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EARLY SEASON HERBICIDE TREATMENT OF WILD HOST PLANTS IN MARGINAL AREAS NEAR FIELDS, ROADS, AND DITCHES AND RESULTING NUMBERS OF TARNISHED PLANT BUGS IN TREATED AND UNTREATED AREAS

G.L. Snodgrass, W.P. Scott, and D.D. Hardee
UDSA-ARS, Southern Insect Management Research Unit
Stoneville, MS
J.T. Robbins
Delta Research and Extension Center, Mississippi State University
Stoneville, MS

Abstract

A single herbicide (Strike 3™) application in early season was made to marginal areas around fields, roads, and ditches in 23 square kilometer (9 square miles) areas of the Mississippi Delta in 1999, 2000, and 2001. The herbicide was used to kill broad leaf weeds in the marginal areas which served as food and reproductive hosts for tarnished plant bugs. The herbicide was effective and caused a significant reduction in wild host densities in the treated areas in all three years. Tarnished plant bug populations in treated areas did not increase significantly in the treated marginal areas during April and May following treatment of the areas in the first two weeks of March in 2000 and 2001. Significant increases in plant bug populations occurred on wild hosts in marginal areas in untreated areas in both years. The herbicide application was made in the first two weeks of April 1999, and in this year plant bug populations increased in marginal areas which were treated. The increase was caused by plant bugs moving to Italian ryegrass which was not affected by the herbicide. Ryegrass is abundant in marginal areas in the delta, and blooms during April. These results showed that the herbicide application was effective in reducing numbers of broad leaf wild hosts and plant bug populations that utilized them. To be most effective, the application should be made in late-February through the first two weeks of March to avoid moving plant bugs onto Italian ryegrass when it is in bloom and can serve as a host.

Introduction

In the delta region of the midsouth 169 host plant species of the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), have been identified (Snodgrass et al. 1984a, 1984b). Most of these hosts are broad leaf weeds that are utilized by plant bugs for food and reproduction when they have flower buds, blooms, or developing seeds. The presence of weed hosts in the winter and spring allows plant bug populations to increase before moving into cotton, *Gossypium hirsutum* L., which is the main crop in the midsouth damaged by plant bugs (Tugwell et al. 1976, Cleveland 1982, Snodgrass et al. 1984). Tarnished plant bugs are controlled in cotton exclusively with insecticides, and have developed resistance to several classes of insecticides (Hollingsworth et al. 1997, Pankey et al. 1996, Snodgrass and Elzen 1995, Snodgrass 1996). Control methods for plant bugs not solely based on the use of insecticides are badly needed.

The delta region of the midsouth is intensively farmed and only a small area of the land is undisturbed by agriculture. Wild hosts of plant bugs are mostly restricted to marginal areas around fields or ditches or along roads. Snodgrass et al. (1991) found that these marginal areas comprised only 2.4% of the land in a 6.4 km square area of Washington County, Mississippi. Eliminating broad leaf host plants with herbicides would be economically feasible in such a small area. In the mid 1990's producers began a widespread weed control program in the delta in which winter and spring weeds weeds are treated in their fields with herbicides in February and March. Additional treatment of the marginal areas around these fields with a broad leaf herbicide could eliminate most early season plant bug hosts in and near the fields.

Tarnished plant bugs overwinter as adults in diapause, and diapause is broken in the midsouth during December (G. L. S. unpublished data). Nymphs can be found on winter weeds beginning in January, with new generation adults produced by mid-March in winters with average or above average temperatures. In cold winters in which wild hosts are stunted or killed, new generation adults are not produced until mid-April. This makes late-February through mid-March the best time for herbicide treatment of wild hosts since treatment would kill weeds on which nymphs were developing or in which eggs were present in normal winters. In cold winters, it would destroy weeds on which plant bugs would be developing when the weeds began blooming in late-March and April.

In the present study, data are presented which showed the effect of a single herbicide application in early season on broad leaf weed density and tarnished plant bug populations on them. The application was made as part of a large experiment designed to determine if destruction of wild hosts in early season could reduce subsequent tarnished plant bug populations in cotton in the treated areas.

