Journal of Plant Diseases and Protection, **118** (5), 185–193, 2011, ISSN 1861-3829.

The occurrence of thrips (Thysanoptera) on food legumes (Fabaceae)

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Received 13 March 2011, accepted 07 September 2011

Abstract

The occurrence, quantity and population fluctuations in thrips (Thysanoptera) on various food legume crops (Leguminosae or Fabaceae) in southern Poland were investigated. Eighteen species of thrips have been described on food legume vegetables, with *Thrips tabaci*, *Frankliniella intonsa* and *Thrips fuscipennis* being the most common. The latter three species made up 90% or more of the total number of thrips collected during 2006 and 2007. Thrips occurred on peas (*Pisum sativum*) and lentil (*Lens culinaris*) in May and June, and on beans (*Phaseolus vulgaris*) and soya beans (*Glycine max*) in June and July. The number of *T. tabaci* on (young) lentil and peas was significantly higher than on beans and soya beans. Most were observed in the flowers and developing young pea pods. A large number of *Frankliniella intonsa* was present during the flowering stage, but the insects were short-lived. *T. fuscipennis* was present in all samples, with a peak in numbers during the flowering period.

Key words: Bean, *Frankliniella intonsa*, lentil, pea, soya bean, *Thrips fuscipennis*, *Thrips tabaci*

Introduction

The conditions in the south of Poland are favourable for growing many species and varieties of food legume crops (Leguminosae or Fabaceae). The most popular are beans and peas. There is currently a trend towards the cultivation of other crops, such as lentils and soya beans. Legumes are inhabited by a number of pests, including thrips (Thysanoptera). Thrips damage crops by feeding directly on leaves, flowers and/or fruits (Lewis 1975, 1997). They are difficult to control due to their small size, high reproduction rates and rapid development of resistance to many insecticides (Shelton et al. 2003).

In Europe, onion thrips (*Thrips tabaci*) is the major foliage pest in field cultures of onion (Nawrocka 2003, Richter et al. 1999), leek (Legutowska & Theunissen 2003), and cabbage (Kahrer 1992, Liu & Sparks 2003, Pobożniak & Wiech 2005). In agreement with their polyphagous nature, they can be found on legume vegetables as well (Wnuk & Pobożniak 2003). In Hungary, onion thrips inhabit soya bean; they initially feed extensively on the leaves, followed by feeding on the generative organs of the crops (Abraham & Kurowi 2003). In the US, *T. tabaci* is a dangerous pest on pea pods (Gaskel 1997). In addition to direct damage, it also contributes to the development of the fungal disease, *Ascochyta pisi*.

In Hungary, pea thrips, *K. pisivorus*, is one of the thrips species associated with more serious damage to pea and bean crops (Jenser & Czencz 1988). In England, *K. pisivorus* causes bud and flower fall, deformation and discoloration of the pods and a lack of seed set (Williams 2008). In parts of France and England, another species, *Thrips angusticeps*, is regarded as the most dangerous pest on pea and lupines (*Lupinus albus*) (Fergusson 1994, Taupin et al. 1991).

At the time of flowering, peas and beans can also be colonised by thrips species that are attracted to flowers. The most common are *Frankliniella intonsa*, *Thrips fuscipennis*, *Thrips flavus* and *Thrips atratus* (Wnuk & Pobożniak 2003). These thrips are attracted to flowers because they require pollen for growth, sexual maturation or oviposition (Kirk 1984).

Knowledge regarding species composition of thrips on legume vegetables is very limited. Most is known about species inhabiting the flowers; the presence of thrips on other parts of the plant or outside the flowering period season is seldom taken into account.

The objective of the present study was to evaluate the occurrence, the quantity and the fluctuations in density and composition of different species of thrips on various legumes during the entire growing season.

Materials and methods

In 2006 and 2007, field experiments were conducted at the Experimental Station of the Faculty of Horticulture, Agricultural University in Krakow, located in Mydlniki (near Krakow, southern Poland) on a typical brown soil with pH 6.5 and organic carbon content of 1.8%. The following species and cultivars of food legumes were used: pea (*Pisum sativum*) – very early cv. Pionier, early cv. Cud Kelwedonu, middle early cv. Walor; bean (*Phaselous vulgaris*) – French bean, early cv. Sandra (with green pods) and middle early cv. Tina (with yellow pods), stunted shell bean, middle late cv. Nata; lentil (*Lens culinaris*) – early cv. Anita; and soya bean (*Glycine max*) – very early cv. Aldana. A randomised block design was used with four replications. Plot size was 16 m^2 (4 × 4 m). Plots were separated by 0.5 m wide paths. Seeds were sown in rows, 0.3 m apart. All pea and lentil varieties were sown on 4 and 3 April in 2006 and 2007, respectively, while all bean and soya bean varieties were sown on 11 and 9 May in 2006 and 2007, respectively. In the spring of 2006 and 2007, the field was fertilised according

