Influence of parasitism by *Thripinema fuscum* on dynamics of local populations of *Frankliniella fusca*

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Abstract: The importance of density dependent regulation of pest species of thrips by natural enemies has only recently gained recognition. Local populations of *Frankliniella fusca* within peanut (*Arachis hypogaea*) fields can build to very great levels, and epidemics of tomato spotted wilt virus are common. A parasitic nematode, *Thripinema fuscum*, was discovered in *F. fusca* in 1995. In subsequent years, we have monitored populations of *F. fusca*, the percent of thrips parasitized, and the incidence of tomato spotted wilt virus while varying aspects of production. In all circumstances declines in numbers of larval thrips were observed as parasitism of *F. fusca* by *T. fuscum* increased.

Introduction

Frankliniella fusca occurs in great numbers in cultivated peanut in the southeastern United States. As is characteristic of many thrips species, *F. fusca* rapidly colonizes the peanut crop and aggregates in the flowers. *F. fusca* is a vector of tomato spotted wilt, and epidemics of the disease in peanut fields have become common. Surveys for natural enemies of *F. fusca* in 1995 revealed a nematode commonly parasitizing female *F. fusca*. This nematode was described as a new species, *Thripinema fuscum* (Tipping et al. 1998).

Juveniles of *T. fuscum* develop within the host thrips, and female and male *T. fuscum* penetrate into the host's gut lumen, exit through the anus, and dwell briefly as a short-lived free-living stage in peanut flowers. Female nematodes enter new *F. fusca* by penetrating between the inter-segmental membranes of their hosts. Ovaries of parasitized *F. fusca* females are reduced, and eggs are absent, rendering such females sterile. Once in a new host, the female *T. fuscum* develops into the swollen shape typical of the genus (Tippping et al. 1998). In this form, only the ovaries and other reproductive structures of *T. fuscum* are visible. While 40-50 immature nematodes typically occur in each adult *F. fusca*, up to 200 have been observed per female *F. fusca* (Tipping et al. 1998).

Up to 80% of *F. fusca* females may be parasitized during the large population peaks of this species. In some years, parasitism was in the range of 55-65%, while in one year a maximum of 40% of *F. fusca* was observed to be parasitized (Funderburk et al. 2002; Funderburk, Stavisky, Momol, and Gorbet unpublished). *Thripinema fuscum* has been observed also at other times of the year, in *F. fusca* collected from wild host plants and other cultivated host plants, including winter wheat. Occasionally, *F. fusca* males have been observed to be infected with nematodes; other thrips species that are occasionally collected from peanut flowers including *Frankliniella occidentalis* and *Frankliniella tritici* were parasitized less than 2% of the time.

Several other species from the genus *Thripinema* have been described as obligate parasites of thrips, including *T. nicklewoodi* from North America, *T. khrustalevi* and *T. reniroai* from Asia, and *T. aptini* from Europe (Loomans et al. 1997). Other species are known from Chile and New Zealand. In general, each species of *Thripinema* demonstrates host specificity for a given thrips species. Lim et al. (2001) observed that *T. nicklewoodi* parasitizes male as well as female *F. occidentalis*, and that parasitism by *T. nicklewoodi* reduced adult *F. occidentalis* longevity. Further, *T. nicklewoodi* was more likely to attack and enter immature stages of *F. occidentalis* (Lim et al. 2001). Similar studies involving *F. fusca* and *T. fuscum* are currently underway (Sims and Funderburk, unpublished).

To evaluate the capacity of *T. fuscum* to regulate populations of *F.fusca* in peanut crops, we observed general trends in populations of *F. fusca* adults and larvae, the percent of *F. fusca* parasitized, and the incidence of tomato spotted wilt in peanuts. Further, seasonal trends in populations and disease as a function of planting date were investigated.

Materials and Methods

Large replicated field plots of peanut were established to assess from 1997 through 2000 the density of *F. fusca* adults and larvae, their parasitized status, and the incidence of tomato spotted wilt. In 1997 and 1998, peanuts from one planting date in mid-season were observed. In 1999 and 2000, peanuts were planted on 14 April, 13 May, and 14 June. In all 4 years, bi-weekly sampling was conducted, at which times 5 terminal buds and 5 flowers per plot were placed in alcohol, and larval and adult *F. fusca* were extracted and counted under a dissecting microscope. Further, 50 female *F. fusca* were aspirated from each plot, and placed in a vial containing a peanut leaf. These fresh samples were placed immediately into a cooler, then refrigerated until each thrips could be dissected, within 48 hours of sampling, in a 3% soapy water solution to detect nematode presence. Tomato spotted wilt incidence was assessed by visual observation of the middle rows of each plot on a bi-weekly basis, and the disease was verified using ELISA.

