REEVALUATING THRESHOLD AND SPRAY TIMES *LYGUS* LINEOLARIS IN NORTH CAROLINA COASTAL PLAINS COTTON

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Abstract

Lygus lineolaris populations have been increasing in North Carolina cotton since 2009. We conducted an experiment to reevaluate the use of currently recommended treatment thresholds of 8 and 16 *L. lineolaris* adults per 100 sweeps for a low and high threshold respectively. We also examined the most effective time to spray *L. lineolaris*, testing sprays of Transform® at pre-bloom, early bloom, late bloom, pre-boll, with an untreated control. We found that *L. lineolaris* adult populations did not differ between treatments, although the fluctuations coincided with the start of bloom as was expected. *L. lineolaris* nymphal populations were high in the late bloom and control plots but showed no difference in the threshold and early treated plots. There were no differences in square retention after the second week of observations. Yield data (pounds of lint per acre) revealed informative differences in treatment where the low and high threshold plots and the pre-bloom plots had the highest yields compared to the rest of the plots. Preliminary conclusions are that current thresholds are appropriate and early spraying during the first weeks of squaring is highly recommended. However, the use of a non-pubescent variety and an insecticide that is no longer recommended for *L. lineolaris* use represents a worst-case scenario that encourages high populations of *L. lineolaris*. Further work is needed with variety selection and recommended insecticides for managing *L. lineolaris* in North Carolina.

Introduction

Tarnished plant bug *(Lygus lineolaris*, TPB) has become a great problem in cotton because of yield losses and the associated costs of treatment. This problem began as an unintended consequence of adopting Bt cotton, which reduced the amount of insecticide sprays for the control of cotton bollworm and budworm. Previously, frequent broad-spectrum insecticide applications for bollworm had also controlled several secondary pests such as the *L. lineolaris* (Musser et al., 2009). Since 2009, the percentage of total cotton acres sprayed for TPB in North Carolina has climbed close to 50%, (Williams 2015). The current circumstances facing NC cotton growers are eerily similar to the situation that faced growers in the Mid-South roughly ten years ago; those same growers are now paying over a $100 per acre for control of TPB (Gore et al., 2015). As of 2016, 71.6% of acres were sprayed for *L. lineolaris* an average of 2.39 times per acre in North Carolina (Moore, *pers. comm*.). The pest reduces yield by causing square loss and abortions of first position fruits (Barman and Parajulee, 2013); therefore, early season management is important to prevent the entire crop from being destroyed. Current strategies recommended in the Mid-South are to use pubescent varieties of cotton combined with sequential spraying, rotation of insecticide chemistry, and other cultural management tools (Gore et al., 2015). Our goal is to use what is known from the experience of Mid-South growers and adapt it for North Carolina before growers here face the same desperate and costly situation as Mid-South cotton growers.

Materials and Methods

These methods are adapted from Musser et al. (2009), which resulted in an update of *L. lineolaris* thresholds for the Mid-South, and are similar to experiments underway in South Carolina and Virginia. We planted 8 row x 40 foot plots of Bollgard II cotton (variety Deltapine 1538) at the Tidewater Research and Extension Center in Plymouth, NC. Plantings were near the end of the planting window, with a fairly aggressive nitrogen program (120 lbs/acre) to encourage *L. lineolaris* populations. Cotton growth was regulated with earlier-than-normal mepiquat chloride application. Other management (excluding that for *L. lineolaris*) followed NC Extension recommendations. There were seven treatments: pre-bloom, early bloom, late bloom, pre-boll, low and high threshold, and an untreated

control. The main purpose of these treatments was to create differential populations at different locations during different times of cotton phenology to evaluate thresholds. A secondary goal of having these treatments was to isolate the time when cotton in NC is most susceptible to *L. lineolaris* injury.

