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THE SPECIES COMPOSITION AND SEASONAL DYNAMICS OF THRIPS (THYSANOPTERA) POPULATIONS ON MAIZE (*ZEA MAYS* L.) IN SOUTHEASTERN POLAND

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Abstract: Thrips species composition and seasonal abundance was studied on maize crops during two seasons (2006–2007), in southeastern Poland. Altogether 21 species have been identified, among them *Frankliniella tenuicornis* (Uzel 1895) and *Haplothrips aculeatus* (Fabricius 1803) which are a graminicolous species and were eudominants, comprising 96.8% in 2006 and 82.0% in 2007 of all collected specimens. Other species occurred only in low numbers. The frequent and numerous presence of *F. tenuicornis* species in their immature stages in the samples, confirmed the role of the maize plant as the host. *H. aculeatus* probably chose maize as a food source and substitute plant for breeding.

Key words: Thysanoptera, *Frankliniella tenuicornis*, *Haplothrips aculeatus*, maize, host plant, seasonal abundance

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important crops in Poland. From the 90's of the XX century, the maize crop systematically increased. In 2008, maize occupied 733,000 hectares (GUS 2009; Michalski 2007). In the southern and western parts of Poland, this crop is cultivated mainly for grain. In northern Poland, maize is grown for silage. At the present time, about 30 pests were identified on maize in Poland and the number is growing (Bereś and Pruszyński 2008). The European corn borer (*Ostrinia nubilalis* Hübner), destroys nearly 50% of maize crops in the southern part of Poland. It is now considered as the most serious maize pest in Poland (Bereś and Konefał 2010; Lisowicz 2003). Other economically important insects harmful for maize are: frit fly (Chloropidae), cutworms (Noctuidae), aphids (Aphidoidea), elatherids (Elateridae) and thrips (Thysanoptera) (Bereś *et al*. 2007). The latter feed on young plants and may halt the growth of the young plants. Thrips also feed on flowers – interrupting fruit development. Most often, however, thirps do not destroy the plants directly but serve as vectors of tospoviruses, and by sucking plant cells they facilitate the spread of bacterial and fungal diseases (Franssen and Mantel 1965; Lewis 1973; Puche *et al*. 1995; Tommassini and Maini 1995; Deligeorgidis *et al*. 2002).

In Poland, the data on thrips abundance and bionomy on maize crops are scarce. In 1965 and 1966, Zawirska (1969) collected thrips from 13 maize farms located in various regions of Poland. Lisowicz (2001) noticed the harmful effects of thrips infestation on maize plants.

Recently, it was discovered that thrips actively take Cry toxins from genetically modified maize plants. This discovery placed them in an important group in the tritrophic structure in the maize ecosystem (Dutton *et al*. 2004; Górecka 2010). The toxin may be injected by predators or parasitoid larvae feeding on thrips.

The aims of this work were: to determine the thrips population structure occurring on maize, determine the species which may be harmful to maize, and study seasonal abundance of harmful species affected by weather conditions.

MATERIALS AND METHODS

The study was carried out during the two growing seasons of 2006 and 2007 on fields of maize, cultivar San (FAO 240), situated in Krzeczowice near Przeworsk (southeastern Poland 49°51′N, 22°18′E). No insecticides were applied on the crop during the study period. In 2006, samples were collected every week from 20th of June to 19th of September (14 samples) from a 5 ha field bordered with winter wheat and sugar beet fields. A railway track, shrub thicket, and houses were situated on the other sides. From May 18th to September 21st of 2007 nineteen

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samples were gathered from a 4 ha field surrounded by sugar beet, winter wheat and spring wheat fields. From every field, twenty plants were randomly taken out between the maize developed periods BBCH 11 (with one developed leaf) and BBCH 53 (with visible apex of inflorescence) (Adamczewski and Matysiak 2002). Later, until the end of the growing season, only ten plants were collected weekly. The plants were transported in plastic bags to the laboratory. The insects were then removed from every plant using a stereoscopy microscope, and placed in 70% ethyl alcohol. Leaf sheaths which provide hiding places for thrips and are their main feeding place, were examined very thoroughly. Adults of all species were identified using the keys of zur Strassen (2003) and Schliephake and Klimt (1979). Larvae were identified according to the key of Vierbergen *et al*. (2010). Some of the specimens were mounted in Berlese fluid, or permanent slides of them were prepared according to the recommendation of Mound and Kibby (1998).