to recommendations for food legumes (70 kg P_2O_5 and 100 kg K_2O in autumn and 35 kg N). No chemical treatments were applied and weeds were removed mechanically and manually. Previously, various vegetables had been grown on this field, of which some (onion, leek, cabbage, and herbs) are important host for thrips. Air temperature and rainfall were recorded with the use of the meteorological station (Fig. 2) at the Experimental Station in Mydlniki about 700 m away from the field experience.

The sampling period in both seasons started in May and lasted until the end of July. Thrips were caught using the standard entomological sweep net. A single sample consisted of four series of 25 sweeps within each plot, which was placed in a plastic bag. In the laboratory, adult and larvae thrips were extracted and kept in a conservation fluid (60% ethanol with glycerol). The larvae were not identified to species, because that is either too difficult or not possible. Adult thrips were determined to species level according to Schliephake & Klimt (1979) and Strassen zur (2003), using a microscopic technique (Zawirska 1994).

For each cultivar, the average number of thrips was calculated and analysed using ANOVA using the statistical software package Statistica 9.0. The Duncan test ($P \leq 0.05$) was used to determine differences between cultivars in the case of siginicance.

Results

Occurrence of thrips species on food legumes

A total of 10687 adult thrips were collected and identified (Table 2). The highest number of thrips (about 2000 per four plots) was observed on lentil and early and middle early cultivars of pea (Cud Kelvedonu and Walor). For other crop cultivars, the number of adult thrips ranged from 1166 on French bean cv. Tina to 799 on soya bean. Eighteen different thrips species were identified (Table 2), with *Thrips fuscipennis* (3828 specimens), *T. tabaci* (3000 specimens) and *Frankliniella intonsa* (2947 specimens) the most frequently occurring. *K. pisivorus* and *Odontothrips loti*, two oligophagous species associated with legumes, occurred at 23 and 35 per four plots. Two species of predatory thrips were present, namely *Aeolothrips intermedius* at 524 adults per four plots and *Scolothrips longicornis* at 7 adults per four plots. Several polyphagous species connected with the flowers of dicotyledonous crops were found, namely *Tenothrips frici*, *Thrips atratus*, *Thrips flavus*, *Thrips major*. Species found in the leaves included *Thrips angusticeps*. Also species that generally feed on cereals and grasses have been found in the peas occasionally: *Chirothrips manicatus*, *Haplothrips aculeatus*, *Limothrips denticornis*, *Neohydatothroips gracilicornis* and *Stenothrips graminum*. The numbers of polyphagous thrips were small and ranged from 4 to 94 specimens per four plots (Table 2). The species composition of thrips on all of the tested legume crops was very similar, however, the abundance of specific species on cultivars differed (Table 2).

When all legumes are planted next to each other (as in this trial), *T. tabaci* prefers lentil (840 specimens per four plots) and pea (middle early cv. Walor and early cv. Cud Kelwedonu, 612 and 681 specimens per four plots, respectively). Early pea (cv. Pionier), bean and soya bean were not preferred by onion thrips as the number of individuals ranged from 104 to 259 per four plots (Table 2). *F. intonsa* and *T. fuscipennis* had similar preferences as *T. tabaci*. In the case of *F. intonsa*, the difference between lentil and pea on the one side and early pea, bean and soya bean on the other side were not as distinct as for *T. tabaci*. In the case of *T. fuscipennis*, the French bean cv. Tina was more heavily infested than the other varieties of beans (Table 2).

Significantly more *F. intonsa* individuals were found on plots with lentil than on plots with other crops. In 2006, the average number of *F. intonsa* was higher on pea (cv. Walor and Cud Kelwedonu) than on other crops and varieties. In 2007, French bean cv. Tina was more heavily infested than other cultivars of beans, soya bean and early pea (cv. Pionier).

In the case of *T. fuscipennis* in 2006, more thrips were found on pea (Walor and Cud Kelwedonu), lentil and French bean cv. Tina than on other varieties of beans and very early pea cv. Pionier. In 2007, middle early pea cv. Walor was more heavily infested than bean cv. Tina and lentil. Bean cv. Nata and Sandra, soya bean and pea cv. Pionier were less inhabited by this species.

