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FIELD PLOT STUDIES OF TARNISHED PLANT BUGS ON SELECTED WILD HOST PLANTS WITH AND WITHOUT BURNDOWN HERBICIDE APPLICATION AND REMOTE SENSING FOR HOST DETECTION

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Abstract

Tarnished plant bug (TPB), *Lygus lineolaris*, feeds and reproduces on a variety of early-season wild host plants before the cotton cropping season begins. These host plants have been the focus of area-wide management programs that use burn-down herbicides to reduce the hosts, thus reducing crop infestation by TPB. Populations of TPB can be reduced by as much as five times when compared with untreated areas. Plot experiments were conducted to determine effects of plant species (broadleaf hosts and non-host grasses) and burn-down herbicide applications (treated or untreated) on TPB populations. TPB numbers were significantly greater in broadleaves vs. grasses. Among broadleaf hosts, radish had the highest TPB numbers followed by crimson clover, hairy vetch, and Austrian winter pea. Burn-down herbicide applications to vetch & rye-grass/vetch treatment plots prevented TPB population increases, while untreated vetch and ryegrass/vetch plots had significant increases of TPB. Untreated vetch and ryegrass/vetch plots had three to ten-fold more TPB than burn-down herbicide treated plots (which is similar to results from area-wide management studies). Remotely sensed imagery of plots revealed NDVI and G-NDVI values of broadleaves that were lower than grasses. Remote sensing may be useful for early-season host detection, but more needs to be known about host phenology, plant stand mixture, and texture.

Introduction

Tarnished plant bug (TPB), *Lygus lineolaris* (Palisot de Beauvois), is a key pest of cotton in the Mississippi Delta and frequently causes substantial economic injury. TPB has been reported to feed on more than 300 species of wild and cultivated host plants (Young 1986). In the Mississippi Delta, TPB feeds and reproduces on more than 150 species of wild broadleaf host plants especially during non-cropping periods (Snodgrass et al. 1984). In late Winter and early Spring, TPB can reproduce and increase population levels on many of these wild host plants and eventually infest cotton fields during the cropping season. Thus wild host plants are the focus of area-wide management strategies that target their destruction (Snodgrass et al. 2000 and Weaver-Missick 1999). Part of this management strategy involves destruction of early-season wild host plants with burn-down herbicides. One of the assumptions of this technique is that TPB is primarily attracted to broadleaf hosts so that vegetation management could be focussed on destruction of broadleaf species. Field plot testing of this assumption could provide an understanding of host preference that would be useful vegetation management. The ability to detect wild host plant areas with geo-spatial technologies could allow for the site-specific application of vegetation management strategies to reduce TPB populations before the cropping season begins. Remote sensing is a promising geo-spatial technology that can be used for detection of crop areas infested by pests and alternate host plant identification (Allen et al. 1999). This technology has been used in late-season to distinguish broadleaf hosts of TPB from grasses and may be useful for early-season hosts as well (Sudbrink et al. 2000). From 2000 to 2002, field plot studies were conducted to identify preference of TPB for selected wild hosts and the effects of burn-down herbicides on host preference, as well as to evaluate the capability of using remote sensing to detect these wild host plants. Specific objectives for the study were to 1) investigate TPB population dynamics on selected wild broadleaf and grass species, 2)evaluate the effects of burn-down herbicides on host preference in TPB, and 3) evaluate remote sensing capabilities for identifying wild host plants of TPB.

Materials and Methods

Wild Host Species Study, 2000

In the Fall of 1999, a randomized complete block (RCB) test was planted at Stoneville, MS, with four broadleaf host species and four grass species in 16mX16m plots with four reps (n=32 plots). Broadleaf plant species included: radish, *Raphanus sativus*, crimson clover, *Trifolium incarnatum*, winter pea, *Pisum sativum*, and hairy vetch, *Vicia villosa*. Grasses included: ryegrass, *Lolium multiflorum*, rye, *Secale cereale*, wheat, *Triticum aestivum*, oats, *Avena sativa.* Sampling for TPB was conducted with a standard 38-cm insect sweep net (25 sweeps/plot) from late February to mid-May. Plant density and % cover were estimated using a 0.25m^2 sampling ring (five rings/plot). Remotely sensed data were acquired aerially with a Real-time Digital Airborne Camera System (RDACS) sensor on 2/25/00 and data were analyzed with ArcView software (Environmental Systems Research Institute Inc., Redlands, California) and ENVI software (Environment for Visualizing Images, Research Systems Inc., Boulder, Colorado).