The species composition was determined into the following groups: eudominants (> 10%), dominants (5.1–10%), subdominants (2.1–5%), recedents (1–2%), and subrecedents (lower than 1%), (Tab. 1). For the eudominants, the seasonal abundance of their developmental stages (for adults, also the structure of the sexes) were calculated separately for each year of the study. The thrips population abundance was analyzed according to weather conditions. The daily temperature and rainfall data measured on sampled areas, was calculated to decade intervals (Figs. 1–8).

RESULTS

During the two years of the study, 3,783 specimens of Thysanoptera representing 21 species were collected: 1,806 of 12 species and 1,977 of 20 species in 2006 and 2007, respectively. Two taxa: *Frankliniella tenuicornis* (Uzel) and *Haplothrips aculeatus* (Fabricius) constituted the group of eudominants with 96.8 and 82.0 percent of all collected specimens in 2006 and 2007, respectively. Additionally *Anaphothrips obscurus* (Müller) as a dominant (5.1%) and *Limothrips denticornis* Haliday (3.8%), and *Haplothrips tritici* (Kurdjumow) (3.9%) as subdominants, were collected more often in 2007 (Tab. 1). All the above mentioned taxa belong to the graminivorous and eurytopic groups, often occupying various species of grasses. The one exception, *H. tritici*, is restricted to wheat plants and up to now was only noted in the southcentral and southeastern regions of Poland (Kąkol 2009; Kąkol and Kucharczyk 2004; Zawirska and Wałkowski 2000).

Table 1. Species composition of populations of thrips collected on maize plants in 2006 and 2007

Species	2006		2007	
	I	II	I	II
Aeolothrips intermedius Bagnall, 1934	2	0.1	23 (2)	1.2
Anaphothrips obscurus (Müller, 1776)	16	0.8	101	5.1
Chirothrips hamatus Trybom, 1895	–	–	11	0.6
C. manicatus Haliday, 1836	1	0.06	7	0.4
Frankliniella intonsa (Trybom, 1895)	–	–	3	0.2
F. tenuicornis (Uzel, 1895)	1,268 (257)	70.2	968 (343)	49.0
Limothrips cerealium Haliday, 1836	–	–	5	0.3
L. consimilis Prieasner, 1926	1	0.06	3	0.2
L. denticornis Haliday, 1836	19	1.0	76	3.8
Odontothrips loti (Haliday, 1852)	–	–	1	0.05
Oxythrips bicolor (O.M. Reuter, 1879)	–	–	1	0.05
Stenothrips graminum Uzel, 1895	–	–	1	0.05
Thrips atratus Haliday, 1836	–	–	1	0.05
T. flavus Schrank, 1776	9	0.6	31	1.6
T. fuscipennis Haliday, 1836	–	–	3	0.2
T. major Uzel, 1895	1	0.06	8	0.4
T. tabaci Lindeman, 1779	2	0.1	1	0.05
T. validus Uzel, 1895	1	0.06	–	
Haplothrips aculeatus (Fabricius, 1803)	480 (15)	26,6	653 (15)	33.0
H. setiger Priesner, 1921	–	–	1	0.05
H. tritici (Kurdjumov, 1912)	6	0.3	79	3.9
Total	1,806		1,977	

I – number of specimens; II – percentage share; in brackets – number of immature specimens