Changes in population densities of *Thrips tabaci*, *Thrips fuscipennis* and *Frankliniella intonsa* over time

Three species, namely *T. tabaci*, *T. fuscipennis* and *F. intonsa*, were chosen for a more detailed analysis (Fig. 1). The three species were selected based on their density, the likelyhood to cause damage to food legumes (Abraham & Kurowi 2003, Gaskel 1997, Kirk 1984) and the fact that these species feed on the generative parts of crops.

T. tabaci was observed on emerging pea and lentil in early May and on beans and soya bean a month later. Densities of adults of the most numerous thrips during emergence and main sprout forming, namely onion thrips, were highest on lentil (40 and 60 per plot, in 2006 and 2007, respectively), followed by early and middle early cultivars of pea (20 and 30 per plot in 2006 and 2007, respectively). During flower bud formation and flowering of lentil and pea (fourth week of May – the third week of June), the number of onion thrips increased Table 1, Fig. 3–4). *T. tabaci* was repeatedly seen feeding on young pea pods. During maturation of the pods, the number of individuals decreased. In contrast, the population density of *T. tabaci* on bean and soya bean, remained at the same level throughout the growing season (Table 1, Fig. 3–4).

Densities of *T. fuscipennis* and *F. intonsa* followed the course over time, although, on most legume crops, the density of *F. intonsa* was higher than of *T. fuscipennis*. *T. fuscipennis* was present in all samples. Adults were active from the beginning of May to the end of July, with maximum activity during the flowering period, which was different for the various crop species and cultivars (Table 1, Fig. 2–3). Similarly, the presence of *F. intonsa* coincided with flowering. The first adults were caught with the appearance of the

