II.14 Effect of Multiple Concentrations and Rates of Carbaryl–Bran Bait

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Introduction

Insecticidal baits are a viable alternative to conventional insecticidal sprays for controlling grasshoppers (Quinn et al. 1989). Baits are particularly effective when the grasshopper community is composed largely of bran "acceptors," or those species that readily consume bran baits (see chapter II.12 on bait acceptance). Most of the recent studies involving bran baits have used concentrations in the range of 2–5 percent toxicant at rates near 1.5 lb/acre. The efficacy of higher concentrations and rates has not been studied extensively. As part of the Grasshopper Integrated Pest Management Project, a study was conducted in northwestern South Dakota to determine the effects of multiple concentrations and rates of carbaryl bran bait on grasshoppers on mixed-grass rangeland.

Multiple Concentrations and Rates of Bran Bait—A Case Study

Fifty-one 40-acre plots were treated with aerial applications of carbaryl bran bait in the following concentrations and rates: 2 percent carbaryl at 0.5, 1, 2, 5, and 10 lb/acre; 5 percent carbaryl at 0.5, 1, and 2 lb/acre; and 10 percent carbaryl at 0.5, 1, and 2 lb/acre. An additional nine plots were used as controls. The baits were applied with a Cessna Ag Truck operating at an altitude of 40–60 ft at 115 miles per hour (mi/hour) and equipped with a standard Transland 20244 spreader. Swath widths were 45 ft. Treatments were applied over a 17-day period from June 27 to July 13, 1987. Approximately 56 percent of grasshoppers were in the nymphal stage at the time of treatments (table II.14–1).

Densities of grasshoppers were estimated in the center of each plot by counting grasshoppers in 40 0.1-m^2 rings (Onsager and Henry 1977) placed approximately 16 ft apart in a 210-ft-diameter circle. Relative abundance of each grasshopper species and instar was determined by collecting grasshoppers near the circle of rings with a sweep net. Densities of individual species were estimated by multiplying their relative abundance by total grasshopper density. Grasshopper populations were monitored before treatment and 2, 4, and 7 days after treatments. Populations were monitored approximately daily from June 26 to July 20 in the control plots.

Changes in densities of total grasshoppers, bran-accepting species, and bran-rejecting species in the control plots were compared with changes in plots treated with the insecticidal baits to determine overall treatment effects. Major bran-accepting species included *Melanoplus sanguinipes,* other *Melanoplus* species, *Ageneotettix deorum, Phoetaliotes nebrascensis,* and *Aulocara elliotti.* Bran-rejecting species included *Aeropedellus clavatus, Amphitornus coloradus, Trachyrhachys kiowa,* and *Opeia obscura.* Although *O. obscura* may be vulnerable to insecticidal baits (see the bait acceptance chapter in this section), we included it in the bran-rejector category because it was not affected by the insecticidal bait in our particular study.

Mean pretreatment densities of total grasshoppers ranged from 13.1 to 22 grasshoppers/yd^2 in the treatment plots. *M. sanguinipes, A. deorum,* and *A. clavatus* constituted 32, 15, and 14 percent of all grasshopper species, respectively, during the pretreatment period (table II.14–1). Bran acceptors constituted 72 percent of all species.

All insecticidal bait treatments, except the 2 percent carbaryl at 0.5 lb/acre, caused significant reductions in total grasshopper density compared with controls (table II.14–2). The greatest mean mortalities, ranging from 72 to 86 percent, occurred in plots treated with 2 percent carbaryl bran bait at 5 and 10 lb/acre, 5 percent carbaryl bran bait at 1 lb/acre, and 10 percent carbaryl at 2 lb/acre. The more standard treatments of 2 percent carbaryl at 1 and 2 lb/acre gave intermediate results, causing average mortalities of 52 and 64 percent, respectively. Applications of bran bait at 0.5 lb/acre were least effective, killing less than 50 percent of all grasshoppers.