Results and Conclusions

Under all of the observed conditions, the number of larval thrips declined as parasitism of *F. fusca* by *T. fuscum* increased. As a result, the spread of tomato spotted wilt was reduced.

In 1997, adult parasitism increased from May through August, reaching a maximum of 63% on 11 August, occurring in conjunction with a decline in number of *F. fusca* larvae (Figure 1). This concurrent increase in parasitism and decline in larval numbers indicates that *F. fusca* reproduction declined as a result of the presence of the nematode parasite.

Tomato spotted wilt was first recorded infecting 10% of plants on 3 July 1997, reaching a maximum of 27% and plateauing by 11 August. The high levels of parasitism which were associated with suppression of larval populations of thrips during midseason reduced secondary spread of tomato spotted wilt (Funderburk et al. 2002). Results of experiments investigating the temporal changes in percent parasitism of *F. fusca* and tomato spotted wilt epidemiology in peanut as affected by insecticide treatments in 1997 and 1998 are further discussed by Funderburk et al. (2002).

Subsequent experiments were initiated in 1999 and 2000 to assess the seasonal occurrence of *F. fusca* in relation to peanut plant phenology. Peanuts were planted in mid-April, mid-May,
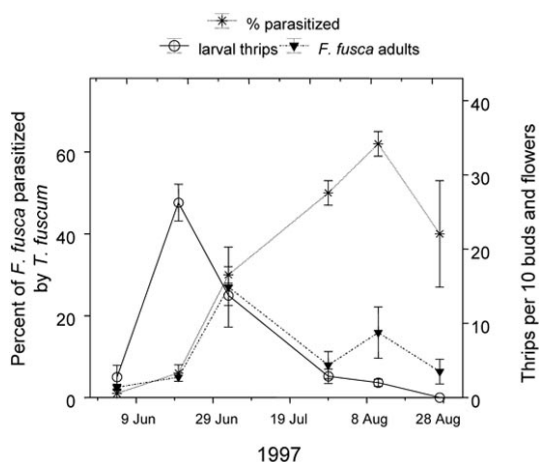

Figure 1. Mean percent (± SEM) of females of *F. fusca* parasitized by *T. fuscum* and mean number (± SEM) of larval and adult *F. fusca* in 10 terminal buds and flowers on peanuts in 1997.

and mid-June. In the April and May plantings in 1999, initial estimates of larval numbers were very great, with suppression observed in early July (Figure 2B). The percent of *F. fusca* adults parasitized was similar (45-60%) across planting dates (Figure 2A), leading to similar levels of suppression of larvae in the April, May, and June plantings by early August. The suppression of thrips populations was observed in peanuts regardless of planting date (Figure 2).