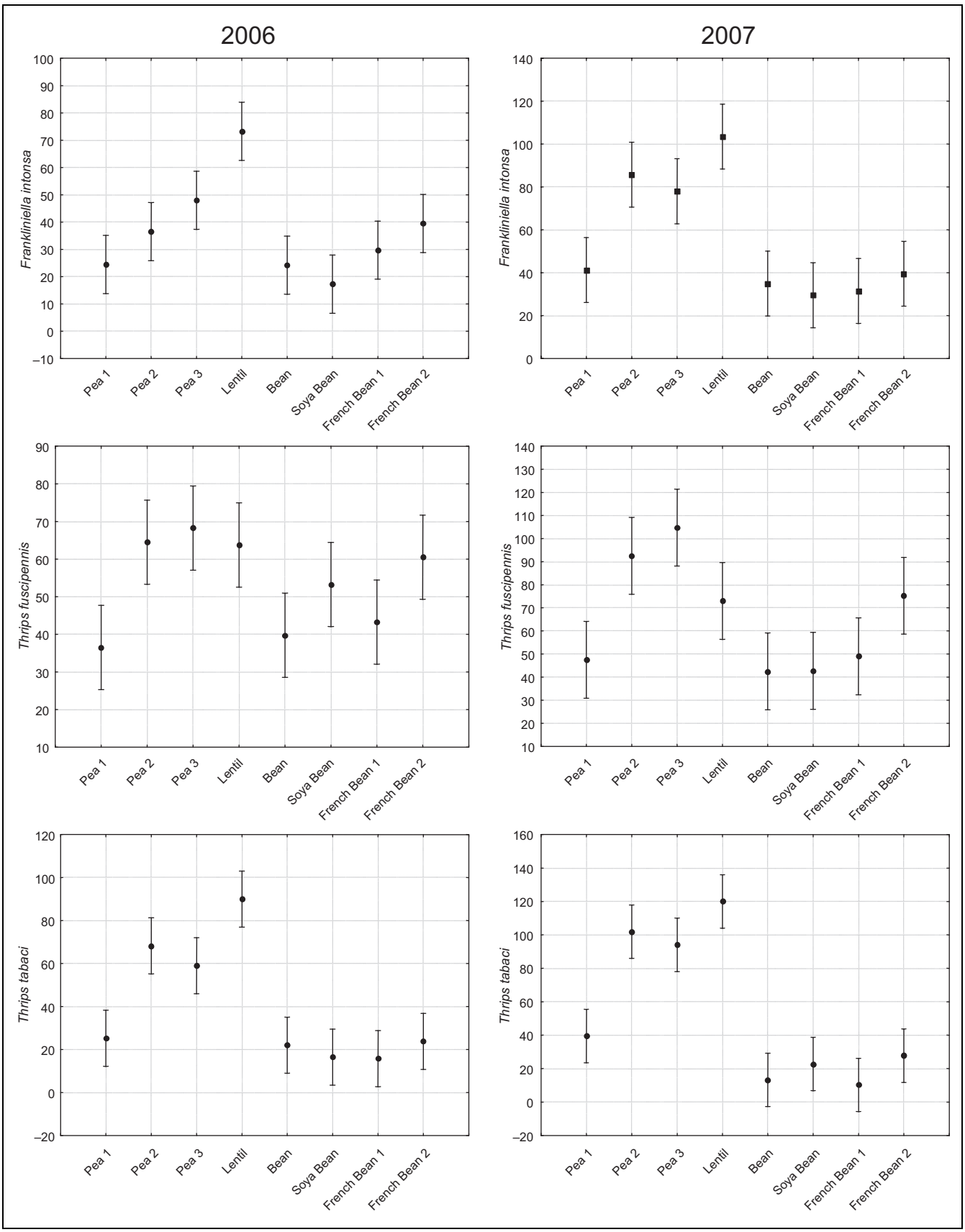

Fig. 1: Abundance of *Thrips tabaci*, *T. fuscipennis* and *Frankliniella intonsa* on food legumes during 2006–2007 in Mydlniki, Krakow Region, Poland. Data were analysed by One-way-ANOVA and the Duncan test ($P \leq 0.05$)
