

EVALUATING EFFECTIVENESS OF FLONICAMID ON *LYGUS HESPERUS***Abhilash Balachandran****Department of Plant & Soil Sciences, Texas Tech University
Lubbock, TX.****David L. Kerns****Megha N. Parajulee****Texas AgriLife Research and Extension Center
Lubbock, TX.****Abstract**

Flonicamid (N-cyanomethyl-4 trifluoromethyl nicotinamide) is a novel insecticidal compound effective against heteropterans and is gaining wide importance in the management of the sucking pest complex in cotton. Flonicamid acts as a feeding blocker, but the mode of action/target mechanism of action is still not clear. The western tarnished plant bug (WTPB), *Lygus hesperus*, is emerging as a major pest of cotton in the Texas High Plains. Feeding by WTPB results in square and immature boll shedding that contributes to lint yield reduction. Management of this pest is mainly by the use of harsher pesticides. Carbine (flonicamid) has been reported to suppress the *Lygus* population in various field trials. Though it acts as a feeding blocker, and the insect starves to death, it is highly beneficial to study sublethal effects of the chemical. One of the most important attributes is looking into how oviposition characteristics are affected by the insecticide. Residual assays with flonicamid were done in the lab using a glass vial assay and a plant based assay to determine the impact on oviposition. Results indicated that flonicamid suppressed oviposition at 48 and 96 HAE. Oviposition in cotton plants showed significant differences on the Bt variety, DP 141B2RF, whereas in Non Bt (DP 174 RF), Carbine[®] and untreated were not different.

Introduction

Lygus is ranked second to bollworm/budworm complex in terms of pest losses in cotton (Williams 2008). The feeding injury results in an increased shedding of immature squares and damage to bolls leading to a reduction in lint yield. For management of the *Lygus* spp., the most important method to date is by use of broad spectrum insecticides (Nordlund 2000). Of the newer pesticidal compounds, flonicamid stands out because of its unique mode of action and specificity towards sucking pests. Flonicamid is reported to rapidly inhibit feeding in aphids (Morita et al. 2007) and *Lygus* spp. (Joost 2006). Apart from inhibiting feeding, flonicamid when administered in sublethal doses could have significant effects on vital characteristics of the insect's life history such as oviposition. The objectives of this study were to study the effect of flonicamid on the oviposition characteristics of *Lygus hesperus* in glass vial assay and on potted cotton plants.

Materials and Methods

A glass vial based assay and plant based assay were conducted with flonicamid to assess the impact on oviposition in *Lygus*. Flonicamid (99% pure, technical grade from FMC, NJ) was tested at five concentrations viz., 10, 25, 50, 100, 250 ppm in 20 ml scintillation glass vials. The concentrations were in sublethal levels to adult *Lygus*, determined by previous toxicity assays with flonicamid (Unpublished data). Ethyl alcohol (99% molecular grade) was used as solvent. The exposure method followed was similar to glass vial bioassay suggested by Snodgrass (1996).

Adult *L. hesperus* females (7-10 day old) in their oviposition stage were randomly selected from the lab colony (Cotton Entomology Lab, Texas AgriLife Research and Extension Center, Lubbock, TX) and introduced at one adult/vial into the treated glass vials. A green bean piece, cut at app. 0.5 cm thickness was placed in between two layers of parafilm on top of each vial, provided a food source/oviposition substrate for the *Lygus*. The vials were maintained in environmental chambers set at a constant temperature of 27 °C and 14:10 light to dark conditions. At 48 hours after exposure (HAE), observations on mortality were taken and the green bean pieces were taken out for assessing the number of eggs laid. Surviving individuals were transferred to new untreated vials with new oviposition / food substrate (green bean) for another 48 h (total 96 HAE). The eggs were counted under a stereo microscope at 20X magnification. Data were analyzed with SAS PROC GLM for 48 HAE and 96 HAE separately and means separated using LSD ($P \leq 0.1$) for mortality and fecundity (SAS Institute 2003).