Materials and Methods

The experiment was conducted in 1999-2001 in Choctaw, Sunflower, and Washington Counties in the delta of Mississippi. In each of the three years, four approximately square test areas 4.8 km (3 miles) on a side were used in the test. Two of the areas were check areas and received no treatment each year. In the two treated areas, a single application of Strike 3 TM herbicide was made. Strike 3™ is a combination of mecoprop, 2,-4-d, and dicamba, and was applied at 1.55 + 0.54 + 0.17 kg AI/ha, respectively. Applications were made using a John Deere® 2355 tractor (John Deere Co., Moline, IL) fitted with a 18.3 m spray-boom having 36 cone 2x nozzles, and calibrated to deliver 43.2 liter/ha at 13.6kg/cm2. The herbicide application was made to all marginal areas in the treated areas in which wild hosts were present. The application was made in the first two weeks of April in 1999, and in the first two weeks of March in 2000 and 2001.

Each of the four test areas was divided into approximately equal quadrants for sampling purposes. Marginal areas with good stands of wild hosts extending at least 100 m in length were identified and marked on aerial maps of the four test areas. These maps were obtained from the Geographic Information Satellite Center at the Delta Research and Extension Center, Stoneville, MS. The identified marginal areas with good stands of host plants were used for sampling plant bugs and to determine host plant species and densities prior to and after the herbicide treatment. The number of marginal areas sampled in each of the four test areas varied and depended on the number of roads and ditches present along with the cultural practices of the growers. At least one marginal area was sampled in each quadrant of the four test areas in each year. Samples were taken at four locations in each of the marginal sample areas. The distance from the beginning of each marginal sample area to the first location sampled in it, and the distances between the next three sample locations, ranged from 5 to 25 m and were selected at random. At each sample location, a rope 7.62 m in length marked in 0.31 m intervals was placed lengthwise through the middle of the area of wild hosts being sampled. Wild hosts were sampled for tarnished plant bugs with a sweep net and the numbers of adults and nymphs captured and the number of sweeps taken was recorded. No effort to separate numbers of plant bugs captured by host was made, since the host plants usually occurred mixed together. Sweep net samples were taken prior to taking plant density counts to avoid disturbing plant bugs on the hosts before they were sampled. Host density was determined by counting the broad leaf plants known to be plant bug hosts found within a wire ring which encompassed an area of 0.25 m2. A list of these host plants along with the time on which plant bugs can be collected on them is found in Snodgrass (1984a,b). Counts were recorded by plant species and were taken at four places along the 7.62 m rope by random selection of four of the 25 distances marked at 0.31-m-intervals along the rope. The ring was laid beside the rope at each distance selected and the counts taken. Placement of the ring on the left or right side of the rope was also selected at random for each of the four counts. Sampling to determine host plant density and plant bug populations was performed prior to the herbicide treatment and after treatment in all four test areas. Host plant densities were determined again at three to four weeks after treatment. Sweep net sampling to determine plant bug populations after treatment was performed one time, three weeks after treatment in 1999. In 2000 and 2001, sampling for plant bugs began about three weeks after treatment and was repeated at two-week intervals through mid-May.

Experimental design was a split plot where the main unit had two treatments with two replications arranged in a completely random resign. Time (the pretreatment and posttreatment samples) was treated as a subunit in the analyses. Quadrants and marginal sample areas were treated as subsamples for the main unit treatment effects and as replications for the time effect. Data were analyzed using PROC MIXED (SAS Institute 1999).