Pea 1 (cv. Pionier), Pea 2 (cv. Cud Kelwedonu), Pea 3 (cv. Walor), French bean 1 (cv. Sandra), French bean 2 (cv. Tina), Bean (cv. Nata), Lentil (cv. Anita), Soya bean (cv. Aldana)

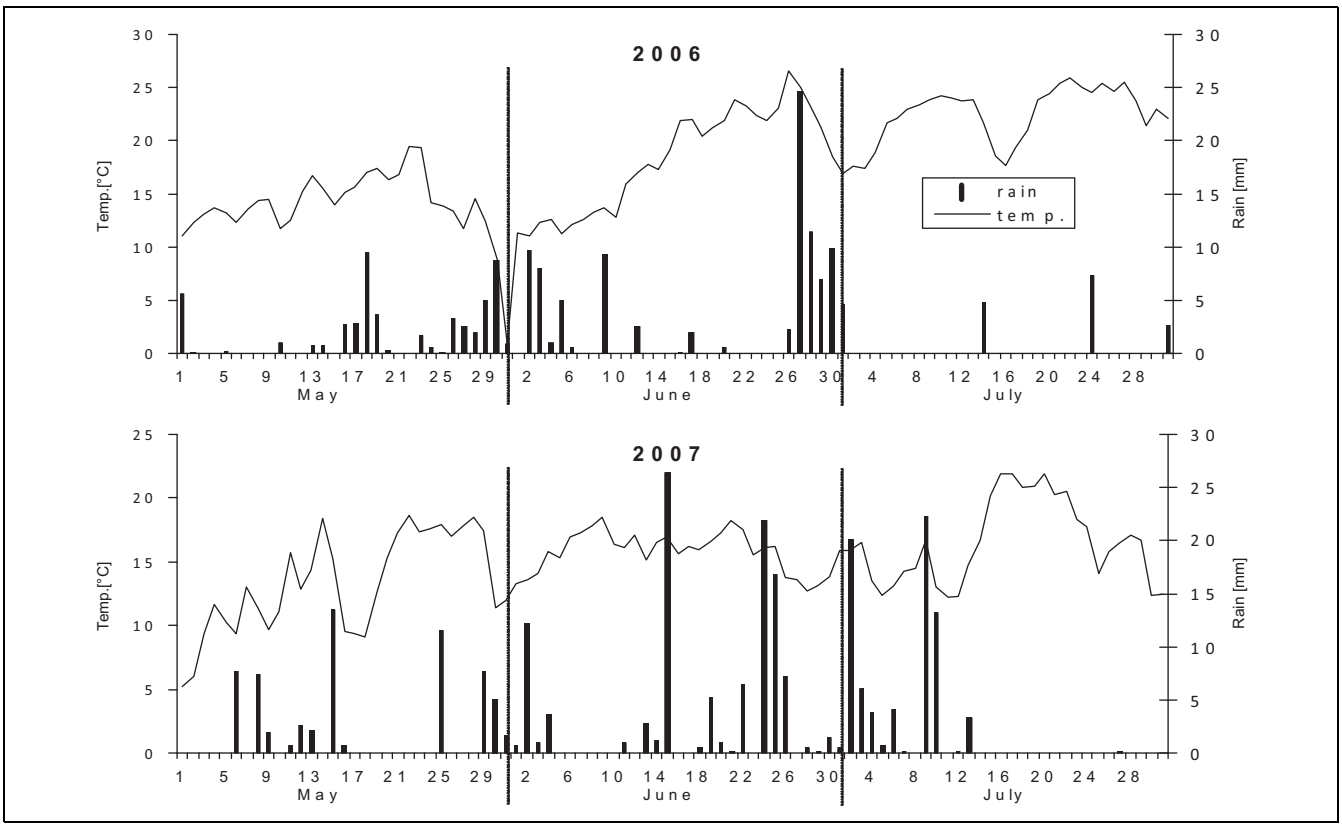

Fig. 2: Temperature and rainfall during the period from May to July in 2006 and 2007 in Mydlniki, Krakow Region, Poland

