N O T E

Transovarial Activity of Novaluron on the Sweetpotato Whitefly (Hemiptera: Aleyrodidae)[1]

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The sweetpotato whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), is a serious agricultural and ornamental pest worldwide (Salas and Mendoz 1995, Fla. Entomol. 1: 154–160). Adults and immatures of *B. tabaci* are reported to cause damage to many agricultural crops (Price and Schuster 1991, Fla. Entomol. 1: 60–68). In addition, *B. tabaci* causes major problems in ornamental crops, mostly in the fall (Osborne and Oetting 1989, Florida Entomol. 3: 408–413). The nymphs and adults of *B. tabaci* cause direct feeding damage when they suck plant juices (Smith 2009, Pg. 1-8 In New Zealand Greenhouse Tomato Crops, AsureQuality LTD., Auckland, New Zealand). On poinsettias, *B. tabaci* feeding causes wilting, yellowing of leaves, and mottling. Honeydew secretion by *B. tabaci* indirectly affects the quality of ornamentals as black sooty mold fungi develop on the honeydew and block photosynthesis (Smith 2009). *Bemisia tabaci* also causes indirect damage to plants, such as abnormal plant growth and reduced yield and/or quality, via transmission of viruses. Geminiviruses transmitted by *B. tabaci* in tomato, pepper, and cotton cause severe yield losses through excessive mottling and reduced flower and fruit production (Moffat 1999, Science 5446: 1835). Similarly, *B. tabaci* also transmits criniviruses, such as cucumber vein yellowing virus, which cause severe stunting and reduces fruit production in cucurbits (Bananej et al. 2014, Phytopathol. Mediterr. 2: 269–276).

Systemic insecticides are effective against *B. tabaci* and are consistently used in the ornamental industry (Price and Schuster 1991). A few examples of insecticides recommended for whitefly control include acephate, afidopyropen, clothianidin, and dinotefuran (Hudson and Joseph 2020, Georgia Pest Management Handbook, pp. 163–336). However, repeated use of insecticides with the same mode of action can cause the development of *B. tabaci* populations that are resistant to the active

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ingredients of these pesticides. Similarly, these insecticides adversely affect natural enemy populations, which triggers unintended consequences for the environment. Thus, there is a need to develop alternative strategies to combat *B. tabaci* in ornamental crops. Studies have shown that egg viability is transovarially reduced when adult females are exposed to insect growth regulators in lepidopterans (Gökçe et al. 2009, Pest Manag. Sci. 65: 229–234; Kim et al. 2011, J. Insect Sci. 11: 126; Kim et al. 2014, Can. Entomol. 146: 347–353), coleopterans (Alyokhin et al. 2009, J. Econ. Entomol. 102: 2078–2083; Cowles 2004, Agri. Forest Entomol. 6: 291–294; Zepp et al. 1979, J. Kans. Entomol. Soc. 52: 662–666) and hemipterans (Joseph 2017, J. Econ. Entomol. 110: 2471–2477; Joseph 2019, Pest Manag. Sci. doi: 10.1002/ps.5342). Previously, the transovarial activity of novaluron has been shown against hemipteran pests (Joseph 2017, 2019; Joseph 2020, Insects. 11: 216. doi 10.3390/insects11040216). However, little is known about the transovarial activity of novaluron on *B. tabaci*. Thus, the objective of the current study was to determine the transovarial activity of novaluron on *B. tabaci*.

Experiments were conducted on bell pepper (*Capsicum annuum* L.) plants grown from seeds in the greenhouse at the University of Georgia Griffin Campus. The plants were fertilized (20:20:20 NPK) at biweekly intervals and regularly irrigated. A colony of *B. tabaci* "biotype B" was maintained on poinsettias at 28°C and 60% relative humidity in a greenhouse. For the experiment, the benzoylurea insecticide novaluron (Pedestal® [10%], OHP Inc., Bluffton, SC) was used at 58.1 g/ha. A water volume of 373.98 L/ha was used to prepare insecticide solutions after consultation with ornamental nursery growers. *Bemisia tabaci* adults were exposed to novaluron using a humidifier (Fig. 1), in which novaluron solution or distilled water was added to the chamber. The humidified vapors containing novaluron residues were passed through a 100-ml centrifuge tube with *B. tabaci* adults (Fisher Scientific, Hampton, NH) that was attached using tape (Fig. 1). The centrifuge tube was modified by removal of its bottom end and was attached to the humidifier's vent. The lid of the centrifuge tube was modified by attaching a piece of "no-see-um" fabric to prevent the escape of *B. tabaci* adults. After exposure of 10 *B. tabaci* adults in the tube for 2 min, the adults were transferred and caged on three leaves of a 6-week-old pepper plant in a greenhouse. After 2 weeks, the *B. tabaci* nymphs on the leaves were enumerated. The experiment was replicated six times with a plant serving as a replicate. Distilled water was used for the nontreated control. This transovarial assay was repeated three times. The numbers of *B. tabaci* immatures on leaves were subjected to one-way analysis of variance using the PROC GLIMMIX procedure ($\alpha = 0.05$) (SAS Institute 2012, Cary, NC). These analyses had a log link function and a negative binomial distribution. The least-squares means were separated by pairwise *t* test ($P < 0.05$).

