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The Competitive Relation Between *Frankliniella occidentalis* and *Thrips tabaci*: The Impact on Life-cycle and Longevity

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Abstract: The duration of life-cycle (egg-adult) and the longevity of the female adults (in days) of two thrips species, *Frankliniella occidentalis* (Pergande) and *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) on cucumber and tomato plants were studied, under controlled conditions. Research indicated that, life-cycle of the two thrips species did not differed significantly between cucumber and tomato plants, while longevity of female adults of *F. occidentalis* is longer in comparison to *T. tabaci* in both plants examined and both species lived longer on cucumber plants in comparison to tomato plants. In mixed colonies of the two species, there were found significant differences in longevity of female adults, indicating that *Frankliniella occidentalis* may reduced longevity of *Thrips tabaci* in a kind of a competitive behavior and this was related to the host-plant and initial thrips population.

Key words: *Frankliniella occidentalis*, *Thrips tabaci*, competition, longevity, life-cycle

Introduction

The western flower thrips, *Frankliniella occidentalis* (Pergande) and onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), are major pests of glasshouse crops worldwide (Broadbent *et al*., 1987; Mandel and van de Vrie, 1988; van Lenteren and Woets, 1988).

In Greece, the two polyphagous thrips species are common and they can develop in great populations in the greenhouse crops and therefore, they cause important damages. They colonize the host-plants on an annual basis and may have five to eight generations per year. To develop control strategies for these thrips species, it is essential to obtain detailed information on its bionomies. These must be obtained under controlled conditions that enhance modeling of the different and often sub-optimal abiotic environments, which thrips experience during the different phases of plant production in greenhouses. Several studies have been conducted on the bionomics of *F. occidentalis* and *T. tabaci* on different host plants in relation to different temperatures (Harris *et al*., 1936; Sakimura, 1937; Bryan and Smith, 1956; Lall and Singh, 1968; Gawaad and Shazli, 1969a,b; Lublinkhof and Foster, 1977; Trichilo and Leigh, 1988; Bene and Gargani, 1989; Robb, 1989; Bunte *et al*., 1990; Mollema *et al*., 1990; Lowry *et al*., 1992; Brodsgaard, 1994). These researchers showed that temperature can cause great differences in developmental time and reproduction and that the host plant, mainly in the presence of pollen, has an important influence on thrips reproduction. Also, the quality of food decreased the time interval from egg to adult and resulted in increased fecundity and longevity.

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F. occidentalis and other species of the genus *Frankliniella* are considered partially zoophagous or phytozoophagous (Andjus *et al*., 2001). They were found actively feeding on mite eggs in May-June but when flowering began, they moved onto the flowers and population trends were then most closely associated with flowering patterns, rather than mites (EMPPO, 1988). The omnivorous thrips species *F. occidentalis*, eats both animal prey and plant foliage. In the presence of mite eggs, adult and larval thrips consumed nearly half the amount of plant tissue as did thrips without prey (Agrawal *et al*., 1999). Variation in host plant quality and availability of prey can exert a strong influence on the feeding preferences of omnivores (Agrawal *et al*., 1999; Agrawal and Klein, 2000). Attack habits of *F. occidentalis* were recorded many times (Agrawal *et al*., 1999; Andjus *et al*., 2001) and interaction between *F. occidentalis* and Florida flower thrips (*F. bispinosa*) was studied on pepper plants (Northfield *et al*., 2004) indicating a kind of competition between thrips species.

The main objective of this study was to estimate the biological cycle (egg-adult) and longevity of female adults of *F. occidentalis* and *T. tabaci* on cucumber and tomato plants under controlled conditions. Additionally, there was an estimation of possible competitive action between the two thrips species in mixed colonies.

Materials and Methods

From July till August 2002 both cucumber (*Cucumis saticus* L., F_1 Kamaron) and tomato (*Lycopersicon esculentum* M., F_1 Arletta) plants were developed in greenhouse into small pots (12×10 cm), using substrate of the type Humosoil 801, covered with plastic cylindrical cages (12×40 cm). The cages had openings (0.06 mm in diameter) for ventilation. By the development of the first real leaf, the plants were transferred under controlled conditions [temperature 25°C, relative humidity 65%, 14:10 h (L:D) and intensity of light 9000 lux]. All plants were irrigated and fertilized according as recommended.

The first part of the study was conducted for *F. occidentalis* on 5 cucumber and 5 tomato plants, while the same was done for *T. tabaci*. We used 20 plants in total, 10 cucumber and 10 tomato. Each plant repetition (cucumber-tomato) was infected by 10 female adults (one day old) from each thrips species, which were collected from rearing. Thrips observation was taking place every day in the morning (08:00 am) using a stereoscope to so ascertain the date of oviposition.

