II.3 Sprays *versus* Baits

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NOTE: Acephate is no longer approved by EPA for rangeland grasshopper control.

Chemicals can be applied in two different forms, liquid sprays or solid-based baits, to suppress or control populations of grasshoppers on rangeland. Both forms have distinct advantages and disadvantages, depending on the situation in which they are used. The diverse habitat, topographical features, meteorological conditions, economic concerns, and environmental constraints associated with grasshoppers on rangeland play an important role in choosing the best form of treatment. This chapter briefly discusses the advantages and disadvantages of both liquid and bait formulations and the eight major factors to be considered in the selection of a type of treatment.

Advantages and Disadvantages

Cost of Aerial Application.—Generally, contract costs are substantially lower for applying sprays than baits. These differences are primarily a result of the wider swaths used in spray application. Bait application costs also may be higher because an acre equivalent of bait typically occupies more space than a liquid. Some types of aircraft and bait-dispensing equipment produce about the same swath width with both sprays and baits. However, most of the few systems that have been evaluated to date produce a narrower swath with baits.

Of the spreader–aircraft combinations evaluated to date, the Bull Thrush (Thrush 1,200 hp) and a Transland 22007 spreader produced the bait swath most similar to the swaths from liquid sprays. The Bull Thrush has a spray swath of 150 ft for oil mixtures and 100 ft for water mixtures and produces a 100-ft swath with bran bait using the 22007 spreader. In contrast, the Turbine Thrush with the same swath widths for oil and water mixtures produced only a 45-ft swath with bran bait and a Transland 20250 spreader. Bait application can become more cost effective if new spreaders, which produce wider swaths, are used and/or if application objectives are changed to omit the old requirement of complete coverage of the treatment area.

Amount of Active Ingredient Required.—Baits typically require significantly less toxicant than sprays. For example, when carbaryl is used in a spray, it is typically applied at 0.375–0.5 lb of active ingredient (AI) per acre. When it is used in a bait, it is typically applied at 0.04 lb (by ground) to 0.03 lb (by air) of AI per acre. The lower amount of active ingredient is attractive from the standpoint of both cost and possible impact on the environment.

Level of Control.—On a typical assemblage of grasshopper species (the total population), sprays applied properly always produce a higher average level of mortality than baits. All species of grasshoppers do not feed equally on currently registered baits, and some species seem to avoid almost any contact with bait on the ground. For species susceptibility to bait, see the chapter "Bait Acceptance by Different Grasshopper Species and Instars" (II.12). Sprays typically produce higher levels of mortality on all species of grasshoppers, through both direct contact with the grasshopper itself and by the grasshopper's feeding on contaminated vegetation (ingestion).

Grasshopper Density and Species Composition.—Sprays produce similar levels of mortality regardless of the grasshopper density. Baits cause highest mortality against low densities of grasshoppers where the dominant species readily consume bait. When very high densities of susceptible grasshoppers (greater than 30–40/yd^2) are treated with bait, there simply are not enough bait particles for all the grasshoppers. According to theoretical models, 1.5 lb of 2 percent carbaryl bait per acre can kill about 65 grasshoppers/yd^2 under perfect conditions. In actual practice, however, it is not likely that this dosage will kill more than 20 to 30 grasshoppers/yd^2. Increasing the amount of bait will increase the level of control slightly but usually not enough to be justified economically.

Nontarget Arthropods.—Sprays kill by both contact and ingestion; baits kill by ingestion. Sprays may affect to some degree both canopy-dwelling and ground-dwelling arthropods, such as insects and spiders. In particular, sprays have the potential to affect those arthropods that feed or rest on the vegetation that has been sprayed. Because baits fall through the vegetation to the ground and work by ingestion only, they may affect only some of the ground-dwelling arthropods that feed on the bait. Both treatments could produce some secondary poisoning of arthropods that scavenge upon affected grasshoppers.