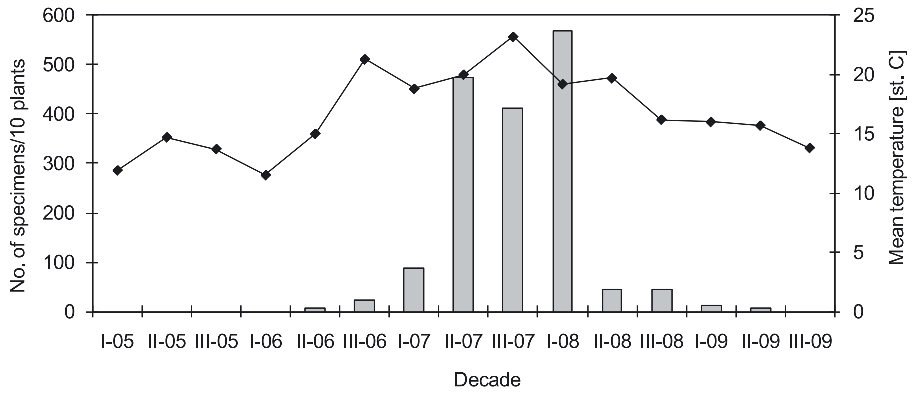

Fig. 1. Seasonal dynamics of thrips population (calculated per 10 maize plants) in 2006 and changes of temperature [°C] in the study period (at decade intervals)

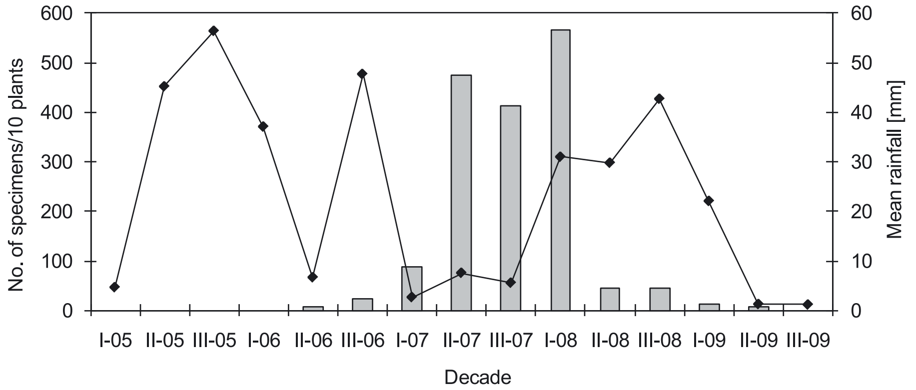

Fig. 2. Seasonal dynamics of thrips population (calculated per 10 maize plants) in 2006 and changes of rainfall [mm] in the study period (at decade intervals)

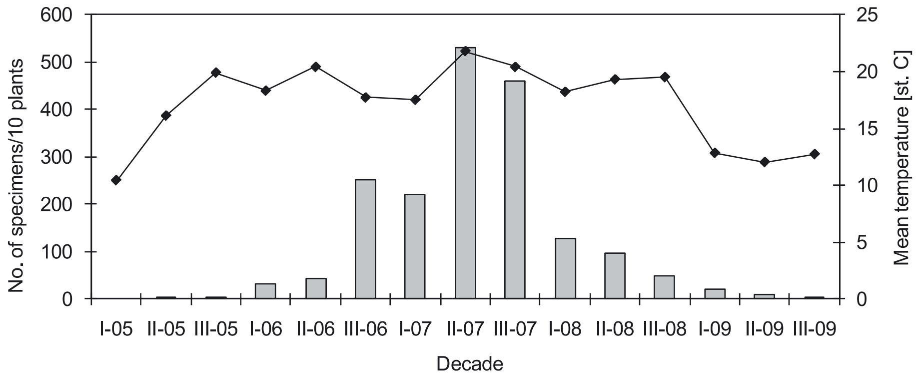

Fig. 3. Seasonal dynamics of thrips population (calculated per 10 maize plants) in 2007 and changes of temperature [°C] in the study period (at decade intervals)

