HOST PLANT AFFECTS THE PREDATION AND OVIPOSITION RATE OF THE PREDACEOUS THRIPS OF SPIDER MITES, *SCOLOTHRIPS LONGICORNIS*

Neda Kheradpir*, Mohammahreza Rezapanah**, Karim Kamali**** and Yaghoub Fathipour***

* Dept. Plant Protection, Fac. Agriculture, Islamic Azad University, Varamin (Pishva) Branch, P. O. Box: 33817-74897, IRAN. E-mail: n.kheradpir@gmail.com
** Dept. Biological Control Research, Plant Protection Research Institute of Iran, P. O. Box: 19395-1454, Tehran, IRAN.
*** Dept. Entomology, Fac. Agriculture, Tarbiat Modarres University, P. O. Box: 14115-336. Tehran, IRAN.
**** Dept. Entomology, Fac. Agriculture and Natural Resources, Islamic Azad University, Science and Research Branch, P. O. Box: 14155-4933, Tehran, IRAN.

ABSTRACT: On the basis of controlling spider mites as a serious pest in four greenhouse vegetables, some experiments were conducted to measure the interaction between the biological control agent, *Scolothrips longicornis* Priesner, and host plant species. The predation and oviposition rates of the predator were monitored as two indices of the predator fitness on the host plants. It was hypothesized that plant chlorophyll content and leaf surface quality can affect this biocontrol agent. The results showed that plant leaf tissue affected the oviposition rate of the predator. As the highest oviposition rate was seen on eggplant (9.70±1.03 larvae) and the lowest belonged to sweet pepper (3.70±0.85 larvae). Predation mean was affected by host plant, also; the result was somehow different, as the highest predation mean was recorded for tomato (6.10±0.88 unfed mite/plant) and sweet pepper was not favorable for prey searching, either. In addition, the chlorophyll content of the host plant could indirectly affect the predator via prey feeding; however, the results indicated the final decisions of predator are related to more than one factor in host plant and prey.

KEY WORDS: Preference, oviposition, predation, *Scolothrips longicornis,* host plant.

When ecologists study interactions between trophic levels, they often limit their attention to two levels as a means of simplifying the analysis and this simplification may mislead many of the tritrophic interactions. In addition, a goal of integrated pest management is to combine optimally all available tactics to maintain pest population below economic injury level. Two strategies of host plant selection (somehow resistant cultivars) and biological control can be greatly effective when used simultaneously in time and related to biological control agent fitness. Because predators often encounter herbivores on plants, the topography of plant surfaces may influence herbivore and natural enemies' interactions (Dicke, 1996; Heinz & Zalom, 1996; Roda et al.*,* 2001) and also host plant quality is expected to enhance the predators via nourishing of pests (Nachman & Zemek, 2002).

Due to the increasing resistance of pests such as *Tetranychus urticae* Koch (Acari: Tetranychidae) to pesticides and exactly the numerous side-effects of chemical control, it is needed to enhance biological control. Cucumber, eggplant, tomato and sweet pepper are among the most cultivated and susceptible host plants cultivated in Iran which are under biological control programs, also. Spider mites suck the chlorophyll out of plant tissue leaving dried out leaves with yellow

or red spots and blotches sometimes with tiny white dots (Zhang, 2003). Among the predators used mainly in controlling spider mites is the specialist predatory thrips *Scolothrips longicornis* Priesner (Thysanoptera: Thripidae), which consumes on all the life stages of spider mites mainly adults. As the predator tend to oviposit into the host plant leaf tissue, deep knowledge of plant-predator interaction is needed for planning an integrated management combining biological and cultural control (Priesner, 1950). Predator should be able to oviposit in the host plant tissue and on the other hand, host plant leaf tissue should be able to keep the eggs until hatched.

To quantify the biological control agent compatibility with the host plant, there is a requirement of knowledge of host plant effect on predator performance and fitness. It means how the plant feature can affect the natural enemies to suppress the pest population. The efficiency with which predators pursue prey can be affected by the texture and structure of the surface that they search (Grevstad et al., 1992), which can be monitored by their consumption and oviposition rate.

