VII.2 Dimilin® Spray for Reducing Rangeland Grasshopper Populations

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Introduction

The insecticides used to control outbreaks of grasshoppers on rangeland are active against a broad spectrum of insects, in both adult and immature stages. For rangeland use in Animal and Plant Health Inspection Service (APHIS) cooperative programs, pest managers apply insecticides at doses and in formulations that have a minimal but acceptable impact on nontarget insects while substantially reducing grasshoppers. Because their activity is broad, these insecticidal sprays sometimes reduce some nonpest insect species in the target areas. However, populations of nontargets have been seen to rebound relatively quickly following treatments on rangeland, even over large areas (see chapter III.3, "Impact of Control Programs on Nontarget Arthropods"). While undesirable, the effects of these sprays on nontarget insects are acceptable. Short-term reductions in nontargets are part of the price pest managers currently pay for artificially bringing an outbreak of grasshoppers back to a normal level.

The goals of insect control today are rapidly expanding. It is environmentally advantageous to reduce the minimal effects of sprays on nontargets even further. Increasing protection to nontargets, particularly those that naturally work to keep grasshopper populations in balance, supports basic integrated pest management (IPM) objectives that encourage and emphasize the use of naturally occurring organisms.

Some insecticides, called insect growth regulators, have a narrower spectrum of activity and cause death in a manner different from most broad-spectrum insecticides. The Dimilin® brand of diflubenzuron, (1-(4-clorophenyl)-3-(2,6 diflourobenzoyl)-urea, is one of these growth regulators. It inhibits chitin biosyntheses and thereby interferes with the formation and deposition of the chitin in the cuticle in an insect exoskeleton. This disruption of normal development may result in death to the insect when molting is attempted.

Diflubenzuron has been shown to be effective against immature stages of several insect pests and is registered in the United States for control of beet armyworm, fall armyworm, and boll weevil on cotton, several insects on soybean, several forest pest insects, and in California on mosquito larvae. Because of its mode of action, nonchitin-forming animals and adult insects and spiders enjoy a reduced risk compared to that of conventional insecticides.

Several studies have been conducted with Dimilin formulated into a bran-based bait for grasshoppers. Wang and Fuller (1991) demonstrated the effectiveness of 1 and 2 lb of 1 percent diflubenzuron bran bait per acre against rangeland grasshoppers on 12-acre plots in southwestern South Dakota. Bomar and Lockwood (1991) demonstrated the effectiveness of the same formula and rate against rangeland grasshoppers on 10-acre plots in eastern Wyoming. Both of these studies utilized ground equipment for application. In two 2-year studies where bait was aerially applied to replicated 40-acre plots, Jech et al. (1993) showed diflubenzuron and carbaryl bran bait treatments to be equally effective on mixed populations of grasshoppers. (Figures VII.2–1 and –2 illustrate technical challenges in using bran materials in aerial spray programs.) However, the study indicated that the species *Phlibostroma quadrimaculatum* (Thomas) could be controlled with diflubenzuron when not controlled with carbaryl bait.

Results of these studies are very promising. However, some damaging species of grasshopper do not readily accept the bran baits and may remain at undesirable levels (Jech et al. 1989 unpubl., 1992 unpubl., and 1993; Onsager et al. 1990; Quinn et al. 1989). Additionally, levels of reduction with all bran-based baits on susceptible species tend to be lower when compared to spray treatments that are deposited directly on both the pest and the preferred food of the pest.

In an effort to take advantage of the desirable qualities of Dimilin while avoiding the general limitations of bran baits, APHIS scientists at the Phoenix Methods Development Center studied spray formulations. Compared to currently used broad-spectrum insecticides, Dimilin should lessen the impact on those nontarget insects and arachnids that are in an adult stage at the time the grasshoppers are treated.

Figure VII.2–1—A load of bran is delivered for onsite mixing with chemicals or insect growth regulators at an airstrip in the Dakotas. (Agricultural Research Service photo by John Kucharsky.)