We used Transform (2.25 oz/A) as the insecticide of choice for all treated plots because it is known specifically to target plant bugs and aphids (which are seldom a pest of NC cotton), while having little effect on other insect pests. The pre-bloom treatment was treated weekly with insecticide applications from pinhead square until first bloom. The early bloom treatment was applied from 1st bloom to the 4th week of bloom. The late bloom treatment was applied from 4th to 5th week of bloom. The pre-boll treatment consisted of weekly sprays from 1st square to 4th week of bloom. The low threshold treatment consisted of a spray when either *L. lineolaris* density (adult or nymph) hits 8 *L. lineolaris* individuals per 100 sweeps or square retention fell below 80%. The high threshold treatment consisted of an application when *L. lineolaris* density (adults) reached 16 *L. lineolaris* individuals per 100 sweeps or square retention dropped below 60%. All treated plots were sprayed after 5th week of bloom with a mixture of bifenthrin (6.4 oz/A) and Bidrin (12 oz/A) for full protection from late season *L. lineolaris* and stink bug pressure. All plots were sprayed with Prevathon (27 oz/A) to prevent lepidopteran damage from confounding yield results before major moth flights.

L. lineolaris densities were sampled weekly using 2 sets of 25 sweep net samples through the top of the canopy with a 15 inch diameter sweep net. We sampled *L. lineolaris* densities using a black drop cloth (36 in by 30 in) shaking the plants on both sides vigorously, and counting the insects on the cloth. Cotton plots were swept and beaten for nymphs and adults every 7 days from the 1st square until 5th week after bloom. Sweep net and drop cloth samples were taken from different rows to avoid confounding results. All plots were sampled 3 days after being sprayed.

Square retention in each plot was determined by examining the presence/absence of squares on the second reproductive node below the terminal. 50 plants were checked every week from 1st square until 1st bloom. Yield data was collected using a 2 row mechanical picker from the last 2 rows of fully matured cotton in each plot in early November.

Results and Discussion

When sweeping for adults, no differences were detected (F=1.15, df=6,140, p= 0.3355). There were only differences between the control and treated plots when sweeping for nymphs (F=2.68, df=6,140, p= 0.0170, Figure 1). The drop cloth was ineffective as expected for detected differences in adult numbers between plots (F=1.21, df=6,140, p= 0.3060). As expected, differences were detected in nymph numbers between plots but only with the control and the high threshold treatment (F=8.41, df =6,140, p<.0001, Figure 2). In counting the number of squares that had fallen off at the terminal among fifty plants there were no differences detected (F=1.55, df=6, 84, p =0.1736).