Table 1: Phenology of food legume crops in Mydlniki (Krakow Region, Poland) in the seasons 2006 and 2007

Plant	Year	May week				June week				July week			
		1	2	3	4	1	2	3	4	1	2	3	4
Pea cv. Pionier	2006	L	B	B/F	F	F/P	P	P					
	2007	L	L	B/F	F	F/P	P	P					
Pea cv. Cud Kelwedonu	2006	L	L	L	B	B/F	F	F/P	P				
	2007	L	L	L	B/F	F	F/P	P	P				
Pea cv. Walor	2006	L	L	L	L	B	B/F	F	P	P			
	2007	L	L	L	B/F	F	F/P	P	P	P			
Lentil cv. Anita	2006	L	L	L	L	B	B/F	F	F/P	P			
	2007	L	L	L	B	B	B/F	F	F/P	P			
French Bean cv. Sandra	2006			L	L	L	L	L	B/F	F	F	P	P
	2007			L	L	L	L	L	F	F	F/P	P	P
French Bean cv. Tina	2006			L	L	L	L	L	B/F	F	F	P	P
	2007			L	L	L	L	L	F	F	F/P	P	P
Bean cv. Nata	2006			L	L	L	L	L	B/F	F	F	P	P
	2007			L	L	L	L	L	B/F	F	F	P	P
Soya Bean cv. Aldana	2006				L	L	L	L	B	B/F	F	F/P	P
	2007				L	L	L	L	B/F	F	F/P	P	P

L = development of sprout and leaves, B = development of flower buds, F = flowering, P = development of pods.

Table 2: Occurrence of thrips (Thysanoptera) species on food legume crops in Mydlniki (Krakow Region, Poland) in the seasons 2006 and 2007

Species		Pea 1	Pea 2	Pea 3	Lentil	French bean 1	French bean 2	Bean	Soya Bean	Total
		Total number per four plots								
Aeolothrips intermedius	F	33	48	57	70	60	59	84	38	449
	M	7	10	8	15	7	12	11	5	75
Anaphothrips obscurus	F	6	14	10	17	4	6	4	6	67
Chirothrips manicatus	F	16	6	8	6	2	5	0	0	43
Frankliniella intonsa	F	205	373	411	613	205	252	221	160	2440
	M	58	96	93	94	40	64	35	27	507
Haplothrips aculeatus	F	0	0	0	5	8	1	0	4	18
	M	1	2	0	2	0	1	0	0	6
Limothrips denticornis	F	0	0	0	3	0	3	0	2	8
Kakotrips pisivorus	F	4	8	8	0	0	3	0	0	23
Neohydatothrips gracilicornis	F	0	0	0	3	0	0	4	5	12
Odontothrips loti	F	0	11	2	21	0	1	0	0	35
Thrips angusticeps	F	4	0	0	0	0	0	0	0	4
Thrips atratus	F	4	15	8	35	8	2	15	7	94
	M	2	3	0	4	0	1	2	0	12
Tenothrips frici	F	0	0	0	4	0	7	1	0	12
Thrips flavus	F	0	0	2	14	4	0	0	0	20
Thrips fuscipennis	F	306	567	616	467	315	470	284	354	3379
	M	30	61	76	80	54	73	45	30	449
Thrips major	F	0	0	0	0	0	0	13	4	17
Thrips tabaci	F	259	681	612	840	104	206	141	157	3000
Scolothrips longicornis	F	0	0	0	0	7	0	0	0	7
Stenothrips graminum	F	4	4	0	2	0	0	0	0	10
Total		939	1899	1911	2295	818	1166	860	799	10687

Pea 1 (cv. Pionier), Pea 2 (cv. Cud Kelwedonu), Pea 3 (cv. Walor), French bean 1 (cv. Sandra), French bean 2 (cv. Tina), Bean (cv. Nata), Lentil (cv. Anita), Soya bean (cv. Aldana).
F = female, M = male

first flowers, and numbers rapidly increased until peak abundance of flowers. After flowering, the number of individuals decreased sharply, probably because other plant species that had started flowering.

Changes in thrips density were in many cases large even within 1–2 days. Densities of thrips were reduced by even small amount of rainfall and reductions in temperature (Fig. 2–4).

