II.21 Bran Bait or Liquid Insecticide Treatments for Managing Grasshoppers on Croplands Adjacent to Rangeland or Conservation Reserve Program Acreages

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The principal emphasis of rangeland grasshopper intergrated pest management (IPM) is to protect forage for domesticated animals and wildlife. Row crops (corn, soybeans, small grains) occur intermixed with rangeland in the northern Great Plains. The undisturbed rangeland soils provide highly suitable habitat for grasshoppers to lay eggs, potentially leading to outbreaks of grasshoppers at levels sufficient to cause devastating damage to the rangeland ecosystem. At these times, nearby row-crops may be severely damaged by grasshopper invasion from infested rangelands.

Even in locations that are predominantly dedicated to row-crop farming, grasshopper outbreaks are not uncommon. Grasshopper sources in row-crop areas typically are roadsides, grassed waterways, fencelines, and other field margin areas where soil containing grasshopper egg pods remain undisturbed. Additionally, parks, wildlife refuges, Native American reservations, and Conservation Reserve Program (CRP) acreages can be potential sources of grasshopper hot-spots.

Farmers are advised to treat immature (third-instar) grasshoppers at or near their hatching sites prior to further movements into the perimeter rows of cropland. Doing so can often alleviate the need to treat an entire row-crop field. Not only does this preventive effort save considerable money over the cost of whole-field treatment, it can greatly reduce potential negative impacts on nontarget organisms (beneficial insects and endangered species).

Choosing the proper treatment and application method are critical considerations to successful grasshopper IPM. For example, in environmentally sensitive areas (wilderness preserves, endangered species habitats, wetlands, and lands adjacent to bodies of water), treatment options may be limited.

Grasshopper IPM Project research has found both benefits and weaknesses associated with ground-applied liquid insecticides and bran bait treatments for control of grasshoppers on row crops near rangeland. Bran bait offers increased environmental benefits compared to conventional liquid treatments. For example, carbaryl–bran bait with 2 percent active ingredient (AI) by weight applied at 2 lb/acre offers 92 to 97 percent less active ingredient compared to conventional liquid formulations of carbaryl (0.5 to 1.5 lb AI per acre). Additionally, baits offer reduced cost for application, improved applicator safety, and minimized risk to many nontarget organisms.

Typically, liquid formulations provide quick broad-spectrum activity, uniform coverage, cost competitiveness, effective control, and residual activity. Liquid sprays also receive wide acceptance among farmers and ranchers. While many of these characteristics may appear favorable for grasshopper control, they may produce undesirable effects on beneficial insects and other nontarget species. Liquid application may pose added concerns for handling and applicator safety when compared to the safety of bran treatments. In addition, aerially applied liquid chemicals are far more prone to wind-related drift problems. Using liquid sprays is questionable where spray sites border or approach environmentally sensitive areas.

To choose the most suitable treatment, carefully review conditions (terrain, density of vegetation, wind direction and speed, temperature, and grasshopper species composition). The Grasshopper IPM (GHIPM) Project has attempted to identify treatments or application methods that can provide acceptable levels of grasshopper suppression in association with short- and long-term environmental factors. To further these efforts, research on grasshoppers at South Dakota State University and within the Project has addressed the use of bran bait and liquid applications in several related studies: row-crop and forage protection, optimizing the level of active ingredient in bran baits, and grasshopper suppression in CRP acreage.

Row Crop and Forage Protection

As mentioned earlier, controlling grasshoppers before their movement from hatching sites into nearby row crops is highly desirable. Studies of the use of bran baits on roadside areas were conducted in Colorado, Minnesota, Montana, North Dakota, South Dakota, and Wyoming. Little definable control was found in North Dakota and Montana with plot integrity questioned.

Problems with control were noted in Wyoming; however, in larger areas, treatment with carbaryl bait provided effective grasshopper population reductions (Lockwood and DeBrey 1990). Failure of bran bait applications to control grasshoppers satisfactorily was far more evident in eastern parts of South Dakota, where roadside areas had a much denser canopy (height of more than 0.75 m) and ground cover (at least 90 percent plants). This scenario contrasts the good to excellent control that bran baits have provided in several separate studies on large tracts of western South Dakota rangeland (Jech et al. 1993, Quinn et al. 1989, Wang and Fuller 1990 unpubl). These erratic results do not warrant a strong endorsement of roadside application for bran baits. As noted earlier, plot integrity may have played a significant role in the less-than-desirable levels of control.

