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MANGO POWDERY MILDEW *Oidium mangiferae* AN ALTERNATIVE FOOD FOR THE PREDATORY MITES *Typhlodromus mangiferus* AND *Typhlodromips swirskii* (PHYTOSEIIDAE) IN ABSENCE OR PRESENCE INCREASING PREY DENSITY OF *Oligonichus mangiferus* (TETRANYCHIDAE) IN EGYPT

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ABSTRACT

The predacious mites, *Typhlodromus mangiferus* Zaber and El- Borolossy and *Typhlodromips swirskii* (Athias-Henriot), reproduced successfully on mango powdery mildew *Oidium mangiferae* Berthet in absence or presence of spider mite prey *O. mangiferus* (Rahman and Sapra) under laboratory conditions of 25±1°C and 60-65% R.H. Adult female of both predators consumed protonymphs of *O. mangiferus* at different experimental densities. The consumption rate increased with increasing prey densities up to 25 protonymphs/female/day and decreased significantly at 35 and 50 protonymphs/female/day for the two predatory mites. Addition of powdery mildew conidia to each prey density significantly reduced consumption of spider mites at 35 and 50 protonymphs/female/day. Mean eggs/female/day by *T. swirskii* and *T. mangiferus* was 0.30.and 0.72 when reared on powdery mildew conidia compared with 1.64 and 1.57 when fed on powdery mildew and tetranychid prey, respectively. This increase in reproduction would have compensated the reduction in protonymph prey consumption due to the presence of mildew conidia. Mite-mildew interactions are discussed.

INTRODUCTION

The predatory phytoseiid mites, *Typhodromus mangiferus* Zaher and El-Borolossy and *Typhodromips swirskii* (Athias-Henriot) are important natural enemies on fruit orchards in Egypt and they are facultative polyphagous predators (Momen and El-Sawy 1993; Momen and El-Borolossy 1999; Al-Azzazy 2005; Abou-Awad *et al.* 2010a,b). Many generalist mite predators of phytoseiid group are thought to consume a broad range of mite and insect species, including various tetranychids eriophyids, tarsonemids, acarids, thrips, young green looper and white flies (Muma. 1971; McMurtry and Rodriquez 1987; Hansen 1988; Hoy and Glenister 1991; Gaugl 1992; McMurtry and Croft 1997; Zhang 2001). They are also thought capable of reproducing on non-prey items including pollen plant exudates, artificial diets and honeydew (Dosse 1961; Ramarkers 1990; Abou-Awad *et al.* 1992; James 1993; Tanigoshi *et al.* 1993; Momen 2004). Presence of a supplementary food in addition to a principal prey can even increase predator's fecundity (McMurtry and Scriven 1964; Ragusa and Swirski 1977; Abou-Awad *et al.* 1998; El-Banhawy *et al.* 2001).

Fungi represent another non-prey alternative food source; *T. pyre* Scheuten, *Amblyseius umbraticus* Chant and *Euseius finlandicus* (Oud.) were observed to feed and successfully develop on apple powdery mildew, *Podosphaera leucotricha* (Ell. and Everh.) (Chant 1959; Kropczynska-Linkewicz 1973; Daftari 1979; Zemek 2005). Eichhorn and Hoss (1990) noted feeding of *T. pyri* on powdery mildew *Uncimula necator* (Sch.) Burr. conected from grape leaves. Zemek and Prenerova (1997) found that the females of the *T. pyri* can feed also on conidia of *Erysiphe orontii* Cast. from tobacco and *Oidium fragariae* Harz. from strawberry.

The two aforementioned predatory phytoseiid mites and their prey the red spider mite *Oligonichus mangiferus* (Rahman and Sapra) inhabited mango trees. Powdery mildew *Oidium mangiferae* Berthet is also a common disease infecting the same trees with severe damage on leaves, panicles and young fruits; up to 90% crop loss can occur due to its effect on fruit set and development. The impact of mildew on acarine predator-prey systems remains unknown. It was felt that further studies of feeding habits of the two phytoseiid predators might provide a better understanding of whether the presence of mango powdery mildew conidia has any effect on the number of prey consumed by *T. mangiferus* and *T. swirskii*. The objective of this study was to evaluate the multitrophic interactions among plants, plant pathogens, acarine prey and generalist predatory phytoseiid mites.

