Effect of Clear Choice™ Herbicide on Tropical Sod Webworms (Lepidoptera: Pyralidae) in St. Augustinegrass[1]

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J. Entomol. Sci. 45(1): 44-50 (January 2010)

Abstract Clear Choice® (Petro-Canada, Calgary, Canada) is an environmentally-friendly herbicide for broad-leaf weed control in turfgrasses. However, our laboratory and field data show that the herbicide also will help control tropical sod webworm, *Herpetogramma phaeopteralis* Guenee, populations in St. Augustinegrass. We believe this is the first report of an herbicide helping to control a pest insect in any turfgrass. Mortality is primarily caused in small and medium-sized larvae by a feeding response (starvation or toxicity via ingestion) rather than direct contact or volatilization. Future research will be needed to determine the specific chemical(s) responsible for the larval mortality and if the herbicide may also help control other insect pests of turfgrasses.

Key Words Herbicide, turfgrass, Pyralidae, sod webworm, oil

Numerous interactions occur among weeds, arthropod pests, and their natural enemies in managed ecosystems. These include phytophagous pest arthropods using weeds as alternate food sources, trophic interactions between weeds and beneficial arthropods, effects on arthropods of habitat modification by weeds, etc. (Norris and Kogan 2000). The effect of herbicides on arthropods also has been investigated with the original impetus for this research coming from early observations that the herbicide 2, 4-D affected sugarcane borer, *Diatraea saccharalis* (F.), populations (Ingram et al. 1947).

There are numerous recorded examples of the effects of herbicides on arthropods. However, there are few, if any, published accounts of the effect of herbicides on arthropods in turfgrass. For example, there is virtually no mention of arthropod-herbicide interactions in 2 recently published turfgrass insect books (Potter 1998, Vittum et al. 1999).

Lepidopteran larvae have long been recognized as major pests of turf grown in Florida. Among these pests, the tropical sod webworm, *Herpetogramma phaeopteralis* Guenee, is considered to be most damaging. This species has a wide tropical distribution and occurs along much of the Gulf Coast of the United States (Kerr 1955). All major southern turfgrasses in Florida are subject annually to potential damage by tropical sod webworms. Widespread damage can occur on virtually all types of turf areas, but infestation levels and the resulting damage are usually greatest on high-maintenance turf areas (Reinert 1983). In Florida, populations are present throughout

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the year, but most damage is incurred in late summer and fall at which time flight activity is at its highest (Cherry and Wilson 2005). Most recently, Reinert (2008) noted resistance to tropical sod webworms in various turfgrass cultivars.

Clear Choice® (Petro-Canada, Calgary, Canada) is a new selective broadleaf herbicide for use on several turfgrasses including St. Augustinegrass (*Stenotaphrum secundatum* (Walt.) Kuntze). It is a food-grade synthetic isoparaffinic oil incorporating active auxinic components. It is reduced risk in that it incorporates a much smaller amount of auxinic components than conventional 3-way herbicides. The chemical composition of Clear Choice is 84% isoparaffinic oil, 0.5% 2,4-D, 0.3% Mecoprop, 0.09% Dicamba, plus emulsifiers. It is also nontoxic to humans, odorless, free of carcinogens, and biodegradable thus being environmentally friendlier than conventional products. Similar petroleum-based mineral oils have been shown to have a wide range of activity against many insects and mites (Fernandez et al. 2005). The objective of our research was to determine if Clear Choice used at the field recommended rate impacted tropical sod webworm populations in St. Augustinegrass.

Materials and Methods

Laboratory tests. Clear Choice was tested as an emulsifiable concentrate which was diluted with water prior to application. Eggs were obtained from field-collected female moths held in 1.9-L glass jars with male moths and St. Augustinegrass stolon (runner plus grass blades) clippings. Sections of leaves with egg masses were dipped in a 10% solution of herbicide, which is the recommended concentration for field application. The age of egg masses used was not controlled because egg masses in a field situation would be of different ages. Egg masses of approximately same sizes were used in controls and herbicide treatment in each replication. Leaves were then allowed to drain and were then stored in 9-cm diam Petri dishes at 25°C and 12D/12L. One egg mass was stored in each Petri dish with moistened filter paper and was considered one replicate. Ten replicates were conducted. Egg hatch was checked every 1 - 2 d for 10 d at which time eggs were not hatching anymore. The number of eggs in a single egg mass ranged from 16 - 30 and, therefore, the % hatch/egg mass was used to standardize the data. The % egg hatch of herbicide treated eggs versus untreated control eggs was determined via *t*-test (SAS Institute 2008). The % control provided by herbicide was estimated using Abbott (1925).