The number of *B. tabaci* nymphs was significantly lower in novaluron-treated leaves than in the nontreated control leaves in trial 2 ($F_{1,4} = 15.2$, $P = 0.017$; Fig. 2). However, a similar number of immatures developed on nontreated control and novaluron-treated leaves ($P > 0.05$). This suggests that *B. tabaci* adults experienced transovarial activity, producing nonviable eggs when exposed to residues of novaluron. This result is consistent with previous reports wherein novaluron elicited transovarial activity against hemipterans such as *Bagrada hilaris* (Burmeister) (Joseph 2017) and *Stephanitis pyrioides* Scott (Joseph 2019). In the current study, transovarial activity was only evident when the fecundity of *B. tabaci*

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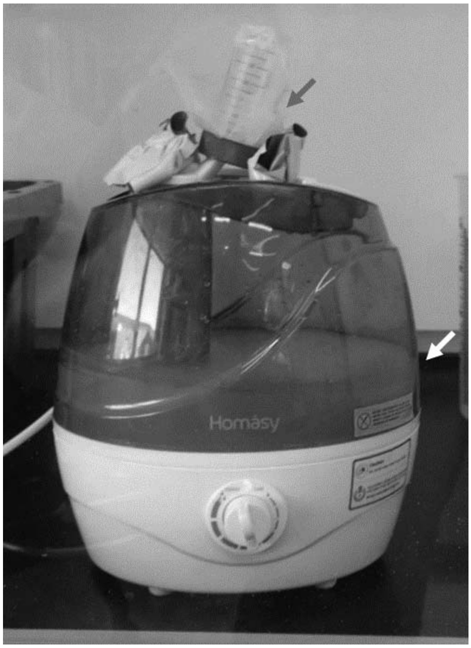

Fig. 1. Exposure of novaluron to *Bemisia tabaci* adults through fumigation. The grey arrow shows novaluron solution and white arrow shows the attachment of modified tube through which the vapors of novaluron pass. Adult *B. tabaci* individuals were introduced into the modified tube.

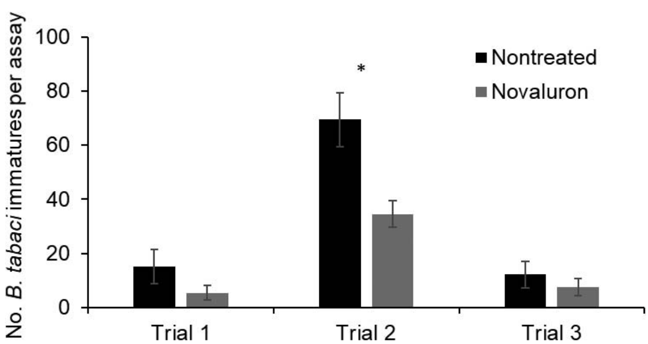

Fig. 2. The mean (± SE) number of *Bemisia tabaci* immatures per assay in transovarial trials 1, 2, and 3 following adult exposure to novaluron via fumigation. The pair of bars with asterisks (*) above each trial indicates a significant difference at $\alpha = 0.05$ with a pairwise *t* test at $\alpha = 0.05$.

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adults was high. Novaluron has limited detrimental effects on adult insects (Joseph 2017, 2019). The current study shows promise for novaluron eliciting transovarial activity against *B. tabaci*; however, further laboratory and field studies are warranted to develop novaluron as an alternative strategy for use in integrated pest management programs for *B. tabaci*.

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