# A COMPARISON OF TARNISHED PLANT BUG POPULATIONS FROM DIFFERENT REGIONS IN MISSISSIPPI

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## Abstract

A laboratory experiment was performed to compare fitness parameters of tarnished plant bug populations collected from the Hills and Delta regions of Mississippi. Each population was split into two cohorts to be reared on cotton or artificial diet to make comparisons of food source as well as region of collection. Populations were collected from pigweed, *Amaranthus* spp., in four locations in each region. Each population was maintained separately and allowed to mate. Progeny from the F1 generation of each population were compared from each region and food source. Parameters measured included development times to fourth instar, fifth instar and adult, total nymphal survivorship, fecundity, and fertility. Populations collected from the Delta region and reared on cotton developed significantly faster to all life stages than other populations while populations from the Hills reared on cotton were significantly slower than other populations except Hills populations reared on artificial diet. Populations on diet had significantly higher survivorship than those reared on cotton. Populations of tarnished plant bug from the Delta region laid significantly more eggs per female per day than populations from the Hills region. Populations reared on cotton also laid significantly more eggs per female per day than those reared on diet. Populations collected in the Delta region laid significantly more viable eggs per female per day than those from the Hills region. Populations reared on cotton produced significantly more nymphs per female per day than those reared on diet. These data indicate there are differences in several fitness parameters between tarnished plant bug populations from the Hills and Delta regions of Mississippi.

## Introduction

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is an important pest of numerous crops in the U.S. (Nordlund 2000). An important factor contributing to the pest status of this insect is its adaptability to a wide range of environments. The tarnished plant bug has one of the broadest host ranges of any insect species with over 300 documented host plants (Young 1986). Similarly, Snodgrass et al. (1984) reported 169 plant species as hosts from the Delta region of Mississippi. The majority of plants preferred by tarnished plant bug include species that are generally abundant in disturbed or early successional type habitats (Layton 2000). Because of this broad host range, tarnished plant bug is able to utilize a succession of different hosts for feeding and reproduction throughout the year. As a result, tarnished plant bug is capable of building high population densities on weedy hosts prior to the crops in the area being attractive for feeding and reproduction.

The tarnished plant bug is an important pest of cotton in Mississippi. Cotton production in Mississippi can generally be separated into two distinct geographical regions, the Hills and the Delta. The Hills region is mostly comprised of smaller cultivatable fields interspersed across the landscape. Overall, land dedicated to row crop agriculture makes up a small percentage of the overall land area (NASS 2007). In contrast, cultivatable land accounts for a larger percentage of the land area in the Delta region. Fields dedicated to row crop agriculture are much larger and more contiguous in the Delta region than in the Hills region (NASS 2007). Although insecticide applications for tarnished plant bug occur annually in both regions, tarnished plant bug is a more economically important pest in the Delta region. During 2011, growers in the Mississippi Delta averaged 7 applications per hectare targeting tarnished plant bug with a total cost of nearly $240 per hectare (Williams 2012). In contrast, growers in the Hills region of Mississippi averaged approximately 1.75 applications per hectare targeting tarnished plant bug with a total cost of $60.51 per hectare (Williams 2012). One reason for this is the development of resistance to the pyrethroids and

organophosphates by tarnished plant bugs in the Delta (Snodgrass 1996; Snodgrass et al. 2008a; Snodgrass et al. 2008b; Snodgrass et al. 2009).

Although resistance does not fully explain the discrepancy in the pest status of tarnished plant bugs between the Delta and the Hills regions of Mississippi. One theory that has been proposed to explain the observed difference in tarnished plant bug pressure in the two regions is that tarnished plant bugs in the Delta are better adapted to cotton than those in the Hills. This may have developed as a result of the relative ecological simplicity associated with the lower host diversity that is characteristic of heavily cropped environments (Layton 2000). The differences in the agricultural ecosystems of the Delta and the Hills and the continuous production of cotton over a large percentage of the land area for a long period of time are factors that could influence adaptation by an insect pest. Given the large gap in control costs, adaptability of the populations of tarnished plant bugs in the two distinct regions needs to be investigated to determine if there is a physiological difference between the two populations.

