REPRODUCTIVE SUCCESS AND DAMAGE POTENTIAL OF TOBACCO THRIPS AND WESTERN FLOWER THRIPS ON COTTON SEEDLINGS

Joel Faircloth, J. R. Bradley, Jr. and John Van Duyn
NC State University
Raleigh, NC

Abstract

A greenhouse study was performed to assess the damage and reproductive potentials of two thrips (Thysanoptera) species in relatively cool temperatures. Through measurements of plant biomass at the end of the study and visual plant damage ratings, the damage potential of tobacco thrips, *Frankliniella fusca* (Hinds), was found to be significantly less than that of the western flower thrips, *Frankliniella occidentalis* (Pergande), overall and on a per thrips basis. There were no differences found in the reproductive potential of either species on either of two cotton varieties. The results of this study confirm the importance of thrips identification since damage to cotton seedlings may be a function not only of the thrips density but also of the species involved.

Introduction

Thrips are early season pests of cotton that typically infest seedlings immediately following emergence. Thrips injure cotton seedlings by rasping the young, tender leaves and terminals, feeding on the juices that are released. Signs of thrips injury on the true leaves include distortion of leaf shape, browning along the margins or over the entire leaf, wholes in the margin, or any combination of these. Thrips injury to the cotyledonary leaves is characterized by stippling that results in loss of chlorophyll or in severe cases a torn, ragged appearance. Studies have found that thrips have the potential to significantly impact various developmental and maturity parameters including yields of cotton (Gaines 1934, Dunham and Clark 1937, Newsom *et al.* 1953, Herbert 1998, Van Duyn *et al.* 1998).

Numerous factors that contribute to the annual variations seen in thrips damage to cotton seedlings have been identified. These factors include cotton variety, weather, and thrips density. Different varieties of cotton have demonstrated varying levels of tolerance to thrips. These variations have been attributed to plant characteristics such as trichome density, gossypol production, and thickness of the epidermal tissue (Rummel and Quisenberry 1979, Gawaad and Soliman 1972, Bowman and McCarty 1997). Faircloth *et al.* (1998) concluded that a combination of cool, wet weather and dense thrips populations during the seedling stage of cotton resulted in heavily damaged cotton and reduced yields.

Another factor that potentially impacts the extent of thrips damage is the species composition of thrips. The importance of species composition as it relates to the extent of damage in a particular year is poorly understood because very little research has been focused on this topic. However, in 1937, J.G. Watts expressed the importance of knowing the species composition of thrips as it relates to their control. Hightower (1958) later documented the importance of species composition when he reported the plant damaging potential of the tobacco thrips on cotton in a greenhouse to be greater than that of the eastern flower thrips, *Frankliniella tritici* (Fitch). Two of the 5 to 6 species commonly found on cotton seedlings in the U.S. are western flower thrips, *Frankliniella occidentalis* (Pergande), and tobacco thrips, *Frankliniella fusca* (Hinds). The most prevalent species inhabiting cotton seedlings in numerous states including North Carolina is the tobacco thrips (Newsom *et al.* 1953, Burris 1980, Van Duyn 1998, All *et al.* 1993). Although past studies conducted in North Carolina reported western flower thrips as comprising only a small proportion of the species complex (Faircloth *et al.* 1999, Van Duyn *et al.* 1998), in 1999 unusually high proportions of western flower thrips were reported on seedling cotton in certain areas (Bacheler 1999). Increased proportions of western flower thrips in seedling cotton are of possible concern for two reasons; 1) western flower thrips are more difficult to control with certain conventional insecticides (Bacheler 1999) and 2) they also may vary from other species of thrips in their reproductive and damage potentials.

The objective of this study was to compare the reproductive success and damage potentials of western flower thrips and tobacco thrips on seedlings of two cotton varieties.

Materials and Methods

This study was conducted in a greenhouse at North Carolina State University in Raleigh, Wake Co., NC. The two varieties used were Deltapine 436 RR and Stoneville 474. The test was planted on 10 October 1999. Seeds were sown in black, plastic, one gallon pots containing Scotts Metro Mix 200 potting soil. Exclusion cages were placed over the pots fitting just inside the lip and gently seated below the soil line. The exclusion cages were cylindrical in shape and contained 0.02” PETG Sheet (AIN Plastics, Inc., Philadelphia, PA) on the sides and Bed Bug 110 screen (Green Thumb Group, Inc., Dawners Grove, Ill) on the top. Temperatures in the greenhouse were manipulated to simulate the cool conditions typically experienced in North Carolina in early to mid May when cotton seedlings are emerging and later elevated temperatures that are typical towards the end of May. From 15 October to 27 October the mean low temperature was

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1108-1111 (2000)
National Cotton Council, Memphis TN

16ºCelsius (C) and the mean high was 28º C. On 28 October, temperatures were increased, remaining at a mean low temperature of 20º C and a mean high of 32º C until the experiment was terminated.