Previous investigations of the interplay between plant morphology and predators related to many different plant-herbivore-predator species. Among morphological feature, plant trichomes can have positive or negative influence on natural enemies. These structures can provide shelters for tiny predators against unfavorable abiotic and biotic factors (Dicke & Sabelis, 1988). Predatory bugs, *Anthocoris confuses* Reuter are greatly affected in predation rate by host plant trichomes (Evans, 1976). Considering the observations of Heinz & Zalom (1996), they showed the effect of trichomes of tomato on effective biological control of whiteflies by predator *Delphastus pusillus* LeConte. In other studies, the leaf hairs had direct effect on whiteflies movement and indirect effect on prey consumption of the predator (Bottrell et al., 1998). In a study, trichomes on the lower surface of gerbera cultivars were shown to affect the predation rate of *Phytoseiulus persimilis* Athias-Henriot (Krips et al., 1999). The oviposition rate of this predatory mite differs according to apple leaves topography (Roda et al., 2001); also, density and length of trichomes on three different plant species have positive and negative effect on functional response of *P. persimilis* to control spider mites (Skirvin & Fenlon, 2001).

A crucial aspect of predator oviposition behaviour is host plant choice and host plant characteristics were among the factors affecting *Episyrphus balteatus* De Geer oviposition rate (vanHaelen et al., 2001). Adult *Hippodamia convergens* Guerrin-Menneville, *Orius insidiosus* Say and *Chrysoperla carnea* Stephens are reported to reduce populations of *Plutella xylostella* L. larvae on cabbage with glossy surface (Eigenbrode et al., 1996). The implication of soybean cultivars on the reproductive capacity and biological control by *O. insidiosus* has great effect on aphids (Lundgren & Fergen, 2006). Female *O. insidiosus* oviposit into plant species with the thinnest layers of epidermal and collenchyma cells, a decision that is significantly correlated with the survival of their offspring. Once a plant species is chosen, the female mainly bases her oviposition decisions on epidermal thickness and the surface density of hair-like appendages on the plants (Lundgren et al., 2008). Also it was shown that choice of oviposition site in anthocorids determines the later distribution of nymphs (Sigsgaard, 2005). Plant architecture is likely to be an important component of the predation risk of *Diurapphis noxia* Mordvilko by the fourteen spotted ladybird, *Propyloea quaturodecimpunctat* L. (Clark & Messina, 1998). Mahdian et al. (2007) showed the effect of plant surface on the functional response of the predatory bug *Picromerus bidens* L.

We used four greenhouse crops that differ largely in their undersurface of the leaves and determined whether searching efficiency of *S. longicornis* differs on

these crops by monitoring their predation rate related to plant leaf structure and chlorophyll content. In parallel, because of the predator's dependence for oviposition into the host plant leave texture, we considered the oviposition rate of predators as a factor of combining biological agents with host plants.

MATERIALS AND METHODS

Spider mites were provided from a colony at Biological Control Department of IRIPP kept on cow-pea plants for at least six months. To determine the predation and oviposition rate of the predator, a spider mite colony was used that originated from mites collected in the last year from a research lima bean field. The mites belonged to the sixth generation were used in the experiments.

Predatory thrips were obtained from a colony reared on spider mites *T. urticae* on cow-pea leaves. Predatory thrips were kept in a container covered by a thin layer of water saturated cotton and a squash leaf disk upside and small leaves of cow pea full of spider mites. Every two weeks, predatory thrips were transferred to a new leaf disk. Containers were kept in a climate room at 25±0.5ºC, 60±65% RH and a photoperiod of 16L: 8D. All experiments were carried out with mated adult females at the age of 3-4 days.