Larvae also were obtained from field-collected female moths held in 1.9-L glass jars to oviposit. Eggs were removed and placed in 15-L plastic pans to rear larvae on St. Augustinegrass stolon clippings. Kerr (1955) reported that tropical sod webworms had 7 larval instars ranging from 1 - 17 mm in length. Larvae of different sizes were tested for exposure to the herbicide. We defined small larvae as 1 - 5 mm long, medium larvae as 6 - 10 mm long, and large as 11 - 15 mm long. St. Augustinegrass stolons were dipped into 10% herbicide and then drained to simulate a field application. Stolons (approx. 4 g wet weight) and 5 larvae of 1 of the 3 sizes were then placed into a 414-ml plastic container. Moistened filter paper was placed on the bottom to maintain high humidity. We believe this method to be a good field simulation because most herbicide coverage would occur on foliage when typically sprayed during daytime when the larvae remain hidden in foliage becoming active at night (Kerr 1955). Each container was considered one replication and held with a control at 25°C and 12D/12L photoperiod for 4 d. After 4 d, containers were opened, and surviving larvae counted. Food in containers was in excess with some remaining after 4 d. Ten replications of each of the 3 sizes of larvae were conducted. The *P* value for the large larvae after 10 replications was a low 0.08. Hence, an additional 10 replications were conducted with large larvae to determine if statistical significance could be achieved at α = 0.05 with additional sample size. The mean survival of herbicide treatments versus controls was determined via *t*-test (SAS Institute 2008). The % control given by herbicide was estimated using Abbott (1925).

The previous test determined mortality of larvae held on treated stolons. However, the cause of mortality could not be determined because larvae might be killed by herbicide on stolons due to contact, feeding, and/or volatilization. Hence, an additional test was conducted to determine if direct contact was the cause of larval mortality. The experimental design was similar to the previous test except for two details. First, all larvae were sprayed with 10% herbicide with a small hand-held aerosol sprayer. Larvae were in a Petri dish with a filter paper bottom and sprayed until larvae were covered with solution. Second, the St. Augustinegrass stolons the larvae were held on were not treated with 10% herbicide. Ten replications were conducted for each of the 3 larval sizes, and statistical analysis was conducted as described in the previous test.

A last laboratory test was conducted to determine if volatilization was the cause of larval mortality. In this test, controls were untreated larvae placed in the 414-ml containers with untreated grass stolons and moistened filter paper on the bottom. In addition, 4 g of grass (wet weight) were suspended in fine mesh cloth in each container to exclude larvae. Herbicide treatments were the same except the grass in the cloth mesh had been previously dipped in 10% herbicide and drained. Larvae were again held 4 d at 25°C. Ten replications were conducted for each of the 3 larval sizes, and statistical analysis was conducted as described previously.

Field tests. Two plots were established in St. Augustinegrass on the Everglades Research and Education Center at Belle Glade, FL. For our evaluations, we used a cylinder method first reported by Crocker and Simpson (1981). More recently, Nagata et al. (2002) have shown the cylinder method to be an excellent field technique to screen pesticides against southern chinch bugs, *Blissus insularis* Barber, in St. Augustinegrass. These cylinders present a realistic field habitat containing natural predators and providing for ambient air, sunlight, and rain conditions and have similar temperatures to the adjacent turf.