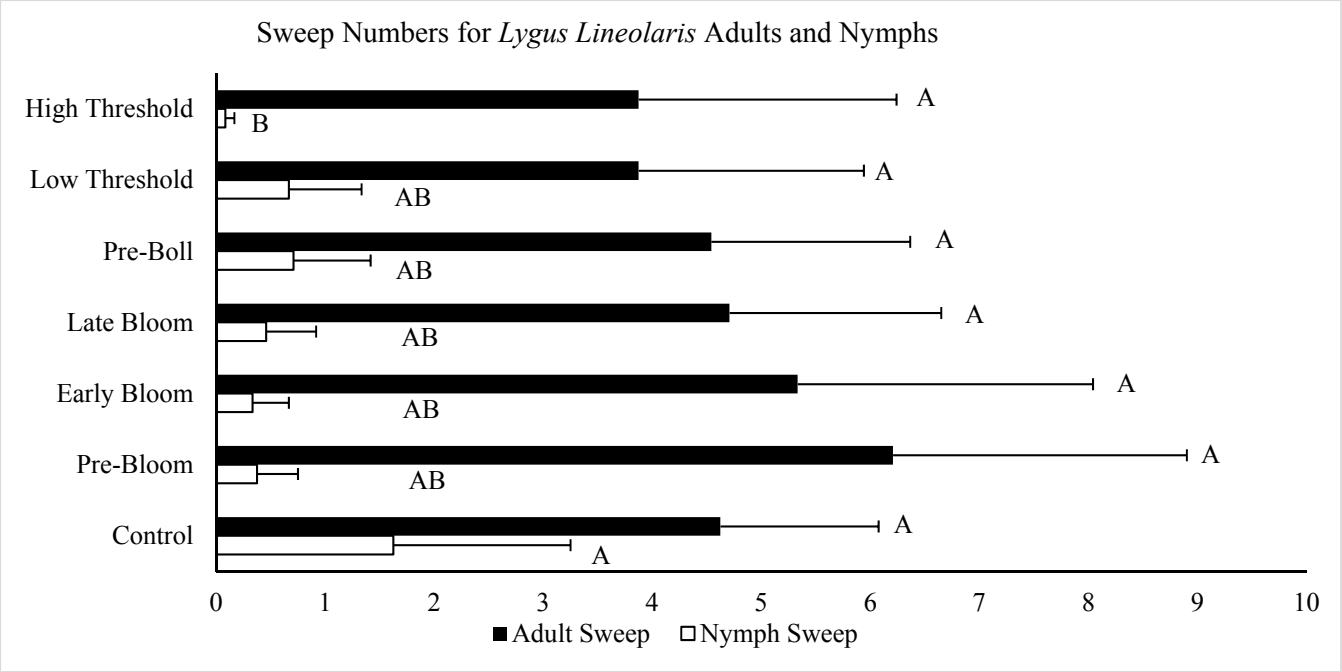

Figure 1: Seasonal averages of *Lygus lineolaris* nymphs and adults caught in sweep net by each treatment in 2016.

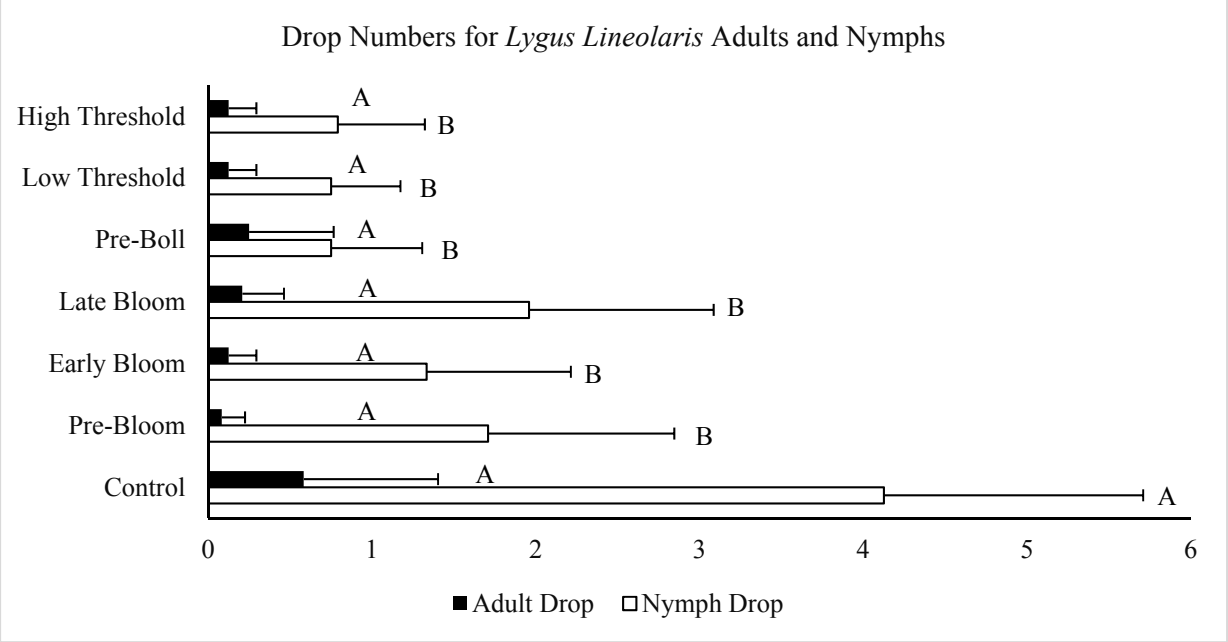

Figure 2: Seasonal averages of *Lygus lineolaris* nymphs and adults caught in drop cloth by each treatment in 2016.

Even though *L. lineolaris* numbers did not show serious differences between treatments, they revealed the importance of early treatment. Adults will arrive when squaring begins and this is reflected in the sharp increase in mid-July (Figure 3). As the plant continues to mature, adults will move on to other resources or die off (Musser et al., 2009). The peak population of adults coincides with the first week of bloom. But it is important to remember that the effectiveness of sweep sampling in chest-high cotton also decreases with time. After the adult population peaks we start to see populations of nymphs increase and the difference between the late treated and early treated plots is clearer. The numbers of nymphs passes the 3 nymph per drop threshold in early August in untreated or late treated plots. The populations peaked a month later in mid-August (Figure 4). Again, this shows the importance of treating adults early to avoid these late peaks of nymphs.