Commercial hybrid of four main greenhouse vegetables, representing different types in trichomes and leaf indices were selected as test plants to determine how plant leaf structure can influence the predation and oviposition rate of *S. longicornis,* feeding on two-spotted spider mite. The most cultivated greenhouse plants such as cucumber cv. Sultan, tomato cv. Cantander, eggplant cv. Valencia and sweet pepper cv. Local were obtained from three commercial companies, Petoseed, Royal and Enza Zaden and subsequently grown in a shared pot that had some barriers under the soil to prevent root connection (Fathipour et al. 2006). The pots were kept in a greenhouse at Biological Control Department of Iran Research Institute of Plant Protection (IRIPP; 25±0.5ºC, 60-65% RH and a photoperiod of 16L:8D).

The distance among the plants and their height was as there was no touch between them but they were so close that the thrips could travel among the plant by a small jump. The experimental plants were chosen in the 4-5 leaves stage for the tests. A transparent cylinder was put on each pot to prevent thrips dispersal. Each plant was infected by 100 adult female spider mites. The predator individuals were starved for 12 hours. Seven female thrips at the age of 3-4 days and 10 male thrips were isolated from the colony on a plants pot combination without prey. For each set, five adult females and two males for insured mating from the isolated colony were transferred to each pot and let them 24 hours consume spider mites (Grevstad & Klepetka, 1992; Krips et al., 1999) and oviposit in the leaf tissue (Coll, 1996; Heinz & Zalom, 1996; Margolies et al., 1997; Venzon et al., 2002; Lundgren & Fergen, 2006). The test was done in 10 replications. After 24 hours, the thrips were removed from the pots and the number of alive spider mites was counted on each plant in each combination. As there is no cannibalism in the first instar larvae of the genus (Covile & Allen, 1977), then after one week, the number of first instar larvae, which hatched successfully, was recorded as the oviposition ability of the predators in correlation with host plant. Data were analyzed using ANOVA and mean comparison method of LSD in SPSS 14.0 software.

Since not all the elements of plant condition can be included in an analysis, some components were used in this experiment as the indicators of host plant effective parameters, namely the amount of chlorophyll per 6 mm² leaf area, leaf

area and thickness. The amount of chlorophyll in leaf tissue was measured by a simple chlorophyll-meter (Minolta SPAD-502) after removing the predator. Ten plants of each species that were used in the oviposition-predation test were used in the experiments. Leaf thickness was measured by a simple micrometer and area was monitored by a leaf area meter (CI-202) instruments. Data were analyzed by ANOVA and mean difference significacy was monitored by LSD comparison test in the software of SPSS 14.0. To obtain the correlation between leaf thickness and oviposition rate and also, leaf area and feeding rate, the data were analyzed through linear regression model to find out any linear correlation.

RESULTS

The predation mean of *S. longicornis* on the four greenhouse crop species is shown in table. 1. The one way ANOVA for these data showed the significant effect of host plant on predation mean of the predator (df=3, *F*=8.121 and *sig*.<0.001). The highest and lowest consumption mean was recorded on tomato and sweet pepper plant with the mean of 6.10±0.88 and 18.2±1.65 left alive mites per plant, respectively. The amount of alive left mites showed no significant difference between cucumber (11.5± 1.66 mite/plant) and eggplant (12.5±2.40 mite/plant).

The oviposition mean of *S. longicornis* in the leaf tissue of the four greenhouse crops is shown in table. 1. The one way ANOVA for these data showed the significant effect of host plant tissue on oviposition capacity of the predator (df=3, *F*=6.614 and *sig*.=0.001). The highest reproductive ability was recorded on eggplant with the mean of 9.70±1.03 first instar larvae per plant and the lowest was observed on sweet pepper (3.70±0.85 1st. instar larvae/plant). The difference between cucumber and tomato was not significant.

