Control of Tarnished Plant Bugs
Using *Beauveria bassiana* and the Insect Growth Regulator, Novaluron

*Jennifer Lund, Tina G. Teague, Donald C. Steinkraus, and Jarrod Leland*¹

**RESEARCH PROBLEM**

Insecticide-resistant populations of TPB have been noted in the Delta region (Hollingsworth et al., 1997; Snodgrass, 1996). Proposed EPA regulatory constraints on organophosphate insecticide use are anticipated. Viable replacements for organophosphate insecticides are needed. These may include efficient, long-lasting, and specific biological control agents. In this study, a commercially available *Beauveria* strain (GHA) (Laverlam, SA) along with an experimental strain in production by USDA-ARS were field tested, alone and in combination with Diamond, as control agents for suppression of plant bugs.

**BACKGROUND INFORMATION**

Tarnished plant bug (*Lygus lineolaris* Palisot de Beauvois) (TPB) is an important pest in mid-South cotton. Current control methods for TPB rely solely on insecticides. The fungal entomopathogen, *Beauveria bassiana*, has been found naturally infecting *Lygus* spp. in Arkansas (Steinkraus and Tugwell, 1997), Mississippi (Leland and Snodgrass, 2000), and California (McGuire, 2002). Results from studies with caged insects indicate that the *B. bassiana* can effectively kill 89 to 100% of adult insects compared to 7 to 11% in controls (Steinkraus and Tugwell, 1997). Previous work has demonstrated that select isolates from *Lygus* spp. are more pathogenic to *Lygus* spp. than the standard commercial strain (GHA) (Leland, 2004; Leland et al., 2005; McGuire et al., 2005). Nymph TPB are generally less susceptible than adults to *B. bassiana*, and therefore the use of a fungal pathogen alone might not provide adequate control of field populations. Novaluron, (tradename Diamond®) is an insect-growth regulator that works by disrupting chitin development and molting. The product shows promise as a management tool for plant bug nymphs (Barkley and Ellsworth, 2004; Smith et al., 2004).

¹ Program technician and professor, Department of Agronomy and Entomology, Arkansas State University, Jonesboro; professor, Entomology Department, Fayetteville; and research entomologist, USDA-ARS, Southern Insect Management Research Unit, Stoneville, Miss., respectively.
RESEARCH DESCRIPTION

Product efficacy was evaluated in caged insect studies conducted at the University Research Farm on the Judd Hill Plantation near Trumann in northeast Arkansas. Cultivar Stoneville 5242 was planted May 00 in a Dundee silt loam soil. Plots were furrow-irrigated. The experiment was arranged in a randomized complete block with 3 replications. Plots for each test were 30-ft long, 3 rows wide and separated by 10-ft alleys; treatment plots were arranged in a RCB with 3 replications.

On the day prior to application, TPB were collected using sweep nets in blooming mustard or wild plant hosts (primarily Erigeron spp.). Insects were held overnight at 27°C in cages with water and ears of fresh sweet corn. For each cage test, 10 organdy-sleeve cages, 6-in. diameter by 18-in. long, with 1 mm X 2 mm openings were secured to randomly selected individual plants in the center row by tying the lower end of each cage around the plant ca 1 ft from the terminal with twist ties. After sunset, 5 TPB nymphs (3rd to 5th instar) or adults were placed into each cage. There were 5 cages each of TPB nymphs and adults in each plot.

There were six treatments: (a) water control (UTC), (b) the commercially available Beauveria (GHA) at a rate of 1 x 10^13 conidia per acre, (c) USDA Beauveria strain (1 x 10^13 conidia/acre), (d) Diamond 0.83 EC (12 oz/acre), (e) GHA (1 x 10^13 conidia/acre) plus Diamond (12 oz/acre) and (f) USDA Beauveria (1 x 10^13 conidia/acre) plus Diamond (12 oz/acre). Applications were made using a 4-row CO_2-charged backpack sprayer calibrated to deliver 11 gpa at 60 psi with TX 10 hollow-cone nozzles on 19-in. spacing.

After 48 hrs plants were cut below the cage and taken to the laboratory where TPB were removed and sorted. Dead insects were placed in moist filter paper-lined chambers, and living insects were placed individually in 2 oz cups with a 0.5-in. cube of wet, floral industry water foam (Water Foam from Styrofab, Waxahatchie, Texas) and a kernel of canned corn. Living insects were held for ten days at 23°C and checked daily for deaths. Dead insects were checked for molting problems (unable to shed exoskeleton, deformed wings, etc.) and outward signs of fungal infection. Results from each of the two experiments were pooled together and ANOVA statistics were used to test the effects of lifestage and treatment on days to death (DTD). Differences in mean DTD were analyzed using Bonferroni adjusted comparisons.

