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Comparison of predatory effect of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) and *Orius tristicolor* (White) (Hemiptera: Antocoridae) on *Drepanothrips reuteri* Urel and *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae)

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Abstract

The purpose of the present study was to explore predatory effect of *Coccinella septempunctata* L. and *Orius tristicolor*, on vines' thrips species, *Drepanothrips reuteri* Uzel and *Frankliniella occidentalis* (Pergande). Each predator species was fed separately by the two prey species in order to avoid interactions (Deligeorgidis et al., 2013). One single female predator corresponded to a prey number of 10, 20, 30 and 40 individuals per treatment and survivor of prey was counted. At this stage, the initial cage where thrips were fed, was removed carefully and replaced by dense muslin cloth, binding each treatment on vines and trapping the upper vine leaf. Eight replications were used for each treatment. *C. septempunctata* killed more *D. reuteri* individuals than *F. occidentalis* (20.625 vs 19.938). Also, *O. tristicolor* killed more *D. reuteri* individuals than *F. occidentalis* (19.719 vs 19.156). Effective predation was decreasing as it is clearly seen, when prey numbers ratio increased. Both predators showed no indications of hanger satiation until the predator/prey ratio 1/40. *C. septempunctata*, were more effective predator than *O. tristicolor*.

Keywords: effective predation, consumption, insects

Introduction

Thysasoptera since the 18th century are considered very important enemies causing economic damages on various cultivations (Marsham, 1796; Curtis, 1860; Osborn, 1888; Froggatt, 1906). Their main representatives, thrips species (Thripidae), may harm flowers, leaves, fruits etc. directly by feeding or indirectly (Alford, 2007). Indirect damages involve their eggs or disease spreding (Pittman, 1927; Hansen, 1929; Bald et al., 1931; Smith, 1957). *Drepanothrips reuteri* Uzel and *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), are widespread enemies of many cultivations, involving vines (Bournir, 1957; Bailey, 1957; Jensen, 1973; Yokoyama, 1977). These species are different in the appearance and the adult size, with different behavior and biology (Parker et al., 1995). Such serious enemies are controlled by insecticides or better by biological enemies (Machar *et al*., 2012), especially by other insects acting as predators (Ogurlu, 2000). Predatory effect capabilities of such predators are essential for controlling thrips or other prey populations (Deligeorgidis, 2000; Deligeorgidis et al., 2005a, 2005b).

The main families used as predators are Anthocoridae, Chrysopidae, Coccinellidae or Hemerobiidae (Onillon, 1990). Coccinellidae are the most common predators for aphids, thrips and whiteflies (Gerling, 1990; Holmer et al., 1993; Deligeorgidis et al., 2005a, 2005b; Mari et al., 2005; Solangi et al., 2005). *Coccinella septempunctata* L. and *Adalia bipunctata* L. (Coleoptera: Coccinellidae) species are considered the most useful (Gordon, 1985; Obrychi et al., 1998; Iperti, 1999; Deligeorgidis et al., 2005a, 2005b; Omkar and Pervez, 2005). Anthocoridae (order: Hemiptera), like *Orius insidiosus* Say, are also useful against aphids, thrips and acarea (Isenhour and Yeargan, 1981; Bugg, 1987; Van de Veire and Degheele, 1995; Pumarino et al., 2012; Wong et al., 2013; Nemec et al., 2016; Tran et al., 2016; Bernardo et al., 2017; Bannerman et al., 2018), *Orius niger* (Wolff) against thrips species (Deligeorgidis, 2002) and *Orius tristicolor* (White) (Higgins, 1992).

The purpose of the present study was to explore predatory effect of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) and *Orius tristicolor* (Hemiptera: Anthocoridae), on vines' thrips, *Drepanothrips reuteri* Uzel and *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae).

Materials and Methods

The two predator species were *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) and *Orius tristicolor* (Hemiptera: Anthocoridae), on the prey species *Drepanothrips reuteri* Uzel and *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), two harmful species of vineyards. The experiment was conducted in the region of Larissa, Greece (mean temperature 27 ± 3 ^{o}C and mean relative humidity 68 ± 3%), under field conditions and normal day light.

Initially, the two thrips species were fed on young vine leaves (*Vitis vinifera* L.) in the vineyard, in special cages covered by muslin, where leaves were provided constantly. The cage dimensions were 15 × 10 × 7 cm. The predators were introduced into the cages in order to estimate predatory effect. Each predator species was fed separately by the two prey species in order to avoid interactions (Deligeorgidis et al., 2013).