Results and Discussion

The Strike 3™ herbicide application was effective in reducing numbers of broad leaf host plants found in the treated areas. The pretreatment host plant density was significantly higher than the posttreatment host plant density in the treated areas in all three years (Tables 1-3). Comparison of pretreatment plant densities among the four test areas in 1999 found that treated area two had a significantly lower plant density than the other three test areas (Table 1). This was caused by lower numbers of henbit, *Lamium amplexicaule* L., narrowleaf vetch, *Vicia angustifolia* Reichard, and cutleaf geranium, *Geranium dissectum* L. in this area. In 2000, check area one had a significantly higher pretreatment host plant density than the other three test areas (Table 2). This was caused by higher numbers of several host plant species including henbit, cutleaf geranium, narrowleaf vetch and cutleaf evening-primrose, *Oenothera laciniata* Hill. Pretreatment plant density in check area one in 2001 was significantly higher than pretreatment plant densities in the other three test areas due to larger numbers of henbit in this area (Table 3). The causes for the higher pretreatment plant densities in some areas in some years are unknown. In the check areas pretreatment plant density declined significantly as compared to posttreatment density in check area two in 1999 (Table 1), check area one in 2000 (Table 2), and in both check areas in 2001 (Table 3). These declines were the result of the natural maturation and death of winter hosts such as henbit and shepherd's purse, *Capsella bursa-pastoria* (L.) Medicus. Dead hosts were not counted in the posttreatment counts. Despite the natural decline in host plant density, plant densities were still significantly higher in the posttreatment counts in the check areas as compared to the posttreatment densities in the treated areas in 1999, 2000, and 2001 (Tables 1-3).

In all three years of the study, posttreatment sweep net samples of wild hosts for tarnished plant bugs in the treated areas were mainly sweeps from grasses which were not affected by the Strike 3™ herbicide treatment. The most abundant grass found in all test areas each year was Italian ryegrass, *Lolium multiflorum* Lamarck. Ryegrass blooms and develops seeds during April and May in the midsouth. The Strike 3™ herbicide application was made in 1999 during the first two weeks of April which destroyed most of the broad leaf hosts in the treated areas and left mainly ryegrass in bloom. Tarnished plant bug adults and nymphs were found on the ryegrass flowers, and nymphs were able to complete their development on them (G.L.S. unpublished data). It is probable that nymphs crawled from their normal hosts onto the ryegrass as the hosts died. No significant differences were found in numbers of plant bug nymphs and adults when posttreatment numbers captured were compared to pretreatment numbers captured in the treated areas in 1999 (Table 4). However, mean numbers of plant bug adults and nymphs were higher in the posttreatment counts in the treated area they were in the check areas. Because of the discovery that tarnished plant bugs could utilize flowering ryegrass as a host, the Strike 3™ application was made about one month earlier in 2000 and 2001 during the first two weeks of March. This prevented tarnished plant bugs from utilizing ryegrass as a host since it was not in bloom when the broad leaf hosts were killed by the herbicide.

In 2000 and 2001, posttreatment counts of plant bug adults and nymphs were never significantly different from pretreatment counts in any week in the treated areas (Table 4). Numbers of adults and nymphs found in the posttreatment counts in the check areas were significantly higher than the pretreatment counts in the check areas from 19 April through 17 May 2000. In 2001, posttreatment counts in the check areas were significantly higher for nymphs as compared to pretreatment counts from 18 April through 17 May, although adults were significantly higher only on 2 May.

Results of this study showed that a single application of Strike 3™ herbicide was effective in reducing densities of broad leaf weeds that serve as early season hosts for the tarnished plant bug. Timing the application for early March was effective in reducing plant bug reproduction since no significant increase in posttreatment numbers of nymphs as compared to pretreatment numbers occurred in the treated areas in 2000 and 2001. In the check areas, a significant increase in posttreatment numbers of nymphs as compared to pretreatment numbers occurred in most sample weeks of both years.

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Table 1. Effect of a herbicide treatment in early April 1999 on tarnished plant bug wild host plant density in marginal areas near roads, fields, and ditches, in the Mississippi Delta.

	Mean no./m^2						
	Pretreatment (25 March)	Posttreatment (9 April)	*P*[a]	Pretreatment comparison	*P*	Posttreatment comparison	*P*
Treated area 1	37.9	6.1	0.001	Trt.area 2	0.002	Trt. area 2	0.504
				Ck area 1	0.176	Ck area 1	0.003
				Ck area 2	0.198	Ck area 2	0.010
Treated area 2	17.6	2.4	0.001	Ck area 1	0.040	Ck area 1	0.007
				Ck area 2	0.030	Ck area 2	0.002
Check area 1	29.9	26.0	0.257	Ck area 2	0.942	Ck area 2	0.562
Check area 2	30.3	22.7	0.028				

[a] The error probability for comparing the two means. Significance is declared at $P \leq 0.05$.