Cotton seedlings were infested with ten adult thrips per plant on 15 October that had eclosed from pupation 0 to 4 days prior to infestation. The thrips were obtained from lab colonies at North Carolina State University. They were extracted from substrate (fresh pole beans) using pasteur pipettes. A small piece of mesh was inserted into the wide end of the pipette and the thrips were sucked into the pipettes by mouth. When ten thrips were drawn into the pipette, the tip was blocked with paraffin wax and the wide end was sealed with parafilm. Each pipette was placed under an exclusion cage with the newly emerged seedlings and the mesh was removed to allow the thrips to escape from the pipettes.

On 29 October and 4 November, the seedlings were visually rated to assess the damage in each treatment. Ratings were based on the severity of thrips feeding damage to the newly emerging true leaves. The signs of thrips damage looked for included distortion, discoloration, and tears or missing areas in the true leaves. The rating scale used ranged from 1-5 and is described as follows: 1= leaves with no apparent damage, 2= slight damage, 3= moderate damage, 4= severe damage, and 5= complete loss of true leaves. During the ratings, plants were turned so the stakes containing the treatment descriptions faced away from the individual quantifying the damage.

The seedlings remained infested for 21 days, representing the period of time that thrips commonly infest North Carolina cotton at damaging population levels. This period of time was also selected to maximize thrips recovery based on documented life cycles (Lewis 1973, Robb 1988). The exclusion cages were lifted from each pot on 4 November while simultaneously severing the seedlings directly below the cotyledonary nodes. A plant washing procedure similar to that described by Irwin and Yeargan (1980) was used. Seedlings were placed in labeled mason jars containing a detergent solution. In the lab each jar was emptied into a number 100 U.S.A. Standard Testing Sieve (150 micrometers), the leaves were washed over the sieve, and the residue left in the sieve was rinsed into a scintillation vial with a 70% ethyl alcohol solution. Each vial was individually emptied into a petri dish under a dissecting scope where the number of juvenile thrips and adult thrips were counted and recorded.

Plants from each jar were dried for 24 hours in a Thelco, Model 17 (Precision Scientific Co., Winchester, Va) drying oven at 65^0 C. At the end of the drying period the plants were removed from the oven and each plant was weighed. The cotyledonary leaves were then removed and the plants were weighed again. All weights were taken with a Precision Standard (OHAUS, Florham Park, NJ) scale.

The test design was a randomized complete block with 3 replicates and 4 treatments. Each block was a different bench within the greenhouse. The 4 treatments were the following: ST 474 plus western flower thrips, ST 474 plus tobacco thrips, DP 436 RR plus western flower thrips, and DP 436 RR plus tobacco thrips. Each treatment within a replicate was represented by eight subsamples (plants). Means of the eight subsamples were entered into the statistical analysis as replicates. All data were subjected to a two way analysis of variance ANOVA and Fisher's least significant differences (LSD) means separation test. These test were performed by Pesticide Research Manager (PRM, Gyllings, Inc).

Results and Discussion

Thrips Reproduction

Both thrips species successfully reproduced under the greenhouse environments utilized; mean numbers of juvenile thrips per plant were 36.90 and 23.97 for tobacco thrips and western flower thrips after 21 days, respectively (Table 1). The numerical differences in juvenile thrips between the two species were not significantly different suggesting that the reproductive potential of both species was equal on seedling cotton in the greenhouse environment. Adult numbers were relatively low upon termination of the test. Cotton variety did not have a significant effect on reproduction in either thrips species (Table 2). Juvenile thrips numbers per plant when combined and averaged over species were almost identical, 29.39 and 31.48 for ST 474 and DP 436, respectively.

Successful reproduction of both thrips species confirmed the validity of the greenhouse techniques employed to compare damage potential on seedling cotton. Furthermore, the adults to juvenile ratios approximate those observed in field experiments.