Wild Host/Burn-Down Study, 2001 and 2002

In the Fall of 2000, a RCB test with factorial arrangement of treatments (5 host treatments X 2 herbicide treatments) was planted at Stoneville with host treatments of vetch, crimson clover, ryegrass, a ryegrass/vetch mix, and a ryegrass/clover mix, in 16mX16m plots with four reps (n=40 plots). Sampling for TPB was conducted with a standard 38cm insect sweep net (25 sweeps/plot) from late February through late April. Plant density and % cover were estimated using a $0.25m^2$ sampling ring (five rings/plot). Remotely sensed data were acquired aerially with an RDACS sensor on 4/6/01 and data were analyzed with ArcView and ENVI software. Once TPB populations were established in broadleaf plots (4/6/01), a burn-down application of 2,4-D herbicide was sprayed on half of the plots and the other half were left unsprayed. This experiment was repeated in 2002 but crimson clover was eliminated from the treatments (3 host treatments X 2 herbicide treatments) due to difficulty in stand establishment. Remotely sensed data were acquired aerially on 4/2/02 with a Duncan 2100 digital video-camera using three spectral bands [green (G)=550nm, red (R)=600nm and near infra-red (NIR)=800nm]. Data were analyzed with ArcView and ENVI software. Once TPB populations were established in broadleaf plots (4/2/02), a burn-down application of 2,4-D herbicide was sprayed on half of the plots and the other half were left unsprayed.

Results and Discussion

Wild Host Species Study, Spring 2000

First collections of TPB individuals from broadleaf host plots occurred in late February, but counts did not reach consistently significant levels until late March (Fig.1). Tarnished plant bug counts increased from late March until reaching peak levels in early May when hosts began to senesce (Fig. 1). Broadleaf host plots had higher TPB numbers than grass plots (Table 1) which may reflect the preference of TPB for broadleaves. Radish was an attractive host plant for TPB from late March throughout the season and the highest TPB numbers in the study were collected from radish plots, followed by crimson clover, vetch, winter pea, and the grass species. Low levels of TPB were collected from ryegrass plots upon anthesis (4/14/00) (Fig 1).

Remote Sensing, 2000

Multi-spectral imagery of the plot study was acquired on 2/25/00, a date chosen due to it's proximity to the time that burn-down herbicide applications are made in much of the Mississippi Delta. A Normalized Difference Vegetation Index (NDVI) was calculated from the image using the red (R) and near infra-red (NIR) bands such that: NDVI= (NIR-R)/(NIR+R). Broadleaf plots were visibly discernable from grass plots and broadleaf NDVI values were significantly lower than those of grasses (Table 1). Among broadleaves, winter pea had the highest NDVI value followed by radish, crimson clover, and vetch. NDVI values did not differ significantly among grass species. The separability of broadleaf NDVI values from those of the grasses in this image may indicate distinct spectral signatures for them that could be useful for site specific vegetation management decisions. However, the differences in NDVI may indicate differences in phenological state between broadleaves and grasses at the time of image acquisition. Field testing of several of these host plants will be required to identify definitive spectral signatures for broadleaf hosts and grasses at several phenological stages of their development.

