RESIDUAL CHEMICAL CONTROL FOR *MELANOPLUS DIFFERENTIALIS* (ORTHOPTERA: ACRIDIDAE) IN URBAN LANDSCAPES

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ABSTRACT

Melanoplus differentialis (Thomas) (Orthoptera: Acrididae) and several other species of grasshoppers invade urban/suburban landscapes and retail/wholesale nurseries during the hot, dry summers in the southern United States to consume the foliage of many species of landscape plants and turfgrass. Two experiments were conducted to determine which insecticides could be used to safely provide residual control for the continual daily migration of grasshoppers in urban landscapes and nurseries. Leaves from treated *Hibiscus moscheutos* were harvested sequentially in time at 1-, 5-, and 11-days posttreatment and adult differential grasshoppers were confined on them for 24-, 48- and 72-hr exposures. Treatments with two synthetic pyrethroids, bifenthrin 0.66F (0.782 ml/liter) and lambda-cyhalothrin 9.52 WP (0.748 g/liter), provided 94 and 83%, mortality respectively, with 24-hr exposure to the 1-day-old treated leaves. Both chemicals provided 100% control of the grasshoppers during 72-hr exposure. The half rate (0.391 ml/liter) of bifenthrin also provided 89% control within the 72-hr evaluation. Treatments with diazinon AG600 (4.25 ml/liter) also provided 80-85% control with 72-hr exposure on the 1-day-old treated leaves. Acephate 75% S (0.803 g/liter) provided 33-39% control on the 1-day-old residues. Lambda-cyhalothrin provided 84% control with 72-hr exposure to the 5-day-old treated leaves. Residual control was also provided at 5 days by bifenthrin and acephate (53% and 46-50%, respectively). Most materials evaluated failed to provide any protection at all and none of the treatments provided residual control when grasshoppers were exposed to 11-day-old residues. No phytotoxicity to hibiscus was observed due to any of the treatments.

Key Words: differential grasshopper, bioassays, bifenthrin, lambda-cyhalothrin, diazinon, acephate, landscape pest, nursery pest

RESUMEN

Melanoplus differentialis (Thomas) (Orthoptera: Acrididae) y varias otras especies de saltamontes invaden paisajes urbanos / suburbanos y viveros de venta al por menor / por mayor durante los veranos calientes y secos al sur de los Estados Unidos para consumir el follaje de muchas especies de plantas paisajistas y grama de césped. Dos experimentos fueron llevados a cabo para determinar cuales insecticidas pudieran ser usados para proveer control residual con seguridad para la continua migración diaria de saltamontes en viveros y paisajes urbanos. Hojas de *Hibiscus moscheutos* tratadas fueron cosechadas en secuencia de tiempo a 1, 5, y 11 días después de tratamiento y saltamontes adultos diferenciales fueron confinados con ellas por exposición de 24, 46 y 72 horas. Tratamientos con dos piretroides sintéticos, bifenthrin 0.55F (0.782 ml/litro) y lambda-cyhalothrin 9.52 WP (0.78 g/litro), proveyeron mortalidad de 94 y 83%, respectivamente, con exposición de 24 hr. a las hojas tratadas de 1 día. Ambos químicos proveyeron 100% de control de los saltamontes durante exposición por 72 hr. La media dosis (0.391 ml/litro) de bifenthrin también proveyó 89% de control dentro de la evaluación de 72 hr. Tratamientos con diazinon AG600 (4.25 ml/litro) también proveyó 80-85% de control con exposición de 72 hr. en las hojas tratadas de 1 día. Acephate 75% S (0.803 g/litro) proveyó 33-39% de control en los residuos de 1 día. Lambda-cyhalothrin proveyó 84% de control con exposición por 72 hr. a las hojas tratadas por 5 días. Control de residuos fue tambien proveido a los 5 días por bifenthrin y acephate (53% y 46-50%, respectivamente). La mayoría de los materiales evaluados fracasaron en proveer alguna protección del todo y ninguno de los tratamientos proveyeron control residual cuando los saltamontes fueron expuestos a los residuos de 11 dias. No fitotoxicidad a los hibiscos fue observada debido a alguno de los tratamientos.

