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# Monitoring of western flower thrips (*Frankliniella occidentalis* [Pergande], Thysanoptera) in the vicinity of greenhouses in different climatic conditions in Slovenia

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To study the bionomics of western flower thrips (Frankliniella occidentalis) in Slovenia in the open, monitoring of this pest was performed on six locations in the vicinity of the greenhouses using light blue sticky boards. From the data obtained during this investigation - from September 1997 till April 1999 - it was established that the occurrence of western flower thrips in the open coincides with periods, when the air temperature is within the estimated limits of favourable conditions (15 °C - 25 °C). It was found that in districts with the temperate continental climate, the favourable period for the development of western flower thrips is between the middle of May and the middle of September. However, in districts with the submediterranean climate, this period extends from the beginning of May till the beginning of October. In the first districts, the air temperatures are above the lower developmental threshold from the middle of April till the middle of October, in comparison to the later districts where the air temperatures are above the same threshold from the end of March till the middle of November. Therefore it can be concluded that in Slovenia western flower thrips (Frankliniella occidentalis [Pergande]) does not overwinter in the open in the stage of an active adult. For the time being it can be considered as an economically important pest only in greenhouses. Agricultura 2: 1-6 (2003)

Key words: monitoring; *Frankliniella occidentalis*; environment; overwintering; Slovenia

## INTRODUCTION

Western flower thrips (*Frankliniella occidentalis* [Pergande]) is one of the most important greenhouse pests in Europe (Brødsgaard 1989; Schmidt and Frey 1995; Tommasini and Maini 1995). This polyphagous species is difficult to control because of its small size, rapid reproduction, and widespread resistance to pesticides (Helyer and Brobyn 1992, Immaraju et al. 1992, Gaum et al. 1994; Herron and Cook 2002). The species feeds on a number of plant stages and tissues within their hosts, ranging from pollen to leaves and other vegetative issues (Van Dijken et al. 1994, Harrewijn et al. 1996). Most of the damage caused by this thrips is based on scarring from its feeding style, besides the species acts as a vector for tomato spotted wilt virus (Chatzivassiliou et al. 2000).

The occurrence of western flower thrips (*Frankliniella occidentalis* [Pergande]) in some greenhouses and their vicinities in Slovenia was first confirmed in 1992 (Janežič 1993). After this year, the presence of this pest was frequent in our country (Trdan et al. 1999). The occurrence of western flower thrips in last decade of 20$^{th}$ century, together with continuing positive trends of air temperature in Slovenia (Rakovec et al. 1998), were the reasons for our investigation of life and development (bionomics) of this pest under different climate conditions. Especially, while western flower thrips is considered as an important outdoor pest in some parts of the world with warmer climate as the present climate of Slovenia (Chyzik et al. 1995, Gonzales 1996, Grove et al. 2001). The study was performed on various locations with different climate conditions, covering most important agriculture areas of Slovenia.

So, up to now, it has been reported that in littoral part of Spain the pest remains active in the open air all over the year in present climate conditions (Lacasa et al. 1995). In the central part of Italy adults can also overwinter outside the greenhouses in a torpid (dormant) form on some hosts (Del Bene and Gargani 1989), but in Hungary it can survive in the field only during the vegetation period (Jenser 1990).

Until recently, the western flower thrips has been considered as an exclusively greenhouse pest in Slovenia, so

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only few payed attention to the direct influence of the environment on its occurrence in various geographic districts. The 18-months investigation of the bionomics of the western flower thrips was undertaken to get data on these influences. The bionomics of *Frankliniella occidentalis* (Pergande) in the open air was studied on six locations in Slovenia, three of them lie in the temperate continental zone while three places are located in the submediterranean climate zone.

The main objective of our study was to investigate the possibility for overwintering of western flower thrips as an active adult in the open air in present climate conditions. Possible extensive outdoor overwintering of this species should result in radical changes of the control strategy, while *Frankliniella occidentalis* (Pergande) belongs among quarantine pests in EU (Karnkowski and Trdan 2002), while tomato spotted wilt virus is one of the most important quarantine virus in the same region (Smith 1999).