Wild Host Burn-Down Study 2001

In 2001, the first collections of TPB occurred in some of the plots in mid-March, but populations did not start to occur consistently until early April due to an unusually cold winter. Cold weather also prevented crimson clover from establishing sufficient stands in plots. In samples taken just prior to burn-down herbicide application (4/6/01), TPB numbers were significantly greater in the vetch and ryegrass/vetch plots compared with the other plots (Table 2). Burn-down herbicide reduced the percent cover of vetch & crimson clover in treated plots while there was no significant change in untreated plots (Table 3). At the first post-burndown sampling date (4/11/01), there were four to seven-fold differences in TPB between treated vetch and ryegrass/vetch plots and untreated vetch and ryegrass/vetch plots, respectively. As in 2000, low numbers of TPB were collected in ryegrass plots when the plants reached anthesis (4/11/01). By the last sampling date (4/20/01), there were six to ten-fold numerical differences in the number of TPB in burn-down vetch and ryegrass/vetch plots vs. untreated vetch and ryegrass/vetch plots, respectively (Table 2). There was a significant interaction between main effects. The differences in TPB numbers between treated and untreated plots reflects similar results from larger scale, area-wide TPB host plant burn-down studies (Snodgrass et al. 2000).

Remote Sensing, 2001

Multi-spectral imagery of the plot study was acquired on 4/6/01 (the date that plant bug populations increased to significantly measurable levels). In addition to NDVI, a Green Normalized Difference Vegetation Index (G-NDVI) was calculated using the green and near infra-red bands: G-NDVI= (NIR-G)/(NIR+G). NDVI and G-NDVI values for crimson clover were significantly lower than those of other plantings (Table 2). Ryegrass had the highest numerical NDVI and GNDVI values, which is consistent with remote sensing data of spectral signatures of grasses compared to broadleaves (Jensen 2000). Separation of broadleaf G-NDVI values from ryegrass may be useful for site specific vegetation management decisions, but it may be difficult to detect species in mixed stands.

Wild Host Burn-Down Study 2002

TPB first occurred in some plots in mid-January, but populations did not start to significantly increase until the last week of March. Before burn-down herbicide was applied, TPB numbers were larger in all of the vetch and vetch/ryegrass plots compared to ryegrass plots (Table 4). Burn-down herbicide reduced the percent cover of vetch in treated plots while there was no significant change in untreated plots (Table 5). At the first post-burndown sampling date (4/11/02), there were three to thirteen-fold differences in TPB numbers between treated vetch and ryegrass/vetch and untreated vetch and ryegrass/vetch plots, respectively. As in previous years, TPB was collected from ryegrass plots when the plants reached anthesis (4/11/02). By the last sampling date (5/7/02), there were four to 22-fold differences in the number of TPB in burn-down vetch and ryegrass/vetch plots vs. untreated vetch and ryegrass/vetch plots, respectively (Table 4). As in 2001, there was a significant interaction between main effects in 2002. The differences in the number of TPB in burn-down vetch and ryegrass/vetch plots vs. untreated vetch and ryegrass/vetch plots reflects similar results in larger scale, area-wide TPB host plant burn-down studies (Snodgrass et al. 2000).

Remote Sensing 2002

Multi-spectral imagery of the plot study was acquired on 4/2/02, the date that plant bug populations increased to consistently measurable levels. Mean NDVI values for vetch were lower than those for ryegrass or mixed plantings of ryegrass/vetch (Table 4). Separability of broadleaf NDVI values from ryegrass may be useful for site specific vegetation management decisions, but it may be difficult to detect vetch in mixed stands. Further field testing of these host plants and grasses will be required to identify definitive spectral signatures for broadleaf hosts and grasses at several phenological stages of their development.

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References

Allen, J. C., D. D. Kopp, C. C. Brewster, & S. J. Fleischer. 1999. 2011: An agricultural odyssey. American Entomologist. 45: 96-104.

Jensen, J. R. 2000. Remote Sensing of the Environment. Prentice Hall: New York. 544p.

Snodgrass, G. L., W. Scott, and J. W. Smith 1984. Host plants and seasonal distribution of the tarnished plant bug in the Delta of Arkansas, Louisiana, and Mississippi. Environ. Entomol. 13: 110-116.

Snodgrass, G. L., W. Scott, D. Hardee, and J. T. Robbins. 2000. Results of a two year study of tarnished plant bug. Proc. 2000 Beltwide Cotton Conf., National Cotton Council of America, Memphis, TN. 2: 1229-1233.