The second part of the study was conducted using mixed colonies of female adults from both species. On 5 cucumber and 5 tomato plants there were placed 5+5 female adults (one day old) from both *F. occidentalis* and *T. tabaci*. On another set of 5 cucumber and 5 tomato plants there were placed 10+10 female adults (one day old) from both thrips species. Thrips observation was taking place every day in the morning (08:00 am) using a stereoscope to ascertain the date of oviposition. The number and site of eggs set every day was counted and flagged by means of a paper sheet, where oviposition sites were marked. This was important in order to distinguish between the eggs and larvae of the two thrips species, monitoring new larvae by the date and site of oviposition, in reference to the original egg.

Finally, the larvae were placed in plastic phials (1,5×5 cm) on a piece of leaf (4×1 cm) of the correspondent host-plant, which was renewed every day until the development of adults, to estimate the duration of life-cycle (egg-adult). For the statistical analysis, 50 eggs were used from each thrips species within each treatment, while the original female adults used, were studied until their death in order to determine longevity.

The statistical analysis was based on factorial ANOVA, with two main factors: thrips species (in separate and mixed colonies) and host-plant species, as described by Snedecor and Cochran (1980).

Table 1: Duration of mean life-cycle (egg-adult) in days of *F. occidentalis* and *T. tabaci* on cucumber and tomato plants at 25°C, in separate (10+0 and 0+10) and mixed populations (5+5 and 10+10 adults of both thrips species)

Adults:	10+0		0+10	5+5		10+10	
Host-plant	*F. occidentalis*	*T. tabaci*	*F. occidentalis*	*T. tabaci*	*F. occidentalis*	*T. tabaci*	
Cucumber	14.62±0.11	14.71±0.12	14.65±0.11	14.72±0.11	14.64±0.12	14.69±0.13	
Tomato	14.72±0.11	14.76±0.12	14.71±0.11	14.75±0.11	14.69±0.12	14.74±0.13	

Table 2: Mean longevity (in days) of the female adults of *F. occidentalis* and *T. tabaci* on cucumber and tomato plants at 25°C, in separate (10+0 and 0+10) and mixed populations (5+5 and 10+10 adults of both thrips species)

Adults:	10+0		0+10	5+5		10+10	
Host-plant	*F. occidentalis*	*T. tabaci*	*F. occidentalis*	*T. tabaci*	*F. occidentalis*	*T. tabaci*	
Cucumber	34.93±0.13	26.48±0.11	35.75±0.14	25.92±0.12	35.04±0.12	23.89±0.13	
Tomato	31.98±0.16	24.01±0.12	33.41±0.16	22.95±0.12	32.52±0.14	20.02±0.13	

Results

The analysis of the results indicated that the duration of the life-cycle (egg-adult) between the thrips species (in separate and mixed populations) on cucumber and tomato plants, respectively did not differed significantly (Table 1). The life-cycle for *F. occidentalis* was found between 14.62 and 14.72 days and for *T. tabaci* between 14.69 and 14.76 days.

The statistical analysis of the results of longevity (in days) of the female adults of *F. occidentalis* and *T. tabaci* (in separate and mixed populations) on cucumber and tomato plants showed statistically significant differences ($p<0.05$) between and within all factors (Table 2). Longevity of *F. occidentalis* showed significant differences between cucumber and tomato in all cases and the same was found for *T. tabaci*. Longevity of *F. occidentalis* was always greater in comparison to *T. tabaci*. In mixed populations there was a tension for decreasing longevity of *T. tabaci*, especially on tomato and in greater initial population (10+10 individuals from each species).

Discussion

The results indicated that the host plant did not influence the biological cycle from egg to adult for both thrips species. Comparing data of our study (Table 1) to these of other studies (Table 3) that refer to the duration of life-cycle of *F. occidentalis* and *T. tabaci* (Harris *et al*., 1936; Sakimura, 1937; Lall and Singh, 1968; Gawaad and Shazli, 1969a,b; Arzone *et al*., 1989; Robb, 1989; Bunte *et al*., 1990; Robb and Parrella, 1991; Lowry *et al*., 1992; Brodsgaard, 1994; Gerin *et al*., 1994), we conclude that they are generally in agreement, with only slight differences. These differences may be attributed to different conditions of thrips growth, the host plant and the different feeding method.