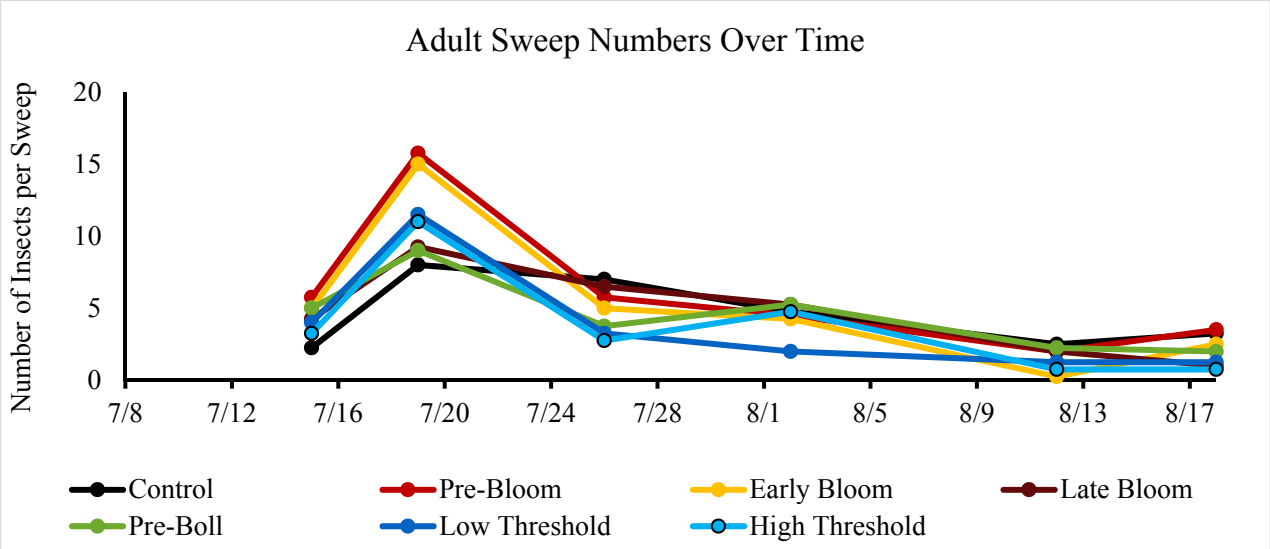

Figure 3: Number of *Lygus lineolaris* adults caught in sweep net over time by each treatment in 2016. Time begins on July 8th, 2016 because initial sprays began on that date with sampling following a week later