Table 2. Effect of a herbicide treatment in early March 2000 on tarnished plant bug wild host plant density in marginal areas near roads, fields, and ditches, in the Mississippi Delta.

	Mean no./m^2						
	Pretreatment (3 March)	Posttreatment (26 March)	*P*[a]	Pretreatment comparison	*P*	Posttreatment comparison	*P*
Treated area 1	47.4	3.9	0.001	Trt area 2	0.265	Trt area 2	0.938
				Ck area 1	0.001	Ck area 1	0.001
				Ck area 2	0.303	Ck area 2	0.002
Treated area 2	35.4	3.0	0.001	Ck area 1	0.001	Ck area 1	0.001
				Ck area 2	0.035	Ck area 2	0.001
Check area 1	111.5	85.0	0.002	Ck area 2	0.001	Ck area 2	0.005
Check area 2	58.5	51.6	0.419				

[a] The error probability for comparing the two means. Significance is declared at $P \leq 0.05$.

Table 3. Effect of a herbicide treatment in early March 2001 on tarnished plant bug wild host plant density in marginal areas near roads, fields, and ditches in the Mississippi Delta.

	Mean no./m^2						
	Pretreatment (5 March)	Posttreatment (2 April)	*P*[a]	Pretreatment comparison	*P*	Posttreatment comparison	*P*
Treated area 1	81.8	1.1	0.001	Trt area 2	0.150	Trt area 2	0.773
				Ck area 1	0.124	Ck area 1	0.010
				Ck area 2	0.938	Ck area 2	0.001
Treated area 2	64.3	4.5	0.001	Ck area 1	0.005	Ck area 1	0.020
				Ck area 2	0.137	Ck area 2	0.001
Check area 1	100.3	33.5	0.001	Ck area 2	0.152	Ck area 2	0.052
Check area 2	82.7	57.8	0.028				

[a] The error probability for comparing two means. Significance is declared at $P \leq 0.05$.

Table 4. Mean number of tarnished plant bugs found on wild host plants in marginal areas near fields, roads, and ditches, untreated and treated with a herbicide in the Mississippi Delta.

Year	Sample area	Life stage	Mean number (*P* value[a]) per sweep				
			Pretreatment	Posttreatment			
			(28 March)	(29 April)			
1999	Treated[b]	Nymph	0.0114	0.0193 (0.55)			
	Check	Nymph	0.0172	0.0146 (0.83)			
	Treated	Adult	0.0214	0.0612 (0.17)			
	Check	Adult	0.0026	0.0563 (0.09)			
			(1 March)	(3 April)	(19 April)	(4 May)	(17 May)
2000	Treated	Nymph	0.0010	0.0060 (0.72)	0.005 (0.60)	0.000 (0.35)	0.006 (0.67)
	Check	Nymph	0.0100	0.0230 (0.24)	0.041 (0.01)	0.043 (0.02)	0.055 (0.01)
	Treated	Adult	0.0060	0.0060 (0.95)	0.020 (0.46)	0.018 (0.52)	0.022 (0.41)
	Check	Adult	0.0040	0.0140 (0.56)	0.038 (0.07)	0.049 (0.02)	0.085 (0.01)
			(5 March)	(2 April)	(18 April)	(2 May)	(17 May)
2001	Treated	Nymph	0.0000	0.0000 (1.00)	0.029 (0.22)	0.001 (0.95)	0.006 (0.80)
	Check	Nymph	0.0000	0.0130 (0.58)	0.056 (0.03)	0.070 (0.01)	0.034 (0.17)
	Treated	Adult	0.0015	0.0017 (0.99)	0.033 (0.43)	0.009 (0.84)	0.003 (0.98)
	Check	Adult	0.0016	0.0015 (1.00)	0.072 (0.11)	0.165 (0.003)	0.014 (0.75)

[a] The *P* value associated with each comparison between the pretreatment mean and the posttreatment mean. Its value is based on the error estimate from the ANOVA and it is equivalent to using a least significant difference comparison.
[b] Treated areas received an application of Strike3 herbicide in the week following the pretreatment sample date.