## Materials and Methods

Four populations of tarnished plant bug adults were collected from both the Hills and Delta regions of Mississippi at two different dates, June 8, 2011 and August 1, 2011 for this experiment. All populations were collected from Palmer amaranth, *Amaranthus palmeri* (S. Wats). Collections were made by taking several sweeps with a sweep net in heavy patches of Palmer amaranth. Sweep nets were then emptied into a plastic container, and tarnished plant bug adults were removed with an aspirator. The adults were then placed in cricket cages for transport back to the rearing facility at Mississippi State University. Each of the four populations was placed in individual 8.3L plastic rectangular containers with self sealing lids (Rubbermaid Servin' Saver®). The lids on the containers were modified by removing the inner plastic so that only the sealing frame remained. The portion of the lid that was removed was replaced with a tuille fine mesh screen. Tarnished plant bug colonies were maintained at 26.7˚C +/- 2˚C with a humidity level of 60% at a photoperiod of 16:8 hour (light: dark). Screens on the containers were changed once per week. The food source (diet packs) for the initial adult population was a standard oligidic diet blend used in tarnished plant bug rearing. Diet packs were changed every Monday, Wednesday, and Friday throughout the oviposition period. Two oviposition packs were also placed on the screen. Oviposition packs were collected and replaced on the same days that the feeding packets were replaced. Oviposition packs were maintained separately for the four populations. Each collection of the study was replicated three times. Date of oviposition served as blocks/replications in a randomized complete block design and nymphs consisted of cohorts from oviposition packs collected on the same days. One cohort from each population (F1 generation) was fed squares and the other cohort was fed artificial diet. Squares were changed daily while diet packs were changed on Monday, Wednesday, and Friday. Due to having too few data points for calculating development times, nymphal instar ratings for each cohort were taken daily during the second collection with mortality being measured every three to four days. Survival rates and time of development on cotton were compared to the cohort reared on diet packs. Survival rates and time of development for Hills populations were also compared to Delta populations. Once nymphs had molted into adults, the sex of each individual was determined. A target population of ten males and ten females from each colony was placed in new containers and allowed to mate unhindered if survivorship allowed. On populations that had low survivorship, as many surviving males and females that could be placed in new containers at a 1:1 male to female ratio were placed in the containers. All populations and cohorts at this stage were fed the oligidic diet that was previously described. Oviposition packs were placed on top of the screen. Eggs were counted on Mondays, Wednesdays, and Fridays to measure fecundity. The eggs laid in oviposition packs were monitored to determine the percentage of total eggs that produced viable offspring expressed as nymphs per female per day.

Development curves were calculated using regression analysis. The relationship for all colonies fit a quadratic equation (Table 1, Figure 1).

Table 1. Regression equations derived to calculate days to each life stage.

| Treatment | Raw Data | | Transformed ($y^3$) | |
|---|---|---|---|---|
| | Equation | P>F | Equation | P>F |
| **Delta Cotton** | $y=-10.33+1.29x-.03x^2$ | <0.01 | y=17.2x-207.08 | <0.01 |
| **Delta Diet** | $y=-7.61+1.00x-.02x^2$ | <0.01 | y=16.81x-210.79 | <0.01 |
| **Hills Cotton** | $y=-7.57+.97x-.02x^2$ | <0.01 | y=16.14x-210.80 | <0.01 |
| **Hills Diet** | $y=-7.53+.97x-.02x^2$ | <0.01 | y=16.88x-219.55 | <0.01 |