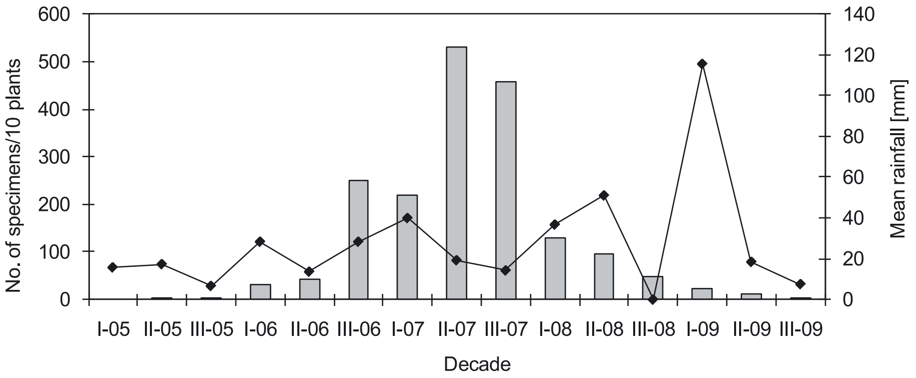

Fig. 4. Seasonal dynamics of thrips population (calculated per 10 maize plants) in 2007 and changes of rainfall [mm] in the study period (at decade intervals)

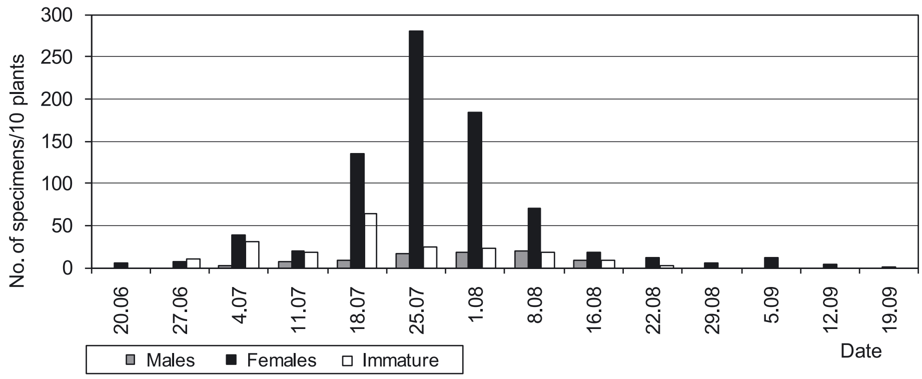

Fig. 5. Seasonal dynamics of *F. tenuicornis* development stages (calculated per 10 maize plants) in 2006 (immature: larvae and pupae)

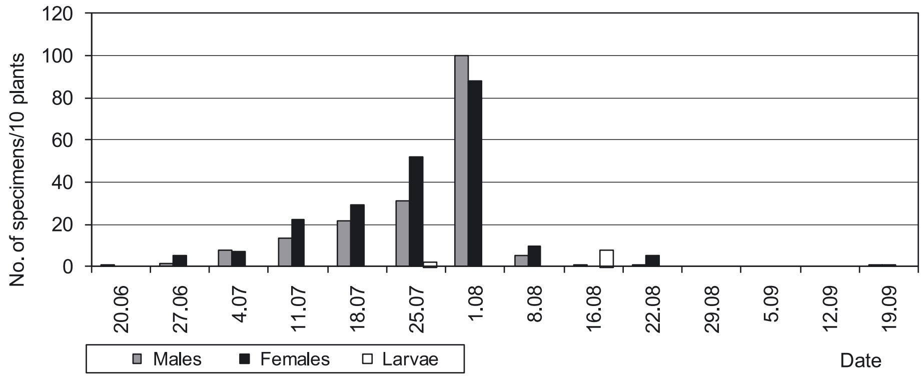

Fig. 6. Seasonal dynamics of *H. aculeatus* development stages (calculated per 10 maize plants) in 2006

