II.5 Success With Reduced Rates of Carbaryl, Malathion, and Acephate Sprays

K. Christian Reuter and R. Nelson Foster

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

Carbaryl, malathion, and acephate have become the chemical insecticide control alternatives in the U.S. Department of Agriculture, Animal and Plant Health Inspection Service's (APHIS) grasshopper cooperative-management programs. Extensive field and laboratory testing of these chemicals over the years have shown that they are very effective in controlling grasshoppers (Skoog et al. 1965; Onsager 1978; Foster et al. 1981 a and b; 1983, 1984, 1985, 1986). Generally, with proper timing of application and acceptable climatic conditions, these treatments will kill at least 90 percent of grasshoppers in the treatment area.

All three chemicals exhibit relatively low toxicity to mammals and have been approved by the Environmental Protection Agency for rangeland grasshopper control. The third factor accounting for the popularity of these three chemicals is their ready availability from suppliers. Often during outbreak situations, and on short notice, there are demands for large quantities of an insecticide to be used anywhere in the Western United States.

Lowering the application rates of these chemicals would be desirable because of reduced costs of the product as well as lessened impact on nontarget organisms. Until viable nonchemical control tools are available for large-scale programs, however, managers of rangeland must take advantage of existing control tools and strive to make them more efficient.

Carbaryl

Current labeling recommends per-acre application rates of carbaryl at 0.375 to 1.0 lb (12–32 fluid oz) active ingredient (AI) in at least 15 oz of spray volume for rangeland grasshopper control. APHIS cooperative programs are restricted to rates of 0.375 to 0.5 lb AI per acre. Sevin 4-Oil® (Rhone-Poulenc) is generally the formulation of choice for rangeland programs at a standard rate of 0.5 lb AI per acre in 20 oz total volume.

In a recent study, Reuter et al. (1993) showed that a 25-percent-reduced rate of an oil formulation of carbaryl was statistically as effective as the standard rate of carbaryl on rangeland grasshoppers. At 1 week after treatment, this reduced formulation had lowered the grasshopper population by 95 percent. At 3 weeks after treatment, mortality remained at 95 percent. In another study (Onsager 1978), a water-diluted formulation of carbaryl at a 50-percent-reduced rate (0.25 lb AI per acre) compared favorably with the standard rate, yielding mortalities of 76 percent at 7 days and 91 percent at 21 days after treatment. There are no data available on the effects of these reduced rates on nontarget organisms, but it is naturally assumed that there would be a reduced impact. Continued control in these studies 1 to 3 weeks after treatment indicate some persistence of the chemical even at a reduced rate. Persistence would be advantageous in controlling additional hatch or migration, especially in early season control efforts.

Malathion

Current labeling recommends per-acre application rates of malathion at 0.58 to 0.87 lb AI (8–12 fluid oz) for rangeland grasshopper control. Criteria in APHIS' cooperative programs restrict treatments to 0.58 lb AI per acre or 8 fluid oz/acre. Several ultralow-volume (ULV) formulations are available and range from 91 to 95 percent active ingredient. In the past, Cythion® ULV was generally the brand name formulation of choice for rangeland programs. At this time, Fyfanon® ULV is the brand name formulation available for programs.

In a study by Foster et al. (1989), results showed that 25- and 50-percent reductions of malathion with an inflight encapsulation material (a polymeric medium) were statistically as effective as the standard rate of malathion on rangeland. At 25 percent less active ingredient, the treatment reduced the grasshopper population 95 percent at 7 days and 92 percent at 21 days. At 50 percent less active ingredient, the treatment reduced the population 92 percent at 7 days and 85 percent at 21 days. Increased persistence of the active ingredient, even at reduced levels, could be economically and environmentally attractive. In a crop protection study by Herbaugh et al. (unpublished data), results with a strip treatment of 4 oz of malathion per acre on rangeland grasshoppers adjacent to cropland showed 74-percent mortality at 2 days after treatment.

Acephate

Current labeling recommends per-acre spray application rates of acephate at 0.094 to 0.125 lb AI in a minimum of 0.5 gal of carrier. APHIS cooperative programs use the minimum of 0.094 lb AI, originally delivered in 1 qt of carrier. Orthene® 75S is the brand-name formulation of choice for rangeland programs and is formulated with Nalcotrol® (an antidrift additive) at 9 fluid oz Nalcotrol per 100 gal of mix plus unsulfured molasses at 3 percent of total volume.