## MATERIAL AND METHODS

The fluctuations in the number of western flower thrips specimens in the open air were studied in connection to weather conditions all over the year. Because of the interesting geographic position of Slovenia, agricultural land is located in three major districts with different climate (subpannonical/temperate continental in the eastern part, subalpine in the central lower part and submediterranean in the western part of the country). These districts also exhibit several local climatic differences (Ogrin 1998, Rakovec and Vrhovec 1998). The goals of our study were to investigate the survival of western flower thrips (*Frankliniella occidentalis* [Pergande]) in the open air during the winter period, and to find possible connections between the fluctuations of the adults and different weather conditions during vegetation period.

The monitoring of the species was performed using light blue sticky boards. They are worldwide as well as in Slovenia most frequently used tool for such purposes during the last decade (Cabello et al. 1991, Br¸dsgaard 1993; Trdan 1999a; Trdan 1999b). Rectangular sticky traps (11 x 13 cm) were used in the period from September 1997 till April 1999 on the following locations: Ljubljana, Kočevje, Juršinci, Vrtojba, Šempeter and Koper.

The meteorological data for this locations were used from the nearest meteorological stations. The pairs of experimental locations and representative meteorological stations, together with their geographical information, climate, long-term averages of mean annual air temperature and cumulative rainfall, are presented in Table 1. The experimental locations were chosen on the base of pronounced populations of western flower thrips in greenhouses reported during the years preceding the monitoring.

During the chosen periods the sticky traps were placed round the greenhouses: 16 boards on the top of pillars app. 1 m high, 4 of them immediately at the greenhouse, 4 at the distance of 10, 4 at the distance of 20 and 4 at the distance of 50 m from the greenhouse. Among 4 traps on each distance from the greenhouses, a single trap was located on each cardinal point. The time of exposure was different for different periods of the year, in summer usually shorter than in winter. After the exposure, the boards were collected and kept in PE bags. Till the examination they were kept in refrigerator (temperature 2-4 °C). They were examined under a classical stereomicroscope (15-times magnification). On both sides only the females were considered, since the determination of males under a stereomicroscope is difficult and unreliable.

**Table 1: Locations where the monitoring of western flower thrips (*Frankliniella occidentalis* [Pergande]) was performed, the nearest meteorological stations and their geographical locations (latitude – φ, longitude – λ, altitude – z), long-term average mean annual air temperatures (T), cumulative annual precipitation (R) for the period 1971-2000, and the area climate zone.**

| Location | Nearest meteorological station | φ [N] | λ [E] | z [m] | T [°C] | R [mm] | Climate* |
|---|---|---|---|---|---|---|---|
| Koper | Portorož | 45° 32' | 13° 34' | 92 | 13.4 | 989 | SM |
| Bilje | Vrtojba | 45° 54' | 13° 38' | 55 | 12.2 | 1531 | SM |
| Šempeter | Nova Gorica | 45° 57' | 13° 39' | 113 | 12.0 | 1446 | SM |
| Juršinci | Starše | 46° 28' | 15° 46' | 240 | 9.8 | 954 | TC |
| Kočevje | Kočevje | 45° 38' | 14° 52' | 461 | 8.6 | 1476 | TC |
| Ljubljana | Ljubljana | 46° 02' | 14° 31' | 299 | 10.2 | 1368 | TC |

* SM – submediterranean, TC – temperate continental

The mean number of females caught per day (N) on each distance from greenhouses was calculated on the basis of all available sticky boards. Usually the data from 4 sticky boards were available, except in cases where some of the boards were removed by strong winds. These are common in the south-western part of the country with the submediterranean climate. The means are represented on figures as white bars. Beside the mean number of females caught per day, also the standard error of mean (Clarke and Cookie 1998) was estimated on the base of the same data. The standard errors of means are represented on figures as vertical lines in the center of white bars.

The favourable temperature conditions for development of western flower thrips (*Frankliniella occidentalis* [Pergande]), i. e. from 15 °C up to 25 °C, were estimated on the basis of our previous study that included laboratory experiments with rearing chamber (Trdan and Milevoj 2000), different literature sources (Shipp and Gillespie 1993; Boissot et al. 1998), and data collected during this study. The lower developmental threshold of western flower thrips, i. e. 9.5 °C, were determined on the basis of literature sources (Gaum et al. 1994, Katayama 1997).