Plant Damage Evaluation

The October 29 damage rating (Fig. 1) revealed that cotton seedlings infested with western flower thrips had a significantly higher damage rating (3.68) than did seedlings infested with tobacco thrips (2.2). Similar results were observed on November 4 when seedlings that were infested with western flower thrips had a damage rating of 3.7 while seedlings that were infested with tobacco thrips had a damage rating of 2.8. Overall damage did not increase proportionally between October 29 and November 4 because greenhouse temperatures had been elevated to simulate temperature increases typical of field conditions. Thus, cotton seedling growth and seedling tolerance to thrips feeding increased at higher temperatures. There were no consistent effects of cotton variety on damage caused by either thrips species.

Effects of Thrips on Plant Dry Weights

Dry weights of cotton seedlings after a 21 day exposure were significantly affected by thrips species (Fig. 2). Western flower thrips significantly reduced seedling dry weight in comparison to tobacco thrips. The mean dry weight of cotton seedlings infested with western flower thrips was 155.1 mg whereas mean dry weight of seedlings infested with tobacco thrips was 196.2 mg. Similar relationships between thrips species and seedling dry weights were seen when plants were weighed after removal of cotyledon leaves. Cotton variety had no significant effect on dry weight values.

Summary

Reproductive potential of tobacco thrips and western flower thrips on cotton seedlings did not differ significantly in this greenhouse study, however, the damage potential of western flower thrips was much greater than that of the tobacco thrips. Thus, not only are numbers of thrips important, but the predominant species infesting a field may markedly impact the potential for damage. The observation that damage ratings did not increase for western flower thrips after the temperature regimes were elevated on October 28 documents the interaction between thrips damage and temperatures during the seedling period. Obviously cotton seedlings have increased tolerance to thrips feeding at higher post-planting temperatures as a result of accelerated growth. This same temperature effect on the damage potentials of thrips has been seen in the desert valleys of California where chemical applications for thrips control are rarely warranted due to consistently warm springs (Ellington *et al.* 1984). These results confirmed the importance of thrips species identification in studies that evaluate thrips management tactics and strategies.

Acknowledgements

We would to thank Russell Groves for the use of thrips from his colonies as well as helping in the design of this experiment.

Literature Cited

All, J. N., P. M. Roberts, G. Langdale, and W. K. Vencil. 1993. Interaction of cover crop, tillage, and insecticide on thrips populations in seedling cotton. Proc. Beltwide Cotton Conf. 1066-1067.

Bacheler, J. 1999. Thrips Pressure in 1999. Carolina Cotton Notes. North Carolina State University Cooperative Extension. http://cropsci.ncsu.edu/ccn/1999/ccn-99-6a.htm . CCN 99-6A.

Bowman, D. T., and J. C. McCarty, Jr. 1997. Thrips (Thysanoptera: Thripidae) tolerance in cotton: sources and heritability. J. Entomol. Sci. 32 (4): 460-471.

Burris, E. 1980. Observations on tobacco thrips (*Frankliniella fusca*) and soybean thrips (*Sericothrips variabilis*) damage to and control in cotton. Northeast La. Agric. Expt. Stn. Prog. Rept. 204-206.

Dunham, E.W. and J.C. Clark. 1937. Thrips damage to cotton. J. Econ. Entomol. 30: 855-857.

Ellington, J., A. G. George, H. M. Kempen, T. A. Kerby, L. Moore, B. B. Taylor and L. T. Wilson. 1984. Integrated pest management for cotton in the western region of the United States. University of California Agricultural and Natural Resources Publication 3305.

Faircloth, J. C., J. R. Bradley, Jr. and J. W. Van Duyn. The impact of thrips cotton productivity: what a difference a year makes. Proc. Beltwide Cotton Conf. 2: 976-978.

Gaines, J. C. 1934. A preliminary study of thrips on seedling cotton with special reference to the population, migration, and injury. J. Econ. Entomol. 27: 740-743.

Gawaad, A. A. A. and A. S. Soliman. 1972. Studies of *Thrips tabaci* (Lindeman) IX. Resistance of nineteen varieties of cotton to *Thrips tabaci* L. and *Aphis gossypii* G. Z. ang. Ent. 70: 93-98.

Herbert, Ames, Jr. 1998. Evaluation of thrips damage on maturity and yield of Virginia cotton. Proc. Beltwide Cotton Conf. 1177-1180.

Hightower, B.G. 1958. Laboratory study on the effect of thrips infestations on the height and weight of seedling cotton. J. Econ. Entomol. 51: 115-16.