In the plant based bioassay, potted cotton plants of two varieties, Bt (DeltaPine 141 B2RF) and Non Bt (DeltaPine

174 RF), were sprayed at the 2-4 true-leaf stage with two different insecticides. The replicated treatments included: 1) Carbine[®] 50 WG (flonicamid) in a concentration of 1.72 g/L, 2) water as a control, and 3) Ammo 2.5 EC (cypermethrin) at 4 ml/L as a positive control. Five pots with two plants each were treated with each treatment solution. Plants were held for 72 h before exposure to *Lygus* so that the bugs are not killed and insecticidal residues will have a sublethal effect. Two adult females in their oviposition phase (7-10 day old) were selected at random from a laboratory colony and then released into each cage. Five days after the releases, mortality observations were taken and surviving adults were removed. Plants were dissected and eggs counted using a stereomicroscope at 20X magnification. Data were analyzed with SAS PROC GLM for both varieties separately and means separated using LSD ($P \leq 0.1$) for mortality and fecundity (SAS Institute 2003).

Results and Discussion

Results of the glass vial based assay indicated that flonicamid suppressed oviposition. There were significant differences in the mean number of eggs at both 48 HAE and 96 HAE. At 48 HAE, the mean number of eggs laid per female was 15.9 in the untreated control whereas, in the other treatments mean values were <1.0 (Figure 1). Increases in mortality were positively correlated with increases in flonicamid concentration and time which might be due to starvation. The 96 HAE data are presented below (Figure 2). The % mortality at 48 HAE was very low and did not give any trend. The % mortality in the highest concentration of 250 ppm at 48 HAE was 8% and at 96 HAE it was 64%, whereas the lowest concentration of 10 ppm recorded mortality of 0 and 48% at 48 HAE and 96 HAE respectively. Mortality in control was always below 12% throughout the experiment. At 96 HAE, females in the untreated control again laid significantly more eggs than the females previously exposed to flonicamid. Ovipositional capacity was regained in 50% of the surviving individuals at 96 HAE when transferred to non treated vials held under the same conditions. Romani et al. (2005) reported in *Lygus rugulipennis* that sensory neurons associated with stylets are involved in selection of oviposition site. Flonicamid exposure to *Lygus* could have altered the proper functioning of the stylet sensillae whereby the insect lost its ability to feed as well as to oviposit, but the oviposition suppression seems to be temporary.

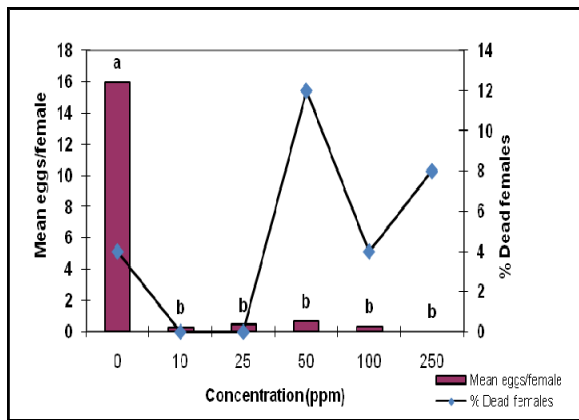


Figure 1. Mean number of eggs/*Lygus* female and % mortality at 48 HAE.

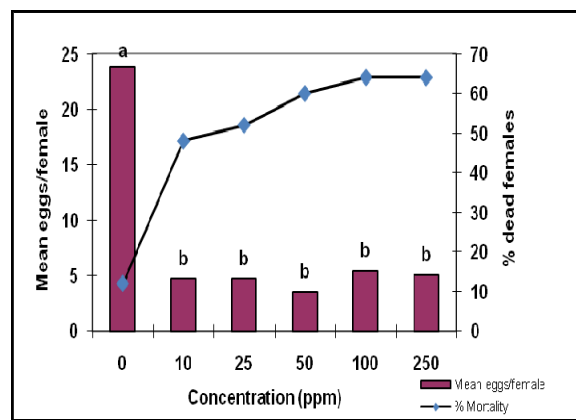


Figure 2. Mean number of eggs/*Lygus* female and % mortality at 96 HAE.

The results of the plant based assay indicated that *Lygus* oviposition on cotton plants treated with insecticide doses showed significant differences on the Bt cultivar plants, whereas with the non Bt cultivar, Carbine[®] and the untreated plants were not different (Figure 3). The control Bt plants (water sprayed) were found to have a mean of 17 eggs/female whereas, plants treated with Carbine[®] and Ammo[®] recorded 10.2 and 0.7 eggs, respectively. The difference in the oviposition patterns in Bt and non Bt cultivars in this study are questionable and needs more investigation. Gutierrez et al. (2006) reported that plant bugs (*Lygus* spp.) are refractory to Bt toxin. Hence, the variation in the present study could possibly be due to phenotypic effects. The results of this study are preliminary and additional research is needed to validate the findings.

