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Interaction of *Aeolothrips intermedius* and *Orius niger* in Controlling *Thrips tabaci* on Potato

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ABSTRACT

Aeolothrips intermedius (Bagnall) and *Orius niger* (Wolff) feed on larvae-I-II and adults of the onion thrips (*Thrips tabaci* Lind.) in the potato fields of Ardabil region. Predation by *O. niger*, one female and one nymph-V and *A. intermedius*, three adults and three larvae-II, was determined in the separated and combined uses at three densities of larvae-II onion thrips with a aim to investigate the additive effect and intraguild predation of *O. niger* and *A. intermedius* in the combined uses and compared with the separated uses at three densities of prey. In the separated uses *O. niger*, one female and one nymph-V, consumed more prey than *A. intermedius*, three adults and three larvae-II, at three densities of prey. Predation in the combined uses of *O. niger* and *A. intermedius* at the 50 and 100 prey densities were higher compared to the separated uses of each predator alone. These results indicated that at the 50 and 100 prey densities, additive effects were occurred on the mortality of prey when two predators were used synchronously. Whereas predation in the combined uses of *O. niger* and *A. intermedius* at the 10 prey density, were not higher than the separated uses of each predator alone. Interaguild predation of *O. niger*, female and nymph V, on *A. intermedius*, adults and larvae-II, were observed also at the 10 prey density. The combined uses of *O. niger* and *A. intermedius* at high population density of onion thrips compare to low density can be successful in biological control of this pest.

Key Words: Interaction; *Aeolothrips intermedius; Orius niger; Thrips tabaci;* Predation; Potato

INTRODUCTION

Onion thrips (*Thrips tabaci* Lindeman) is a major pest of many crops, which transmit TSWV on damaged plants (Van Rijn *et al*., 1995; Theunissen & Schelling, 1997; Jones, 2005). Its genetic elasticity has enabled it to develop resistance to almost every insecticide applied in the field (Lewis, 1997). Therefore using resistant plants, sticky traps and natural enemies for control of thrips can be useful (Alimousavi *et al*., 2007; Ranamukhaarachchi & Wickramarachchi, 2007).

In the potato fields of Ardabil region, onion thrips is the most frequently found alongwith *Aeolothrips intermedius* (Bagnall) and *Orius niger* (Wolff) as major predators of onion thrips and it is found that they feed on larvae-I-II and adults of onion thrips on potato. Therefore *O. niger* and *A. intermedius* could be good candidates for biological control of onion thrips on potato.

Specific studies on the predation rates of *O. niger* and *A. intermedius* in singly and combined use at different densities of onion thrips are limited in scientific literature. *Orius* species have been proven as effective predators when used for the biological control of onion thrips and *Frankliniella occidentalis* (Pergande) (Van De Viere & Degheele, 1992; Dissevelt *et al*., 1995; Deligeorgidis, 2002; Tommasini & Nicoli, 2002; Blaeser *et al*., 2004). Also Adults and larvae I-II of *A. intermedius* were found as predator of thrips species specially *F. occidentalis* and onion thrips (Bournier *et al*., 1978 & 79; Lacasa *et al*., 1982; Torres-Vila *et al*., 1994; Riudavets, 1995).

Frequently, *Orius* species were used in combination with the predatory mites in biological control of thrips (Gillespie & Quiring, 1992; Sanchez *et al*., 1997; Fejt & Jarosı´k, 2000; Shipp & Wang, 2003). The impact of these combinations on thrips biological control was narrow mainly, because *Orius* species not only prey on thrips but also on predatory mites, that is intraguild predation.

In this study, we tested the hypothesis that intraguild predation and additive effect are present among *O. niger*, one female and one nymph-V and *A. intermedius*, three adults and three larvae-II, in the separated and combined uses for the biological control of the onion thrips at three densities. Also we assessed that *A. intermedius* subjects to predation by *O. niger* at three densities of prey. These results can be useful in biological control of onion thrips by two predators, *O. niger* and *A. intermedius*, in the potato fields.

MATERIALS AND METHODS

Collecting and rearing of prey and predators. Onion thrips was collected from the potato fields and reared on

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bean plants (*Phaseolus vulgaris* L.) in greenhouse at the University of Mohghegh Ardabili in 2007. Larvae-II onion thrips (two day old) was collected from infested leaves and were used for experimental tests.

