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Examining the relationship between flower thrips (Thysanoptera: Thripidae) spatial distribution and blueberry (Ericales: Ericaceae) flower density

Elena M. Rhodes[1,]*, *Oscar E. Liburd*[1], *and Sabine Grunwald*[2]

Southern highbush blueberry (*Vaccinium corymbosum* L. × *V. darrowii* Camp) (Ericales: Ericaceae) is an important crop in Florida, where it is grown for the highly profitable early-season fresh market (USDA 2010). Flower thrips (*Frankliniella* species) are one of the key pests of blueberry. In Florida, *Frankliniella bispinosa* (Morgan) (Thysanoptera: Thripidae) is the dominant species collected (Arévalo & Liburd 2007). The thrips injure blueberry flowers when they feed and oviposit in developing flower tissues. This injury can cause scarring on developing fruit that makes the fruit unmarketable (Arévalo-Rodriguez 2006).

Thrips populations tend to form one or a few "hot spots," small areas of comparatively high thrips numbers, on blueberry plantings (Arévalo & Liburd 2007). These hot spots begin forming about 7 to 10 d after bloom initiation, peak when the majority of the flowers are open (12–15 d after initiation), and decline until most of the flowers have become fruit (approx. 22 d after initiation) and very few thrips remain (Arévalo & Liburd 2007). The objective of this study was to determine if thrips density is related to flower density. The hypothesis was that thrips population density in space has a positive linear relationship with flower density. Two experiments were conducted, one on a farm in Inverness, Florida, in 2009 and another on a farm in Windsor, Florida, in 2010. White traps were used as the standard monitoring tool for thrips because Liburd et al. (2009) found them to be an effective device for monitoring thrips in southern highbush blueberries. Arévalo & Liburd (2007) found a strong correlation (r = 0.76) between thrips per flower and thrips per trap in rabbiteye blueberries (*Vaccinium virgatum* Aiton).

On the Inverness farm, 100 white sticky traps (Great Lakes IPM, Vestaburg, Michigan) were distributed throughout a 1 ha, 4- to 7-yr-old southern highbush blueberry planting in a regular grid at 7.61 m increments. An additional 30 traps were placed randomly throughout the plot. Traps were replaced weekly over a 5 wk period from 30 Jan to 26 Feb 2009 and taken to the University of Florida, Small Fruit and Vegetable Laboratory in Gainesville, Florida, where the number of thrips per trap was counted and recorded.

The percentage of open flowers present in each blueberry row in the study was recorded when traps were collected. The sampling area consisted of 38 rows with a dirt road in the middle (19 rows on either side of the dirt road). Each row contained blueberry plants of the same variety and age.

Linear regression analysis was used to determine if the number of thrips (dependent variable) was related to the percentage of open flowers (independent variable). All 130 sample points were input into the analysis by assigning to each trap the percentage of open flowers recorded from the row in which the trap was hung. Because some of the assumptions of least squares regression could not be met even after transformation, Theil regression (Hollander & Wolfe 1999) was used and Kendall's tau, a nonparametric correlation statistic (Hollander & Wolfe 1999), was calculated (Wessa 2008) for all sampling dates.

At the Windsor farm, a smaller study was conducted due to space constraints: 20 white sticky traps were placed in a 2,464 m^2 area of a 7-yr-old southern highbush blueberry planting. Traps were spaced approximately 15 m apart within each of 5 blueberry rows. The spacing between rows was 10 m. Each trap was replaced weekly. Thrips data were collected as in the Inverness study. Percentage of open flowers was recorded from each sampled plant where traps were collected. Traps and flower data were collected for 6 wk from 18 Feb to 25 Mar 2010.

Least squares regression analysis (SAS Institute 2002) was used to determine if the number of thrips per trap (dependent variable) was related to the percentage of open flowers (independent variable). The thrips per trap (x) data were $\log_{10}(x + 1)$ transformed to meet assumptions of least squares regression.

On the Inverness farm, a significant positive linear relationship between percentage of open flowers and thrips per trap occurred on 30 Jan (τ = 0.36, C = 2,594, n = 130, P_{slope} < 0.0001; Fig. 1a) and 5 Feb (τ = 0.24, C = 1,791, n = 130, P_{slope} = 0.0002; Fig. 1b). No relationship was found between the 2 variables on any other date (all $\tau \le 0.07$, $C \le 556$, n = 130, $P_{slope} \ge 0.25$).

On the Windsor farm, there was a significant negative linear relationship between percentage of open flowers and $\log_{10}$ thrips per trap on 18 Mar (R^2 = 0.24, t = −2.67, df = 19, P_{slope} = 0.0156; Fig. 2). No relationship was found between the 2 variables on any other date (all R^2 < 0.03, $|t| \le 1.23$, df = 19, P_{slope} > 0.23).

According to Arévalo-Rodriguez (2006), flower thrips population density is strongly correlated with the percentage of open flowers over time. The results from the Inverness study indicate that this relationship may exist in space, also. Differences in percentages of open flowers in space and time probably exist because multiple varieties are grown on the same farm to maximize cross pollination (Childers & Lyrene 2006). Different varieties begin to flower at different times and for different lengths of time (Rhodes et al. 2012).