MATERIALS AND METHODS

Young mango sprouts (*Mangiferae indica* L.), heavily infected with powdery mildew, served as a source of fresh of mango mildew, *O. mangiferae*. Protonymphs of the red spider mite, *O. mangiferus* were obtained from heavily infested mango leaves and used a prey in the experiments. Adult females of the predators *T. mangiferus* and *T. swirskii* were taken from stock colonies maintained on nymphs of *Tetranychus urticae* Koch as prey in the laboratory. *T. urticae* populations were maintained on kidney bean plants *Phasaolus vulgaris* L., kept separately in an environmental chamber with the same conditions as that of the predatory mites.

Arenas (3 x 3 cm) of excised succulent mango leaves placed on saturated cotton in Petri dishes were used to confine the predators. Newly molted, unfed and mated adult females of the same age were transferred singly to the rearing arenas and exposed to seven different prey densities from 5 to 50 protonymphs of *O. mangiferus* (10 replicates from each density). A few stands of cotton wool were provided as an ovipositor site on each arena. Mildew conidia were added to the arenas by brushing them from infected mango leaves. The brushing was carried in a way to ensure that approximately 0.5g of conidia was spread evenly on an arena surface. The daily fecundity of each female predator was recorded daily in the presence and absence of the prey. The number of individual prey killed per female was also recorded daily. All the dead prey were removed and replaced with one of seven levels of prey availability 5, 10, 15, 20, 25, 35 and 50 protonymphs of the tetranychid mite *O. mangiferus*, and were restocked daily for the completed oviposition period. The experiments were conducted under laboratory conditions at 25± 1°C, 60-65% R.H. and 18 L: 6-day photoperiod. Mean number of eggs laid, prey consumption and oviposition period per predator female were compared using F tests.

RESULTS AND DISCUSSION

The obtained results demonstrated that in the absence of the red spider mite *O. mangiferus*, the duration of oviposition phytoseiid predators *T. mangiferus* and *T. swirskii* on the mango powdery mildew *O. mangiferae*, as an alternative food, was shorter than with tetranychid prey, as a basic food. plus powdery mildew. Oviposition rates also showed differences between predators of the same food; the maximum number of eggs laid per female per day was 0.72 and 0.30 for two predatory species, respectively (Tables 1 and 2). Availability of alternative food in the environment is, however, prerequisite. The mango powdery mildew conidia occurs on the succulent leaves and panicles in the winter and may thus be an important alternative food mainly for over wintered females of predators that are gradually activated in spring when spider mites are usually scarce (Al-Azzay 2005). Powdery mildew can thus contribute to high density of *T. mangiferus* and *T. swirskii* early in the season before rapid increase of tetranychid population and there by preventing outbreaks. However, Reding *et al.* (2001) reported that apple and cherry leaves infected with powdery mildew were more frequently infested with spider mites and mite densities were greater than on leaves without mildew. The authors thus suggest that effective management of powdery mildew could reduce the need for acaricides and consequently reduce the incidence of outbreaks of spider mites.

It is of interest to note that the number of *O. mangiferus* consumed by female predators in the presence of powdery mildew significantly increased with increasing prey densities. The consumption rate for both predators reached a maximum at 25 protonymphs/fema1e/day and dropped at higher densities (35 and 50 protonymphs l/female/day) (Tables 1 and 2). Presence of mango powdery mildew did not change the oature of the predatory phytoseiid mite's response. In fact, the predacious mites have finite capacities for consuming prey, oviposition and moving within limited areas within a unite time (Takafuje and Chant 1976). Phytoseiid, however, are more efficient at converting digested prey into eggs at lower densities of prey than at higher ones (Chant 1961; Ball 1980; Eveleigh and Chant 1981; Friese and Gilstrap 1982; Momeo 1996). On the other hand, occurrence of *T. mangiferus* and *T. swirskii* on infections of mango powdery mildew would have maintained the predator populations at moderate levels as indicated, especially when the red spider mites are commonly scarce.

If oviposition rate *T. mangiferus* and *T. swirskii* is used as a fitness measure. the mango powdery mildew with tetranychid prey *O. mangiferus* should be considered as a more profitable foods than mildew due to they allowed predators to lay nearly 2.18 and 12.6 times more eggs compared with mango mildew conidia, respectively.

Table 1: Consumption rate, fecundity and oviopsition period (days) of the predatory mite *T. mangiferus* on powdery mildew in presence and absence of tetranychid prey *O. mangiferus* at 25°C.