A. intermedius was collected from the potato fields and reared on bean plants infested to onion thrips inside jars 4 L sized and soil substrate. Top of the jars were covered with silk screen in order to ventilation. Adults and larvae-II *A. intermedius* (two day old) were collected and used for experimental tests.

O. niger was the most difficult species to rear, therefore immature stage of *O. niger* was collected from the potato fields and then reared in transparent Plexiglas cylinders cage (12 cm high & 7 cm diameter) with one leaf and one sheath of bean plant, which was infested with larvae of onion thrips. New prey was added daily for immature stage of *O. niger* into cage. Females and nymph-V of *O. niger* (two day old), emerged from rearing units, were used for experiments. All rearing units were kept at 25±1^{o}C, 50±5% rh. and 16:8 (L:D) photoperiod.

Experimental setup. Female or nymph-V of *O. niger* are larger than larvae-II or adult of *A. intermedius*, so one female or nymph-V of *O. niger* consumes more prey than one larvae-II or adult of *A. intermedius*. Therefore predation was determined per one female and one nymph-V *O. niger*, three adults and three larvae-II *A. intermedius* in the separated and combined uses in the laboratory at 25±1^{o}C, 50±5% rh. and 16:8 (L:D) photoperiod.

Predation in the separated uses of predators (1) one female *O. niger*; (2) one nymph-V *O. niger*; (3) three adults *A. intermedius* and (4) three larvae-II *A. intermedius* at three densities of prey, 10, 50 and 100, per cage were investigated. Each treatment was replicated 10 times.

Predators combination tests established in 4 pairwise of two predators: (1) one female *O. niger*+three adults *A. intermedius*; (2) one female *O. niger*+three larvae-II *A. intermedius*; (3) one nymph-V *O. niger*+three adults *A. intermedius*; and (4) one nymph-V *O. niger*+three larvae-II *A. intermedius* and in three densities of prey, 10, 50 and 100, for each pairwise. Each treatment was replicated 10 times. In both separated and combined use experiments, predators were separated by two day old, then starved for 24 h and finally added into transparent Plexiglas cylinder cages containing determined prey densities,10, 50 and 100. Also in the combined uses, additive effects and intraguild predation were calculated based on the mean predation of *O. niger* in the separated uses by the following formulas. Because, it was found that *Orius* spp. fed on herbivore and predatory thrips (Lattin, 1999).

IGP%= A*100/3 (a)

Where IGP% is percentage of intraguild predation, A is the number of *A. intermedius* (Adult or larvae) eaten by *O. niger* and 3 is the number of *A. intermedius* (Adult or larvae) at the start of experiment.

Additive effect (%) = ((T-O)*100)/A (b)

Where T is the total number of prey eaten by the combined uses at defined density and O and A are the mean number of prey eaten by *O. niger* and *A. intermedius*, respectively at same defined density.

Statistical analysis. Prior to analysis, data of predation in the separated and combined uses were log transformed to meet the assumptions of normality and homogeneity of variances. Then data of both experiments, the separated and combined uses, were conducted in factorial design analysis of variance (PROC ANOVA, SAS Institute, 1999). The LSD value (P=0.05 and 0.01) was calculated for comparison of means in both experiments.

RESULTS

In the separated uses, predation of *O. niger*, one female and one nymph-V and *A. intermedius*, three adults and three larvae-II, during 24 h are presented in Table I. *O. niger*, one female and one nymph-V, consumed significantly more prey than *A. intermedius*, three adults and three larvae-II, at three densities of prey (P=0.01). Predation by one nymph-V *O. niger* was lower than one female at three densities of prey, so that these differences were significant at P=0.05 and 0.01. Also prey consumed by three larvae-II *A. intermedius* was lower significantly compare to the three adults at each defined prey density (P=0.05 & 0.01). One female and one nymph-V *O. niger* consumed significantly more prey at the 50 and 100 prey densities compare to the 10 prey density (P=0.01). Also prey consumption by three adults and three larvae-II *A. intermedius* at 50 and 100 prey densities were higher significantly than the 10 prey density (P= 0.05).