Foster et al. (1979) demonstrated that results from acephate applied at rates 33 and 67 percent below the standard rate were statistically comparable to the standard 12 to 13 days after treatment (78 percent and 60 percent mortality, respectively), although the reduced rates did not produce mortality as consistently among replications as the standard rate. Orthene is generally thought to persist in the field from 7 to 10 days after application. Persistence of Orthene is somewhat less than that of Sevin-4 Oil but greater than that of Cythion, which lasts only for a few days.

Discussion

Large-scale grasshopper outbreaks generally demand immediate attention and significant reductions in a short time. These demands can be met with carbaryl, malathion, or acephate sprays as each can greatly reduce grasshopper populations in a week or less, and each is readily available from suppliers. The same cannot be said for carbaryl bran bait, *Nosema locustae* (a biological control organism), bran bait, or other alternatives in the developmental stages. Carbaryl bran bait is readily available but not particularly effective against high densities of diverse grasshopper assemblages. *Nosema locustae* has never consistently proven effective for grasshopper control, and production capabilities would be a limiting factor for large-scale programs.

Success with reduced rates of these established chemical sprays is both environmentally and economically attractive. Further reductions in treatment rates are certainly attainable with the advent of improved formulations and additives in conjunction with sound applied research. Although reduced rates may yield lower control, the availability of Hopper software (Grasshopper Decision Support System) makes it possible to evaluate each treatment option in accordance with various management scenarios. Lower control percentages may ultimately prove to be acceptable in terms of economic benefits and costs.

References Cited

Foster, R. N.; Henderson, J. A.; Huddleston, E. W.; Bullard, R. G. 1981a. Effect of Triton X-190 and water on malathion and carbaryl related rangeland grasshopper mortalities, 1978. Insecticide and Acaricide Tests 6: 136.

Foster, R. N.; Onsager, J. A.; Reuter, K. C.; Roland, T. 1985. Field evaluation of an aqueous formulation of carbaryl for rangeland grasshopper control, 1983. Insecticide and Acaricide Tests 10: 237.

Foster, R. N.; Reuter, K. C.; Gourd, J. M.; Enis, P. J.; Wooldridge, A. W. 1983. Field experiments on the toxicity of acephate for control of grasshoppers (Orthoptera: Acrididae) on rangeland. Canadian Entomologist 115: 1163–1168.

Foster, R. N.; Reuter, K. C.; Henderson, J. A.; Wooldridge, A. W. 1981b. Orthene with Nalcotrol for control of grasshoppers on rangeland 1979. Insecticide and Acaricide Tests 6: 137.

Foster, R. N.; Reuter, K. C.; Smith, M. E.; Swain, J. L.; Dyer, R. 1984. Comparison of acephate formulations for control of adult grasshoppers on rangeland, 1983. Insecticide and Acaricide Tests 9: 288.

Foster, R. N.; Reuter, K. C.; Walgenbach, D. D.; Bohls, R. A.; Swain, J. L.; Roland, T. J. 1989. Field comparison for rangeland grasshopper control, 1986. Insecticide and Acaricide Tests 14: 265–266.

Foster, R. N.; Staten, R. T.; Reuter, K. C.; Henderson, J. A. 1979. Low rates of Orthene for control of grasshoppers on rangeland, 1979. Insecticide and Acaricide Tests 6: 137.

Onsager, J. A. 1978. Efficacy of carbaryl applied to different life stages of rangeland grasshoppers. Journal of Economic Entomology 71: 269-273.

Reuter, K. C.; Foster, R. N.; Jech, L. E.; Walgenbach, D. D.; Walgenbach, D. R.; Roland, T. J. 1993. Field evaluation of a reduced rate of carbaryl spray on rangeland grasshoppers (Orthoptera: Acrididae). Journal of the Kansas Entomology Society 66(2): 231–236.

Skoog, F. E.; Cowen, F. T.; Messenger, K. 1965. Ultra-low-volume aerial spraying of dieldrin and malathion for rangeland grasshopper control. Journal of Economic Entomology 58: 559–565.

References Cited—Unpublished

Foster, R. N.; Reuter, K. C.; Staten, R. T.; Swain, J. L.; Roland, T. J.; Walgenbach, D. D.; Bohls, R. A.; Villaveces, A. 1989. Field evaluation of controlled released malathion against grasshopper populations (Orthoptera: Acrididae) in South Dakota, 1986. In: Pink Bollworm and Range Pests Station, 1989 annual report, Phoenix, AZ: U.S. Department of Agriculture Animal and Plant Health Inspection Service.

Herbaugh, L. L.; Foster, R. N.; Reuter, K. C.; Roland, T. J.; Bennett, D. 1986. Evaluation of selected liquid sprays and baits to control migration of grasshoppers from rangeland to adjacent cropland (unpublished report).