One single female predator corresponded to a prey number of 10, 20, 30 and 40 individuals per treatment and survivor of prey was counted. At this stage, the cage was removed carefully and replaced by dense muslin cloth, binding each treatment on vines and trapping the upper vine leaf. Eight replications were used for each treatment and a control cage with absence of predators was also used for the two prey species, where no mortality was observed. The adult female predators were starved for 24h before the introduction into the cages. Experimental application, and model implementation were based on Deligeorgidis et al. (2005a, b; 2011). After this stage which lasted for one day, upper leaves were cut off the vines in order to count thrips survival after predator attacks.

Results and Discussion

Killed prey data are presented in Tables 1 and 2. *C. septempunctata* killed more *D. reuteri* individuals than *F. occidentalis* (Means 20.625 and 19.938 respectively, in Table 1). Also, *O. tristicolor* killed more *D. reuteri* individuals than *F. occidentalis* (Means 19.719 and 19.156 respectively, in Table 2). Effective predation was decreasing as it is clearly seen, when prey numbers ratio increased. In 1/10 ratio, no prey managed to escape and all thrips individuals were consumed. Figures 1 and 2 present the predation models, where it is clearly shown a linear model with high correlation coefficients (r over 0.97 and close to 1, statistically significant at 0.01).

The equations describing predatory effect of *C. septempunctata* on *D. reuteri* and *F. occidentalis* were: $y = 0.725x + 2.5$ and $y = 0.713x + 2.125$ correspondingly. The model was linear in both cases indicating high efficiency without any indication of hanger saturation or successful escapes, according to Deligeorgidis et al. (2005a,b; 2011) who presented the main parameters for efficient predation, like individual escaping and hanger that is satisfied depending on the predator/prey ratio (Losey and Denno, 1998). The equations describing predatory effect of *O. tristicolor* on *D. reuteri* and *F. occidentalis* were: $y = 0.711x + 1.938$ and $y = 0.701x + 1.625$. They were also linear and with high correlation coefficients. Some differences in size and behavior between the two thrips species may explain the differences in effective predation (Deligeorgidis et al., 2005a, b; 2011).

Table 1. Predatory effect of adult female *C. septempunctata*, on *D. reuteri* and *F. occidentalis*, in field trials

Predator /prey ratio	***Drepanothrips reuteri***										***Frankliniella occidentalis***									
	Replications/prey consumed								**Total**	**Mean**	**Replications/prey consumed**								**Total**	**Mean**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
1/10	10	10	10	10	10	10	10	10	80	10±0	10	10	10	10	10	10	10	10	80	10±0
1/20	18	16	18	17	16	17	17	17	136	17± 0.27	15	17	16	16	15	15	16	16	126	15.75± 0.25
1/30	23	25	24	22	23	24	24	23	188	23.5± 0.33	21	23	23	22	21	23	24	23	180	22.5± 0.38
1/40	31	32	32	32	32	33	32	32	256	32± 0.19	31	32	31	32	32	31	32	31	252	31.5± 0.19
										20.625										19.938

Table 2. Predatory effect of adult female *O. tristicolor*, on *D. reuteri* and *F. occidentalis*, in field trials

Predator /prey ratio	***Drepanothrips reuteri***										***Frankliniella occidentalis***									
	Replications/prey consumed								**Total**	**Mean**	**Replications/prey consumed**								**Total**	**Mean**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
1/10	10	10	10	10	10	10	10	10	80	10±0	10	10	10	10	10	10	10	10	80	10±0
1/20	15	16	15	15	16	16	15	15	123	15.375± 0.18	15	14	14	15	14	13	15	14	114	14.25± 0.25
1/30	22	22	21	23	22	21	23	22	176	22±0.27	20	21	23	21	21	22	21	22	171	21.375± 0.32
1/40	31	32	32	31	31	32	32	31	252	31.5± 0.19	31	32	31	31	32	30	30	31	248	31±0.27
										19.719										19.156

