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Blueberry Gall Midge: A Key Pest of Rabbiteye Blueberries

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ADDITIONAL INDEX WORDS. *Dasineura oxycoccana*, pupation rate, blueberry bud injury

Blueberry gall midge, *Dasineura oxycoccana* (Johnson) is a key pest of rabbiteye blueberries that produces dramatic yield losses in the southeastern United States. Blueberry gall midge is a relatively minor pest of southern highbush blueberries where injury is largely confined to vegetative buds. Adults emerge in early spring and females oviposit between developing flower and leaf bud scales. Larvae feed inside the buds, causing deformities in developing leaves; damage to flower buds causes necrosis and frequently results in flower bud abortion. To determine the influence of temperature on survival and rate of development, we exposed flower buds to various temperatures in environmental chambers. Larval and pupal development at the lowest temperature tested suggests that growers need to apply insecticides for blueberry gall midge early in the season while temperatures are still low.

Florida is one of the major producers of early-season blueberries in North America. In Florida, both rabbiteye, *Vaccinium virgatum* Aiton, and southern highbush, *V. corymbosum* L. × *V. darrowii* Camp hybrids, are grown (Williamson et al., 2000). Over the last decade, the production trend has been toward more southern highbush and less rabbiteye blueberries (Williamson et al., 2000). Blueberry gall midge, *Dasineura oxycoccana* (Johnson) (Fig. 1), is a major pest of rabbiteye blueberries (Lyrene and Payne, 1995; Sampson et al., 2002); the midge is generally much less problematic in southern highbush cultivars.

Blueberry gall midge adult females deposit eggs in blueberry flower and leaf buds. When the eggs hatch, the larvae feed on the bud tissues until they are ready to pupate. Mature larvae exit the buds and fall to the ground where they pupate in the soil (Bosio et al., 1998). While the leaf buds of both southern highbush and rabbiteye blueberries are susceptible to midge infestation, the flower buds of most southern highbush clones are fairly resistant (Lyrene and Payne, 1995). Among rabbiteye cultivars, a high degree of variability exists in the susceptibility of flower buds to gall midge damage (Lyrene and Payne, 1995). Flower bud injury due to larval feeding results in death of the bud and loss of subsequent yield. The most susceptible cultivars can lose in excess of 80% of their flower buds to midge feeding (Sampson et al., 2002). Midge larvae feeding in leaf buds cause deformation of expanding leaves and can kill vegetative meristems (Lyrene and Payne, 1992).

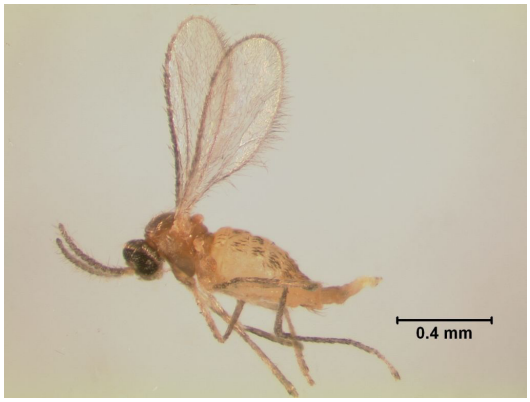

Fig. 1. Adult blueberry gall midge female. Blueberry gall midge adult females deposit eggs in blueberry flower and leaf buds. While the leaf buds of both southern highbush and rabbiteye blueberries are susceptible to midge infestation, the flower buds of most southern highbush clones are fairly resistant.

One of the main challenges of managing blueberry gall midge is knowing when to initiate sprays; reliable forecasting would help growers improve the timing of sprays. Temperature has a direct effect on insect development rates and is a key component of insect population dynamics, which can be used to develop forecasting models (Diaz et al., 2007). Before models can be developed for blueberry gall midge; however, we need to better understand how temperature affects its activity. The objectives of this study are to determine how temperature affects larval emergence from flower buds and to measure the development rate of pupae held at different constant temperatures.