Evaluating Potential Treatment Rates—A Field Study

In 1991 we conducted a detailed study to (1) generally evaluate an aerially sprayed formulation for control of grasshoppers on rangeland, (2) determine the most effective dose of three candidate doses for achieving immediate and seasonlong effectiveness on both the total grasshopper population and the individual component species of the population, and (3) determine the usefulness of the treatments for suppression or controlling migration into the treated area during the season of treatment.

In this study, we applied three doses of Dimilin 25W spray in volumes of 32 oz/acre to 40-acre mixed-grass rangeland plots in western South Dakota. Three sets of plots were treated with Dimilin spray at 0.015, 0.030, and 0.045 lb active ingredient (AI) per acre. An additional set of plots was sprayed with the standard carbaryl rangeland treatment (Sevin®-4 Oil ULV at 0.5 lb AI/acre) for comparison. A fifth set of plots was left untreated. When applications were made, most grasshoppers were in the second or third instar.

We found that all three dosages of Dimilin caused reduction as great as the standard carbaryl treatment after 1 week. After 2 weeks, all treatments showed reduction in the range of 94 to 96 percent. Reductions continued to increase to the end of the study and 9 weeks after treatment ranged from 96 to 98 percent.

Overall, we found no differences in the effects of Dimilin and carbaryl. Dimilin showed almost immediate acceptable reduction of grasshoppers within 7 days and continued to be effective throughout the season of treatment. Measurable migration into the Dimilin-treated plots was undetectable. Surviving hatch that might have occurred was also undetectable. In this study, in terms of providing acceptable control, Dimilin proved to be an excellent alternative for consideration when treating grasshoppers on rangeland.

Figure VII.2–2—The treated bran bait is sacked and then dumped into a chamber in the fuselage of the spray plane. Inside that chamber, APHIS-developed aerating equipment keeps the bran bait from clumping, which would cause uneven applications of product. (Agricultural Research Service photo by John Kucharsky.)

Use of Dimilin Spray Under Operational Conditions

In 1993, we conducted a study to evaluate the usefulness of two formulations of Dimilin for control of grasshoppers on rangeland under operational conditions that could be experienced during a large-scale grasshopper control program. In this study, we aerially applied Dimilin 25W, Dimilin 2F, and carbaryl (Sevin-4 Oil ULV) to mixed-grass rangeland plots in western North Dakota. All three formulations were sprayed in a diesel carrier. We applied each treatment to a square 640-acre block. Both Dimilin treatments were applied at the dose of 0.0156 lb AI/acre in 32 fluid oz of mix. The carbaryl treatment was applied in 20 fluid oz of mix per acre at the dose of 0.5 lb AI and was used as a standard rangeland treatment for comparison. We compared reduction in grasshopper populations within the operational plots to populations of untreated grasshoppers in adjacent areas surrounding the treated plots. Most grasshoppers treated were in the second or third instar.

We found that the standard (Sevin-4 Oil ULV) treatment caused greater reductions in grasshoppers after 1 week than the Dimilin treatments. After 2 weeks, all three treatments caused reductions in grasshoppers that would be acceptable in large-scale program efforts. However, the Dimilin 2F and carbaryl treatments were causing greater reductions than the Dimilin 25W. Mortality at 3 weeks after application showed that all three treatments were performing equally well. After 4 weeks, we found that the Dimilin 2F formulation caused greater reductions in grasshoppers compared to the other treatments. Trends in our study showed that mortality increased over the 4 weeks after treatment with Dimilin 2F and started to decline with Dimilin 25W and Sevin-4 Oil ULV between the second and third week after treatment.

From a cursory examination of the study area 16 weeks after treatment, we found that no obvious additional hatch had survived, nor had any migration into the treated area occurred. Densities of grasshoppers were no greater than at 4 weeks after treatment.

In our operational study, the 2F formulation proved to be more compatible with the spraying system. The 25W formulation mixed with diesel resulted in a precipitant that could potentially cause a clogging problem with the spraying system and made cleanup significantly more difficult.

Results from our study demonstrated that a low amount of Dimilin active ingredient per acre with the 2F formulation can be used in a large-scale control program manner for control of grasshoppers on rangeland. Upon final Environmental Protection Agency registration, Dimilin—because of its mode of action and its reduced spectrum of activity—could be an attractive option to be considered for controlling grasshoppers on rangeland.

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