Among the different leaf area indices, two studied parameters in this paper showed significant difference. The largest and smallest leaf area was recorded for cucumber leaves (A= 13.84±0.57 cm², *F*= 41.801, *sig*. <0.000) and tomato (A= 4.71±0.36 cm²), respectively. On the other hand, the thickest leaf was belonged to eggplant with 0.45±0.01 mm thickness and the thinnest leaf was for sweet pepper (0.29±0.01 mm) with significant difference (F= 18.64, sig.<0.000). Regression model between oviposition rate and leaf thickness showed linear increasing correlation (F= 6.713, Sig. = 0.14; r=0.48, figure 1) that showed increasing the leaf thickness, the predator preferred to lay more eggs. Mostly, egg laying were observed around leaf thickness of 0.35-0.50 mm which is so close to eggplant leaf thickness (figure 1). In addition, regression between feeding rate of the predator (log unfed mites) and leaf area showed similar results, as by increasing the leaf area from tomato to cucumber, more mites were left unfed with significant difference (F= 5.779, Sig.=0.021; r= 0.404).

Chlorophyll content of four experimental plants showed significant difference, too (df=3, *F*=7.374 and *sig*.=0.001). The highest amount of chlorophyll was recorded in cucumber leaves (37.37±1.56 mg/g), followed by tomato and sweet pepper with no significant difference and at last, eggplant (26.94±1.79 mg/g) had the lowest chlorophyll content (Table 1) which would be another indirect effect of host plant o the predation rate of *S. longicornis*.

DISCUSSION

Our study showed that plant morphology can substantially alter the foraging success and predation of *S. longicornis* searching for prey on the plant surface. We found that the mean of prey consumption by the predacious thrips varied

among different Solanaceous and Cucurbitaceous species with diverse architecture. These discrepancies in feeding and oviposition rate of the predator can be explained by the difference in chlorophyll content, leaf area and thickness, which would enhance or suppress the nutritional aspect of the prey and plant surface structure. The lowest consumption rate on sweet pepper suggested that *S. longicornis* searches less effectively on sweet pepper than other threes. Effects can also indirectly mediate predator search through the host and prey (Sabelis et al., 1999; Kennedy, 2003). Highest predation rate of the predator on tomato leaf surface can be due to smallest leaf area which would limit the foraging arena for the predator or refuging surface for the prey. On the other hand, lower predation mean on sweet pepper could be related to the physical and chemical properties of this host plant. Although the leaf area of sweet pepper showed no difference with eggplant and the chlorophyll content, the slippery surface of sweet pepper may play an important role on foraging efficiency of predators. These results of Yasuda (1998) indicated that chlorophyll in the prey diet serves as an important cue in the prey-locating behavior of *Eocanthecona furcellata* Wolff in lettuce, bean and spinach. It means that the amount of (E)-phytol as a component of chlorophyll in spinach led the higher feeding rate in this predator. In previous study it was found that spider mites has lower developmental time and fecundity value on sweet pepper than other greenhouse vegetables (Kheradpir et al., 2008); that is, sweet pepper can be an unfavorable host plant for this prey. Although the chlorophyll content of sweet pepper was as much as tomato, because of higher potassium level could not be a good host plant for prey and subsequently not a good prey for a predator (Malekahmadi et al., 2005). The use of non-destructive methods of chlorophyll measurement provides reliable and effective means of plant analysis in a ide range of biological context (Samsone et al., 2007). Somehow plant structure and nutrition can change the searching efficacy of a predator (Mahdian et al., 2007; De Clercq et al., 2000). In another study, plant species had a significant effect on the functional response of *P. persimilis* to eggs of *T. urticae*. But as there was no effect of the host plant species on the number of prey eaten by *P. persimilis,* this removed the possibility that the effect in functional response is due to plant chemistry (Skirvin & Fenlon, 2001). According to the data collected from our experiment, we can conclude that the difference in number of eaten preys among different host plants is related to plant chemistry and at the first level the chlorophyll content of the leaves would be the most effective factor. By the way, all data in our study does not exactly support this hypothesis. It means that as we explained above, although sweet pepper had relatively high chlorophyll content, the slippery surface of the leaves and secondary metabolites in plant chemistry mediated by prey consumption prevent the predator to show its maximal predation capacity and switch to the other host plants. On the other hand, highest chlorophyll content in cucumber leaves over passed by heavy density of trichomes on the leaf surface that made a good shelter for prey to hide against the predator. The predator individuals apparently compensate relatively lower chlorophyll content in tomato (at the same level with sweet pepper) by eating more preys. The lower consumption rate on eggplant than tomato is difficult to explain; it is possible that the trichomes structure makes it more difficult for *S. longicornis* to find its prey. According to Kheradpir et al. (2010), diference in trichome density on the four experimental plants would lead to affecting *S. longicornis* movement ability which can explain the data obtained in this experiment. However, to discount fully the effect of the secondary plant compounds on the predation rate of this predator, more detailed research of the plant biochemistry is necessary.

