Comparative Bionomics of Frankliniella occidentalis and Frankliniella tritici

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COMPARATIVE BIONOMICS OF *FRANKLINIELLA OCCIDENTALIS* AND *FRANKLINIELLA TRITICI*

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Two of the most abundant thrips in the southeastern USA are *Frankliniella occidentalis* (Pergande) and *Frankliniella tritici* (Fitch) (Thysanoptera: Thripidae). *Frankliniella occidentalis* is a key pest because of damage caused by its feeding and oviposition in many crops and because it is a vector of *Tomato spotted wilt virus* (Childers 1997; Ullman et al. 1997). Although *F. tritici* is not a vector of *Tomato spotted wilt virus* (Assis Filho et al. 2005), its abundance and morphological similarity to *F. occidentalis* makes it a management concern for growers and crop consultants (Reitz 2002). Despite superficial similarities in their habits and host plants, the seasonal population dynamics of these species differ dramatically (Eckel et al. 1996; Funderburk et al. 2000; Reitz et al. 2002), yet efforts to better understand their population dynamics are hindered by a lack of comparative biological data and because observing individual thrips in the field is almost impossible. Therefore, laboratory studies can provide critical information to better understand their population dynamics. The objectives of this study were to compare development and reproductive success of *F. occidentalis* and *F. tritici*.

To determine immature development time, individual adult females were allowed to oviposit for 8 h in 2.5-cm sections of green bean pods contained in 30-ml clear plastic cups. Then females were removed, and the bean sections were held in an environmental chamber (28.0 ± 1.0°C, 65.0 ± 10.0% r.h., 14:10 L: D photoperiod). Bean sections were observed every 12 h under a stereomicroscope to determine when larvae began to emerge. Then a single newly emerged larva from each female was transferred to fresh bean pod section. These individuals were checked every 12 h to determine when molting occurred. There are 2 active larval stages followed by 2 relatively quiescent non-feeding stages, the propupa and pupa (Moritz 1997). Because data were recorded on an interval scale and composed of different events (molts), survival analyses based on the Wei, Lin and Weissfeld model were used to compare development of the life stages (Li & Lagakos 1997; Wei et al. 1989). In this model, molts were stratified according to their order of occurrence with adult eclosion as the terminating event. Because of the stratification, separate hazard ratios can be estimated for each life stage as well as a comparison of the overall development of the species. Subjects that did not complete development were censored.

To determine female adult longevity and fecundity, newly emerged adult females were placed individually in small Petri dishes containing a 2.5-cm piece of green bean, with the ends sealed with Parafilm. Beans were replaced every 24 h, and this process continued for each thrips until death. Beans were subsequently examined over 7 d for larval emergence. The total number of offspring produced per adult female was recorded. Fecundity was analyzed by repeated measures analysis of covariance, with species as a treatment and longevity as a covariate. This analysis allowed a comparison of total fecundity and daily fecundity of thrips. Adult longevity was compared based on survival analysis in which mortality was examined by comparing the Cox proportional hazard for each species (Cox 1972) with ties handled by Breslow's method (Breslow 1974). Insects that were accidentally lost during the experiment were considered censored observations and not included in fecundity analyses. Experiments were replicated 3 times with colonies that had been established for 4-8 months from specimens collected in Gadsden County, FL. Voucher specimens are deposited in the collections of the author. All statistical analyses were performed in SAS ver. 9.1 (SAS 2004).

Time to egg hatch was approximately 3 d for both *F. occidentalis* (range 2.5-3.5 d) and *F. tritici* (range 2.5-3 d). Overall immature development from oviposition to adult eclosion was significantly faster for *F. tritici* (median = 11.0 d, range = 9.5-14.0 d, n = 26) than for *F. occidentalis* (median = 12.0 d, range = 9.5-14.5 d, n = 20; χ^2 = 14.10, df = 5, P = 0.015). There were no significant differences between the species in development times of the 2 larval stages (median = 2.0 d, range = 1.0-4.0 d, and 3.0 d, 2-4 d, for first and second stadia, respectively), and the propupa stage (median = 1.0 d, range = 0.5-3 d; P > 0.25 for each stage comparison). The difference in total development resulted from the shorter pupal stage of *F. tritici* (median = 2.0 d, range = 1-3 d) compared with *F. occidentalis* (median = 3.0 d, range = 2-5 d; χ^2 = 5.14, df = 1, P = 0.02).