Materials and Methods

Blueberry gall midge larvae were collected from infested rabbiteye flower buds (variety 'Aliceblue') taken from organic blueberry farms in Gainesville, FL, and Hawthorne, FL. Rabbiteye flower buds were used because high infestations were observed in the rabbiteye blueberries at these farms providing an abundant source of larvae for the laboratory experiments. Flower bud samples were collected at both farms in 2006 and at the Gainesville farm only in 2007. Beginning in early Feb. 2006 and mid-Jan. 2007, flower buds were collected each week and taken to the Small Fruit and Vegetable Integrated Pest Management Laboratory at the University of Florida Entomology and Nematology Department (Gainesville, FL) for processing.

We would like to thank the Gainesville Organic Blueberry Farm and McCord's Organic Blueberry Farm for allowing us to collect flower buds at their farms.
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Experiment I—Larval activity in flower buds. To determine the influence of temperature on survivorship of blueberry gall midge larvae and to assess its impact on the rate of larval development, infested flower buds were exposed to various constant temperatures. The experiment was set up in a completely randomized design with three treatments (temperature), 29.4, 21.1, and 12.8 °C (85, 70, 55 °F), and five replications. Environmental chambers were set for constant temperature and photoperiod of 16:8 (L:D). Each week 450 flower buds were collected from each farm. Buds were thoroughly mixed together to assure equal distribution of infested buds to the various treatments (temperatures), then divided evenly among 15 petri dishes (30 buds per dish) which served as replications. Petri dishes [diameter 9 cm (3.5 inches)] were lined with moistened filter paper and sealed with Parafilm® (Pechiney Plastic Packaging, Menasha, WI) to prevent larvae from escaping. Petri dishes were examined every 72 h for 2 weeks and the number of larvae emerging was counted. Differences in the number of larvae emerging were analyzed using repeated-measures analysis of variance (PROC MIXED, SAS Institute, 2003).

Experiment II—Development rate of pupae. Mature blueberry gall midge larvae (third instar) were collected from infested flower buds and placed individually in 5-mL (0.17 oz) polystyrene vials (Falcon 2054; Becton Dickenson Labware, Lincoln Park, NJ) filled with a 2-cm- (0.8-inch) deep layer of vermiculite moistened with deionized water. For the purposes of the experiment, the pupal stage was defined as starting when larvae introduced to the pupation vials burrowed into the substrate, and ending when adults emerged (Weston and Diaz, 2005). Vials were placed in environmental chambers under the same conditions as for Experiment I. Vials were checked every 24 h for 16 d for emerging adults. For each temperature, 140 vials were prepared.

Results and Discussion

Experiment I—Larval activity in flower buds. In 2006, no significant differences were observed in the mean number of larvae emerging per flower bud from the Gainesville farm (F = 2.39; df = 2, 48; P = 0.102) or the Hawthorne farm (F = 1.14; df = 2, 40; P = 0.33) at any of the three temperatures. However, in 2007 there was a significant difference (F = 24.6; df = 2, 104; P < 0.001) in the mean number of larvae emerging per flower bud among temperature treatments (Fig. 2). Significantly more larvae emerged from flower buds at 21.1 °C (70 °F) than 12.8 °C (55 °F). This discrepancy between sample years may be related to overall gall midge population density. The total number of midge larvae collected at the Gainesville farm in 2007 was over three times as much as the number collected in 2006.

Rate of larval emergence was reduced by lower temperature. Figure 3 shows the percentage of total larvae emerging from buds at regular intervals for each temperature. At 29.4 °C (85 °F) and 21.1 °C (70 °F), 88% and 68% of the larvae had emerged by the fifth day (respectively). At 12.8 °C (55 °F), less than 50% of the larvae had emerged after 9 d.