The number of adult *F. fusca* increased early in the season in 1999, and continued to increase through early July, while larval numbers were declining (Figure 2). Observations of adult population trends and rates of parasitism elucidate our understanding of thrips movement into plots of varying planting dates. Relatively low percent parasitism (25%) of *F. fusca* was observed in the June-planted peanut, while 70% were parasitized in the April planting on 7 July, indicating that parasitized *F. fusca* may disperse less than non-parasitized individuals. Further indication of this trend is provided by the observation that when parasitism was lowest in the May planting (15 July), *F. fusca* adults were at their greatest level (Figure 2). Studies investigating local movement of *F. fusca* involving use of mark and recapture techniques are confirming a lower dispersal rate of infected *F. fusca* (K. Ingram and J. Funderburk unpublished).
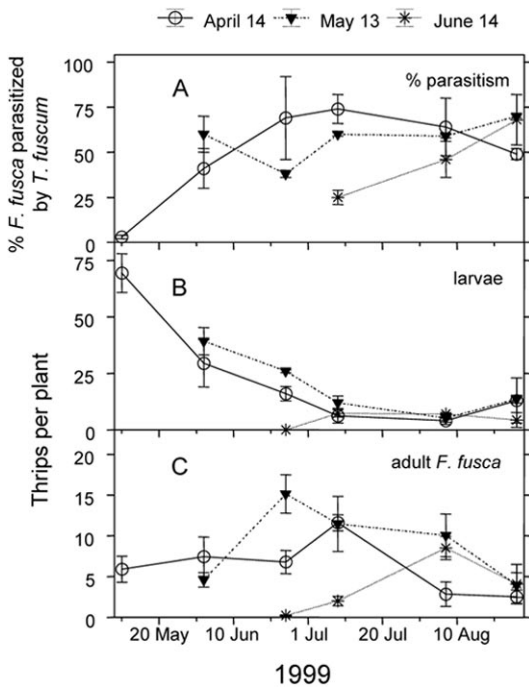
Figure 2. Mean percent (± SEM) of females of *F. fusca* parasitized by *T. fuscum* (A); mean number (± SEM) of larval (B) and adult (C) *F. fusca* per peanut plant in 1999.
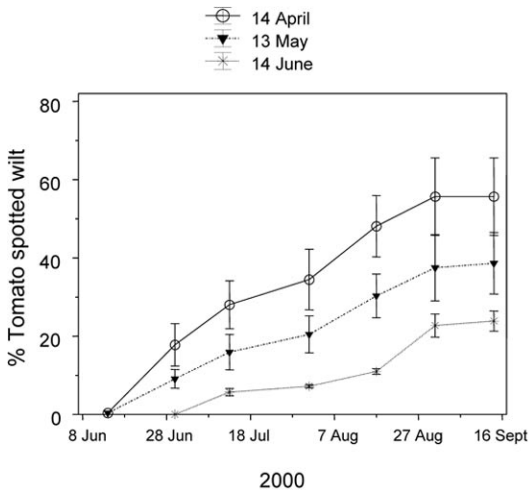
The effect of changes in populations of larval *F. fusca* on tomato spotted wilt epidemiology in 2000 is evident in Figure 3. During this season, the percent of parasitism dropped drastically in late July to less than 30% under conditions of unusually dry and hot weather (data not shown). A small buildup was seen in larval numbers following the drop in parasitism in all planting dates, which likely contributed to the late-season second cycle of disease incidence (Figure 3). Aside from the surge in larval numbers following the drop in percent parasitism, larval *F. fusca* were suppressed to the greatest extent in the peanuts planted in June (data not shown), which is reflected in the lowest incidence of tomato spotted wilt (Figure 3).

The impact of natural enemies on flower thrips populations has been difficult to measure, and the inaccessibility of thrips dwelling in flowers has been implicated as a possible cause. Nematodes of the genus *Thripinema* overcome this problem by dwelling within the thrips or as a brief free-living stage in flowers. Current investigations in Chile are revealing that *Thripinema* occur, and suppress thrips populations, under geographically and climatologically varied conditions (J. Funderburk and R. Ripa unpublished). Continued observations of flower thrips in native plants and crop hosts will further elucidate the importance of members of the genus *Thripinema* in thrips population regulation and in tospovirus epidemiology worldwide.

References

Funderburk JE, Stavisky J, Tipping C, Gorbet D, Momol T, and Berger R. 2002. Infection of *Frankliniella fusca* (Thysanoptera: Thripidae) in peanut by the parasitic nematode *Thripinema fuscum* (Tylenchidae: Allantonematidae). *Environmental Entomology* **31**, in press.

Lim UT, Van Driesch RG and Heinz K.M. 2001. Biological attributes of the nematode, *Thripinema nicklewoodi*, a potential biological control agent of western flower thrips. *Biological Control* **22**, 300-306.

Loomans AJM, Murai T and Greene ID. 1997. Interactions with hymenopterous parasitoids and parasitic nematodes, pp. 355-397. *In* T. Lewis [ed.], *Thrips as crop pests*. CAB, Wallingford, Oxon, UK.

Tipping C, Nguyen KB, Funderburk JE and Smart GC Jr. 1998. *Thripinema fuscum* n.sp. (Tylenchidae: Allantonematidae), a parasite of the tobacco thrips, *Frankliniella fusca* (Thysanoptera). *Journal of Nematology* **30**, 232-236.

Figure 3. Mean incidence (± SEM) of peanut plants infected with tomato spotted wilt in 2000.