The oviposition mean in *S. longicornis* on our experimental plants showed the direct effect of both structural and chemical effect of host plants. *O. insidiosus* showed an obvious preference for laying eggs on certain plant structures among the host plants of pole bean, soybean, redroot pigweed and velvetleaf (Lundgren et al. 2008; Lundgren & Fergen, 2006). Coll (1996) also found that *O. insidiosus* does not prefer to lay eggs on the vegetative structure of sweet peppers and tomatoes. Our observations support this conclusion that many dinocot plants are unacceptable oviposition sites for *S. longicornis,* specially in case of sweet pepper and tomato. This being said, our result showed that *S. longicornis* can distinguish between egg-laying sites, but the mechanisms behind the oviposition decision and its implications for biological control remain to be investigated. Thickness of the external covering may also render some species unsuitable as oviposition sites (Castane & Zalom, 1994); dense trichomes also as what we have seen in cucumber could render predators to find suitable place to penetrate their ovipositor (Armer et al., 1999; Roda et al., 2001). Among the spider mites predators, *P. persimilis* and *Typhlodromus pyri* Scheuten has been shown to distinguish plant structure to lay egg on and mostly they prefer dense trichomes surfaces rich of hidden preys, however the trichomes density and the leaf surface topography diversify their response. We can conclude that the predacious thrips follows the same strategies to find more prey, but as it has bigger size, so it should prefer lower densities of trichomes (Krips et al., 1999). On the other hand, the leaf tissue has great effect on the oviposition rate of a predator which lay egg inside the leaf tissue. In comparison with other thripids, female thrips of *Scirtothrips perseae* Nakahara laid eggs into the small avocado fruit rather than any other vegetative parts of the plant (Hoddle, 2002). Oviposition behavior of the western flower thrips, *Frankliniella occidentalis* Pergande on greenhouse cucumber showed most eggs were laid in the leaves, along veins and under leaf hairs, with only a few on plant stems and flowers (Kiers et al., 2000). According to Kishimoto & Adachi (2008), the predacious thrips in the genus of *Scolothrips* preferred leaves with trichomes, but there should be long and shelter type not as dense as it can not walk through; the result of our study regarding to higher oviposition rate in eggplant is supported by this hypothesis.

Our data showed that plant characteristics influence the ability of *S. longicornis* to respond to changes in prey density and suggest that the predator may perform better as a biological control agent of mite pests on eggplant and sweet pepper than on tomato. However, host plant is only one source of variation in the way that predators respond to varying prey densities. Predation behavior of an arthropod predator may be affected by a complex of biotic and abiotic factors. Totally, the experimental results appeared that *S. longicornis* is less efficient as a biological control agent on sweet pepper. The prey consumption ability of a predator within a plant is just one aspect that needs to be considered in developing biological control strategies. The predator also needs to be able to locate its prey, and hence the movement of predators within the plant canopy is also important. If the morphological feature of a plant affect the movement of a predator to such a degree that it is unable to move rapidly between patches of its prey then, irrespective of its predation capacity, its use as a biological control agent is limited.

LITERATURE CITED

Armer, C. A., Wiedenmann, R. N. & Irwin, M. E. 1999. Effects of soybean mosaic virus on the facultative phytophagous predator *Orius insidiosus* (Heteroptera: Anthocoridae). Environmental Entomology, 28: 1036-1043.