An intense cold snap that occurred from 4 to 6 Feb 2009 (FAWN 2009) may explain the low thrips numbers recorded on 6 Feb on the Inverness farm. The lack of a relationship between thrips and flowers on 13 Feb probably happened because peak flowering occurred dur-

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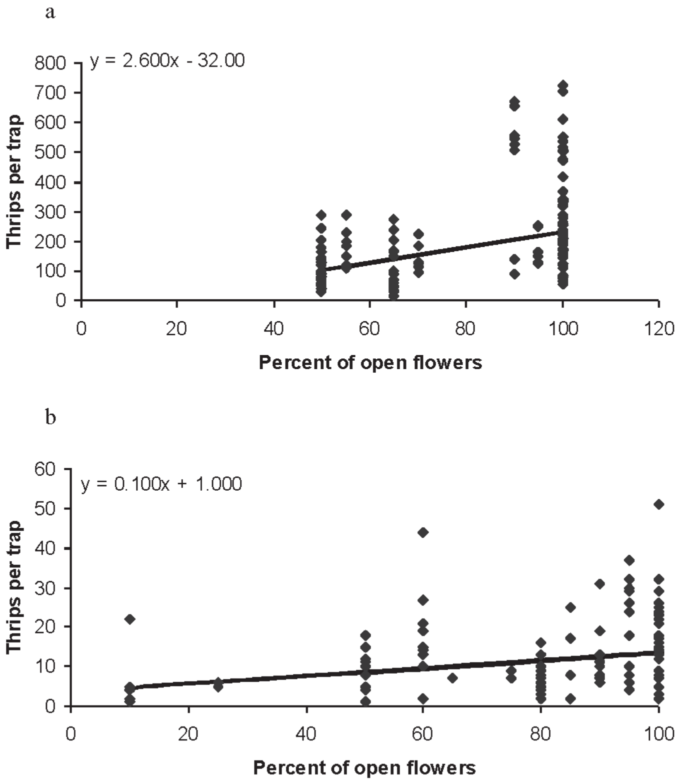

Fig. 1. Graphs showing percentage of open blueberry flowers vs. thrips per trap from the Inverness farm on a) 30 Jan and b) 5 Feb 2009. The black lines represent regression lines fitted by Theil regression.

ing this week. The thrips population continued to increase after peak flowering for 2.5 wk, possibly due to delayed development (transition from larvae and pupae to adults), which may have resulted in the lack of a relationship on 20 and 26 Feb.

On the Windsor farm, a negative linear relationship between thrips and flowers occurred on 18 Mar. This, and the lack of any other significant relationships, may have been a result of the unusually cold winter weather that occurred throughout Jan and Feb 2010 (FAWN 2010).

Although numbers of thrips on sticky traps are correlated with thrips per flower (Arévalo & Liburd 2007), using flower samples might produce a stronger correlation with flower density. Sticky traps only monitor for adults, whereas larvae are present in flowers along with adults. More accurate measures of flower density are also needed.

Results from the Inverness study indicate that flower thrips density is related to flower density. A better understanding of the relationship between thrips density and flower density could help in revising management programs. For example, scouting could be concentrated in areas where thrips density is likely to be high, and insecticide applications could be made to those sites where population density is high as opposed to whole field applications.

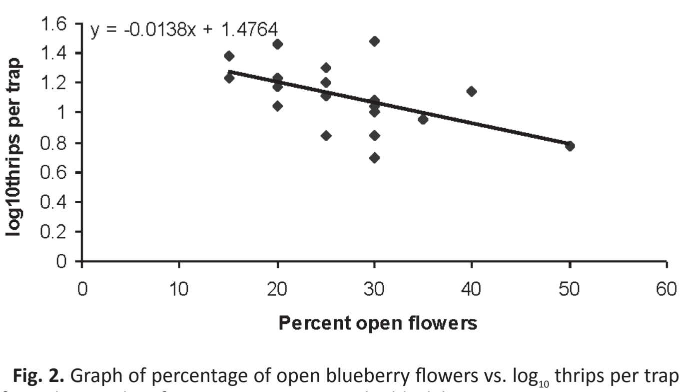

Fig. 2. Graph of percentage of open blueberry flowers vs. log_{10} thrips per trap from the Windsor farm on 18 Mar 2010. The black line represents a regression line fitted by least squares regression.

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Summary

Flower thrips tend to form areas of high population, termed "hot spots," in blueberry plantings. This study provided evidence that thrips density may be correlated with flower density in space. Further understanding of the relationship between flower density and thrips numbers could lead to better scouting and management programs.

Key Words: *Frankliniella*; hot spot; nonparametric correlation; Theil regression; southern highbush

Sumario

Los trips de las flores suelen formar zonas de alta población, que se llaman "puntos calientes", en las plantaciones de arándanos. Este estudio provee evidencia de que la densidad de trips se puede correlacionar con la densidad de las flores en espacio. Una mayor comprensión de la relación entre la densidad de las flores y el número de trips podría resultar en mejores programas de muestreo y de manejo.

Palabras Clave: *Frankliniella*; punto caliente; correlación no paramétrica; Regresión Theil; arándanos de variedad highbush de sur

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