Several species of grasshoppers invade urban/suburban landscapes and retail/wholesale nurseries during the hot, dry summers in the southern United States to consume the foliage of many species of landscape plants and turfgrass. The feeding behavior of several species of *Melanoplus* grasshoppers has been studied (Feaver 1985, Fielding and Brusven 1992, Harvey and Thompson 1993, Hinks et al. 1990). Based upon limited surveys during the summer and fall of 1998 and 1999 and the summer of 2000, the differential grasshopper, *Melanoplus differentialis* (Thomas)

(Orthoptera: Acrididae), is the species most frequently encountered in damaging numbers in the Texas landscape. Additionally, the two-striped grasshopper, *M. bivitattus* (Say), and migratory grasshopper, *M. sanguinipes* (Fabricius), migrate into the urban environs to cause significant damage to the landscape.

Cooperative extension reports from Kansas (Bauernfeind 1992) and Texas (Patrick 1998) also report these species as the primary grasshopper pests of gardens and urban landscapes. Nymphs are usually not a problem in urban plantings as they normally develop in pasture and field-crop settings. Only after they molt to the adult stage do we see the migration into urban landscapes. However, in rural landscapes, severe damage may result from both nymphs and adults that readily move by walking from adjacent fields and roadsides. A mature grasshopper feeding on a small shrub or bedding plant can soon disfigure it and several feeding adults can ruin the aesthetic value of plants around a home within a short time. The economic impact to a retail or wholesale nursery can be very high. Plants are sold for their aesthetic value and even limited grasshopper feeding can soon render the plants unsaleable.

Outbreaks are usually preceded by several years with hot, dry summers and warm autumns (Patrick 1998). Also, the dry weather increases survival of both nymphs and adults. The extremely hot and dry summer of 1998 created ideal conditions for extensive outbreaks of grasshoppers across much of the southern United States. Populations the following years (1999 and 2000) were also high and caused extensive damage. As pastures, field crops and uncultivated areas were either harvested or desiccated from the drought conditions, mature grasshoppers readily dispersed into plant nurseries and the urban landscape in search of food. As a result, extensive damage was common, especially in Texas, on lawns and many species of landscape plants. Control strategies were needed to manage the invasion within the urban scape and in plant nurseries. The purpose of these experiments was to determine which insecticides could be used to safely control grasshoppers on landscape plants and in nursery culture and also, to determine if any of the treatments could provide residual control for the continual daily migration of the adults.

Materials and Methods

Two experiments were conducted to evaluate insecticides for residual control. Chemicals and rates evaluated are given in Tables 1 and 2. For each experiment, 'Disco Rose Red' Hibiscus, *Hibiscus moscheutos*, plants [ca. 30 to 40 cm high grown in 15-cm diam. (1 gal) pots] were obtained from a local nursery. Plants were sprayed to runoff with the respective treatments. Silwet, an organosilicon wetting agent, was added to each treatment at a rate of 1 ml/liter of water. Two plants were treated with each insecticide in each replicate to ensure adequate treated foliage would be available for sequential residual evaluations. Plants were maintained in full sun to allow maximum bio-degradation of the treatment chemicals. Leaves were clipped at 1- and 5-days posttreatment (DAT) in Experiment 1 and at 1-, 5-, and 11-DAT in the second experiment, bagged, placed in a cooled ice chest and taken to the laboratory. Two to three treated leaves were caged with each individual adult grasshopper in 9-cm diam. × 20 mm plastic growth chambers and the individuals were observed every 24 hr for up to five days. Each feeding chamber was first provided with two 7-cm filter paper discs, saturated with distilled water, to maintain foliage turgidity. For both experiments, 5 reps each with 4 adults were evaluated for the respective days after treatment. For each evaluation period, mortality ratings were made at 24-, 48-, 72-, 96- and 120-hr after grasshoppers were caged on the clipped, treated plant material.

For these studies, field populations of adult differential grasshoppers were collected from stands of Johnsongrass, *Sorghum halepense* (L.) Pers., growing in railroad or highway rights-of-way at sites in either Denton or Collin Co., TX. Adults were individually collected with a sweep net, transferred to stems and leaves of Johnsongrass in plastic shoe boxes that had been modified with screen lids, and stored in cooled ice chests for immediate transport to the laboratory. Only grasshoppers that appeared healthy the next day were used to initiate the residue studies. Either males only or females only were used within each replicate, to ensure that any differences in susceptibility due to sex would be accounted for statistically as replication error.