Bottrell, D. G., Barbosa, P. & Gould, F. 1998. Manipulating natural enemies by plant variety selection and modification: A realistic strategy? Annual Review of Entomology, 43: 347-367.

Castane, C. & Zalom, F. G. 1994. Artificial oviposition substrate for rearing *Orius insidiosus* (Hemiptera: Anthocoridae). Biological Control, 4: 88-91.

Clark, T. L. & Messina, F. J. 1998. Plant architecture and the foraging success of ladybird beetles attacking the Russian wheat aphid. Entomologia Experimentalis et Applicata, 86: 153-161.

Coll, M. 1996. Feeding and ovipositing on plants by an omnivorous insect predator. Oecologia, 105: 214-220.

Coville, P. L. & Allen, W. W. 1977. Life Table and Feeding Habits of *Scolothrips sexmaculatus* (Thysanoptera: Thripidae). Annal of Entomological Society of America, 70 (1): 11-16.

De Clercq, P., Mohaghegh, J. & Tirry, L. 2000. Effect of host plant on the functional response of the predator *Podisus nigrispinus* (Heteroptera: Pentatomidae). Biological Control*,* 18: 65-70.

Dicke, M. 1996. Plant characteristics influence biological control agents: implications for breeding for host plant resistance. Bulletin IOBC/WPRS, 19 (5): 72-80.

Dicke, M. & Sabelis, M. W. 1988. How plants obtain predatory mites as bodyguards. Netherlands Journal Zoology, 38 (2-4): 148-165.

Eigenbrode, S. D., Castagnola, T., Roux, M. B. & Steljes, L. 1996. Mobility of three generalist predators is greater on cabbage with glossy leaf wax than on cabbage with a wax bloom. Entomologia Experimentalis et Applicata, 81: 335-343.

Evans, E. D. 1976. The role of predator-prey size ratio in determining the efficiency of capture by*Anthocoris nemorum* and the escape reactions of its prey*Acyrthosiphon pisum*. Ecological Entomology, 1: 85-90.

Fathipour, Y., Haghani, M., Talebi, A. A., Baniameri, V. & Zamani, A. A. 2006. Natural parasitism of *Liriomyza sativae* (Diptera: Agromyzidae) on cucumber in field and greenhouse conditions. Bulletin IOBC/WPRS. 29: 155-160.

Grevstad, F. S. & Klepetka, B. W. 1992. The influence of plant architecture on the foraging efficiencies of a suite of ladybird beetle feeding on aphids. Oecologia, 92: 399-404.

Heinz, K. M. & Zalom, F. G. 1996. Performance of the predator *Delphastus pusillus on Bemisia* resistant and susceptible tomato lines. Entomologia Experimentalis et Applicata, 81: 345-352.

Hoddle, M. S. 2002. Oviposition preferences of *Scirtothrips perseae* Nakahara (Thysanoptera: Thripidae) in southern California avocado orchards. Pan-Pacific Entomologist, 78 (30): 177-183.

Kennedy, G. C. 2003. Tomato, pests, parasitoids and predators: tritrophic interactions involving the genus *Lycopersicon*. Annual Review of Entomology, 48: 51-72.

Kheradpir, N., Rezapanah, M., Kamali, K. & Fathipour, Y. 2010. The Searching Behavior of *Scolothrips longicornis* (Priesner) in Relation to Plant Surface Topography. International Journal of Environment, Agriculture and Biotechnology (under publishing).

Kheradpir, N., Khalghani, J., Ostovan, H. & Rezapanah, M. 2008. Study of some biological and demographic traits of *Tetranychus urticae* population on three greenhouse cucumber cultivars. Journal of Agricultural Science, 1: 77-82.

Kiers, E., de Kogel, W. J., Balkema-Boomstra, A. & Mollema C. 2000. Flower visitation and oviposition behavior of *Frankliniella occidentalis* (Tysan.: Thripidae) on cucumber plants. Journal of Applied Entomology, 124 (1): 27-32.