Sudbrink, Jr., D. L., F. A. Harris, J. T. Robbins, G. L. Snodgrass, S. J. Thomson. 2000. Remote sensing of late season pest damage to cotton & wild hosts of tarnished plant bug in the Mississippi Delta. Proc. 2000 Beltwide Cotton Conf., National Cotton Council of America, Memphis, TN. 2: 1220-1223.

Young, O. P. host plants of the tarnished plant bug, Lygus lineolaris, (Hemiptera: Miridae). Ann. Entomol. Soc. Am. 79: 747-762.

Weaver-Missick, T. 1999. Banishing tarnished plant bugs from cotton. Agricultural Research. 47 (7): 12-14.

Table 1. Mean NDVI values and TPB counts for eight plant species, Stoneville, MS, 2000.

Plant	Type	Mean NDVI Values 2/25/00	TPB/25sweeps seasonal mean
Radish	Broadleaf	0.2884 b	35 a
Crimson clover	Broadleaf	0.2167 c	9.67 b
Hairy vetch	Broadleaf	0.0557 d	5.25 c
Winter pea	Broadleaf	0.3300 b	4.67 c
Ryegrass	Grass	0.5266 a	1.79 d
Rye	Grass	0.4658 a	0.94 d
Wheat	Grass	0.4894 a	0.29 d
Oats	Grass	0.4938 a	0.27 d

Means followed by the same letter do not significantly differ (P=0.05, S-N-K).

Table 2. Vegetation indices and TPB counts in host plant burn-down study, Stoneville, MS, 2001.

			TPB per 25 sweeps		
	Mean NDVI	Mean G-NDVI	Pre-treat	Post-treat	
Treatment	Values 4/6/01	Values 4/6/01	4/6/01	4/11/01	4/20/01
Ryegrass					
No burndown	0.5934 a	0.5491 a	0.00 b	0.30 b	1.30 b
Burndown	0.5941 a	0.5609 a	0.00 b	0.00 b	0.80 b
Hairy Vetch					
No burndown	0.5582 a	0.4970 ab	2.80 a	3.80 a	8.50 a
Burndown	0.5584 a	0.5054 ab	2.30 a	0.50 b	0.80 b
Crimson clover					
No burndown	0.3297 b	0.2780 c	0.00 b	0.50 b	2.50 b
Burndown	0.2403 c	0.1938 d	0.00 b	0.00 b	0.00 b
Ryegrass/vetch mix					
No burndown	0.5865 a	0.5311 ab	3.00 a	4.00 a	9.50 a
Burndown	0.5867 a	0.5024 ab	2.30 a	1.00 b	1.50 b
Ryegrass/clover mix					
No burndown	0.5632 a	0.4868 ab	0.00 b	0.00 b	2.50 b
Burndown	0.4905 a	0.4452 b	0.30 b	0.00 b	0.30 b

Means followed by the same letter do not significantly differ (P=0.05, S-N-K).

Table 3. Mean percent ground cover of planted species, Stoneville, MS, 2001.

	Pre-burndown % cover, 4/6/01			Post-burndown % cover, 4/17/01		
Treatment	ryegrass	vetch	cr.clover	ryegrass	vetch	cr.clover
Ryegrass						
No burndown	93.9	NP	NP	97.5	NP	NP
Burndown	97.5	NP	NP	99.5	NP	NP
Vetch						
No burndown	8.0*	82.0	NP	8.8*	82.75	NP
Burndown	NP	87.5	NP	3.0*	6.25	NP
Crimson clover						
No burndown	0.5*	NP	30.65	NP	NP	39.8
Burndown	0.63*	NP	19.5	NP	NP	15.3
Ryegrass/vetch mix						
No burndown	33.75	60.8	NP	43.5	54.5	NP
Burndown	40.75	56.0	NP	65.0	15.88	NP
Ryegrass/clover mix						
No burndown	60.75	NP	11.5	73.0	NP	11.0
Burndown	42.25	NP	7.85	69.3	NP	2.0

NP = not planted in treatment plots.

* - Volunteer or accidental ryegrass plants in non-ryegrass plots.