RESULTS AND DISCUSSION

Average Days to Death

Overall there was a significant effect of treatment, stage, and the interaction of the two on mean DTD (all p < 0.0004). When looking at each treatment separately, adults had a significantly higher mean DTD than nymphs for all treatments (Bonferroni Adjusted all p < 0.0010). Both UTC nymphs and adults had significantly higher DTDs than all other treatments (all p < 0.0234) (Fig. 1). There was no difference in the different treatments when looking at nymphs only. For adults, the USDA strain treatments were significantly different than the Diamond (both p < 0.0012), while the GHA treatments were not.
Percent Mortality

Initial mortality (to day 2) ranged from 2.9 to 10.3% for adults and 17.2 to 25.8% for nymphs. Mortality from day 3 to 5 ranged from 4.7 to 34.0% for adults and 25.5 to 44.6% for nymphs. Mortality from day 6 to 10 ranged from 45.9 to 64.8% for adult insects and 23.9 to 40.1% for nymphs (see Table 1 for cumulative percent mortalities). When nymphs and adults are combined, it appears that initial mortality (to day 2) is consistent between all treatments (ranging between 10.3 to 17.8%), but by day 5 fewer untreated TPB died than in other treatments (25.8 % for UTC, 37.4 to 57.0% for treated). By day 10, mortality was 69.0 % in the UTC compared to 84.8 to 94.5% from Diamond and/or Beauveria treatments (Fig. 2).

Greater mortality and more rapid death were observed in Diamond and Beauveria treatments compared to the untreated control. No increase in mortality or reduction in days to death was measured when Diamond was added to Beauveria. There was a slight increase effect on the USDA+ treated adults, which was not significantly different than the USDA alone but was different than both the GHA-treated insects. It is unknown why the insect-growth regulator affected pathogenicity in adults and not nymphs. The fungal contamination exhibited in the UTC and Diamond-treated insects could have been from several different sources. First, we used field-collected insects in our cage study. B. bassiana has been shown to exist in low levels in natural populations (Steinkraus and Tugwell, 1979; Leland and Snodgrass, 2005). Some of the “contamination” could be simply a result of using these wild-collected individuals in the study. The second explanation could be drift from our spraying. Thirdly, the contamination could have occurred when we were transferring insects from cages to cups.

PRACTICAL APPLICATION

Practical replacements for organophosphate insecticides may be found by testing reduced risk materials for efficacy against adult and nymphal stages of plant bug in the field. We will repeat and expand caged-insect studies in 2006.

ACKNOWLEDGMENTS

Special thanks to Larry Fowler and the staff at the University of Arkansas Division of Agriculture at Judd Hill for their assistance. We also thank Dr. Stephen Coghlan for statistical advice and guidance. The project was supported by a grant from USDA-CSREES PMAP.

LITERATURE CITED

sas populations of tarnished plant bugs (Heteroptera: Miridae) to insecticides, and
tolerance differences between nymphs and adults. Journal of Economic Entomol-
Leland, J.E. 2005. Characteristics of Beauveria bassiana isolates from Lygus line-
olaris populations of Mississippi. Journal of Agricultural and Urban Entomology
22:57-72.
bassiana, for control of plant bugs (Lygus spp.) (Heteroptera:Miridae). Biological
Control 35:104-114.
bassiana in Lygus lineolaris (Heteroptera: Miridae) populations from wild host
bassiana in San Joaquin Valley populations of Lygus hesperus (Heteroptera: Miri-
lar characteristics of Beauveria bassiana isolates from California Lygus hesperus
Smith, P.R., G.M. Lorenz, W.H. Robertson, D. Plunkett, D.R. Johnson, and R.
Edmund. 2004. Performance of Diamond (Novaluron) for control of Heliothines
National Cotton Council, Memphis, Tenn.
Snodgrass, G.L. 1996. Insecticide resistance in field populations of the tarnished
plant bug (Heteroptera: Miridae) in cotton in the Mississippi Delta. Journal of
Economic Entomology 89:783-790.
Steinkraus, D.C. and N.P. Tugwell. 1997. Beauveria bassiana (Deuteromycotina:
Moniliales) effects on Lygus lineolaris (Hemiptera: Miridae). Journal of Entomo-
logical Science 32:79-90.
Table 1. Cumulative percentage of dead insects. This table shows the cumulative percentage of dead adults and nymphs at days 2, 5, and 10. It also includes the percent survival of insects for each treatment.

<table>
<thead>
<tr>
<th></th>
<th>Nymphs</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Died 2 (%)</td>
</tr>
<tr>
<td>UTC</td>
<td>157</td>
<td>17.2</td>
</tr>
<tr>
<td>Diamond</td>
<td>139</td>
<td>22.3</td>
</tr>
<tr>
<td>GHA</td>
<td>128</td>
<td>25.8</td>
</tr>
<tr>
<td>GHA+</td>
<td>134</td>
<td>24.6</td>
</tr>
<tr>
<td>USDA</td>
<td>129</td>
<td>20.2</td>
</tr>
<tr>
<td>USDA+</td>
<td>153</td>
<td>25.5</td>
</tr>
</tbody>
</table>
Fig. 1. Average days to death (DTD). Adults with the same letter (A, B, C, or D) signify no significant difference between treatments. Nymph average DTDs with the same letter (P or Q) represent no significant difference between treatments.

Fig. 2. Percentage of dead insects. This graph shows the percentage of insects (both nymphs and adults) dying between DAT 0 and 2, DAT 3 and 5, and DAT 6 to 10.