Experiment II—Development rate of pupae. Temperature had a clear effect on the rate of blueberry gall midge pupation and the number surviving to adulthood. Almost exactly the same number of adults emerged at 29.4 °C (85 °F) and 21.1 °C (70 °F). Development rate at these two temperatures was similar, with adults emerging approximately 2 d earlier at the higher

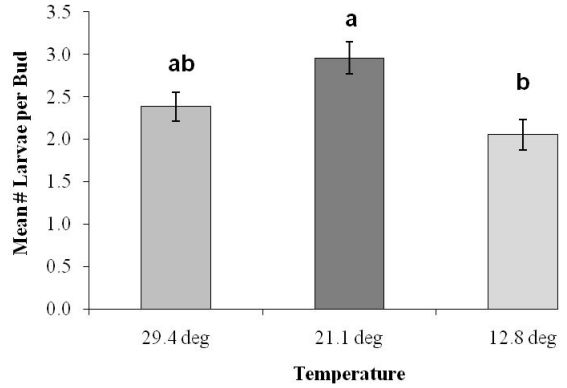

Fig. 2. Mean number of blueberry gall midge larvae that emerged per blueberry flower bud at three constant temperatures. Flower buds (n = 1350 for each temperature) were collected from a blueberry farm in Gainesville, FL in 2007. Mean separation by Tukey's Studentized range test, 5% level.

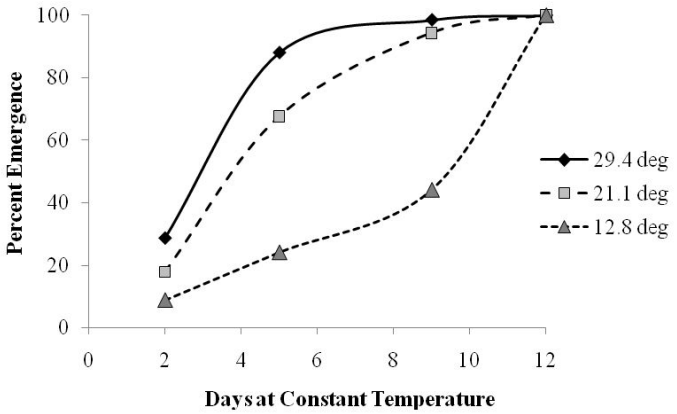

Fig. 3. Cumulative percent emergence of blueberry gall midge larvae from blueberry flower buds at three constant temperatures. Flower buds (n = 1350 for each temperature) were collected from a blueberry farm in Gainesville, FL in 2007.

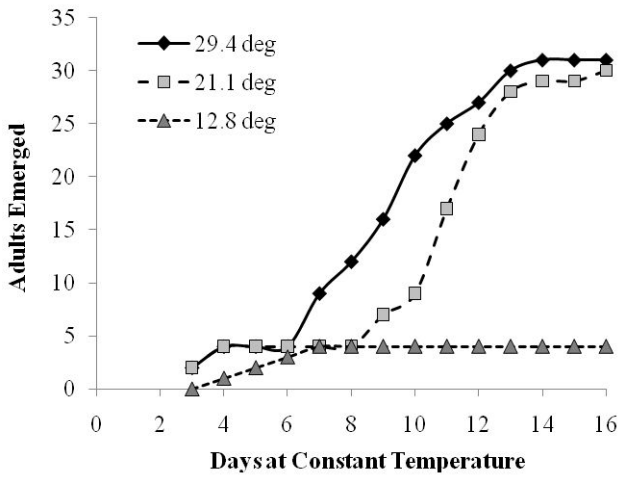

Fig. 4. Cumulative blueberry gall midge adult emergence in pupation vials (n = 140 for each temperature) at three constant temperatures in 2007.

temperature (Fig. 4). Only four midge adults emerged at 12.8 °C (55 °F). The low temperature was not lethal, but because so few adults emerged it indicates that this temperature may be near the threshold for pupation.

This work shows that blueberry gall midge is active at temperatures lower than previously expected. Overall midge emergence was only slightly affected by different temperatures, but the rate of emergence was greatly affected from 12.8 to 29.4 °C (55 to 85 °F). Our results indicate that growers need to begin their management operations for blueberry gall midge early in the season when temperatures are still low. We recommend that in Florida, scouting should begin in January or early February. Further research should be done to precisely determine developmental threshold temperatures and produce temperature-based models for use in midge scouting.

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