On 9 August 2007, six PVC cylinders (3 cylinders = 3 replicates/plot) were set into the 2 plots. Each cylinder was 15.2 cm in diam by 15.2 cm high and set into the soil so that the rim was approx. 10 cm above the soil surface. Thereafter, 10 medium-sized (6 - 10 mm long) larvae were placed into each of the 6 cylinders and each cylinder covered with fine mesh cloth held in place with rubber bands. These cloth tops allow air, sunlight, and rain into the cylinders. Tropical sod webworm larvae were obtained from eggs from adults collected on the research center. On 10 August 2007, the cloth tops were removed from the cylinders, the herbicide applied to 1 plot, and the tops quickly replaced. A 10% solution of herbicide was applied at 749 l/ha with a CO_2-powered sprayer. After 4 d, the 6 cylinders were dug up and transported to a laboratory where they were carefully examined for larvae. The preceding procedure was repeated 4 more times on 4 later dates with new plots, larvae, etc. The procedure was limited to 3 replicates per date because of limited numbers of suitably sized larvae for testing at any one time and the extensive time needed to find surviving larvae in the turf in the cylinders.

Data from the 5 dates were pooled giving a total of 15 replications. Differences between mean larval survival in the control (untreated) versus herbicide treatment were analyzed via a *t*-test (SAS Institute 2008). The % control of the herbicide treatment also was estimated by adjusting for natural mortality using Abbott (1925).

Results and Discussion

Survival of tropical sod webworm after exposure to stolons dipped in herbicide is shown in Table 1. The herbicide had no significant effect on egg survival. However, the herbicide significantly reduced survival of all 3 sizes of larvae. The % control was highest with small larvae and lowest with large larvae. This shows that as larvae grew they became less susceptible to the herbicide.

Survival of larvae after being sprayed with the herbicide is shown in Table 2. The herbicide significantly reduced survival of small larvae and did not significantly reduce survival of medium or large larvae. However, insight into the mechanism(s) causing mortality is provided by comparing data from Tables 1 and 2. The herbicide killed 97% of unsprayed small larvae on herbicide-dipped stolons versus 20% of sprayed small larvae on untreated stolons. Similarly, the herbicide killed 80% of unsprayed medium-sized larvae on herbicide-dipped stolons versus 4% of sprayed larvae on untreated stolons. Also, the herbicide killed 24% of unsprayed large larvae on herbicide-dipped stolons versus 0% of sprayed larvae on untreated stolons. These data show that direct contact with the herbicide is a minor factor in killing larvae.

Survival of larvae exposed to volatilization of the herbicide but not dipped leaves or contact via spraying is shown in Table 3. Volatilization from the herbicide did not significantly reduce survival of any of the 3 larval sizes. Taken as a whole, the preceding data show that the herbicide is primarily killing larvae via a feeding response (starvation or toxic ingestion) and not direct contact via spraying or volatilization.

Field survival of larvae after herbicide application is shown in Table 4. On all 5 dates, larval survival consistently averaged lower in the herbicide treatment than the control treatment. When the data were pooled, a *t*-test showed significantly lower tropical sod webworm survival ($P < 0.0001$) in the herbicide treatments than the control. Also, the laboratory data (Table 1) and field data are reasonably consistent in that the estimated % control for the herbicide was 80% for medium-sized larvae in the

Table 1. Laboratory survival of different stages of tropical sod webworms after exposure to stolons dipped in 10% Clear Choice™ herbicide

	Control	CC	
Stage	Mean ± SD	Mean ± SD	% Control+
Egg*	97.7 ± 4.8	94.8 ± 7.1	3
Small larvae**	3.3 ± 1.3	0.1 ± 0.3	97
Medium larvae**	4.4 ± 0.5	0.9 ± 0.9	80
Large larvae**	4.3 ± 0.6	3.3 ± 1.1	24

*% egg hatch; *t*-test showed no significant difference ($P > 0.05$) in survival between the control and Clear Choice (CC) treatment.

**Survival of 5 larvae held 4 days; *t*-test showed a significant difference between control and Clear Choice in small larvae ($P < 0.0001$), medium size larvae ($P < 0.0001$), and large larvae ($P < 0.01$).

+ % control estimated from Abbott (1925).