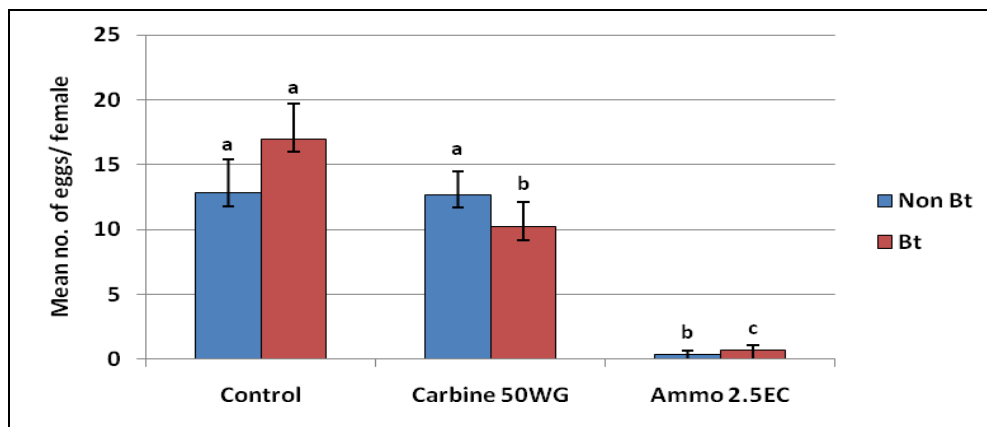


Figure 3. Mean number of eggs/*Lygus* female on cotton

Summary

In the glass vial assays, sublethal concentrations of flonicamid were very effective in blocking oviposition in *Lygus*. An increase in mortality was found with concentration at 96 HAE, which might be due to starvation. Oviposition capacity is regained in 50% or the surviving individuals at 96 HAE when transferred to non treated vials under same conditions. Oviposition in cotton plants exposed to sublethal levels of Carbine[®] showed significant differences in a Bt variety (DeltaPine 141 B2RF), relative to a non Bt variety (DP 174 RF), where no differences were detected. These differences are likely due to phenotypic characteristics rather than the presence or absence of Bt toxins.

Acknowledgements

Funding for this study was provided by the USDA-CSREES RAMP grant, Plains Cotton Growers, Inc. Texas Tech University provided a the travel grant. The authors also acknowledge the assistance of Ram Babu Shrestha and Bo Kesey of the Texas AgriLife Research and Extension Center, Lubbock, Texas.

References

- Gutierrez, A.P., J.J. Adameczyk, S. Ponsard, and C.K. Ellis. 2006. Physiologically based demographics of Bt cotton – pest interactions: I. Pink bollworm resistance, refuge and risk. *Ecological Modelling* 191:3-4, pp. 346-359.
- Joost, H. 2006. Flonicamid- a novel mode of action for piercing and sucking insects. *In Proceedings, Beltwide Cotton Conferences, National Cotton Council, Memphis, TN*, pp. 1583-1590.
- Morita, M., T. Ueda, T. Yoneda, T. Koyanagi, and T. Haga. 2007. Flonicamid, a novel insecticide with rapid inhibitory effect on aphid feeding. *Pest Manag. Sci.* 63:969-973.
- Nordlund, D. A. 2000. The *Lygus* problem. *Southwest. Entomol. Suppl.* 23:1-5.
- Romani, R., G. Salemo, F. Frati, E. Conti, N. Isidoro, and F. Bin. 2005. Oviposition behavior in *Lygus rugulipennis*: a morpho-functional study. *Entomologia Experimentalis et Applicata* 115:17-25.
- SAS Institute. 2003. PROC User's Manual, version 9.1. SAS Institute, Cary, NC.
- Snodgrass, G.L. 1996. Glass-vial bioassay to estimate insecticide resistance in adult tarnished plant bugs (Heteroptera: Miridae). *J. Econ. Entomol.* 89:1053-1059.
- Williams, M.R. 2008. Cotton insect losses-2007. *In Proceedings, Beltwide Cotton Conferences, National Cotton Council*, p. 927.