## RESULTS AND DISCUSSION

On all the locations (Fig. 1-6) the first females were observed already in September or October 1997. The temporal pattern of the number of specimens caught on the boards, which were placed at different distances from greenhouses, was rather uniform for all experimental locations. The only exception was location Ljubljana, where the population of pest went through a mass gradation in the greenhouse some month before monitoring started and remained in it also during first two observation periods. Afterwards, the number of female adults in the greenhouse was drastically reduced, because of the removal of the host – the

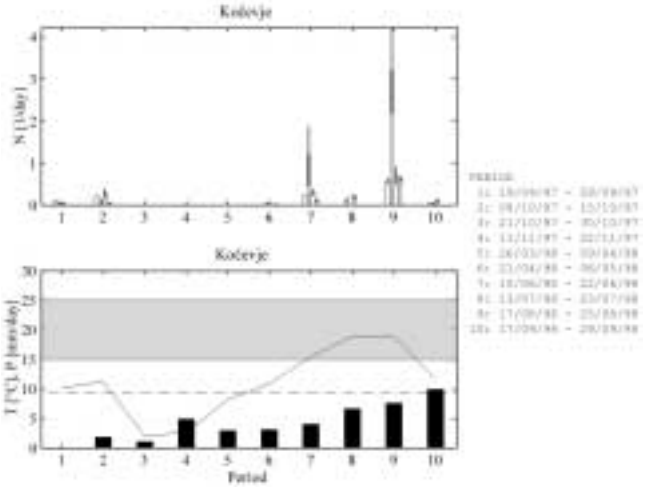


**Fig. 1. A number of females caught per day (N) on experimental location Kočevje in different periods (top figure) together with simultaneously observed mean daily air temperatures (T in °C) solid line, and cumulative daily precipitation (P in mm) – black bars on the nearest meteorological station (bottom fiure). White bars for single period present mean N at the various distances – 1 m, 10 m, 20 m, and 50 m, and line in their centers the corresponding standard error of mean. Shaded area on bottom figure presents the favourable temperature conditions, and dashed line the lower developmental threshold of western flower thrips (*Frankliniella occidentalis* [Pergande]).**

