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Physical structures of host plants affect preference behaviour of predaceous thrips, *Scolothrips longicornis* (Thysanoptera: Thripidae)

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ABSTRACT: The aim of this study was to determine the effect of plant physical structures of leaf surface on the first step of host plant preference behavior of predacious thrips, *Scolothrips longicornis.* The experiment was carried out using individual predators on two sets of leaf disks belonging to four host plants (cucumber, tomato, sweet pepper and eggplant) and the couple units of the plant leaf disks (tomato + cucumber, cucumber + eggplant and eggplant + tomato). Time taken for selection process was set to 5 minutes. The number selecting each plant and time needed to make decision were recorded and analyzed. Final results revealed the predator had no significant preference to the four plant disks, except in couple combination tests, eggplant with some physical features such as trichome type and density had the highest rate of selection. Predacious thrips preferred host plants with rational dense trichomes, which are arranged in clusters and leave some space for the predator to walk, search prey and also oviposit. Plants such as sweet pepper with low trichome density were not favorable for the predator. The predator could make decision between host plants within a family with similar leaf surface structure sooner than plants of different plant families confirming the effect of host plant structure on predator foraging behavior.

KEY WORDS: Host plant, preference, *Scolothrips longicornis.*

INTRODUCTION

Spider mites (Acari: Tetranychidae) are widespread agricultural pests which often cause severe damage to various crops (Gerlach and Sengonca, 1985). Biological control would be a good alternative to the other management methods, especially chemical control. Among the natural enemies of spider mites are predacious thrips with varying degree of specialization in mites. All species in the genus *Scolothrips* appear to be specialized predators of spider mites (Priesner, 1950). *Scolothrips longicornis* Priesner is a native predator in Iran in many plant fields such as cucumber, bean, tomato and sugarcane. In combining different management methods such as natural enemies and host plants, their interaction should be studied to predict the final output of the program (Pakyari *et al.,* 2008). Although major attention is focused on the host plant volatiles induced by herbivores affecting the natural enemies' reaction toward host plants, in some cases it is seen that plant physical structures such as color, architecture of the plants, extrafloral cup nectaries, special pads in leaf axils, hollow pocket in leaves or stems, surface complexity and tissue pockets or tufts of trichomes in vein axils could have greater effect (Marquis, 1996; Coll *et al.,* 1997; Clarck and Messina, 1998; Agelopoulos *et al.,* 1999; Roda *et al.,* 2001). The success of ladybird larvae *Coccinella septempuntata* L. in suppressing aphid population is largely related to the host plant surface structures (Bottrell *et al.,* 1998). Trichomes are the major factors which play opposite roles for the predator; they can alter their route toward prey and increase their handling time, or even prevent their oviposition as seen in *Anthocoris confusus* (Evans, 1976). On the other hand, they can provide shelter to hide behind and find more prey or provide a more efficient path to reach prey (Dicke and Sabelis, 1988). Agrawal (1997) also found the effect of avocado plant trichomes on the searching time of the phytoseiids. *Neoseiulus cucumeris* Oudemans is affected by eucalyptus leaf trichomes (Beard and Walter, 2001).

Some other studies show the effect of wax layer of the leaf surface on predators' efficiency (Eigenbrode *et al.,* 1996; White and Eigenbrode, 2000; Norton *et al.,* 2001; Chang and Eigenbrode, 2004).

As there is limited knowledge about the searching behavior of predatory thrips in relation to physical features of host plants, the aim of this study was to find out the effect of host plant physical surface factors on the decision making process of predacious thrips *S. longicornis* under laboratory condition.

MATERIAL AND METHODS

Predacious thrips *S. longicornis* was taken from laboratory colonies maintained on mixed stages of *Tetranychus urticae* Koch reared on cowpea plants. Colonies had been sustained in the laboratory with field collected individuals added periodically.