Data were adjusted (Abbott 1925) in Experiment 1 (Table 1) since mortality in the untreated check approached 10% at both 72-hr evaluations. No adjustment was needed in Experiment 2, since no grasshoppers died in the untreated check during the study. All data were analyzed using Analysis of Variance and General Linear Model Procedures. Treatment means were separated by Waller-Duncan k-ratio t test (k = 100) (P = 0.05) (SAS Institute 1990). Percent mortality data was transformed by arcsines before analysis. Untransformed means are presented.

Results and Discussion

Treatments with two synthetic pyrethroids, bifenthrin 0.66F (Talstar) (0.782 ml/liter) and lambda-cyhalothrin 9.52 WP (Simitar) (0.748 g/liter), provided 94 and 83% mortality, respectively, with 24-hr exposure to the 1-DAT hibiscus leaves (Table 2). Furthermore, both chemicals provided

TABLE 1. CONTROL OF DIFFERENTIAL GRASSHOPPERS (*MELANOPLUS DIFFERENTIALIS*) WITH INSECTICIDES. TREATMENTS IN EXPERIMENT 1 APPLIED ON 10 SEPT. 1998 (5 REPS, EACH WITH 4 ADULT GRASSHOPPERS).

Treatment[a]	Rate (ml or g product/liter)	Exposed 1-DAT[b]			Exposed 5-DAT[b]		
		24hr	48hr	72hr	24hr	48hr	72hr
Diazinon AG600	4.25 ml/l	40 a[cd]	53 a	83 a	—	—	—
+ Abamectin 0.15 EC	+ 0.31 ml/l						
Diazinon AG600	4.25 ml/l	20 b	58 a	78 a	0 b	0 b	0 b
Acephate 75WP	0.8 g/l	5 bc	21 b	33 b	25 a	35 a	50 a
CGA293,343 25 WG	0.16 ml/l	0 c	0 c	22 bc	—	—	—
+ Emamectin Benzoate 5 SG +	0.23 ml/l						
CGA293,343 25 WG	0.32 ml/l	0 c	5 bc	17 bcd	—	—	—
Pymetrozine 50 WG	0.19 g/l	5 bc	5 bc	5 cd	—	—	—
Abamectin 0.15 EC	0.31 ml/l	5 bc	5 bc	5 cd	—	—	—
Emamectin Benzoate 5 SG	0.23 ml/l	0 c	0 bc	0 cd	—	—	—
Pymetrozine 50 WG	0.19 g/l	0 c	0 c	0 cd	—	—	—
+ Abamectin 0.15 EC	+ 0.31 ml/l						
Pymetrozine 50 WG	0.19 g/l	0 c	0 c	0 d	—	—	—
+ Emamectin Benzoate 5 SG	+ 0.23 ml/l						
CGA293,343 25 WG	0.16 ml/l	0 c	5 bc	0 cd	—	—	—
+ Abamectin 0.15 EC	+ 0.31 ml/l						
Untreated Check	0	0 c	0 bc	0 cd	0 b	0 b	0 b

[a]Silwet, an organosilicon wetting agent was added to all treatments at a rate of 1ml/liter of water.

[b]Leaves were harvested from plants with the respective treatments at 1- and 5-days-after-treatment and caged with individual grasshopper adults. Mortality of the grasshoppers was assayed after 24-, 48- and 72-hr exposure and feeding on the treated leaves.

[c]Analysis was made on arcsine transformation of the percent mortality data: percent mortality is presented.

[d]Means in a column not followed by the same letter are significantly different by Waller-Duncan k-ratio t-test (k = 100) (P = 0.05).

TABLE 2. CONTROL OF DIFFERENTIAL GRASSHOPPERS (*MELANOPLUS DIFFERENTIALIS*) WITH INSECTICIDES. TREATMENTS IN EXPERIMENT 2 APPLIED ON 24 SEPT. 1998 (5 REPS, EACH WITH 4 ADULT GRASSHOPPERS).