Calibration of Equipment.—It is a misconception that calibration of bait-applying equipment is more difficult than calibration of spray equipment for liquid chemical insecticides. This common misconception is based on lack of experience with bait equipment and its calibration techniques and procedures. Insecticide applicators typically have much more experience with the equipment used to disperse sprays. The Aircraft and Equipment Operations unit of the U.S. Department of Agriculture's Animal and Plant Health Inspection Service lists, to date, 28 different types of fixed-wing aircraft that have been studied and approved for sprays. In contrast, only three different types have been approved for application of baits. With experience, applicators should encounter no substantial difference in the difficulty of equipment calibration for sprays or bait. (A procedure for calibrating bait equipment is found in this section's chapter on "Equipment Modification, Swath Width Determination, and Calibration for Aerial Application of Bran Bait With Single-Engine Fixed-Wing Aircraft" [II.18].)

Aerial Drift and Length of Application Day.—Sprays are much more susceptible than baits to wind-assisted drift and can be carried much greater distances. Drift is a function of wind and temperature at the time of application and the weight of the liquid or solid particle being dispensed. A rise in temperature increases the evaporation and reduces the droplet size in sprays. These changes result in increased buoyancy and drift. For further discussion on the effect of wind and temperature on sprays, see the chapter "Factors Affecting Application and Chemical Deposition" (II.7).

Changes in temperature do not affect the drift of bait. Bait can be very confidently directed to the area of treatment. It is not unusual to discontinue spray application when either wind or temperature conditions might result in unacceptable drift. Winds generally must reach levels that threaten the safety of flight operations before application of baits is discontinued.

Established buffers around bodies of water reflect the dangers of drift and the reduced risk when baits are used. In large-scale cooperative programs, baits can be used within 200 ft of water; sprays require a 500-ft buffer. Spray application usually happens early in the morning, shortly after sunrise, when meteorological conditions are acceptable. These conditions may last for only 1–3 hours. Application of bait can take place at any time during daylight hours, when safe operation of the equipment may be ensured.

Ease of Application.—In spray operations, the applicator must spot clogged nozzles. Applicators can prevent most clogging problems by ensuring that the spraying system is absolutely clean before the material to be sprayed is loaded. Baits require more attention during application. The pilot must manage the physical process of opening the hopper gate of the aircraft consistently. In addition, the pilot must constantly watch for signs of uneven flow of bait during application.

Baits must be carefully inspected for lumps before they are loaded into the aircraft. These lumps will cause partial or complete blockage at the aircraft gate opening and result in nonuniform flow during application. Bait requires more space than sprays. An acre's worth of bait (2 percent carbaryl at 1.5 lb/acre) occupies space equal to about 90 fluid oz, requiring about 3–11 times as much space as an acre's worth of spray material (acephate 32 oz/acre, carbaryl 20 oz, and malathion 8 oz).

How To Decide What To Do

In discussing the eight major considerations that could affect the choice of spray versus bait treatments, no priorities are offered here because no simple rules apply. There are situations where any one of the eight considerations may be the most important determinant of a decision to use either bait or liquid sprays. The complexity of the decision process was one of the reasons why the Grasshopper Integrated Pest Management Project developed Hopper, a computer-based decision support system (see "Decision Support Tools" section of this handbook).

The preferred procedure for deciding on bait versus liquid spray treatment is to gather as much information as possible on the eight considerations under discussion and key that information into Hopper. If specific data on certain questions are lacking, Hopper will generate "default" or representative values that will be reasonably close over a variety of rangeland sites. However, it is likely that accurate site-specific data will yield better recommendations than default values. Hopper will also accept spe-

cific data in the form of a range of values, with upper, middle, and lower levels being used to compare decisions under worst-case, best-case, and most likely scenarios. Finally, a manager is free to accept or reject the assessments of Hopper because there may be considerations that only the manager can evaluate for relative importance. However, Hopper's advice can help a manager maximize the chances of making a good decision.