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Weed Management on Military Artillery Ranges

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Various commercial chemicals were tested to control visually obstructive weed populations abundant in the target zones on the Fort Riley Military Reservation. With the use of the integrated pest management concept, several herbicides applied at lower amounts than the historical treatment were effective in reducing tall weedy plants by at least 90%. A change in these chemicals thus would help to meet the United States Department of Defense directive to reduce pesticide usage.

INTRODUCTION

It is imperative for safety purposes that in the target zone adjacent to military artillery ranges be free of tall obstructive vegetation. Historically, chemicals have been used to control unwanted vegetation, but large amounts of herbicide usually were applied. Today with greater sensitivity to the environment, more rational use of pesticides is the commonsense practice promoted.

Integrated pest management (IPM) initiated in the early 1960s is a program that uses multiple tactics to maintain pest damage below the economic injury level and at the same time provides protection against hazards to humans, animals, plants, and the environment (Edwards, Thurston, and Janke, 1991). One approach is to identify the least hazardous chemical that can be used with minimal dosages and the appropriate cultural and biological techniques that can be integrated into a management strategy. An IPM program targets containment rather than eradication.

The United States Department of Defense is currently under a directive to reduce pesticide use by 50% by the year 2000 (Memorandum of Merit #2, Instruction 4150.7). Lowering the rate of pesticide use as well as using more active chemicals are being considered. A study to assess the effectiveness and environmental impacts of an array of vegetation management tools that could be employed at the Fort Riley Military Reservation, Kansas was initiated by Ft. Riley, USGS-National Biological Service, and Kansas State University.

In 1993, the reference year for the 50% reduction mandate, 3900 lbs (1769 kg) of the herbicide 2,4-D (23% of the total pesticide usage at Ft. Riley) were applied to 1950 acres (790 hectares) of upland prairie artillery range to control *Helianthus annuus* L. (common sunflower) and to a lesser extent, *Ambrosia trifida* L. (giant ragweed). When mature, these species compromise the soldiers' training mission by obstructing the line of sight to targets. Typically, a single aerial application of 2,4-D at 2 lbs/acre (2.24 kg/ha) at 2 to 3 gallons spray volume/acre (18.7 to 28.1 L/ha) is made during April or May each year. We report here the testing of alternate herbicides in an effort to identify those that are effective in controlling the target species, require minimal amounts of active ingredient, have low toxicity, are economical, and are approved for commercial application.

Methods and Materials

A lowland 10-acre (4.04 ha) field in Camp Forsyth, Ft. Riley (39° 4′ 32″ N, 96° 51′ 0″ W) was selected as a surrogate to the artillery ranges. The site was vegetated with mostly native tallgrass prairie species dominated by perennial, warm-season, C_4 grasses; *Andropogon gerardii* (big bluestem), *Sorghastrum nutans* L. Nash (Indian grass), *Andropogon scoparius* Michx., (little bluestem), and *Panicum virgatum* L. (switch grass), accompanied by less abundant C_3 species in the Asteraceae, Fabaceae, Brassicaceae, and other families. In addition, the site had a large population of annual sunflowers. Ragweed also was present but infrequent. Soils at the site are classified as Muir (deep silty loam), which also occurs on the artillery ranges along with Wymore and Smolan. As on the artillery ranges, vegetation is burned annually. The prescribed burn for 1998 occurred on April 10.

Four chemical treatments, 2,4-D LVE at 1.9 lbs active ingredient/acre (pai/a) or 2.13 kg/ha, dicamba + 2,4-D at 0.96 pai/a (1.08 kg/ha), chlorimuron (Classic) at 0.012 pai/a (0.0134 kg/ha), and prosulfuron (Peak Accu-Pak) at 0.036 pai/a (0.040 kg/ha), were applied and control plots were not sprayed. For convention, trade names of chemicals are used in this report (Humburg, 1989). Herbicides were selected using cost, toxicity and efficacy ratings (Regehr and others, 1999). Rates of application were determined from chemical label guidelines and typically were in the middle to upper third of the labeled range for the intended use and targeted pest. The selected rates were considered sufficiently concentrated to reduce significantly or stunt the target species in one application. The acute oral toxicities (LD_{50}) for the herbicides (Table 1) ranged from 300 to 1000 (2,4-D) to greater than 5000 (Classic). All of them are classified federally as slightly toxic (LD_{50} above 500). For additional information refer to Material Safety Data Sheets (MSDS) and product labels as published by industrial chemical firms and to Humburg

Table 1. Herbicides used in 1998 Aerial-Spray Field Trials.

Chemical	Application rate	Toxicity*	Cost**
2,4-D	**@ 4 pt/a:1.9 pai/a (2.13 kg/ha)**	**300–1000 mg/kg**	**$8.75/a ($21.61/ha)**
2,4-D + Dicamba	@ 2 pt/a:0.96 pai/a (1.07 kg/ha)	300–1000 mg/kg	$8.16/a ($20.16/ha)
Classic (chlorimuron)	@ 0.75oz/a:0.012 pai/a (0.013 kg/ha	>5000 mg/kg	$8.00/a ($19.76/ha)
Peak Accu-Pak (prosulfuron)	@ 1oz/a:0.036 pai/a (0.04 kg/ha)	>4360 mg/kg	$11.75/a ($29.02/ha)

Historical treatment in bold.

* LD_{50} (acute oral).

** Approximate retail costs from '1999 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland' SRP 826, Kansas State University Agricultural Experiment Station and Cooperative Extension Service.