		Exposed 1-DAT[b]			Exposed 5-DAT[b]			Exposed 11-DAT[b]		
Treatment[a]	Rate (ml or g product/liter)	24hr	48hr	72hr	24hr	48hr	72hr	24hr	48hr	72hr
Bifenthrin 0.66F	0.782 ml/l	94.4 a[cd]	94.4 ab	100 a	40.0 ab	45.5 b	52.6 b	0 [nss]	0 [ns]	0 [ns]
Lambda-cyhalothrin 9.52WP	0.748 g/l	83.3 a	100 a	100 a	55.0 a	68.4 a	84.2 a	0	0	0
Bifenthrin 0.66F	0.391 ml/l	50.0 b	83.3 b	88.9 b	15.0 bc	15.0 c	26.3 cd	—	—	—
Acephate 75%S	0.803 g/l	33.3 bc	38.9 c	38.9 c	40.0 ab	45.5 b	45.5 bc	0	0	0
Deltamethrin 50SC	1.564 ml/l	16.7 cd	16.7 cd	16.7 d	5.0 c	10.5 c	26.3 cd	—	—	—
Deltamethrin 50SC	0.391 ml/l	0 d	0 d	0 d	0 c	10.5 c	26.3 cd	—	—	—
Carbaryl 4 SL	2.50 ml/l	0 d	0 d	0 d	0 c	0 c	5.3 d	—	—	—
Imadocropid 75WP	0.038 g/l	0 d	0 d	0 d	0 c	0 c	5.3 d	—	—	—
Untreated Check	0	0 d	0 d	0 d	0 c	0 c	0 d	0	0	0

[a]Silwet, an organosilicon wetting agent was added to all treatments at a rate of 1 ml/liter of water.

[b]Silwet, an organosilicon wetting agent was added to all treatments at a rate of 1 ml/liter of water. Leaves were harvested from plants with the respective treatments after 1-, 5-, and 11-days-after-treatment and caged with individual grasshopper adults. Mortality of the grasshoppers was assayed at 24-, 48- and 72-hr exposure and feeding on the treated leaves.

[c]Analysis was made on arcsine transformation of the percent mortality data: percent mortality is presented.

[d]Means in a column not followed by the same letter are significantly different by Waller-Duncan k-ratio t-test (k = 100) (P = 0.05).

100% control of the grasshoppers with 72 hr exposure. The half rate of bifenthrin (0.391 ml/liter) also provided 89% control with 72 hr exposure. Treatments with either diazinon AG600 (4.25 ml/liter) or diazinon AG600 (4.25 ml/liter) + abamectin 0.15 EC (Avid) (0.31 ml/liter) also provided 78-83% control with 72 hr exposure to the 1-DAT leaves (Table 1). Acephate 75% S (Orthene TTO) (0.803 g/liter) provided limited initial control (33-39%) (Table 2). Other treatments evaluated did not provide more than 22% control for the 1-day residue evaluation. Mortality at 96- and 120-hr was not significantly greater than for the 72-hr evaluation.

To determine residual control, leaves that had been treated 5 and 11 days earlier were also harvested and grasshoppers were caged on them. Lambda-cyhalothrin provided 84% control within 72 hr on the 5-DAT leaves. Both bifenthrin and acephate also provided residual control (53 and 46-50%, respectively) at 5 days. The increase in residual control for acephate, from 33- 39% at 1 day to 46-50% at 5 days could probably be attributed to its systemic action. None of the treatments provided any residual control when grasshoppers were exposed to 11-DAT leaves. No phytotoxicity to hibiscus was observed due to any of the treatments.

A higher level of control might have been achieved with these treatments if they were applied directly to the feeding grasshoppers or if the grasshoppers were immediately exposed to the treated foliage. Also, a higher level of control would be anticipated if the treatments were applied to the immature stages. It was the main purpose of these experiments, however, to evaluate the effect of these toxicants on grasshoppers that were migrating onto the treated plants. Only a limited percentage of the grasshopper population will actually be sprayed when the treatment is applied.

These experiments provide important management information for the nursery and landscape industries. These experiments show bifenthrin and lambda-cyhalothrin (both synthetic pyrethroids) and diazinon, each provide significant control of grasshoppers, even when they migrate onto the treated foliage a day after treatments are applied. This level of control may increase if the grasshoppers are directly contacted with the spray treatments. Bifenthrin, lambda-cyhalothrin and acephate also provided at least 5-day residual control for the differential grasshopper. By choosing one of the more residual chemicals, repeat applications should only be necessary every 5 days or even weekly to protect landscape plants. Each of the effective insecticides is labeled for grasshoppers and available for homeowner or commercial treatment of landscape plants.

This article reports the results of research only. Mention of a proprietary product does not constitute an endorsement or recommendation by the Texas A&M University Agriculture Program.

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