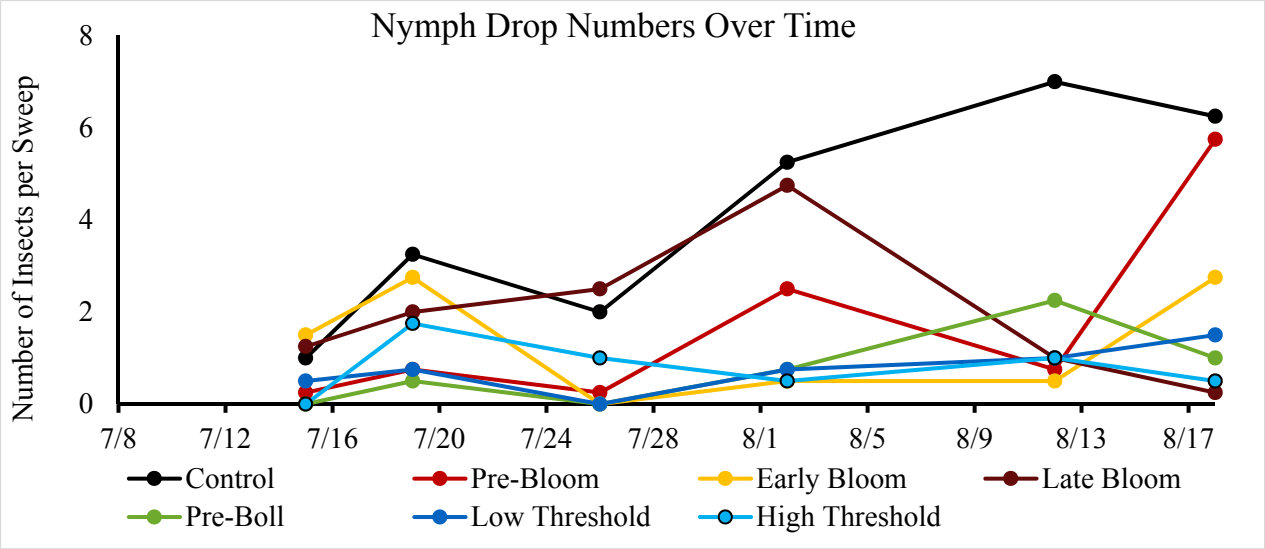

Figure 4: Number of *Lygus lineolaris* nymphs caught in drop cloth over time by each treatment in 2016. Time begins on July 8th, 2016 because initial sprays began on that date with sampling following a week later.

Yields (pounds of lint per acre) were useful in highlighting differences between plots that could not be detected with nymph or adult numbers ($F = 3.56$, $df = 6, 21$, $p = 0.0137$, Table 1). Consistent and early treatment works in improving yields compared to later season sprays or no action at all.

Table 1: Yields, number of sprays, and statistical ranking for each treatment (Tukey's test $P < 0.05$) at the end of study. Yield is in lint harvested per acre after ginning.

# of Sprays	Treatment	Average (lbs/acre)	Rankings
0	Control	546.76875	C
2	4th to 5th Bloom	623.90625	ABC
3	1st Bloom to 4th Bloom	712.3875	AB
5	1st Square to 5th Bloom	803.1375	AB
5	1st Square to 4th Bloom	887.08125	A
6	Low Threshold	878.00625	A
6	High Threshold	900.69375	A

The preliminary conclusions from this work are that current thresholds appear to be adequate for treating *L. lineolaris.* Early treatment is crucial for success as seen with yields harvested and nymph population differences between early and late treated plots. Controlling adult numbers early helps with mitigating the impact of nymphs later in the season. The high number of sprays applied was a cause of concern because of the risk of increasing resistance. This experiment demonstrates that North Carolina cotton growers can experience yield loss by *L. lineolaris.* It is unclear if this is going to be as detrimental as the plant bug crisis that hit the Mississippi Delta.

However, these are results for one year of study in one field in eastern North Carolina. More study is required before any broad sweeping conclusions can be made. It should also be noted that Tropical Storm Hermine and Hurricane Matthew were factors that may have affected population numbers of *L. lineolaris* and may have curtailed yields as plants were knocked down. Further work is planned and we will include the use of a mix of Bidrin and bifenthrin to simulate current recommendations for *L. lineolaris* instead of Transform®, which is ineffective when used alone and recommended to be mixed with another product (NC Manual). We may increase reps and add additional locations to improve the accuracy of this study.

Acknowledgements

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References

Barman, A. K., and M. N. Parajulee. 2013. Compensation of Lygus hesperus induced preflower fruit loss in cotton. J. Econ. Entomol. 106: 1209–1217.

Gore, J., Catchot, A., Cook, D., and F. Musser. 2015. Best Management Practices for Tarnished Plant Bug in Cotton Mississippi State University Agricultural and Forestry Experiment Station and Mississippi State University Extension Service. http://www.mississippi-crops.com/2015/03/05/best-management-practices-for-tarnished-plant-bug/ Accessed 2/1/2016

North Carolina State University. 2017. Chapter 5 Insect Control. North Carolina Agricultural Chemicals Manual. p 84. https://content.ces.ncsu.edu/north-carolina-agricultural-chemicals-manual/insect-control

Musser, F. R., Catchot, A. L., Stewart, S. D., Bagwell, R. D., Lorenz, G. M., Tindall, K. V,C.A., Daves.A. 2009. Tarnished plant bug (Hemiptera: Miridae) thresholds and sampling comparisons for flowering cotton in the midsouthern United States. *Journal of Economic Entomology*, *102*(5), 1827–1836. http://doi.org/10.1603/029.102.0513

Williams, M. R. 2014. Cotton Insect Losses 2014. North Carolina Summary. Mississippi State University. http://www.entomology.msstate.edu/resources/croplosses/2014loss.asp. Accessed 2/15/2016

Williams, M. R. 2015. Cotton Insect Losses 2015. North Carolina Summary. Mississippi State University. http://www.entomology.msstate.edu/resources/croplosses/pdf/2015/table20.pdf. Accessed 1/15/2016