All treatments caused significant mortality of bran-accepting species of grasshoppers compared with controls (table II.14–2). The greatest mortality occurred in plots treated with 2 percent carbaryl at 10 lb/acre (97 percent), 5 percent carbaryl at 2 lb/acre (90 percent), 2 percent carbaryl at 5 lb/acre (90 percent), and 5 percent carbaryl at 1 lb/acre (88 percent). The commonly used treatments of 2 percent carbaryl at 1 or 2 lb/acre caused 72 and 89 percent mortalities, respectively, of bran-accepting grasshopper species. Applications of 2 and 5 percent carbaryl at 0.5 lb/acre caused 45–54 percent reductions in the bran acceptors. Densities did not change in control plots.

Table II.14–1—Relative abundance of grasshopper species and instars and number of plots occupied on the pretreatment sampling dates, June 26–July 7, 1987, Harding County, SD

Species	No. of plots occupied	Percentage of grass-hoppers[1]	Percentage of individuals in each instar					
			I	II	III	IV	V	Adult
Melanoplus sanguinipes (F.)	55	32.31	0.0	0.9	13.6	17.0	32.1	36.4
Ageneotettix deorum (Scudder)	55	14.35	0.0	0.8	4.6	15.2	57.6	21.8
Aeropedellus clavatus (Thomas)	51	13.95	0.0	0.0	0.0	0.0	0.0	100.0
Melanoplus dawsonii (Scudder)	40	5.31	0.4	4.7	23.8	27.7	20.6	22.8
Melanoplus confusus Scudder	47	4.57	0.0	0.0	0.0	0.0	0.0	100.0
Amphitornus coloradus (Thomas)	50	4.55	0.0	0.0	2.7	9.5	43.1	44.6
Melanoplus infantilis Scudder	44	3.76	0.2	2.8	15.9	15.3	31.7	34.0
Trachyrhachys kiowa Thomas	48	2.50	0.0	0.6	10.5	16.8	35.0	37.1
Melanoplus spp.	38	2.32	25.0	74.6	0.0	0.0	0.4	0.0
Orphulella speciosa (Scudder)	31	2.13	0.4	2.0	11.8	34.1	29.5	22.2
Phoetaliotes nebrascensis (Thomas)	39	2.10	4.5	40.1	36.7	14.8	3.9	0.0
Aulocara elliotti Thomas	38	1.92	0.0	0.0	0.5	0.8	20.0	78.7
Melanoplus packardii (Scudder)	46	1.47	0.6	4.9	16.0	38.8	32.8	8.7
Melanoplus femurrubrum (DeGeer)	17	1.36	6.1	20.8	42.8	15.6	11.0	3.7
Melanoplus bivittatus (Say)	34	1.30	0.0	1.5	5.7	12.8	15.1	64.8
Opeia obscura (Thomas)	39	1.19	0.0	2.4	15.3	39.3	36.1	6.9
Others (26 species)	—	4.91	6.8	10.6	13.6	14.3	23.0	31.7
All species	55	100.00	1.1	4.3	10.0	13.7	27.3	43.6

[1]Based on a total of 12,063 grasshoppers collected.

Table II.14–2—Pretreatment densities and reductions in grasshopper densities 7 days after treatments with different rates and concentrations of carbaryl bran bait, Harding County, SD