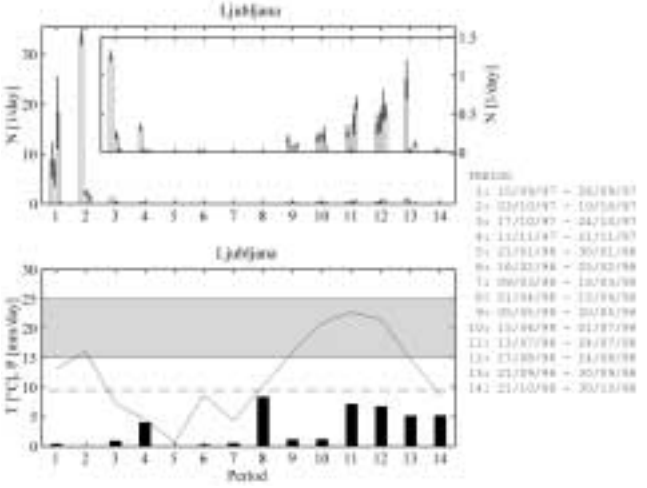


**Fig. 2. The same as Figure 1, but for experimental location Ljubljana**

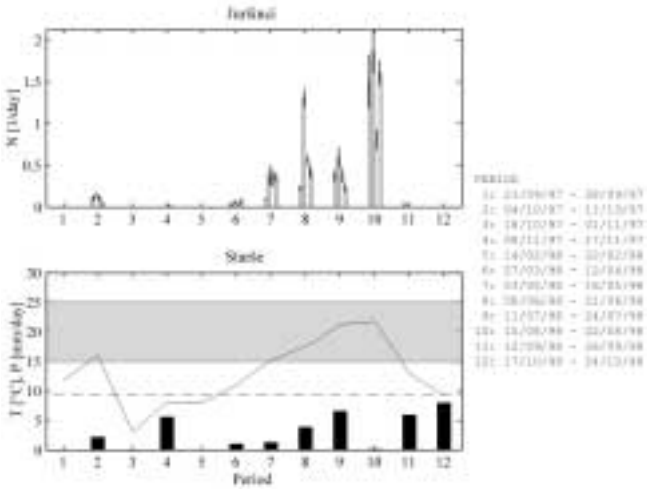


**Fig. 3. The same as Figure 1, but for experimental location Juršinci**

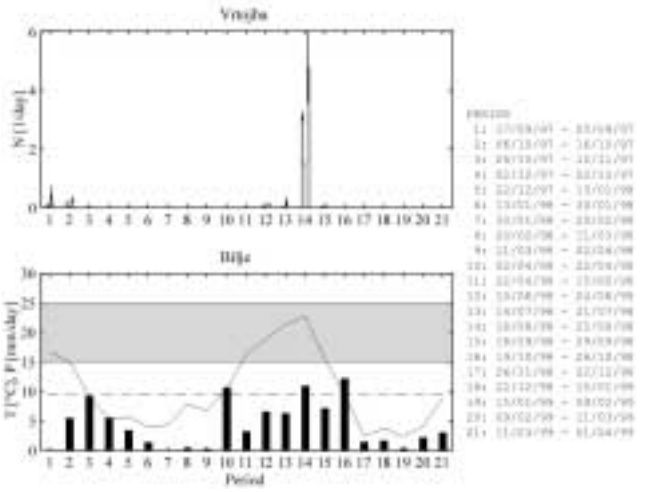


**Fig. 4. The same as Figure 1, but for experimental location Vrtojba**

cucumbers. In general, the occurrence of western flower thrips coincides with periods, when the air temperature is within the estimated limits of favourable conditions.

In the beginning of November no female adults were found any more in the central part of Slovenia (Fig. 1-3), only single specimens were found on the three locations in Slovenian Primorje (Fig. 4-6). The unusually warm December 1997 - February 1998 period made us proceed with the monitoring in Ljubljana and Juršinci (Fig. 3), but no thrips were found on the boards there. *Frankliniella occidentalis* (Pergande) did not reach its lower developmental threshold at that time in spite of the very warm period, so the thrips did not leave the nearby of greenhouses, where they overwintered very probably as adults or as non adult stages in soil. No female adults were found in Vrtojba (Fig. 4), Šempeter (Fig. 5) and in Koper (Fig. 6) during the winter months. The rare specimens caught very probably originated from the greenhouses nearby.

In the spring 1998 the first females were observed in the period from the end of February till the beginning of March in Koper. This has been expected, as the average temperatures on this location were the highest and so these females were the first to enter the active period. The greenhouse on this location was empty during the winter months and we assume that the specimens would have been found even earlier if not so.

In Šempeter the female adults were detected app. one month later, they were found also 50 m from the greenhouse, which could mean that they could overwinter on the host plants (trees, bushes or wild growing grasses) or in soil. In Vrtojba the first females were observed in the period between the end of April and the beginning of May. This may be due to non heated greenhouse on this location which is also considerably more exposed to wind compared to the location in Šempeter.

In Juršinci first females were observed app. at the same time as in Šempeter. They came very probably from the greenhouse where ornamental flowers were grown at that time. In