The aim of this study was to identify the reaction of thrips *S. longicornis* toward host plant physical surface structures such as trichomes. In order to investigate predator reactions toward host plant surface (Roda *et al.,* 2001), predator preference on leaf disks of four host plant species and their combinations at first contact was observed. At the first step, leaf disks of four plant species, cucumber (*Cucumis sativus cv. Sultan*), tomato (*Lycopersicon esculentum*), eggplant (*Solanum melongena*) and sweet pepper (*Capsicum annuum*) were prepared. These species are commonly cultivated under greenhouse conditions in Iran. The 30 square mm disks were provided in middle area of the leaf with the margin of main vein and placed upside down around a center on moist tissue paper to avoid losing humidity during the test. There was no gap between the disks and their sides were parallel so the thrips could walk on the disks easily. On each leaf disk, fifteen spider mite eggs were put as prey. Ten replications of disks in different Petri dishes (90mm diameter) were prepared and for each disk combination a female thrips prestarved for 8 hours was used. Totally 50 predators were considered for the experiment. The predators were isolated 5 days before the test from the semi-natural culture and kept on a leaf disk of squash full of mites in all the developmental stages. Eight hours before the test, the predators were put in a small Petri dish without any food to standardize the experimental condition and preventing the effect of previous feeding. Each predator was placed individually on the center of the disks and had 5 minutes to choose its favorable host plant leaf disk. During this period, its behavior was observed and the final decision was made about its behavior when the predator stopped on a disk and no more movement was seen (Beard and Walter, 2001). If after 5 minutes the predator was still walking and searching the area, it was omitted from the experiment (Coll, 1996; Eigenbrode *et al.,* 1996; Clark and Messina, 1998; Lliusia and Penuelas, 2001). Finally only 50 predators were used in the experiment and the data on 41 individuals were analyzed. For the second step, leaf disks of the same species were used in combinations of two plants: cucumber + tomato, cucumber + eggplant and tomato + eggplant. As sweet pepper was recorded as a non-favorable host plant for spider mites, it was omitted from the second step of the experiment. The procedure of the test was replicated as in the previous experiment, except, if after five minutes the predator could not decide among the host plants, it was recorded as no-choice and included in the data. Ten combinations of each couple host plants were prepared and finally data on 30 individuals were recorded. The final data of both tests were analyzed in non-parametric statistics of Chi-square test in SPSS 14.0. Time needed for decision making of the predator was recorded by a chronometer and the data were analyzed using one-way ANOVA and compared in Duncan's method.

RESULTS AND DISCUSSION

Results obtained from host preference studies on four host plant species revealed no significant difference in preference at the confidence level of 95% (X2 = 6.122, sig. = 0.10). The predators showed a tendency to choose eggplant leaf and consequently, cucumber and tomato had the highest choice rate (Table 1). The non-significant difference in the preference of predator showed that the predator could not choose the host plant at first contact with the structural features of host plant and it would take time to select the suitable host plant for its physiological needs. However, their final decision would not be accidental as in the combination tests, significant difference was observed in all the plant combinations.

Predacious thrips chose eggplant leaf disk in the combination of cucumber + eggplant with 3 no-choices and significant difference ($X^2 = 13.40$, sig. = 0.001). Again eggplant had the highest preference rate in the combination of tomato + eggplant with 2 no-choices ($X^2 = 11.40$, sig. = 0.003). In the combination of cucumber + tomato, preference rate tended toward cucumber leaf disks with 4 no-choices ($X^2 = 6.259$, sig. = 0.012). Significant difference was observed in the preference of the predator in couple combination leaf disks of plants indicating that eggplant would be the most favorable host plant which could provide a suitable pathway for predators to search prey and eventually oviposit in the leaf tissues. Cucumber leaf disks were the second choice among the four examined leaf disks indicating the logical and aiming attitude of the predator toward selecting host plants compared to tomato and sweet pepper.

Table 1. Number of leaf disks of host plant selected by *S. longicornis* in five minutes

Plant combinations		No. predator used	cucumber	tomato	eggplant	Sweet pepper	No-choice
Four plant combination		50	8	9	16	8	1
Units of two plant combinations	Test 1	30	21	6			4
	Test 2	30	8		19		3
	Test 3	30		11	17		2

There would be an explanation for the predators behavior in non-significant choice among four plants that is related to the host plant volatiles (Kheradpir *et al.,* 2009). These volatiles known as herbivore induced plant volatiles (HIPVs) are such compounds which are produced and / or released after infection of the herbivore on host plants and can play a role as info-chemicals to call natural enemies (unpublished data; Vet and Dicke, 1992). Predacious thrips in our experiment could be confused at first contact with four different volatile fogs belonging to the host plants and so it was not able to distinguish the most suitable one. On the other hand on combinations of two host plants, the predator engaged with a light concentration of host plant volatiles that would be easier to choose. Although host plant volatiles are reliable factors at distance, their impact on the final decision according to the olfactometery test cannot be ignored and finally the host plant physical factors are the last indices which are used the best by the host for searching prey and making colony (Roda *et al.,* 2001). As the main goal of this study was to investigate the predator's first decision in contact with different host plant surfaces, it is preferred not to talk about differences in host plant volatile quality and quantity.

