Damage by Western flower thrips, *Frankliniella occidentalis* to strawberry: Effect of pest density, pollen and interactions between its predators *Orius laevigatus* and *Neoseiulus cucumeris*

Thesis

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ABSTRACT

Strawberry (*Fragaria* x *ananassa*) is an important crop, intensively cultivated for its aromatic red fruits. Its high nutritional value and delicate flavor have made it a regular part of the diet of millions. The spontaneous occurrence of various pests on the crop and their control by chemical means hinder the present demand for pesticide-free produce. *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), commonly known as Western flower thrips (WFT), has been considered a key pest of strawberry in many parts of the world, including Israel. It has been thought to cause damage to both flowers and fruits. The nature and extent of damage, however, remain ambiguous. In recent years, biological control of this pest has gained focus to encourage safe produce.

The overall objective of this study was to elucidate the relationship between WFT density and damage to strawberry fruits and flowers, to explore the role of pollen on the pest-predator interaction, and to suggest economic thresholds for WFT on strawberry.

In order to assess density dependent WFT damage on fruits and flowers, two separate experiments were conducted in the greenhouse. Five different densities of WFT were caged individually for four consecutive days on mature flowers and pinkish fruits. Damage on flowers was assessed by measuring the area of the receptacle, while a WFT damage index was developed to assess the nature and extent of damage to strawberry fruits. There was a significant size reduction of the strawberry receptacle at densities exceeding 10 WFT/flower. Flower damage was characterized by dry and withered anthers and stigma. Similarly, significant fruit damage was detected at densities above 10 WFT/fruit. Damaged fruits exhibited surface bronzing, russeting, feeding punctures and silvering around the achenes. WFT was not responsible for fruit deformation.

In the present study, *Orius laevigatus* (Fieber) (Hemiptera: Anthocoridae) and *Neoseiulus cucumeris* (Oudemans) (Acari: Phytoseiidae) were chosen as biocontrol agents of WFT and their separate and joint contributions to the control of WFT on strawberry was explored. First, within-plant distribution of WFT and its predators was explored. More thrips were found on strawberry flowers bearing pollen than on those without pollen, regardless of the presence of predators. In absence of pollen, thrips were recovered primarily on the fruits. Similar distribution was recorded for *O. laevigatus*,

whereas *N. cucumeris* was found in flowers bearing pollen only when *O. laevigatus* was absent in the flower.

It was clear that *O. laevigatus* feeds on *N. cucumeris* as well as WFT. *Neoseiulus cucumeris* feeds only on first instar WFT; however, in the laboratory *N. cucumeris* was also found to attack second instar WFT. The effect of pollen on the interactions between these arthropods was also explored, since *O. laevigatus* and *N. cucumeris* feed and develop on pollen especially when prey is scarce. Intraguild predation (IGP) between thrips predators has been thought to reduce the efficiency of WFT control. Pollen had a significant effect on the efficiency of both WFT predators and on the extent of fruit damage, as well. Significantly less IGP was observed in the presence of pollen when tested on a leaf disc. When both predators were present on the strawberry plant, significantly lower fruit damage was observed in the absence of pollen than in its presence.

In Israel, two distinct strawberry growing periods are recognized per year, winter and spring. The winter produce is targeted for international markets because of its high off-season export value. Because of their low value compared to the winter produce, spring season yields are sold on the local markets. The production of export quality fruit in the winter was found to be associated with low WFT occurrence. Studies show that the WFT population remains low during winter and increases with the onset of spring. Thus the two target markets require two sets of decision making tools.

In the present study two economic injury levels (EIL) were calculated. Statistics on annual strawberry production and marketing for 2002/03 published by the Extension Service of the Ministry of Agriculture were used for calculating EIL. The study indicated an EIL of 5 WFT/fruit for export quality strawberries, and 16 WFT/fruit for the local market. A field survey conducted to explore the ratio of WFT density on strawberry flowers and fruits revealed that 3-4 times more WFT are found on flowers than on fruits. The calculated EIL was 15 WFT/flower for export and 50 WFT/flower for the local market. The EILs were then used to calculate the ET. To compensate for a 1-day response time between sampling and treatment, ET_{export} was set at 67 % of EIL_{export} = 10 WFT/flower. During the spring the thrips population may increase rapidly due to higher temperatures. Thus, ET_{local} was thus set at 50 % of EIL_{local} = 25

WFT/flower. The effect of pollen and predation by *O. laevigatus* and *N. cucumeris* on WFT was then taken into account adjusting the ET for export and local market produce.

In conclusion, the results of this study indicate that WFT causes mostly cosmetic damage to strawberry fruits; higher densities render the fruit unsuitable for export. In strawberry the presence of pollen helps to reduce damage both by reducing the predation of *N. cucumeris* by *O. laevigatus*, and by causing most of the WFT population to move onto flowers rather than fruit. Because the rate of predation of the pest is relatively low in the presence of pollen, it is recommended that each species of predator be released separately, at a time when pollen is unavailable, i.e. between peaks of flowering. If one of the predators is present in the field and the other species is to be released to augment control of WFT, releases should be planned at the flowering stage in order to minimize antagonistic interactions between the two predators.

The results of this study suggest a quantitative approach to control WFT which makes it possible to take the combined effects of predation and crop phenology (presence/absence of pollen) into account when considering control measures. The data indicate that routine monitoring of WFT, its predators, and the presence of flowers would promote a cost effective WFT management program in strawberry.