Grasshopper behavior (preference for open canopy over shaded areas or reduced natural ability to search for food associated with the settling of bran flakes) may be important considerations in control efforts. Grasshoppers hatching several days following a bran application are not likely to suffer negative impact because baits lack residual control.

Despite these negative factors, bran baits remain a strong option when other methods are impossible to use. Even though populations are not always reduced to subeconomic levels at the site of a bran treatment, partial control may be sufficient to reduce further movement into adjacent row-crop areas.

Seedling corn (about 3 inches in height) was treated with chlorpyrifos–bran bait to control *Melanoplus bivittatus* immature (second-instar) grasshoppers with reductions of 40 to 50 percent that resulted in subeconomic pest densities (Boetel et al. 1990a). Under a more controlled setting, screen cages (1 by 1 by 0.5 m) were placed over seedling corn and artificially infested with 20 third-instar *M. sanguinipes.* One hundred percent control was achieved after a 24-hour period with several toxicant treatments on bran bait (Wang et al. 1991). Applications directly to seedling crop foliage throughout the field would appear to be a more suitable treatment method than bran applications that were limited to field margins.

Unlike most row-crop annuals, alfalfa does not require seedbed preparation or cultivation after its initial establishment. This lack of cultivation contributes to high grasshopper survival across alfalfa fields. Field borders surrounding alfalfa are potentially even more suitable for grasshopper egg laying because of their vegetative diversity (Pooler 1989 unpubl.) and the long-term absence of soil disruption by cultivation practices. Thus, even though grasshoppers are likely to be found throughout an alfalfa field, the highest densities may still exist in perimeter areas.

Bran bait, carbaryl 2 percent AI at 2 lb/acre, was compared to a liquid application of carbaryl (Sevin® XLR, 4E) at 1 lb/acre on alfalfa plots (400 by 800 m) to control grasshoppers. Numbers of fourth- and fifth-instar grasshoppers were 20 and 18 per square meter, respectively, in pretreatment density estimates. Counts 4 days after bran bait treatment were almost unchanged (20). Conversely, a 99.5-percent reduction in grasshopper density was observed in plots that received liquid applications of carbaryl. Dead grasshoppers were observed on the ground in bran-bait-treated plots. Invasion from perimeter areas was obvious, but bran baits were offering little or no residual control. While initially effective, bran baits proved a poor choice in alfalfa because of the lack of residual control.

Optimizing the Level of Active Ingredient in Bran Baits

The percent of active ingredient placed onto bran flakes played only a minor role in grasshopper mortality in several field and laboratory studies. Significant differences were not detected among 2- and 5-percent carbaryl-treated bran baits. Likewise, 1- and 3-percent chlorpyrifos treatment provided similar grasshopper control (Boetel et al. 1990b). These results suggest that the lower dose bran baits contain sufficient toxicants to control grasshoppers. Laboratory trials provided evidence that 0.0007 g of bran flake treated with 2-percent carbaryl was adequate to cause death. Thus, bran-accepting grasshopper species will not require feeding on multiple flakes or high percentages of toxicant to receive a lethal dose.

Grasshopper Suppression in CRP Acreage

The stable environment of CRP lands is similar to rangeland in that grasshopper populations can build up in this habitat and threaten nearby croplands. Failure of bran baits to control grasshoppers effectively in roadside studies resulted in efforts to use liquid applications. Liquid applications can be cost prohibitive on CRP lands, where little economic return is expected. Thus, studies using lower rates of several insecticides (carbaryl, chlorpyrifos, dimethoate, esfenvalerate, diflubenzuron) have been undertaken.

Primary emphasis was placed on the need for residual activity in the presence of constant invasion potential. Carbaryl at 0.5, 0.75, and 1 lb AI per acre offered excellent control up to 10 weeks after treatment. Using the lowest rate would offer a farmer-acceptable control with significant economic savings. Other compounds tested offered similar results; however, several years of data support the carbaryl findings.

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