	T. mangiferus							
	P^{1} +F + RM (mean ±SD)					P^{1} + F (mean ±SD)		
No. Prey provided daily	Total no. eggs deposited /female	Daily rate	Total no. prey consumed /female	Daily rate	Ovipsition period (days)/ female	Total no. eggs deposited /female	Daily rate	Ovipsition period (days) /female
5	9.0±0.33^{a}	0.62	90.0±6.4^{a}	6.21	14.5±0.66^{a}	4.6±0.31^{a}	0.37	12.5±0.42^{a}
10	11.5±0.77^{b}	0.70	169.4±6.3^{b}	10.33	16.4±0.34^{a}	5.0±0.19^{a}	0.39	12.8±0.36^{a}
15	15.4±0.69^{c}	0.92	288.7±4.4^{c}	17.18	16.8±0.19^{a}	4.8±0.12^{a}	0.38	12.6±0.39^{a}
20	20.2±0.64^{d}	1.29	320.1±5.4^{d}	20.52	15.6±0.47^{a}	7.1±0.16^{a}	0.59	11.9±0.44^{a}
25	22.2±0.11^{de}	1.41	361.6±5.3^{de}	23.18	15.6±0.24^{a}	7.2±0.14^{a}	0.61	11.8±0.47^{a}
35	22.2±0.21^{ef}	1.43	285.9±6.1^{f}	18.44	15.5±0.29^{a}	6.9±0.36^{a}	0.48	14.4±0.22^{ab}
50	22.3±0.56^{def}	1.57	198.3±5.7^{g}	13.96	14.2±0.34^{a}	7.3±0.01^{a}	0.72	10.1±0.33^{a}

P^{1}, *T. mangiferus*; F, powdery mildew *O. mangiferae*; RM. Red spider mite *O. mangiferus*; SD, standard deviation of mean. Data for the predator followed by the same letter are not significantly different (P = 0.01, Duncan's test).

Table 2: Consumption rate, fecundity and oviopsition period (days) of the predatory mite *T. swirskii* on powdery mildew in presence and absence of tetranychid prey *O.mangiferus* at 25°C.

T. mangiferus								
No. Prey Provided daily	P^1 +F + RM (mean ±SD)					P^1 + F (mean ±SD)		
	Total no. eggs deposited /female	Daily rate	Total no. prey consumed /female	Daily rate	Ovipsition period (days) /female	Total no. eggs deposited/female	Daily rate	Ovipsition period (days) /female
5	7.5±0.44^{a}	0.69	75.0±2.1^{a}	6.9	10.9±0.47^{a}	2.2±0.01^{a}	0.28	8.0±0.16^{a}
10	9.3±0.13^{b}	0.69	160.0±3.8^{b}	8.21	13.5±0.33^{ab}	2.3±0.01^{a}	0.23	9.9±0.21^{ab}
15	13.1±0.31^{c}	0.91	227.5±7.1^{c}	15.8	14.4±0.19^{bc}	2.0±0.01^{a}	0.28	7.2±0.43^{ac}
20	17.0±0.51^{d}	1.18	271.4±2.8^{d}	18.85	14.4±0.18^{bc}	2.2±0.01^{a}	0.30	7.3±0.39^{ac}
25	19.8±0.61^{de}	1.36	309.8±10.7^{e}	21.22	14.6±0.24^{bc}	1.4±0.04^{a}	0.21	6.7±0.37^{ac}
35	20.2±0.86^{de}	1.45	257.6±6.9^{df}	18.53	13.9±0.28^{bc}	1.8±0.01^{a}	0.23	7.8±0.29^{ac}
50	22.5±0.98^{de}	1.64	158.0±6.4^{b}	11.53	13.7±0.21^{bc}	1.8±0.01^{a}	0.13	7.9±0.16^{ac}

P^1, *T. swirskii*; F, powdery mildew *O. mangiferae*; RM, red spider mite *O. mangiferus*; SD, standared deviation of mean. Data for the predator followed by the same letter are not significantly different (P = 0.01, Duncan's test).