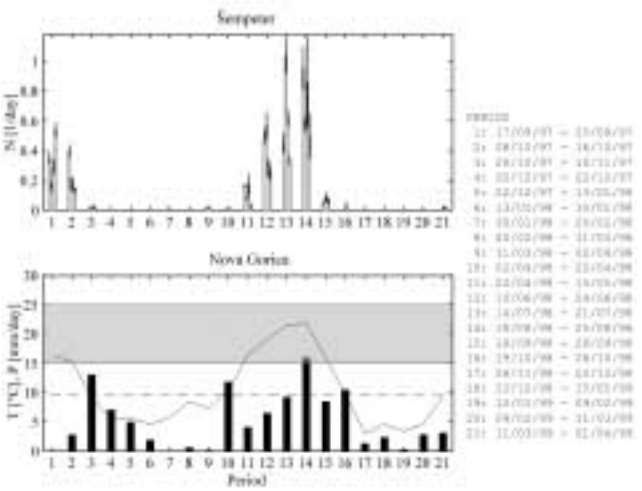


**Fig. 5. The same as Figure 1, but for experimental location Šempeter**

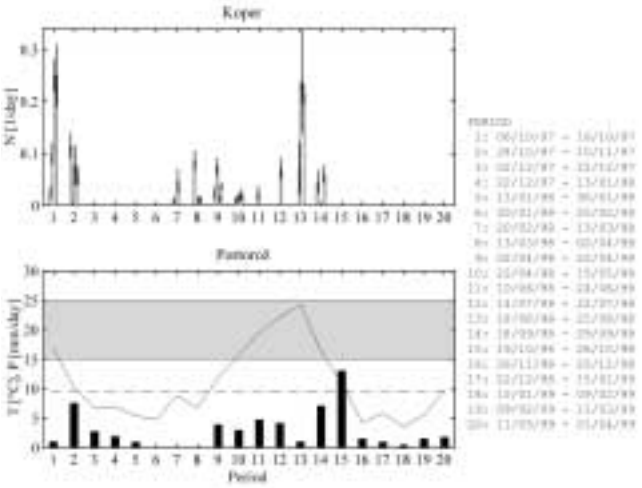


**Fig. 6. The same as Figure 1, but for experimental location Koper**

Kočevje and in Ljubljana the first females were found app. at the same time as in Vrtojba.

In the period from May 1998 till September 1998 the number of females caught per day drastically differs among different experimental locations. There are various reasons for these differences. Different amount of precipitation on chosen experimental locations could be the decisive reason. The agrotechnical measures undertaken also play an important role. So, intensive insecticide treatments of chrysanthemums in the greenhouse in Kočevje (Fig. 1) resulted in a greater number of thrips further from the geenhouse, where plenty of suitable host plants were available. Using the herbicides to control weeds in the greenhouses or turf in their vicinity can drastically reduce the number of the specimens at small distances from the greenhouses. This was true for Kočevje, Juršinci and Vrtojba. The pronounced decline of the pest population in the greenhouse in Ljubljana is a result of the spring weed control in it. Namely, during autumn 1997 and winter 1997/98 the species could comfortably survive as adults on the weeds present (e. g. *Stellaria media* (L.) Vill. and *Convolvulus* spp., only single specimens were found on the latter).

The constantly present uniform population in Juršinci had plenty of vegetables to feed on, the abundant foliage was a shelter from unfavourable weather conditions (above all the heavy rainfall).

The results for comparable locations Vrtojba and Šempeter show pronounced maximum in the number of the western flower thrips caught on the light blue sticky boards in Vrtojba. These can be attributed to the less abundant precipitation in the period before the boards were placed. On such exposed sites, rainfall have a pronounced influence on the bionomics of the species in the open air. The low number of the specimens caught in Koper was very probably due to relatively empty greenhouse during the entire vegetation period.

The thrips fed on wild growing plants (Jenser 1990, Chellemi et al. 1994, Trdan et al. 1999), so they were found also at greater distances from the greenhouse. The occurrence of western flower thrips (*Frankliniella occidentalis* [Pergande]) in Šempeter was rather uniform, due to the great variety of plants grown there, so the pests have many host plants to choose from, when they look for shelter in time of unfavourable weather conditions.

In September 1998 the pest became less frequent on all the locations, in October only single specimens were found on some locations. During the last period of this investigation (March 1998) first females were already found on the sticky boards, on these location (e. g. Šempeter) they appeared at the same time as during the previous year.