Discussion

In both years, weather conditions were favourable for the development of both crops and thrips. From the second half of May to mid-July, there was little rain and mild temperatures (Fig. 3). Eighteen thrips species were detected on food legume vegetables, with *Thrips tabaci*, *Frankliniella intonsa* and *Thrips fuscipennis* constituting over 90% of the number of thrips collected.

Thrips tabaci

T. tabaci occurred in almost all samples and preferred peas and lentils. There were two periods when onion thrips infested peas and lentil, namely in spring (1st – 3rd week of May), when crops are young and succulent, and during flowering (4th week of May – 2nd week of June). The presence of onion thrips in flowers of peas was also described by Wnuk & Pobożniak (2003). A large number of *T. tabaci* adults and larvae remained on the peas after flowering and started feeding on pea pods, inducing white and brown spots. The possibility of onion thrips feeding on pea pods was also indicated by Gaskel (1997).

Of the three pea cultivars tested, the very early cv. Pionier was significantly less infested by *T. tabaci* than the other two cultivars. The difference could result from the earlier and shorter growing season or from biochemical or morphological differences with the other pea cultivars (Brodbeck et al. 1990, 2001, Riefler & Koschier 2009, Žnidračic et al. 2007).

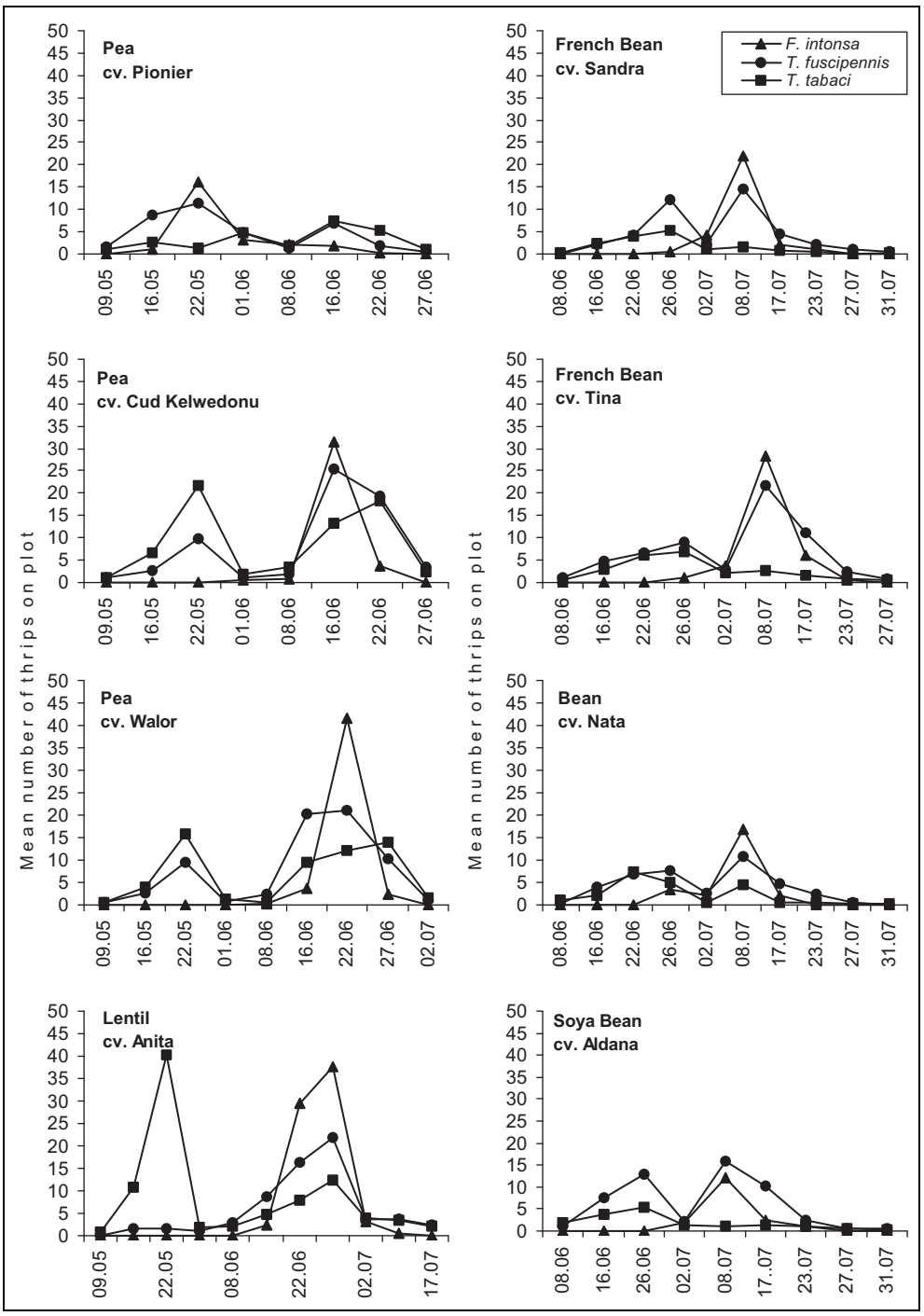

Fig. 3: Population fluctuation of *Thrips tabaci*, *T. fuscipennis* and *Frankliniella intonsa* on food legumes in Mydlniki (Krakow Region, Poland) in the 2006 season

On beans and soya bean, *T. tabaci* was mainly observed before the flowering period, and numbers were significantly lower than on peas and lentil. Also, its percentage share on these crops was smaller (12.7% – 19.6%). It seems that onion thrips prefers to feed on young parts of legumes.

Apart from *T. tabaci*, only *K. robustus* is known to cause damage to the flowers and pods of pea. Females of *K. robustus* lay eggs in the flowers of crops in early June and hatched larvae feed on young pods or move to new flowers, damaging them (Jenser & Czencz 1988, Zawirska 1994). In England, adults of *K. robustus* (syn. *K. pisivorus*) thrips appear from May to August, causing damage to pea pods (Williams 2008). *K. robustus* was not numerous in the area around Krakow in Poland. However, many researchers in Poland treat pea thrips as a common and dangerous pest on legume crops, although that was not supported by the data in this study. In contrast, *T. tabaci* was numerous and is threatening peas. Large numbers of larvae and adult *T. tabaci* were observed feeding especially on young pea pods, which led to deformations and even death of pods.