The total number of reproductive days also increased, but then declined at the highest level of prey density (Tables 1 and 2). These results are in agreement with the results reported by Zemek (2005) and pozzebon *et al.* (2009). Reding *et al.* (2001) reported that the mycelia and spores of powdery mildew do not serve only as food, but may provide protective structures and or alter the microclimate to favor phytophagous or predacious mites similar to domatia and hairs. It is worth noting that Abou-A wad *et al.* (2010a,b) reared *T. swirskii* and *T. mangiferus* at the same stage of prey and conditions, respectively, without powdery mildew. They noted that the oviposition rate was 1.2 and 1.06 eggs/female/day, respectively. In the present experiments, the number of eggs laid per females per day for the two predatory mites in the presence of spider mites and mildew conidia increased to 1.64 and 1.57, respectively (Tables 1 and 2). It seemed that the density of tetranychid mite *O. mangiferus* in presence mango powdery mildew enhanced the fecundity of the two aforementioned phytoseiid predators.

Some mite-mildew interactions might be even beneficial to a pathogen. Batra and Stavely (1994) mentioned that mite individuals can increase fungi incidence on host plants by vectoring fungi on their body parts. On the other hand, predatory mites may be useful as a biological control of powdery mildew conidia. For example when released the predatory tydeid mite *Orthotydeus lambi* (Banks) at high densities, it was able to reduce the incidence and severity of powdery mildew on both wild and cultivated grapes (English-Loeb *et al.* 1999). However, results of this study showed that the presence of mango powdery mildew conidia has significant effect on the number of eggs laid and prey consumed by the predatory phytoseiid mites *T. mangiferus* and *T. swirskii.* Additional work may be needed to shed light on the realistic role of acarine-mildew interactions.

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استخدام مسحوق فطر المانجو أوديم مانجيفيرا كغذاء بديل لكلا مـــن المفترســـان تيفلودرومس مانجيفيرس وتيفلودرومبس سويرسكاي في وجود او عـــدم وجـــود كثافة من الفريسة اوليجونيكس مانجيفيرس

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** قسم الحيوان الزراعى و النيماتودا – كلية الزراعة جامعة الازهر – القاهرة

تعتبر المفترسات الأكاروسية التابعة لفصيلة فايتوسيدي الشهيرة من أهم الأعداء الطبيعية للأفات الأكاروسية المختلفة في مجال المكافحة الحيوية ومن هنا كانت تلك الدراسة علي المفترسين الأكاروسيين تيفلودرومس مانجيفيرس و تيفلودرومبس سويرسكاي و الاوليجونيكس مانجيفيرس كفريسة بأعداد مختلفة ٥، ١٠ ، ١٥ ، ٢٠ ، ٢٥ ، ٣٥ ، و ٥٠ حورية أولي ، ولقد كان لزاما دراسة كيفية تواجد تلك المفترسات علي مدار العام بالرغم من عدم وجود فرائس في بعض أوقات السنة . لذلك كانت الدراسة علي فطر البياض الدقيقي كغذاء بديل و المتواجد علي نفس العائل وهي أشجار المانجو .حيث تم عمل مكررات كالأتي (مفترس + فريسة + بياض دقيقي) و (مفترس + بياض دقيقي فقط) لكلا من المفترسين وتمت التربية علي درجة حرارة ٢٥ درجة و رطوبة ٦٠-٦٥ % .

وكانت النتائج كالاتي .

- استمرت المفترسان في نشاطهما العادي من حيث اكتمال دورة حياتها ووضع البيض وحتي الموت وذلك في وجود الفطر فقط وعدم وجوج الفريسة .
- يمكن للفطر أن يعتبر عذاء بديل في فصل الشتاء وفي حالة عدم وجود فرائس . كما يمكن للفطر أن يزيد من أعداد المفترسات في بداية الموسم و قبل حدوث زيادة في تعداد الأفة مما يحدث توازن بين المفترس والأفة .
- كانت أعلي نسبة استهلاك لكلا من المفترسين عند عدد ٢٥ حورية ثم قلت عند وجود كثافة عالية ٣٥ ، ٥٠ حورية أولي
- كانت اكبر كمية بيض موضوعة عند التغذية علي الفطر فقط هي ٠.٧٢ ، ٠.٣٠ بيضة يوميا لكلا من المفترسين علي التوالي بينما كانت ١.٥٧ ، ١.٦٤ في حالة وجود المفترس مع الفريسة مع الفطر.
- كان هناك فروق معنوية جدا بين كمية البيض الموضوع في حالة وجود المفترس مع الفريسة و الفطر و وجود المفترس مع الفطر فقط.

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