The results regarding time needed to make decision showed that *S. longicornis* can make decision among four plant leaf disks in 61.75 ± 9.3 seconds, with no significant difference among experimental leaf disks. It is seen that the thrips chooses its favorable host plant according to its physical feature in around one minute. In the second step, the predator faced with couple combinations of leaf disks selected its host plant sooner. Between eggplant and cucumber, the predator made the decision in 35.22 ± 2.9 seconds and showed no significant difference when selecting between tomato and cucumber (31.34 ± 2.4 sec). The results showed significant difference when the predator was to choose between eggplant and tomato (78.25 ± 3.1 sec.). It can be concluded that *S. longicornis* could select its favorable host plant more easily according to the physical features of leaf surface between two plants of different families (Cucurbitaceae and Solanaceae) with different leaf structure than within one family (Solanaceae). As trichome structure in solanaceous plants is multi-lobular and the predator preferred leaf disks with this trichome style, eggplant and tomato were selected sooner than cucumber when combined. On the other hand, when the predator had to select between tomato and eggplant in combination, it took longer time with significant difference. Time needed to make decision between leaf surface structure can be an index of investigating foraging behavior that reveals its ability to make decision. Less time is needed with more variation in leaf structure.

Variation in trichome type among the four experimental plants can explain the final decision of the predator. In solanaceous plants like eggplant, sweet pepper and tomato, trichomes were in branched style with 5 - 7 setae in each bunch ; in cucumber, belonging to Cucurbitaceae, trichomes were individuals in close distance of each other. Probably multilobular trichomes of eggplant leaf disks provided suitable shelter for predaceous thrips to locate its prey and finally find a good place to oviposit but solitary and dense trichomes of cucumber impeded walking. Sweet pepper leaf surface with partially distant trichome bunches was not suitable for predator establishment on plant surface. According to similar studies, *Typhlodromus pyri* chooses the host plant according to its trichome density to find a suitable oviposition site. Smaller natural enemies are more affected by the leaf surface structure. As bigger sized predators such as lacewing larvae are not affected by plant trichome (Clark and Messina, 1998), Kauffman and Kennedy (1989) showed that density of trichome or glandular hairs can affect the movement of parasitoids and small predators especially at first contact. Finally it can be concluded that the predacious thrips chooses its host plant in close distance regarding trichome type and density. Physical structure of leaf surfaces leads to final decision of the predator to select its favorable host plant. Eggplant with the accumulated type of five trichome groups with long distance between neighboring groups would be the best host plant which provides a good shelter for the thrips, suitable for oviposition and also for searching prey. Eggplant leaf surface can affect the predator residence time by modifying the predator mobility or preference to oviposit (Clark and Messina, 1998). It seems plants have evolved such traits like dense multi-lobular trichomes to attract natural enemies to plants to retain them on the plant surface once they are attracted to herbivore induced plant volatiles (Marquis, 1996). The other examined host plants had leaf surface with more dense trichomes or the shape and the size of the trichomes were not favorable for the predator. Other predators of spider mites such as phytoseiids also get influenced by host plant surface (Beard and Walter, 2001). Marquis (1996) concluded that decreased trichome abundance may not only make leaves more accessible to arthropod predators but also to their prey and morphological traits are under indirect selection by the third trophic level for increased accessibility of predators and parasitoids to the plant's herbivores. The effect of plant surface on predator selection at first contact could be a key factor for the final result of prey foraging.

Although trichome quality and shape may affect *S. longicornis*, it is difficult to recognize its individual effect beside other physical and chemical signals from host plants. Karban and Agrawal (1997) have demonstrated the positive effect of plant domatia and trichomes on predaceous arthropods but there is no study done about *S. longicornis.* This study provides a link in testing the mutualism between host plant and predaceous thrips by measuring host plant trichome type on the predators' first reaction toward plant leaf surface structure. Further investigations are needed to show the effect of physical traits of host plant on the following steps in herbivore location by predaceous thrips.

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