Frankliniella intonsa

F. intonsa was one of the most abundant species. The period that this species was present was very short and coincided

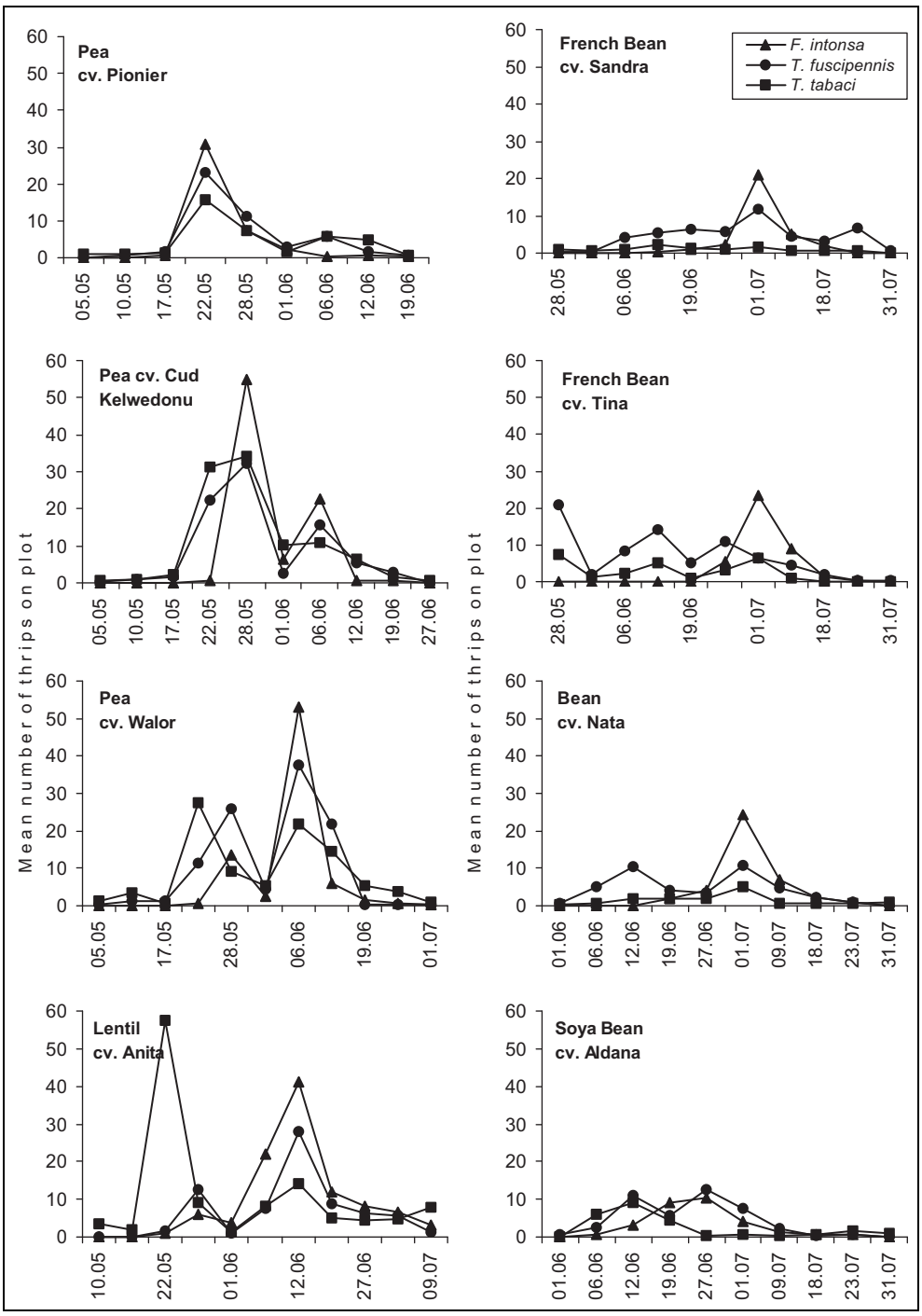

Fig. 4: Population fluctuation of *Thrips tabaci*, *T. fuscipennis* and *Frankliniella intonsa* on food legumes in the 2007 season

with flowering. Of all thrips collected, the percentage of *F. intonsa* was similar on all crops and ranged from 23.04% on soya bean to 30.8% on lentil. *F. intonsa* is characteristic for legume flowers (Strassen zur 2003). In Poland, *F. intonsa* was frequently observed on peas, beans, and broad bean, but also on forage legumes (red clover, sainfoin, and vetch; Wnuk & Pobożniak 2003). A large number of *F. intonsa* adults were found on flowers, with the larvae feeding on pollen grains (Kirk 2008a). Daily feeding rates were 0.2–0.7% of the average total pollen production of a flower per thrips per day, which is sufficient to reduce crop yield or plant fitness (Kirk 2008b). *F. intonsa* may also feed on the post floral and flower petals, causing flowers to dry up and drop (Zawirska 1994).

Thrips fuscipennis

T. fuscipennis is a second frequent inhabitant of the flowers and was present during the spring and summer months. Like *F. intonsa*, numbers of *T. fuscipennis* increase during flowering. *T. fuscipennis* feeds on the pollen of many crops including pea. Pollen increase the oviposition rate of females compared with feeding on floral tissue (Kirk 2008a). In the

presented data, *T. fuscipennis'* share in the population of thrips was above 45% for beans, and above 35% for peas. *T. fuscipennis* is a frequent visitor of pea, field pea, and bean flowers, but there is no information about its influence on these crops (Wnuk & Pobożniak 2003). Nevertheless, the large numbers of *T. fuscipennis* on crops tested in this study warrants further investigation.

The massive flight of *F. intonsa* and *T. fuscipennis* during flowering was preceded by one or two warm days and lasted several days. The flowers on which they feed are short-lived, which might compel the thrips to leave the old hosts as soon as the weather is suitable for flight (Fig. 2–4). Mass flights of *F. intonsa* are known to occur in sunny, constant weather with a minimum temperature of 20°C (Lewis 1964). *T. tabaci* was not observed to take many short flights. *T. tabaci* has a lower minimum for flight than other thrips species, but activity decreased with a temperature decline. A sudden cooling and rain resulted in a rapid decline in the activity of all species of thrips and activity increased when temperatures increased, provided that the crops were still attractive to the insects.

The majority of all thrips were phytophagous, with only *A. intermedius* and *S. longicornis* considered as predacious. *A. intermedius* was present during the entire growing season. Although, *A. intermedius* is predacious its larvae can puncture leaves and suck sap, especially from the petals of flowers (Strassen zur 2003). The density of *A. intermedius* may respond to the presence of some small sized, phytophagous thrips species, such as *T. tabaci* (Trdan et al. 2005).

In summary, food legumes in Poland were mainly inhabited by three species of thrips: *T. tabaci*, *T. fuscipennis* and *F. intonsa*, the first of which occurs throughout the growing season while the other two infested crops during flowering. Onion thrips were present in high numbers on leaves and flowers, and were feeding on young pea pods, which led to injury or deformation. Further research will be directed towards examining the importance and harmfulness of onion thrips on cultivars of peas differing in growing season length and morphological features.

Acknowledgements

The author would like to thank Professor I. Zawirska for providing her with the skills needed for the preparation and marking of thrips and Dr W. Sierka for confirming the taxonomic designations of the collected material.

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