Irwin, M. E. and K. C. Yeargan. 1980. Sampling phytophagous thrips in soybeans. IN Kogan and Herzog eds. Sampling methods in soybean entomology. Springer-Verlag, New York. 283-304.

Lewis, T. 1973. Thrips, Their Biology, Ecology, and Economic Importance. Academic Press, New York.

Newsom, L. D., J. S. Roussel, and C.E. Smith. 1953. The tobacco thrips, its seasonal history and status as a cotton pest. Louisiana Agric. Expt. Sta. Tech. Bull. 474 pp.

Robb, K. D. 1988. Analysis of *Frankliniella occidentalis* (Pergande) as a pest of floricultural crops in California Greenhouses. Ph.D. dissertation, University of California, Riverside.

Rummel, D. R., and J. E. Quisenberry. 1979. Influence of thrips injury on leaf development and yield of various cotton genotypes. J. Econ. Entomol. 72: 706-709.

Van Duyn, J., J. R. Bradley, Jr., A. L. Lambert, C. P. Suh, and J. C. Faircloth. 1998. Thrips management with Gaucho seed treatment in North Carolina cotton. Proc. Beltwide Cotton Conf. 1183-1185.

Watts, J. G. 1937. Reduction of cotton yield by thrips. J. Econ. Entomol. 30: 860-863.

Table 1. Mean number of adult and juvenile thrips per plant of each species at 21 days after infestation of cotton seedlings.

thrips species	mean # of juvenile thrips/ plant	mean # of adult thrips/plant
F. fusca	36.9 a	2.52 a
F. occidentalis	23.97 a	4.27 a

Means in the same column followed by the same letter are not significantly different, Fisher's LSD, ($P \leq 0.05$).

Table 2. Mean numbers of adult and juvenile thrips tobacco and western flower thrips per plant on two cotton varieties at 21 days after infestation.

cotton variety	mean # of juvenile thrips / plant	mean # of adult thrips / plant
ST 474	29.38 a	3.63 a
DPL 436	31.48 a	3.15 a

Means in the same column followed by the same letter are not significantly different, Fisher's LSD, ($P \leq 0.05$).

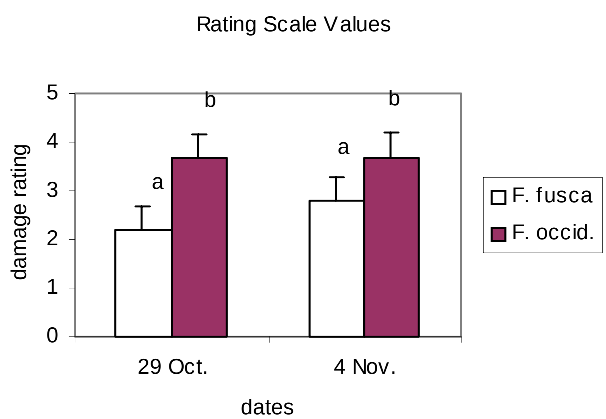

Figure 1. Mean ratings of damage to cotton seedlings by two thrips species at 14 and 21 days after infestation of cotton seedlings. The rating scale used ranged from 1-5 and is described as follows: 1= leaves with no apparent damage, 2= slight damage, 3= moderate damage, 4= severe damage, and 5= complete loss of true leaves. Means of the damage ratings from 29 October and 4 November followed by the same letter are not significantly different, Fisher's LSD, ($P \leq 0.05$).

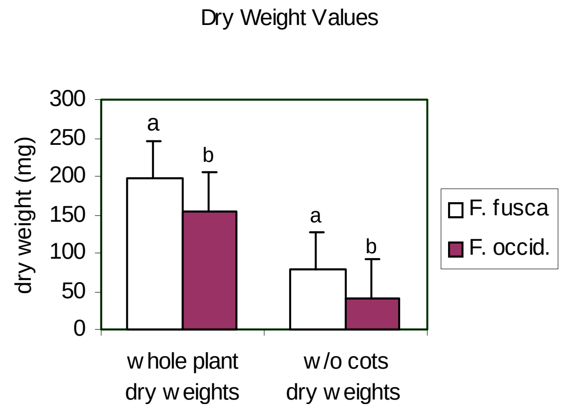

Figure 2. Mean biomass weights of cotton seedlings with and without cotyledon leaves after a 21 day exposure to tobacco and western flower thrips. Means of whole plant weight and means of whole plant weight minus cotyledons followed by the same letter are not significantly different, Fisher's LSD, ($P \leq 0.05$).