Kishimoto, H. & Adachi, I. 2008. Predation and oviposition by predatory *Stethorus japonicus*, *Oligota kashmirica benefica*, and *Scolothrips takahashii* in egg patches of various spider mite species. Entomologia Experimentalis et Applicata, 128 (2): 294-302.

Krips, O. E., Kelijn, P. W., Willems, P. E. L., Gols, G. J. Z. & Dicke, M. 1999. Leaf hairs influence searching efficiency and predation rate of the predatory mite *Phytoseiulus persimilis* (Acari: Phytoseiidae). Experimental and Applied Acarology*,* 23: 119-131.

Lundgren, J. G., Fergen, J. K. & Riedell, W. E. 2008. The influence of plant anatomy on oviposition and reproductive success of the omnivorous bug *Orius insidiosus*. Journal of Animal Behaviour, 75 (4): 1495-1502.

Lundgren, J. G. & Fergen, J. K. 2006. The oviposition behavior of the predator *Orius insidiosus*: acceptability and preference for different plants. Biocontrol, 51 (2): 217-227.

Malekahmadi, F., Kalantari, Kh. M. & Torkzadeh, M. 2005. The effect of flooding stress on induction of oxidative stress and concentration of mineral element in pepper (*Capsicum annum*) plants. Iranian Journal of Biology, 18 (2): 110-119.

Mahdian, K., Tirry, L. & De Clercq, C. 2007. Functional response of *Picromerus bidensi*: effects of host plant. Journal of Applied Entomology, 131 (3): 160-164.

Margolies, D. C., Sabelis, M. W. & Boyer, J. E. Jr. 1997. Response of a phytoseiid predator to herbivore-induced plant volatiles: selection on attraction and effect on prey exploitation. Journal of Insect Behaviour, 10 (5): 695-709.

Nachman, G. & Zemek, R. 2002. Interactions in an tritrophic acarine predator-prey metapopulation system III: effects of *Tetranychus urticae* (Acari: Tetranychidae) on host plant condition. Experimental and Applied Acarology, 25: 27-42.

Priesner, H. 1950. Studies on the genus, *Scolothrips*. Bull. Soci. Fouad ler Entomology, 34: 39-68.

Roda, A., Nyrop, J., English-Loeb, G. & Dicke, M. 2001. Leaf pubescence and two-spotted spidre mite webbing influence phytoseiid behavior and population density. Oecologia, 129: 551-560.

Sabelis, M. W., Van Baalen, M., Bakker, F. M., Bruin, J., Drukker, B., Egas, M., Janssen, A. R. M., Lesna, I. K., Pels, B., Van Rijn, P. C. J. & Scutareanu, P. 1999. The evolution of direct and indirect plant defence against herbivorous arthropods. In: Olff, H., Brown, V.K., Drent, R.H. (Eds), Herbivores: between plants and predators. Oxford, Blackwell Science Ltd. PP: 109-166.

Samsone, I., Andersone, U., Vikmane, M., Ievina, B., Pakarna, G. & Ievinsh, G. 2007. Nondestructive methods in plant biology: an accurate measurement of chlorophyll content by a chlorophyll meter. Acta Univer. Latviensis, 723: 145-154.

Sigsgaard, L. 2005. Oviposition preference of *Anthocoris nemoralis* and *A. nemorum* (Heteroptera: Anthocoridae) on pear leaves affected by leaf damage, honeydew and prey. Biocontrol Science and Technology, 15 (2): 139-151.

Skirvin, D. J. & Fenlon, J. S. 2001. Plant species modifies the functional response of *Phytoseiulus persimilis* (Acari: Phytoseiidae) to *Tetranychus urticae* (Acari: Tetranychidae): implication for biological control. Bulletin of Entomological Research, 91: 61-67.

vanHaelen, N., Haubruge, E., Gasper, C. & Francis, F. 2001. Oviposition preference of Episyrphus balteatus. Mededelingen, 66 (2): 269-275.