Also, by comparing the results of longevity of the female adults of *F. occidentalis* and *T. tabaci* (Table 2) with similar results of other studies (Table 3), great differences were detected. These differences are related to the different feeding conditions of thrips and the different feeding method. The higher values of *F. occidentalis* compared to these of *T. tabaci*, may be related to the fact that *F. occidentalis* needs adequate food quantities for a longer period to accomplish development. On the other hand, the higher longevity values of female adults for both thrips species observed in cucumber than in tomato may be related to the quality of nutrition (host-plant preference referred by Deligeorgidis *et al*., 2005, 2006) and the resistance of cucumber. However, further studies are required in order to better understanding the biology of both thrips species. General descriptive biology is well

Table 3: Several life history parameters of *F. occidentalis* and *T. tabaci* in different conditions and plants

Host plant	Temp. (°C)	L:D (h)	(% RH)	Egg to adult cycle (days)	Adult female longevity (days)	Source
F. occidentalis						
Chrysanthemum	25	-	55±5	15-16	~15	Arzone *et al.* (1989)
Chrysanthemum leaves+pollen	25	14:10	45-55	12.9	31.4	Robb (1989)
Bean leaves	25	16:8	-	12.4	13.2	Bunte *et al.* (1990)
Chrysanthemum	25	-	-	26.86	12.91	Robb and Parrella (1991)
Peanut	25	14:10	-	13.8	2.33	Lowry *et al.* (1992)
French bean	25	16:8	43	14.08	14.2	Gerin *et al.* (1994)
Bean	25	16:8	~100	13.2	10.8	Brodsgaard (1994)
T. tabaci						
Various	25	-	-	16.1	-	Harris *et al.* (1936)
	30	-	-	11.2	19.9	
Onion	mean	-	-	-	max	Sakimura (1937)
	21				59	
Onion	mean	-	mean			Lall and Singh (1968)
	23.4	-	54.4	16.0	20.1	
	22.0	-	60.6	17.5	19.7	
Castor oil	22	-	65-70	-	18.7	Gawaad and Shazli (1969a)
Green leaves						
onion bulbs	25	-	70	13.9	-	Gawaad and Shazli (1969b)
Castor oil	25	-	70	13.3	-	Gawaad and Shazli (1969b)
Garlic bulbs	25	-	70	19.9	-	Gawaad and Shazli (1969b)
Stored						
onion bulbs	25	-	70	18.6	16.0	Gawaad and Shazli (1969b)
New onion bulbs	25	-	70	18.7	15.3	Gawaad and Shazli (1969b)

documented for many thrips species and the temperature-dependent duration of developmental period of thrips is a known phenomenon (Lewis, 1973; Ananthakrishnan, 1984). However, studies regarding a specific thrips species e.g., *F. occidentalis* and *T. tabaci*, are not often referred in the relative literature, although cucumber and tomato are economically important plants. A few studies concerning the life history of *F. occidentalis* and *T. tabaci* in a narrow spectrum of host plants at 25°C are available, as shown in Table 3.

From the above mentioned data, we conclude that life-cycle of *F. occidentalis* and *T. tabaci* independently did not differ on both plant species (cucumber-tomato), while the longevity of the female adults differed significantly.

The factorial analysis involving longevity of adults revealed great and significant differences between and within all factors. In mixed populations there was a tension for decreasing longevity of *T. tabaci*, especially on tomato and in greater initial population (10+10 individuals from each species). This indicated that *F. occidentalis* may caused a decrease in longevity of *T. tabaci* in a kind of a competitive behavior. Considering that attack habits of *F. occidentalis* were recorded many times (Agrawal *et al*., 1999; Andjus *et al*., 2001) and a kind of competition between *F. occidentalis* and Florida flower thrips (*F. bispinosa*) was found on pepper plants (Northfield *et al*., 2004), we concluded that this kind of action may also occur between *F. occidentalis* and *T. tabaci*. *F. occidentalis* is larger than *T. tabaci* and may frighten the smaller adults of *T. tabaci*. Additionally, *F. occidentalis* needs more food for its growth and may competes *T. tabaci* especially on tomato plants. Tomato plants are less preferred than cucumber plants (Deligeorgidis *et al*., 2005, 2006) and *T. tabaci* showed a significant decrease in longevity in tomato treatments. This was more apparent in larger initial population (10+10 thrips individuals, instead of 5+5 thrips individuals).

Concluding, *T. tabaci* adults' longevity was influenced by *F. occidentalis*, the host-plant and the initial thrips population. The kind of competition found needs more investigation, in order to determine the exact competitive action (direct attack, frightening, or competition for food) and the stage, during which this action is taking place (preoviposition, oviposition or postoviposition period). It is possible that, this action is taking place during preoviposition period or until early oviposition, with direct impact on the duration of oviposition and postoviposition and finally the longevity of *T. tabaci* adults.

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