(1989). Costs of the chemicals used ranged from $19.76 to $29.02/ha. Herbicides were applied in 5 gallons/acre spray volume (96.8 L/ha) using a CO2-powered backpack sprayer and a 4-nozzle boom equipped with low-volume flat-fan nozzles (TeeJet#8001).

Two dates of application were used to test the effect of plant stage of development on treatment effectiveness. The first treatment herbicides were applied on May 26, 46 days after the site was burned. Winds were out of the north at 0 to 2 mph (0 to 1 m/s), temperature was 67°F (19°C), and the relative humidity was 53%. Sunflowers averaged 8 to 12 in (20 to 30 cm) in height. The second application occurred on June 12. Winds again were from the north at 0 to 2 mph, the temperature was 82°F (28°C), and the relative humidity was 55%. Sunflower stem heights averaged 13 to 17 in (33 to 43 cm). Total application volume was 5.0 gal/acre (47.2 L/ha) for both treatments dates. Precipitation after the first application occurred 13 days later on June 8 (0.96 in or 2.4 cm). Ten days elapsed after the second application before 1.37 in (3.5 cm) of rain fell.

The experimental design was a randomized complete block with each treatment and time of application replicated four times. Spray strips were 6.7 ft (2 m) by 50 ft (15.2 m), each separated by a 6 ft (1.5 m) no spray buffer. Within each strip, six permanent 0.5 m^2 plots were established at 8 ft (2.4 m) intervals along a centerline running the length of each cell. The first and last plots were 5 ft (1.5 m) from the border. Just prior to the first application and at three 4-week intervals thereafter, sample plots were measured to determine the number of sunflower stems and their maximum and minimum heights. Ragweed was too infrequent to evaluate. Stem count data were subjected to arcsine square root transformation and analyzed by PROC-GLM (SAS, 1996).

Results and Discussion

No differences existed among herbicide treatments ($P > 0.41$) or between dates of application ($P > 0.10$) for any evaluation time. All treatments were highly effective in reducing the number of sunflower plants in the respective spray strips (Fig. 1). One month after application, they were over 90% effective in reducing sunflower stems (2,4-D; 97%, Classic; 98%, 2,4-D+dicamba; 98%, Peak; 93%). At the 2nd-month evaluation, most treatments had completely eliminated sunflowers in the sample plots except Peak, which had 3% of the prespray stems remaining. At 3 months after application, Peak's effectiveness was increased to 98%, whereas the remaining treatments continued to be sunflower free. An expected coincident decline was observed for the no-spray control (7, 38, and 80% reductions at 1-, 2-, and 3-month evaluations, respectively), most likely the result of competition and predation by insects. When stem counts were analyzed by time of application, all of the stems remaining in the Peak plots at two and three

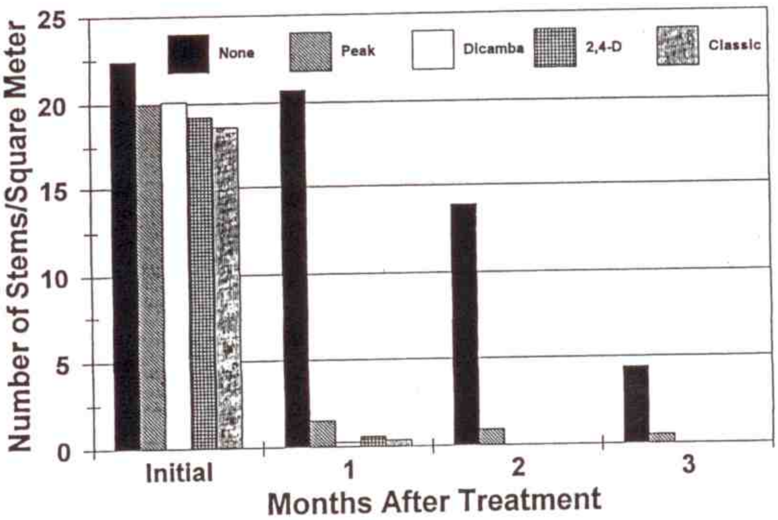

Figure 1. Herbicide effectiveness on sunflower for two dates of application combined at 1, 2, and 3 months after spraying.

months after application were from one of the four spray strips in the first spray application (Time 1).

Sunflower stem height also was used as a measure of treatment effectiveness. The average maximum height for each treatment by evaluation interval (pooled replicates) was greatly decreased with herbicides. At one month after application for Time 1, maximum heights decreased for treatments 2,4-D+ dicamba, 2,4-D, and Classic, while heights in the Peak treatment remained about the same. Heights in the control treatment increased by nearly 100%. By the second month after application, 2,4-D,2,4-D+ dicamba, and Classic treatments had zero stem counts, whereas Peak-treated plants had more than doubled in height, and control plants had increased by approximately 20%. At the final evaluation, the 9 stems remaining in the Peak-treated strips had an average maximum height of 38 in (96 cm); the average for stems in the control strips was 35 in (88 cm). Both these heights were substantially lower than that of the dominant grass, big bluestem, which averaged 80 in (200 cm).

CONCLUSIONS

All treatments utilized in the field trials were highly effective in reducing the number of individual sunflower plants in the study plots. Classic herbicide offered the lowest pounds of active ingredient and was priced similarly to the historical treatment, 2,4-D. If conditions experienced in the field trial were typical, the substitution of Classic at 0.012 pai/a (0.013 l/ha) for 2,4-D would reduce the amount of active ingredient of herbicide by more than 90% in the artillery range area of use at Fort Riley. Utilization of Classic in lieu of 2,4-D would provide a substantial contribution to reduce pesticide use at Ft. Riley. Thus, the IPM management technique of using minimal dosages of chemicals could help to reduce the amount of alien (manmade) substances in the environment.

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