Venzon, M., Janssen, A. & Sabelis, M. W. 2002. Prey preference and reproductive success of the generalist predator *Orius laevigatus*. OIKOS. 97: 116-124.

Yasuda, T. 1998. Role of chlorophyll content of prey diets in prey-locating behavior of a generalist predatory stink bug, *Eocanthecona furcellata*. Entomologia Experimentalis et Applicata, 86 (2): 119-124.

Zhang, Z. Q. 2003. Mites of greenhouses: identification, biology and control, CABI Publishing. 244 pp.

Table 1. Host plant parameters and predator predation and oviposition mean on the four experimental plants.

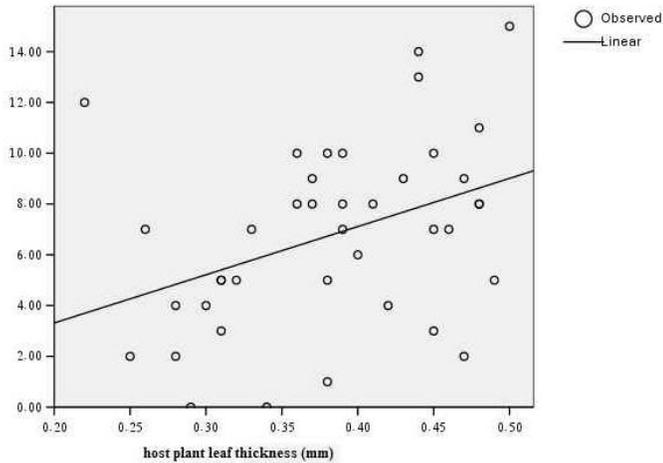| Host plant	Area (cm²)	Thickness (mm)	Chlorophyll content (mg/g)	Oviposition mean	Predation mean (unfed mites)
Tomato	04.71±0.36[c]	0.39±0.02[b]	32.18±1.34[b]	7.50±0.68[b]	6.10±0.88[c]
Cucumber	13.83±0.57[a]	0.37±0.01[b]	37.37±1.56[a]	6.20±1.02[b]	11.5±1.66[b]
Eggplant	10.80±0.73[b]	0.45±0.01[a]	26.94±1.79[b]	9.70±1.03[a]	12.5±2.40[b]
Sweet Pepper	11.21±0.64[b]	0.29±0.01[c]	33.64±1.54[c]	3.70±0.85[c]	18.2±1.65[a]

Figure 1. Regression curve between host plant leaf thickness and the predator oviposition preference (y axis: mean number of alive larvae).
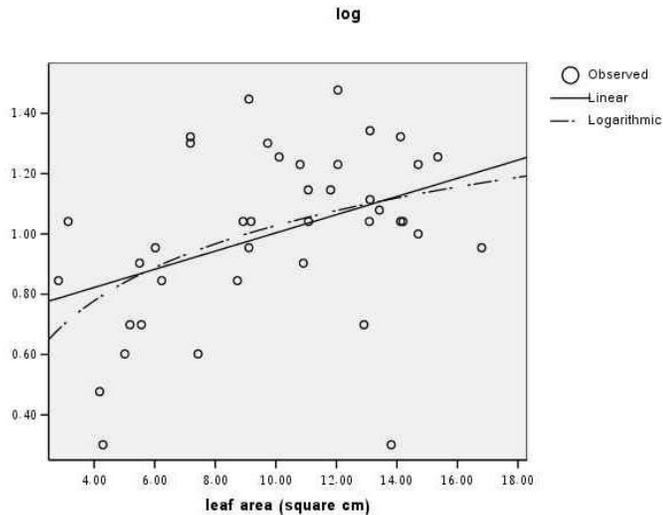

Figure 2. Regression curve between host plant leaf area and predation rate as the log number of unfed mites. Increase leaf area, more unfed mites left (y axis: mean number of alive mites).