Grasshopper variable	Treatment[1]	Pretreatment density[2] ($\bar{x} \pm$ SEM) standard error of the means	Percent reduction[3] ($\bar{x} \pm$ SEM)
Total grasshoppers	Control	13.7 ± 1.91a	8.1 ± 12.66a
	2% — 0.5	12.5 ± 2.43a	31.3 ± 10.69abcd
	2% — 1.0	13.8 ± 0.61a	51.7 ± 17.01be
	2% — 2.0	17.4 ± 2.81a	63.9 ± 2.17efgh
	2% — 5.0	17.4 ± 4.21a	75.3 ± 8.20gk
	2% — 10.0	20.1 ± 6.57a	85.9 ± 7.91k
	5% — 0.5	16.4 ± 1.40a	37.4 ± 15.58bcdf
	5% — 1.0	18.6 ± 5.53a	77.9 ± 7.54hk
	5% — 2.0	18.0 ± 4.92a	56.0 ± 8.05ceg
	10% — 0.5	12.0 ± 2.83a	49.9 ± 5.98bcdf
	10% — 1.0	13.9 ± 2.39a	58.7 ± 3.81deg
	10% — 2.0	17.3 ± 2.33a	72.3 ± 4.71ek
Bran acceptors	Control	9.4 ± 1.43a	5.7 ± 12.77a
	2% — 0.5	8.7 ± 1.42a	45.2 ± 19.72b
	2% — 1.0	8.4 ± 0.60a	60.2 ± 17.80bcd
	2% — 2.0	11.3 ± 1.40a	77.5 ± 4.85cdef
	2% — 5.0	13.6 ± 4.53a	89.6 ± 5.79fg
	2% — 10.0	17.0 ± 5.23a	97.4 ± 2.34g
	5% — 0.5	12.6 ± 1.30a	53.5 ± 11.42bc
	5% — 1.0	15.1 ± 4.45a	87.9 ± 6.98efg
	5% — 2.0	10.2 ± 2.44a	89.8 ± 1.25efg
	10% — 0.5	8.2 ± 2.22a	72.1 ± 8.67cde
	10% — 1.0	10.1 ± 1.12a	69.5 ± 4.07bcd
	10% — 2.0	13.8 ± 1.74a	80.8 ± 8.47def
Bran rejectors	Control	3.4 ± 0.63a	0.1 ± 16.62ab
	2% — 0.5	3.1 ± 0.86a	–34.6 ± 24.01b
	2% — 1.0	3.2 ± 0.54a	34.6 ± 29.41ac
	2% — 2.0	5.7 ± 1.90a	–27.0 ± 44.99ab
	2% — 5.0	2.5 ± 0.28a	37.8 ± 8.79ab
	2% — 10.0	4.6 ± 1.13a	59.6 ± 28.41c
	5% — 0.5	3.7 ± 0.44a	8.5 ± 27.83ab
	5% — 1.0	3.4 ± 1.12a	33.4 ± 13.77ab
	5% — 2.0	7.7 ± 2.47a	9.1 ± 20.79ab
	10% — 0.5	3.2 ± 0.45a	15.4 ± 20.98ab
	10% — 1.0	3.3 ± 1.33a	12.2 ± 43.52ab
	10% — 2.0	3.3 ± 1.00a	–112.0 ± 117.23b

[1]Percent of carbaryl applied—application rate in lb/acre.
[2]No./yd^2.
[3]A negative percent reduction indicates an increase in grasshoppers.
Note: Means within columns followed by the same letter are not significantly different at the 0.1 level (Fisher's protected SD).

In general, bran-rejecting species were not affected by the treatments (table II.14–2). However, the greatest reduction in bran rejectors (60 percent) occurred in plots treated with 2 percent carbaryl at 10 lb/acre. Because changes in densities in these plots were highly variable, it could not be determined if this reduction was caused by mortality or natural variation in grasshopper populations.

Conclusions

The following conclusions can be drawn from the study. First, the quantity of carbaryl bran bait applied to rangeland affects grasshopper mortality. Baits applied at 0.5 lb/acre are relatively ineffective. The highest rates (5 and 10 lb/acre) were very effective in controlling grasshoppers. These results do not suggest, however, that more bait is always better (see chapter II.15 on multiple applications of bran bait). For example, 78 percent mortality was achieved in plots treated with 5 percent carbaryl at 1 lb/acre. Also, the small increase in mortality caused by higher rates may not be economically justifiable.

Second, the concentration of carbaryl seemed less important than the rate of application. For example, 2 and 10 percent carbaryl applied at a rate of 2 lb/acre caused similar grasshopper mortalities.

Finally, high mortality of grasshoppers was achieved because the grasshopper community was composed mainly of the bran-accepting *Melanoplus* species. Insecticidal baits are less effective when there is a higher proportion of bran-rejecting species (Quinn et al. 1989, Jech et al. 1993).

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