tires which are not easily punctured. The tractor is usually operated at a speed of 3 miles per hour.

Experimental Use and Results

Studies were initiated at several locations in central and

Almost all of the honey mesquites in this dense stand were killed by a herbicide solution applied with the brush roller during August. This coastal bermudagrass pasture in central Texas was infested with 1500 mesquite trees per acre, averaging 6 feet tall.

south Texas during the 1981 growing season to evaluate the brush roller for control of honey mesquite *(Prosopis glandulosa* var. *glandulosa)*, the most common and widespread brush species in the state. Herbicides applied in most experiments included glyphosate (Roundup), picloram (Tordon 22K), and the relatively new compounds triclopyr (Garlon) and 3,6-DPA (Lontrel). Applied as sprays, all of these except glyphosate are known to be effective for control of honey mesquite at rates of application of 0.5 to 1 pound per acre of active ingredient. Glyphosate is of interest because it is the safest for use in pastures adjacent to susceptible crops. These herbicides were applied with the brush roller in spring, summer, and fall in solutions with concentrations of 0.2 and 1.0 pound per gallon of actual herbicide. In other studies, 2,4,5-T and a 1:1 mixture of picloram and 2,4,5-T were applied in a wide range of solution concentrations, from 0.025 to 0.5 pound per gallon. The solutions are mixed by diluting the commercial liquid formulations with water.

Regardless of concentration, all of these herbicides top-killed mesquite within 2 weeks of treatment, and observations made during the growing season following treatment showed that root kill was usually high. At concentrations of either 0.2 or 1.0 pound per gallon, picloram or 3,6-DPA invariably killed most mesquites when wiped on with the roller as early as April or as late as August. Triclopyr and glyphosate sometimes tended to be less effective, but generally gave acceptable levels of control (70% or more). An exception occurred when rain fell too soon after treatment to allow adequate uptake of these herbicides. In this instance, however, picloram and 3,6-DPA Lontrel solutions containing 1.0 pound per gallon still killed almost all treated mesquites. Root kill obtained in these studies has ranged from 70% under hot, dry conditions in south Texas to 100% under more favorable growth conditions in central Texas.

Honey mesquite has also been successfully controlled with 2,4,5-T applied with the roller. A solution concentration of at least 0.5 pound per gallon of 2,4,5-T is required. High root-kill has also been obtained with similar concentrations of the 1:1 mixture of 2,4,5-T and picloram. Levels of control are generally far higher than those usually resulting from foliar sprays of the same herbicides. Treatments can apparently be applied with the brush roller at any time during the growing season, whereas sprays must be applied to honey mesquite during late May and June to be most effective in Texas. The roller has not been adequately evaluated under adverse growing conditions, but it is likely that drought will substantially reduce its effectiveness.

Careful measurement of amounts of herbicide solutions used and time required during treatment of 5- to 10-acre pastures infested with honey mesquite have provided some information on costs. Herbicide use has averaged about 0.3 pound per acre in infestations of average density, between 100 and 500 trees per acre. Between 4 and 8 acres have been treated in an hour, depending on plant density. Assuming a cost of $10.00 per pound of herbicide and $4.00 per hour for labor, typical stands of honey mesquite can be killed with the brush roller for $5.00 per acre. Cost increases with the density of the brush stand, since more herbicide solution is used and more time is required to treat an acre. When treating dense stands with solutions containing high herbicide concentrations, the amount of herbicide applied per acre with the brush roller will exceed that applied with conventional broadcast sprays. However, the relatively high root-kill obtained with the roller may justify the use of additional herbicide.

Although the machine has not been tested extensively on many species, preliminary studies suggest that it will work well on other weed and brush plants, including some that are not readily killed with sprays. These include twisted acacia *(Acacia tortuosa)*, common goldenweed *(Isocoma coronopifolia)*, and the spray-resistant false broomweed *(Ericameria austrotexana)*. In addition, herbaceous weeds such as annual broomweed (*Xanthocephalum* spp.) have been completely controlled in the spring, when tall enough to be contacted by the carpeted roller.

Factors Affecting Results

Choice of herbicide has not seemed to be a major consideration. All herbicides evaluated with the roller have worked satisfactorily. However, solution concentration is important. Studies designed to determine the minimum herbicide concentration required are still under way, but it is clear that solutions containing 0.1 or 0.2 pounds per gallon of picloram or 3,6-DPA are adequate under most conditions. These concentrations of triclopyr or glyphosate apparently are sufficient when applied in spring or early summer, but up to 1.0 pound per gallon is required for acceptable control later in the growing season.

Experience with the brush roller has shown that the most important consideration affecting its performance is to maximize the amount of solution that is transferred onto the weeds or brush. The carpet must be kept nearly saturated during use. Continuous rotation of the cylinder is important, since this allows more solution to be held in the carpet. Otherwise, it would flow to the lower edge and drop off.

Obviously, much more herbicide is deposited on foliage than on abraded stems, and there is some question as to which route of herbicide entry into the plant is more important. Comparisons of treatments applied with and without the stem scraper have shown that topkill occurred somewhat slower if it is removed, but levels of ultimate root kill were similar. Application to the scraped stems may be more important during drier conditions, however.