In the combined uses of *O. niger* and *A. intermedius*,

Table I. The means (±SE) of prey consumed per one female and one nymph-V *O. niger* and three adults and three larvae-II *A. intermedius* at three densities of prey by the separated uses

Prey	*O. niger*		*A. intermedius*	
density	One female	One nymph-V	Three adults	Three larvae-II
10	9.4 ± 1.94	9.1 ± 1.87	8.1 ± 1.77	7.7 ± 1.82
50	16.63 ± 7.4	12.27 ± 7.16	8.73 ± 1.97	7.91 ± 1.96
100	16.89 ± 5.17	14.44 ± 6.65	8.89 ± 2	8.1 ± 2.35

LSD= 0.2 (P=0.05) and 0.28 (P=0.01)

Table II. Analysis of variance for prey consumption in the combined uses of *O. niger* (one female and one nymph-V) and *A. intermedius* (three adults and three larvae-II) at three densities of prey

Sources	d.f.	M.S.	F	p
Predators combination	3	83.58	9.92	0.0001
Prey density	2	1801.82	213.82	0.0001
Predators combination*Prey density	6	19.44	2.31	0.039
Error	108	8.42		

CV% = 16.95

Table III. The prey consumed in the combined uses of *O. niger* (one female and one nymph-V) and *A. intermedius* (three adults and three larvae-II) at three densities of prey, survivalship of predators in three prey densities

Combined uses	Prey density	Prey consumption	Survival (%)			
			one female *O. niger*	one nymph-V *O. niger*	three adults *A. intermedius*	three larvae-II *A. intermedius*
One female *O. niger* + three adults *A. intermedius*	10	9.6 ± 0.5	100	-	46.6	-
	50	23.7 ± 2.98	100	-	100	-
	100	24.5 ± 1.6	100	-	100	-
One female *O. niger*+ three larvae-II *A. intermedius*	10	9.3 ± 0.5	100	-	-	0
	50	20.5 ± 2.52	100	-	-	93.3
	100	22.7 ± 2.98	100	-	-	100
One nymph-V *O. niger* + three adults *A. intermedius*	10	9.1 ± 0.59	-	100	76.67	-
	50	17.5 ± 2.55	-	100	100	-
	100	20.1 ± 2.76	-	100	100	-
One nymph-V *O. niger*+ three larvae-II *A. intermedius*	10	8.7 ± 0.56	-	100	-	63.33
	50	16.1 ± 2.17	-	100	-	100
	100	18.8 ± 1.97	-	100	-	100

LSD= 2.58 (P=0.05) and 3.41 (P=0.01)

analysis of variance and predation in each treatment during 24 h are presented in Tables II and III, respectively. Predation in the combined uses of *O. niger* and *A. intermedius* at the 50 and 100 prey densities were higher significantly compared to the separated uses of each predator alone (Table I & III). Also survivalship of both *O. niger* and *A. intermedius* (defined mature & immature stages) in the combined uses at the 50 and 100 prey densities were 100%, with exception of 93.3% for *A. intermedius* in combined use of one female *O. niger*+three larvae-II *A. intermedius* at the 50 prey density (Table III). These results indicate that when two predators were used synchronously at the 50 and 100 prey densities, the additive effects were observed on the mortality of prey (Table V). The percentage of additive effects ranged between 48.42% in the combined use of one nymph-V *O. niger*+three larvae-II *A. intermedius* at the 50 prey density and 85.6% in the combined use of one female *O. niger*+three adults *A. intermedius* at the 100 prey density (Table V). The differences of predation in the combined uses of *O. niger* and *A. intermedius* at the 10 prey density, were not significant than the separated uses of each predator alone at the same prey density. Also survivalship of both female and nymph-V *O. niger* in the combined uses of *O. niger* and *A. intermedius* at the 10 prey density were 100%, but for *A. intermedius* (adults & larvae) were 0% in one female *O. niger*+three larvae-II *A. intermedius*, 46.6% in one female *O. niger*+three adults *A. intermedius*, 63.33 in one nymph-V *O. niger*+three larvae-II *A. intermedius* and 76.67 in one nymph-V *O. niger*+three adults *A. intermedius* (Table III). These results indicate that at the 10 prey density, interaguild predation of *O. niger*, female and nymph-V, on *A. intermedius*, adults and larvae-II, were observed (Table IV). In the 10 prey density the percentage of interaguild predation were 100% in the combined use of one female *O. niger*+three larvae-II *A. intermedius*, 53.3% in one female *O. niger*+three adults *A. intermedius*, 36.7% in one nymph-V *O. niger*+three larvae-II *A. intermedius* and 23.3% in one nymph-V *O. niger*+three adults *A. intermedius* (Table IV). Also a very low interaguild predation was observed in combined use of one female *O. niger*+three larvae-II *A. intermedius* in the 50 prey density (Table IV). Therefore the combined uses of *O. niger* and *A. intermedius* at high population density of onion thrips compare to low density can be successful in biological control of this pest.