Adult longevity of females differed between the species, with *F. occidentalis* having a significantly greater longevity than *F. tritici* (log rank test χ^2 = 8.2, df = 1, P = 0.004). The quartile estimates of times at which 25%, 50%, and 75% of the individuals had died were all significantly greater for *F. occidentalis* (Fig. 1A) indicating that the greater survivorship of *F. occidentalis* was consistent throughout the adulthood. Initial survivorship was high for both species, with less than 10% mortality in the first week after eclosion. The maximum longevity was similar for both species,
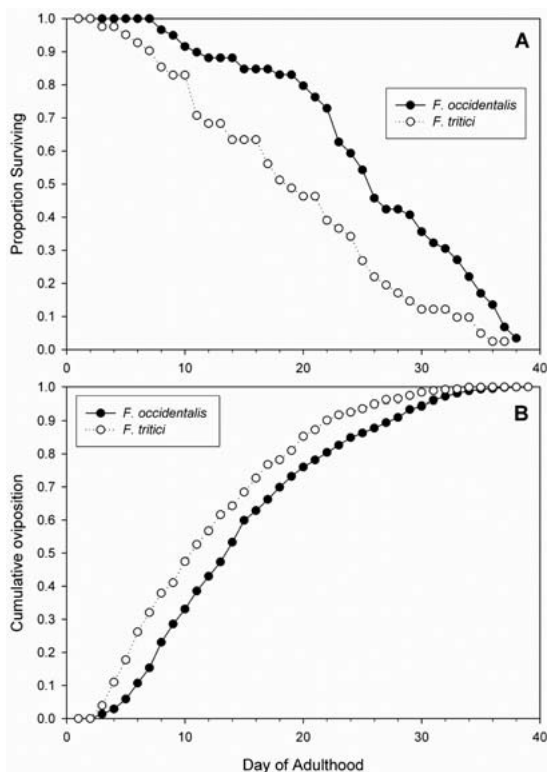
Fig. 1. Adult longevity (A) and mean cumulative lifetime fecundity (B) of *Frankliniella occidentalis* (*n* = 35) and *F. tritici* (*n* = 35) females.

with females living up to 38 and 39 d for *F. tritici* and *F. occidentalis*, respectively. However, the hazard ratio of *F. tritici* to *F. occidentalis*, which

compares how rapidly subjects are dying, was 1.894 (95% confidence interval: 1.223-2.934), indicating that the rate of death was almost twice as fast for *F. tritici* compared with *F. occidentalis*.

There was a 2-day preoviposition period for both species (Fig. 1B). The majority of eggs were laid in the first 2 weeks of adulthood for both species (Figs. 1B and 2). Reproduction varied significantly over time (*F* = 1.87, *df* = 31, 1017, *P* = 0.003), with both species showing cyclical peaks and declines in daily oviposition (Fig. 2). Despite the difference in lifespans, total numbers of progeny averages were similar for *F. tritici* (52.4 ± 4.4) and for *F. occidentalis* (49.4 ± 4.3; *F* = 0.30, *df* = 1, 47, *P* = 0.60).

The mean daily fecundity was over 9% higher for *F. tritici* (2.26 ± 0.13) than for *F. occidentalis* (2.07 ± 0.11; *F* = 4.19, *df* =1, 47, *P* = 0.046). This difference resulted from the low number of eggs laid by the oldest *F. occidentalis* females towards the end of their lifetime. The maximum number of eggs laid in 1 d was 18 for *F. occidentalis* and 17 for *F. tritici*. Lifetime reproduction was significantly related to adult longevity for *F. tritici* (slope estimate ± 95% CI: 2.88 ± 1.12 eggs per additional day of adulthood, *t* = 8.01, *df* = 47, *P* < 0.0001) but not for *F. occidentalis* (slope estimate ± 95% CI: 1.02 ± 1.83, *t* = 1.62, *df* = 47, *P* = 0.12).

While *F. occidentalis* has been intensively studied, little information on the bionomics of less pestiferous *Frankliniella* species is available. The results of the present study demonstrate that there are broad similarities in the development and reproduction of *F. occidentalis* and *F. tritici*, although these similarities may change at higher or lower temperatures than tested in the present study. Still, both species are capable of increasing
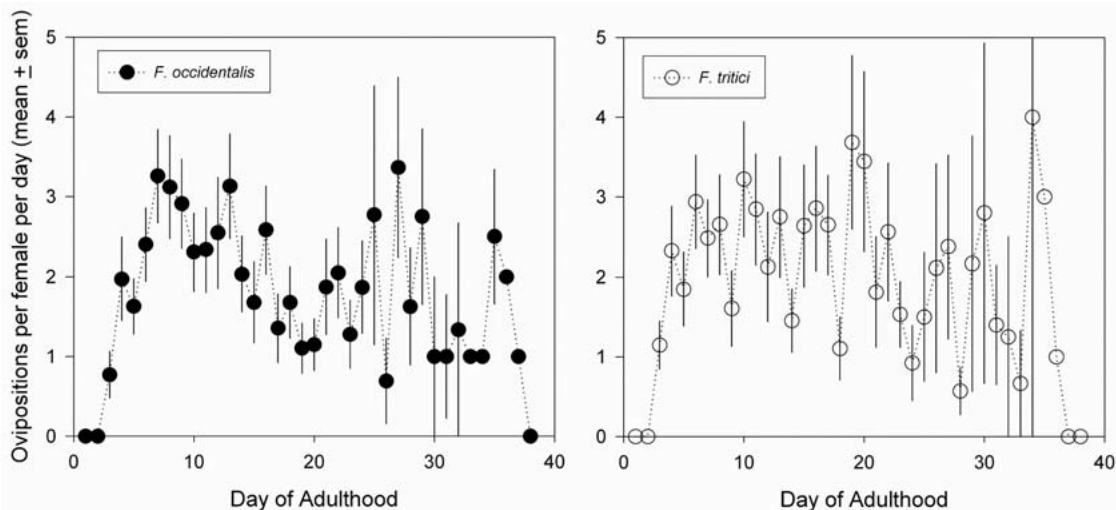