Effectiveness of the brush roller against woody brush plants is limited by plant size. Seedling mesquite trees or regrowth following shredding that is 4 feet high or less are easily killed. Larger plants are more resistant, but this is overcome by increasing herbicide concentration in the solution. Honey mesquites with basal stem diameters of 4 inches or more will often break at the soil surface as the tractor rolls over them. These invariably resprout. Infestations of large trees must be mechanically treated by shredding, chaining, or roller chopping 2 to 3 years prior to herbicide application with the brush roller.

Woody plant density also limits effectiveness. Plants may protect their neighbors from being scraped and wiped if they are growing too close together, but this is not a great problem until density exceeds about 500 plants per acre. The roller has been used in solid stands with as many as 1620 mesquite trees per acre, ranging in height from 3 to 8 feet. In these situations, retreatment the following year will be necessary. High plant density is not a problem when treating smaller multistemmed shrubs such as goldenweeds, however.

Other considerations may also make a second application with the brush roller necessary, if complete control is desired. Many weed and brush infestations contain seedlings too small to be wiped by the roller. In scattered stands, it is sometimes difficult for the tractor driver to tell which plants have or have not been treated. Use of a dye or other marker might solve this problem.

Potential for Use

Initial evaluations suggest that the brush roller may provide more effective control of at least some species of brush and weeds than is currently possible. As a management tool, it should be useful in a variety of situations. Since the small tractor is highly maneuverable and inexpensive to operate, widely scattered shrubs and tree seedlings can be individually treated where new infestations are encountered. The machine can also be used to "clean up" regrowth after other brush control treatments are employed. In these situations, brush problems can be inexpensively controlled before they become dense enough to require more expensive, broadcast treatments, and the effective life of other kinds of brush management practices can be extended. The brush roller can also be used independently as a broadcast applicator in thick infestations, although swath width is narrow in comparison to those of either ground or aerial spray equipment, or pelleted herbicide applicators. Rough terrain may also limit its use in many situations.

Fire Hazard Reduction Practices for Annual-type Grassland

John V. Stechman

Prevention of grassland fire is widely sought by livestock owners to avoid economic losses of dry forage, damage or destruction of fences and other structures, and watershed disturbance. The attendant atmospheric and aesthetic "pollution" caused by a burn, although short-lived, is often construed as undesirable to an environmentally aware public. The visual impact of fire-blackened earth is intensified by associated, adverse psychological effects and persists until secondary growth obscures the aesthetic damage. Exclusion of natural grassland communities from livestock grazing and other kinds of domestic agriculture is desirable for hydrologic, ecologic, educational and recreational purposes, but, depending on one's viewpoint or land management objectives, may be detrimental. The resulting accumulation of excessive grass litter reduces soil temperatures and bacterial activity, depresses nutrient cycling and availability, lowers the yield and palatability of herbage for wildlife, and, of critical concern, represents a potential for conflagration.

The productive California annual grasslands of Mediterranean "savanna" climate, with alternating 6-month rainy and dry seasons, present a high fire hazard in the dry summer season. Maximum herbage yield of most annual species is reached at seed maturity in late May, and the bulk of the dry weight of tall grases is retained well into late August. Records of the California Division of Forestry indicate that over 80% of grassland fires occur during the period from May 1 to August 31 between 9 AM and 6 PM, caused mainly by equipment use and arson. The impact of fire and practices commonly utilized for its prevention and suppression were the center of interest of a study and demonstration on an annual grassland in San Luis Obispo County, California.

Study Area and Procedures

A 3-year study was initiated in the summer of 1977 on a 200-acre County School System Environmental Education Campus located in the Coast Range 6 miles west of San Luis Obispo. The site has been protected since 1968 for studies of natural and cultural history by children of primary and secondary school level. The effects of grazing, discing and mowing were investigated, along with controlled burning to evaluate the impact of wild fire. Climate of the area is characterized by average annual precipitation of 21.7 inches occurring primarily from November through April, and mean temperatures of 64.9° F for July, and 51.6° F in January. During the study, rainfall averaged 34.1 inches and temperatures were near-normal. Topography of the site selected for treatment is gently rolling and the soils are Los Osos-Diablo Clay loam varients 18 to 30 inches deep, developed over sandstone or shale. Forty-eight species of plants were identified in the cover. Dominant grasses are annual ryegrass *(Lolium multiflorum)*, softchess *(Bromus mollis)*, and wildoats *(Avena fatua, A. barbata)*. Secondary grasses include false brome *(Brachypodium distachyon)* and purple needlegrass *(Stipa pulchra)*. Principal forbs are filaree (*Erodium* spp.), burclover *(Medicago polymorpha)*, hog fennel *(Lomatium utriculatum)*, and hayfield tarweed *(Hemizonia luzulaefolia)*. All, excepting the needlegrass, are annuals.

Four treatments were repeated annually for 3 consecutive years. The treatments were: burning, discing, and mowing, applied on contiguous, 1-acre, rectangular plots during the dry herbage period each year, 1977 through 1979, and winter-spring grazing, 1978 through 1980. The latter plot was located within an adjacent 20-acre pasture. Two comparable plots were established as untreated controls bordering, but at opposite margins of the treated plots. Discing was done with an off-set disc and mowing with a rotary flail to about 2 to 4 inches stubble; both were applied in 2 directions at each treatment time with a wheel tractor. Burning was conducted in the late morning under temperatures between 75 and 90° F and relative humidities of 20 to 40%, a thin layer of uncharred herbaceous litter remained after burning, typical of fast, low temperature grass fires. Grazing by cattle was controlled at a

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