DISCUSSION

Biological control can be more effective if antagonists perform in a synergistic or additive mode. On the contrary, Intraguild predation (where two predators that share a common prey species also feed on each other) results in less effective biological control (Riechert & Lawrence, 1997; Rosenheim, 1998 & 2005; Venzon *et al.*, 2001; Rosenheim, 2005; Xu *et al.*, 2006). Snyder and Ives (2003) reported that increasing the diversity of natural enemy species on crops lead to progressive declines in herbivore equilibrium density. But other studies found that in the combined use of natural enemy species, additive effects or intraguild predation may explain the efficiency of natural enemy communities in suppression of herbivore populations (Wittmann & Leather, 1997; Rosenheim, 1998 & 2005).

Intraguild predation is usually more intense when prey density is low. Our research indicated that the combined use of *O. niger* and *A. intermedius* in high population density of onion thrips can be applied successfully in integrated pest management. The combined use of *O. niger* and *A. intermedius* can't be applied usefully in control of onion thrips at low density. These results can be explained by non-existence resource competition between both predators' species at high prey density. Leon-Beck and Coll (2007) by combined use of female with five second-instars nymph of *O. laevigatus* Say on (1) *Helicoverpa armigera* eggs (prey), (2) pollen (plant) and (3) *H. armigera* eggs + pollen, reported that fewer cannibalistic events and shorter feeding on conspecifics were recorded in the presence of pollen, prey or both than in their absence.

The outcome of the combined uses of predators

Table IV. Intraguild predation in the combined uses of *O. niger* (one female and one nymph-V) and *A. intermedius* (three adults and three larvae-II) at three densities of prey

Intraguild predation	Prey density	Three larvae-II *A. intermedius*	Three adults *A. intermedius*
One female *O. niger*	10	100	53.3
	50	6.6	0
	100	0	0
One nymph-V *O. niger*	10	36.7	23.3
	50	0	0
	100	0	0

Table V. Additive effects in the combined uses of *O. niger* (one female and one nymph-V) and *A. intermedius* (three adults and three larvae-II) at three densities of prey

Additive effects	Prey density	Three larvae-II *A. intermedius*	Three adults *A. intermedius*
One female *O. niger*	10	-	2.47
	50	48.92	80.98
	100	66.78	85.6
One nymph-V *O. niger*	10	-	0
	50	48.42	59.9
	100	50.11	63.67

depends on the foraging behavior of the predators. Brødsgaard and Enkegaard (1995) reported that the combined use of the anthocorid bug *Orius majusculus* (Reuter) and the predatory mite *Phytoseiulus persimilis* Athias-Henriot delayed the control of the spider mite *Tetranychus urticae* Koch due to the intraguild predation of *O. majusculus* on *P. persimilis*. Also Venzon *et al.* (2001) found that release of bug into the populations of predatory mites and spider mites had little or no effect on numbers of both mite species and cucumber plant and fruit weight. In contrast, Chang (1996) assessed an additive effect on the mortality of the bean aphid *Aphis fabae* Scopoli when predatory larvae of the lacewing *Chrysoperla plorabunda* (Fitch) and the coccinellid beetle *Coccinella septempunctata* Linnaeus were used synchronously.

Prey preference and plant characteristics can be effective on the intraguild predation and additive effect in the combined use of predators. Norton and English-Loeb (2001) reported that the leaf domatia of the wild grape, *Vitis riparia*, significantly increased mite survivorship of the predaceous species *Amblyseius andersoni* in the presence of the predatory bug, *O. insidiosus* and the coccinellids *C. septempunctata* and *Harmonia varigata.*

CONCLUSION

Orius species may play a large role in beneficial thrips population dynamics, because beneficial thrips are vulnerable to predation by *Orius* species. Our results suggest that at high density of onion thrips the additive effects were observed in combined use of *O. niger* and *A. intermedius*. Whereas at low density of onion thrips the intraguild predation of *O. niger* on *A. intermedius* were presented in combined use of *O. niger* and *A. intermedius*. However, further research need to be done on biological and ecological aspects of the *O. niger* and *A. intermedius* to complement information on their successful application against onion thrips in potato culture.

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