Fig. 2. Mean daily fecundities of *Frankliniella occidentalis* (*n* = 26) and *F. tritici* (*n* = 25) over the completed female lifetime. Bars represent standard errors of the means.

rapidly with overlapping generations. The faster development and higher daily oviposition of *F. tritici* may enable its populations to build at faster rates than populations of *F. occidentalis* and contribute to its greater abundance in the southeastern USA (Reitz 2002).

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. I appreciate the technical assistance of Eric Hansen and Xinhua Yan, and the comments of Joe Funderburk on an earlier draft.

SUMMARY

The development and reproduction of *Frankliniella occidentalis* and *F. tritici* were evaluated. Both species showed similar patterns in development and reproduction at 28.0°C. However, median development time for immatures of *F. tritici* was 1 d faster than for *F. occidentalis*, and although *F. occidentalis* females survived longer than *F. tritici*, there was no difference in total progeny production.

REFERENCES CITED

ASSIS FILHO, F. M., J. STAVISKY, S. R. REITZ, C. M. DEOM, AND J. L. SHERWOOD. 2005. Midgut infection by *tomato spotted wilt virus* and vector incompetence of *Frankliniella tritici*. J. Appl. Entomol. 129: 548-550.

BRESLOW, N. E. 1974. Covariance analysis of censored survival data. Biometrics. 30: 89-*99*.

CHILDERS, C. C. 1997. Feeding and oviposition injuries to plants, pp. 505-537 *In* T. Lewis [ed.], Thrips as Crop Pests. CAB International, New York.

ECKEL, C. S., K. CHO, J. F. WALGENBACH, G. G. KENNEDY, AND J. W. MOYER. 1996. Variation in thrips species composition in field crops and implications for tomato spotted wilt epidemiology in North Carolina. Entomol. Exp. Appl. 78: 19-29.

FUNDERBURK, J., J. STAVISKY, AND S. OLSON. 2000. Predation of *Frankliniella occidentalis* (Thysanoptera: Thripidae) in field peppers by *Orius insidiosus* (Hemiptera: Anthocoridae). Environ. Entomol. 29: 376-382.

LI, Q. H. L., AND S. W. LAGAKOS. 1997. Use of the Wei-Lin-Weissfeld method for the analysis of a recurring and a terminating event. Statistics in Medicine. 16: 925-940.

MORITZ, G. 1997. Structure, growth and development, pp. 15-63 *In* T. Lewis [ed.], Thrips as Crop Pests. CAB International, New York.

REITZ, S. R. 2002. Seasonal and within plant distribution of *Frankliniella* thrips (Thysanoptera: Thripidae) in north Florida tomatoes. Florida Entomol. 85: 431-439.

REITZ, S. R., J. E. FUNDERBURK, E. A. HANSEN, I. BAEZ, S. WARING, AND S. RAMACHANDRAN. 2002. Interspecific variation in behavior and its role in thrips ecology, pp. 133-140 *In* R. Marullo and L. A. Mound [eds.], Thrips and Tospoviruses: Proc. 7th Int'l. Symposium Thysanoptera, July 2-7, 2001, Reggio Calabria, Italy. Australian National Insect Collection, Canberra.

SAS. 2004. SAS/STAT User's Guide, version 9.1. SAS Institute, Cary, NC.

ULLMAN, D. E., J. L. SHERWOOD, AND T. L. GERMAN. 1997. Thrips as vectors of plant pathogens, pp. 539-565 *In* T. Lewis [ed.], Thrips as Crop Pests. CAB International, New York.

WEI, L. J., D. Y. LIN, AND L. WEISSFELD. 1989. Regression analysis of multivariate incomplete failure time data by modelling marginal distributions. J. American Stat. Assoc. 84: 1065-1073.