Table 4. NDVI values and TPB counts in host plant burn-down study, Stoneville, MS, 2002.

Treatment	Mean NDVI Values 4/2/02	TPB per 25 sweeps Pre-treat 4/2/02	TPB per 25 sweeps Post-treat 4/11/02	TPB per 25 sweeps Post-treat 5/7/02
Ryegrass				
No burndown	0.4015 a	0.00 b	0.80 c	2.50 b
Burndown	0.4034 a	0.00 b	1.30 c	2.50 b
Hairy vetch				
No burndown	0.3458 b	4.30 a	16.3 b	67.5 a
Burndown	0.2924 c	4.00 a	4.80 c	3.00 b
Ryegrass/vetch mix				
No burndown	0.4480 a	5.00 a	24.3 a	18.3 b
Burndown	0.4323 a	4.80 a	1.80 c	4.00 b

Means followed by the same letter do not significantly differ (P=0.05, S-N-K).

Table 5. Mean percent ground cover of planted species, Stoneville, MS, 2002.

Treatment	Pre-burndown % cover, 4/2/02 ryegrass	Pre-burndown % cover, 4/2/02 vetch	Post-burndown % cover, 4/24/02 ryegrass	Post-burndown % cover, 4/24/02 vetch
Ryegrass				
No burndown	96.90	NP	95.50	NP
Burndown	96.15	NP	95.75	NP
Vetch				
No burndown	1.80*	93.00	2.10*	91.0
Burndown	1.75*	88.00	8.55*	0.00
Ryegrass/vetch mix				
No burndown	60.25	39.50	64.25	35.30
Burndown	52.00	47.80	87.25	0.00

NP = not planted in treatment plots.
* - Volunteer or accidental ryegrass plants in non-ryegrass plots.

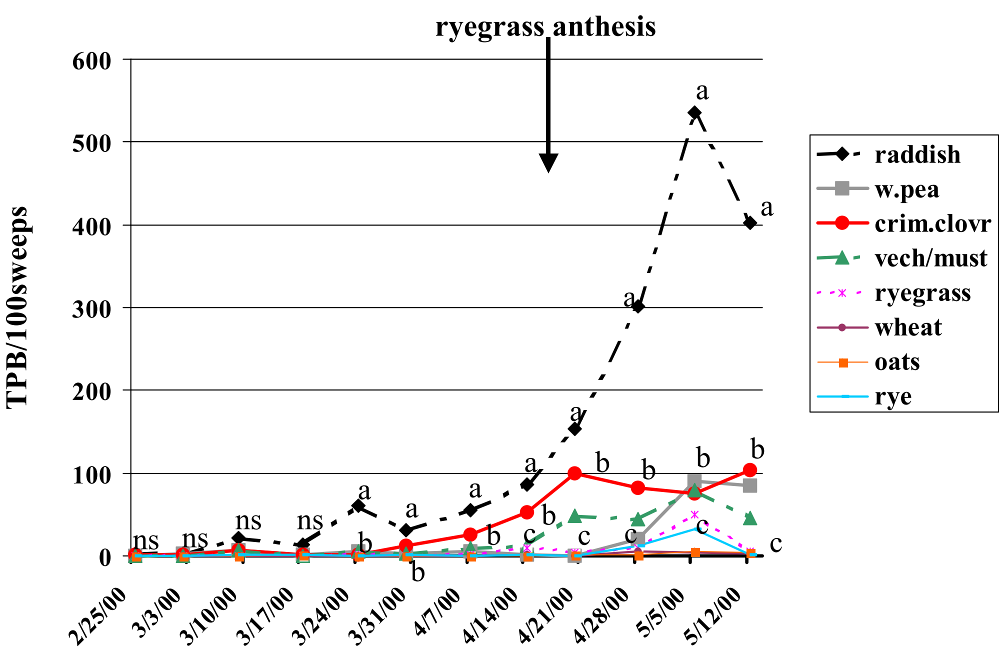

Figure 1. Tarnished plant bug counts on eight plant species, Stoneville, MS, 2000.