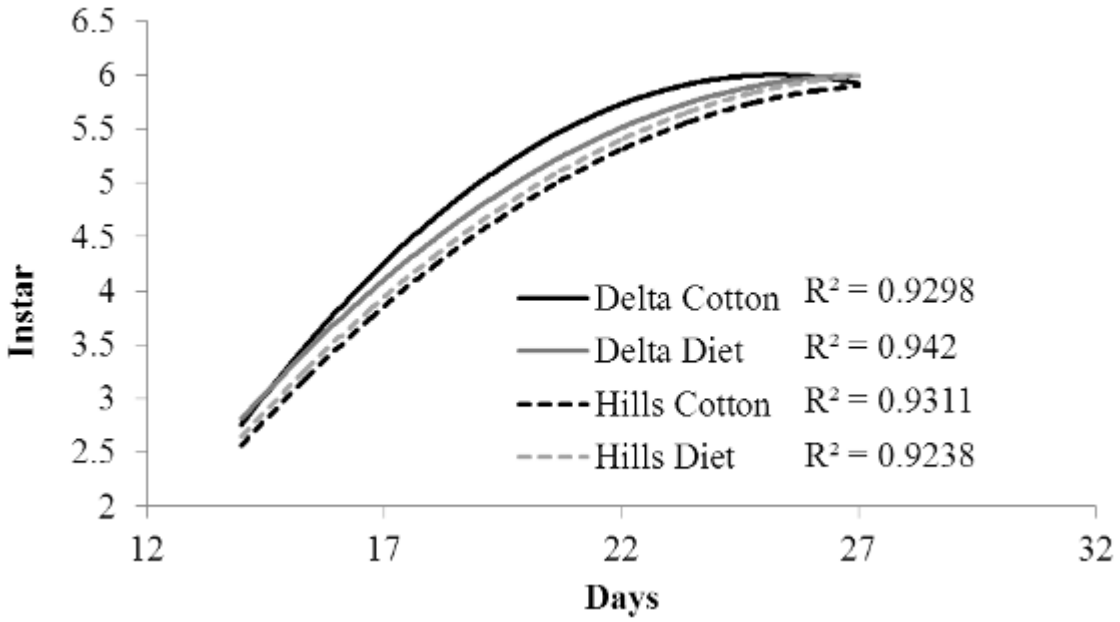


Figure 1. Regression curves developed for calculating days to each life stage.

Therefore, data were transformed by cubing the *y* variable (instar) to linearize the relationship (Ott 1993) so that the regression equation could be used to calculate days to fourth and fifth instar, and adulthood (Table 1, Figure 2).

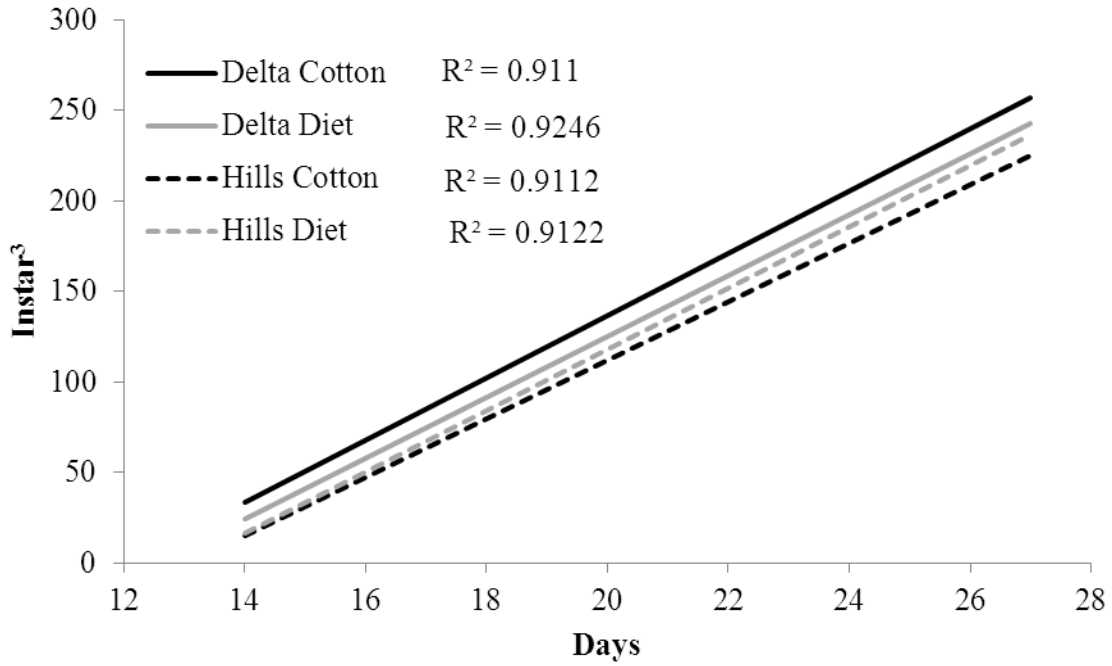


Figure 2. Cube transformed regression curves used for developing equations to calculate days to each instar.