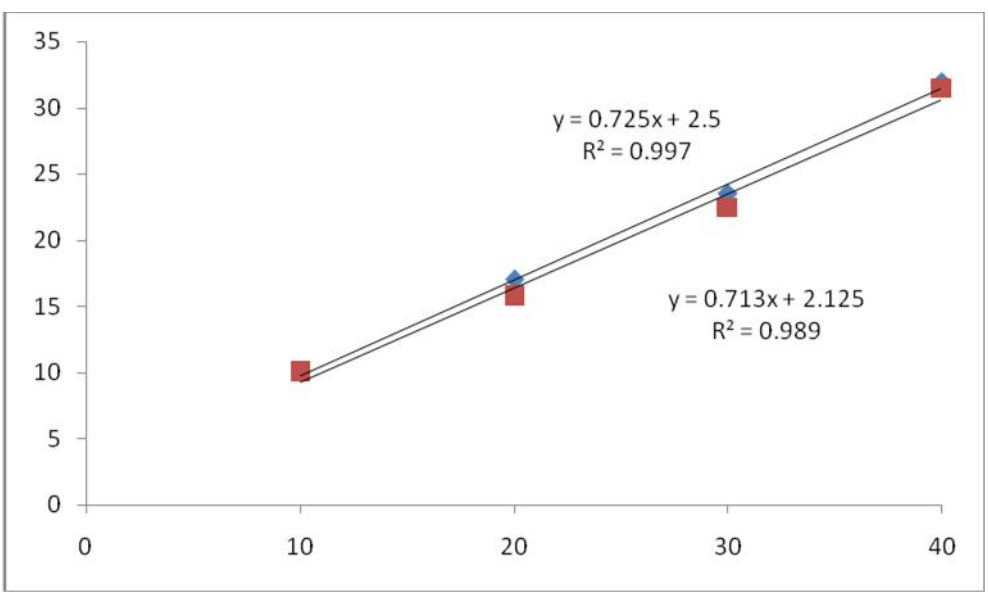

Figure 1. Mean predatory effect of adult female *C. septempunctata*, on *D. reuteri* and *F. occidentalis*, in field trials. Linear model adapted from Deligeorgidis et al. (2005a, b)

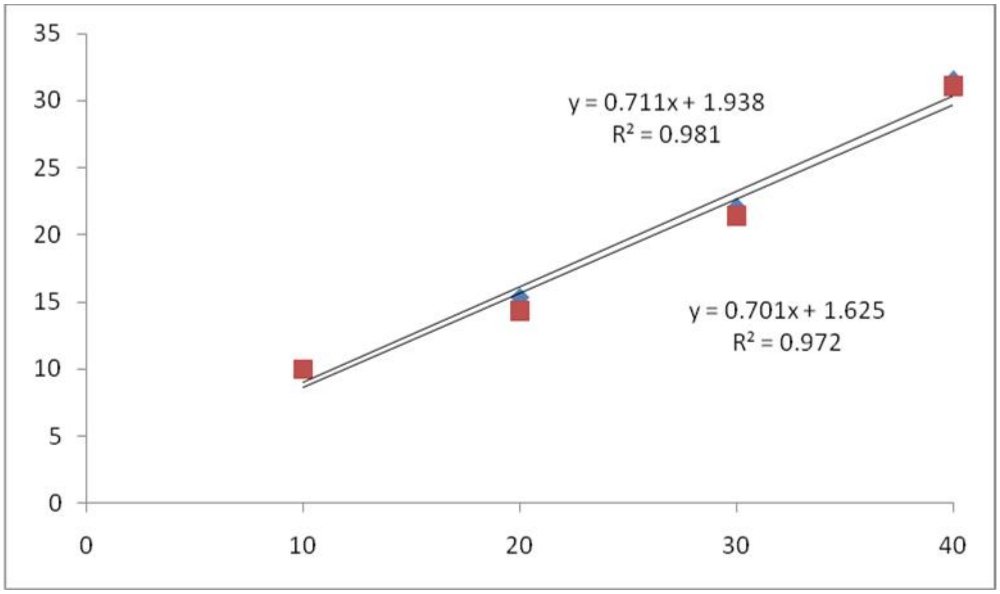

Figure 2. Mean predatory effect of adult female *O. tristicolor*, on *D. reuteri* and *F. occidentalis*, in field trials. Linear model adapted from Deligeorgidis et al. (2005a, b)

Comparing these equations, the slops (a-values) in the case of *C. septempunctata* were greater indicating the higher level of predation. Effective predation of *C. septempunctata* is ensured by the greater numbers of prey individuals consumed (Deligeorgidis et al., 2005a,b; 2011). Similar results to our study were recently reported by Stavridis et al. (2018) and Deligeorgidis et al. (2019), without any obvious hanger satiation by predators at the predator/prey ratios used.

Concluding, both predators showed no indications of hanger satiation until the predator/prey ratio 1/40. They were both efficient predators since many prey individuals were killed. *C. septempunctata* was the most effective predator. Effective predation was more intense in the case of *D. reuteri*.

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