Table 2. Laboratory survival of different size larvae of tropical sod webworms after being sprayed with 10% Clear Choice™ herbicide

Larvae	Control*	CC*	% Control**
	Mean ± SD	Mean ± SD	
Small	4.0 ± 0.8	3.2 ± 0.6	20
Medium	4.7 ± 0.7	4.5 ± 0.8	4
Large	4.8 ± 0.4	4.8 ± 0.4	0

* Survival of 5 larvae held 4 days; *t*-test showed a significant difference between control and Clear Choice (CC) in small larvae ($P < 0.05$), not in medium size larvae ($P > 0.05$), and not in large larvae ($P > 0.05$).
** % control estimated from Abbott (1925).

laboratory test using dipped leaves to simulate field application and 61% for medium-sized larvae in the field test after herbicide treatment.

In summary, Clear Choice will be marketed primarily as an environmentally-friendly herbicide for broad-leaf weed control in turfgrasses. However, our laboratory and field data show that Clear Choice also will help to control tropical sod webworm populations in St. Augustinegrass. We believe this is the first report of an herbicide which helps control a pest insect in any turf grass. Our data also show that mortality is primarily caused in small and medium-sized larvae, by feeding mechanisms (antifeeding or toxicity via ingestion) rather than direct contact or volatilization. This helps explain why the herbicide is effective against the larvae under field conditions because during the day when spraying application is typically made, most larvae are hidden down below grass foliage (Kerr 1955) and receive little direct contact with the herbicide. Also, because Clear Choice is sprayed on the grass in an open-field situation, volatilization would not be expected to be a significant factor in killing the insects. However, the larvae are active only at night (Kerr 1955) at which time they may feed on herbicide-coated grass blades.

The exact chemical responsible for killing the larvae is not known. As noted earlier, the chemical composition of Clear Choice is 84% isoparaffinic oil, 0.5% 2,4-D, 0.3% Mecoprop, 0.09% Dicamba, and 15% emulsifiers. The use of mineral oil for pest management has a long history and has been used on a wide spectrum of pests and a

Table 3. Laboratory survival of different size larvae of tropical sod webworms after exposure to volatilization of Clear Choice™ herbicide

Larvae	Control*	CC*	% Control**
	Mean ± SD	Mean ± SD	
Small*	4.5 ± 0.5	4.3 ± 0.4	6
Medium*	4.2 ± 0.9	3.8 ± 0.9	10
Large*	4.4 ± 0.8	4.4 ± 0.7	0

* Survival of 5 larvae held 4 days; *t*-test showed no significant difference ($P > 0.05$) between control and Clear Choice (CC) in any larvae.
** % control estimated from Abbott (1925).

Table 4. Field survival of tropical sod webworm larvae in St. Augustinegrass after Clear Choice™ herbicide applications

		Control**	CC**
Date*	Replications	Mean ± SD	Mean ± SD
8/14/07	1 - 3	5.0 ± 1.7	1.3 ± 1.1
8/20/07	4 - 6	5.3 ± 1.5	2.3 ± 2.3
8/27/07	7 - 9	6.0 ± 1.0	3.0 ± 2.0
9/25/07	10 - 12	3.3 ± 3.1	1.3 ± 2.3
10/2/07	13 - 15	6.7 ± 1.5	2.5 ± 0.7
	All+	5.3 ± 2.0	2.1 ± 1.7
	% Control++	0	61

* Date of application. Different plots are used for each date.

** 10 medium size larvae per cylinder (replication) held 4 days; Clear Choice (CC) applied at 10% concentration in 80 gal/acre (749 l/ha).

+ 15 replications pooled; *t*-test showed significant difference ($P < 0.0001$) between control and Clear Choice.

++ % control estimated from Abbott (1925).

variety of crops (Fernandez et al. 2005). However, small amounts of 3 herbicides are also present, and herbicides such as 2,4-D have been known to affect arthropods (Norris and Kogan 2000). Also, the effects, if any, of the emulsifiers were not determined. Future research will be needed to determine the specific chemical(s) responsible for larval mortality. Also, other potential effects of Clear Choice on tropical sod webworms may be investigated such as repellency and ovipositional deterrence. And lastly, it needs to be determined if Clear Choice may also help control other insect pests of turfgrasses.

Acknowledgment

This research was funded by the Petro-Canada Corporation.

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