Regression equations were developed for each replication. Within each replication, the cube of each life stage (fourth and fifth instar, and adult) was used in the regression equation to solve for *x* (days). By cubing the life stage, back transformation was not needed to get the actual days. For the adult stage, six was used for the *y* variable. Regression equations were developed for each replication in order to perform analysis of variance on mean days to each life stage for each region and food source combination. Data for days to each life stage, total survivorship, numbers of eggs per female per day, and number of viable eggs per female per day were analyzed with analysis of variance (Proc Mixed SAS 1996). Percent fertility was calculated based on the numbers of eggs per female per day and analyzed with analysis of variance. In the model, region, food, and region by food interaction were designated as fixed effects, and replication was designated as a random effect. Degrees of freedom were calculated using the Kenwood-Rogers method. Differences were considered significant for $\alpha$=0.05.

## Results and Discussion

Region of collection had no significant effect on survivorship of tarnished plant bug; however, food source had a significant impact on survivability of tarnished plant bug populations (Table 2). Those populations reared on oligidic diet had significantly higher survivorship compared to those reared on cotton.

Table 2. Effect of region of collection and food source on survivorship rates of tarnished plant bug populations.

| | **Cotton** | **Diet** | **Mean** |
|---|---|---|---|
| | **Mean (Std. Err.)** | **Mean (Std. Err.)** | **Mean (Std. Err.)** |
| **Hills** | 61.92 (6.94) | 81.20 (2.97) | 71.56 A (4.2) |
| **Delta** | 58.62 (5.76) | 73.59 (4.02) | 66.11 A (3.78) |
| **Mean** | 60.27 b (4.42) | 77.4 a (2.57) | |

Tarnished plant bug from the Delta region reared on cotton developed significantly faster than those cohorts collected from the Hills region reared on cotton, approximately 2 days faster to adulthood (Table 3).

Table 3. Effect of food by region interaction to each life stage.

| | Days to 4th Instar | Days to 5th Instar | Days to Adult |
|---|---|---|---|
| | Mean (Std. Err.) | Mean (Std. Err.) | Mean (Std. Err.) |
| **Delta Cotton** | 15.86 c (0.21) | 19.26 c (0.39) | 24.34 c (0.66) |
| **Delta Diet** | 16.45 b (0.24) | 19.91 b (0.48) | 25.07 b (0.86) |
| **Hills Diet** | 16.89 ab (0.29) | 20.32 ab (0.55) | 25.44 ab (1.01) |
| **Hills Cotton** | 17.13 a (0.31) | 20.69 a (0.61) | 26.01 a (1.05) |

Tarnished plant bug populations collected in the Delta laid approximately 1.6 fold more eggs than those collected in the Hills (Table 4). Similarly, populations of tarnished plant bug reared on cotton laid approximately 1.6 fold more eggs than those reared on the standard oligidic diet (Table 4).

Table 4. Effect of region of collection and food source on eggs per female per day.

| | Cotton | Diet | Mean |
|---|---|---|---|
| | Mean (Std. Err.) | Mean (Std. Err.) | Mean (Std. Err.) |
| **Hills** | 2.24 (0.23) | 1.35 (0.24) | 1.79 B (0.19) |
| **Delta** | 3.54 (0.46) | 2.22 (0.25) | 2.88 A (0.29) |
| **Mean** | 2.89 a (0.28) | 1.78 b (0.19) | |

Means in a column followed by the same upper case letter and means in a row followed by the same lower case letter are not significantly different at ($P \leq 0.05$) (LSD=.62226).

As evidenced, significant differences were observed in several fitness parameters. These data certainly provide validation that there is potentially a biotype difference between the two regions. Tarnished plant bug populations in the Delta region appear to be more fit for life on cotton compared to those from the hills region.

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