As far as temperature is considered, in the districts with the temperate climate (Kočevje, Ljubljana and Juršinci), in present climate conditions the favourable period for the development of the pest in the open air is generally from the middle of May to the middle of September. In districts with the submediterranean climate (Vrtojba, Šempeter and Koper), the period with the favourable conditions is a bit longer. It extends from the beginning of May till the beginning of October. In the first districts, the lower developmental threshold is exceeded from the middle of April till the middle of October, in comparison to the latter districts where the same threshold is exceeded from the end of March till the middle of November. This conclusions base on our

**Table 2: Long-term averages (1971-2000) of mean monthly air temperatures (T in °C) and cumulative precipitations (P in mm) for meteorological stations near experimental locations.**

| Meteorological station | Portorož | | Bilje | | Nova Gorica | | Starše | | Kočevje | | Ljubljana | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month / Variable | T | P | T | P | T | P | T | P | T | P | T | P |
| Jan | 5.0 | 63 | 3.4 | 99 | 3.0 | 95 | -0.6 | 41 | -0.9 | 80 | -0.1 | 71 |
| Feb | 5.5 | 54 | 4.4 | 75 | 4.1 | 74 | 1.4 | 44 | 0.4 | 84 | 1.8 | 71 |
| Mar | 8.3 | 68 | 7.8 | 84 | 7.4 | 83 | 5.5 | 60 | 4.1 | 106 | 6.1 | 87 |
| Apr | 11.8 | 74 | 11.3 | 119 | 11.0 | 114 | 9.9 | 69 | 8.1 | 115 | 10.0 | 103 |
| May | 16.6 | 76 | 16.1 | 135 | 15.9 | 122 | 14.9 | 83 | 13.1 | 115 | 15.0 | 113 |
| Jun | 20.2 | 94 | 19.3 | 160 | 19.3 | 145 | 18.1 | 109 | 16.2 | 148 | 18.1 | 154 |
| Jul | 22.7 | 64 | 21.7 | 113 | 21.7 | 101 | 19.9 | 110 | 18.2 | 118 | 20.4 | 117 |
| Aug | 22.5 | 78 | 21.2 | 124 | 21.1 | 114 | 19.2 | 105 | 17.5 | 127 | 19.8 | 134 |
| Sep | 18.7 | 114 | 17.2 | 152 | 16.8 | 158 | 15.1 | 94 | 13.7 | 146 | 15.5 | 131 |
| Oct | 14.3 | 118 | 12.5 | 178 | 12.2 | 164 | 9.8 | 91 | 9.0 | 161 | 10.3 | 147 |
| Nov | 9.5 | 104 | 7.5 | 163 | 7.3 | 150 | 4.3 | 84 | 3.8 | 157 | 4.5 | 137 |
| Dec | 6.3 | 82 | 4.2 | 129 | 3.8 | 126 | 0.5 | 63 | -0.1 | 117 | 0.7 | 103 |

monitoring of the western flower thrips on experimental locations and simultaneous observed values of mean daily air temperatures on the meteorological stations near the experimental locations (Fig. 1-6). Also the long-term averages of mean monthly temperatures measured on representative meteorological stations (Table 2) were considered.

The results of similar investigations in the northeastern part of the USA which have a similar climate as Slovenia can be used to confirm the conclusions presented in this work.

They state, that the first adults usually are found in May and they overwinter in soil in the open air in spite of the fact that the temperatures during the winter can be below zero as long as 35 days in succession (Felland et al. 1993, 1995). The climate in Slovenia is milder even in the continental part of the county. The data for January, the coldest month in Slovenia, are as follows: in Kočevje and in Maribor the lowest temperatures are not below zero for more than 26 days and in Ljubljana not for more than 24 days in succession (Hydrometeorological Institute of Slovenia 1996). Though western flower thrips can be active in the open all the year round in the littoral region in Spain, the climate in the Slovenian Primorje is obviously colder and gives no such opportunities.

The overwintering in an non active form, though in the open air, does not give the pest any possibility to develop a resistance to lower temperatures on the short term. Trials of systematic adaptation of active larvae and adults to lower temperatures which were conducted in England, failed. The insects were not able to overwinter in an active form (McDonald et al. 1997).

Though the results of the monitoring show that the pest can survive during the winter period either in protected places (e. g. greenhouses etc.) or in soil, no serous damages by this pest are probable on its hosts which are grown in the open. Meaning that in Slovenia, the western flower thrips (*Frankliniella occidentalis* [Pergande]) can be considered an economically important pest only in greenhouses, at least until it develops strains which would be resistant to lower temperatures or untill the climate in Slovenia has changed considerably.

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