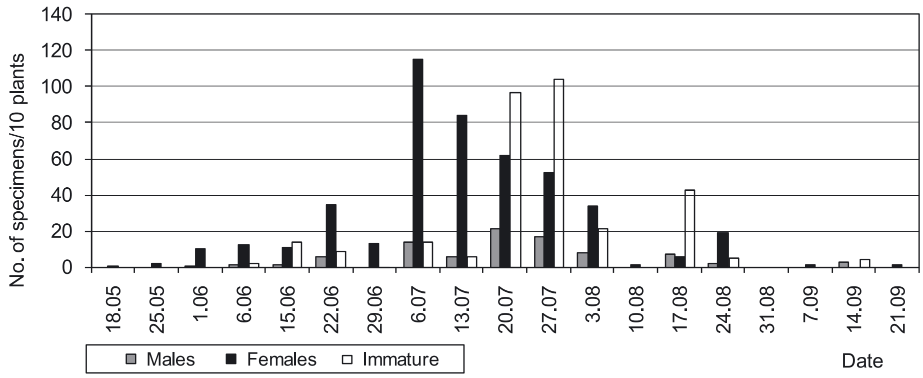

Fig. 7. Seasonal dynamics of *F. tenuicornis* development stages (calculated per 10 maize plants) in 2007 (immature: larvae and pupae)

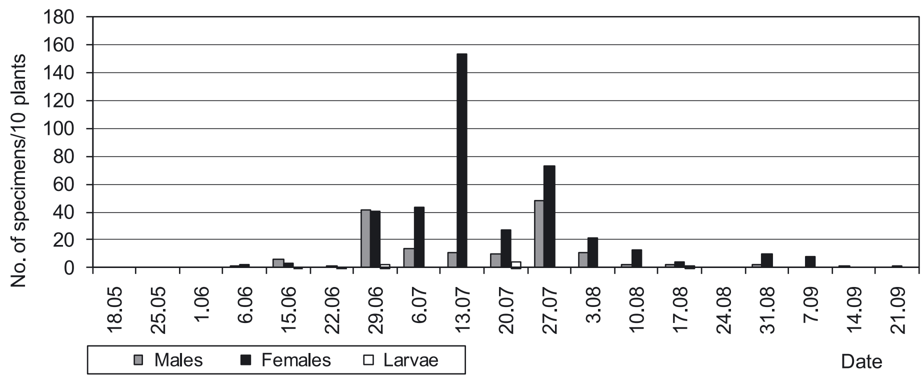

Fig. 8. Seasonal dynamics of *H. aculeatus* development stages (calculated per 10 maize plants) in 2007

Apart from the above mentioned species, *L. denticornis* Haliday (1.0%) in 2006, *Aeolothrips intermedius* Bagnall (1.2%) and *Thrips flavus* Schrank (1.6%) in 2007 were classified as recedents and the others as subrecedents (Tab. 1).

The collected immature stages were only from the eudominant species. For *F. tenuicornis,* they comprised 20.3% (235 larvae, 22 pupae) and 35.4% (326 larvae, 17 pupae) of all specimens in 2006 and 2007, respectively; for *H. aculeatus* there were only 15 larvae for each year of study (Tab. 1, Figs. 5–8). Because quiescent and non-feeding pupal stages of thrips develop in the soil or plant litter, only a few *H. aculeatus* individuals occurred in the collected samples.

Higher temperatures and lower rainfalls in the spring of 2007 allowed us to collect thrips from the beginning of May. In 2006, the first specimens were collected from plants a month later. The species were collected more numerously in periods with the highest temperatures and the lowest rainfalls in the sampled areas (Figs. 1–4). An increase in the thrips populations was observed between the second half of July and the beginning of August, when they peaked (Figs. 1–8). In both seasons, adults of dominant species predominated with the exception of immature (mainly larvae) *F. tenuicornis*. The more numerous immature were collected at the end of July, two weeks after the period when females had their peak of occurrence (Fig. 7). Among adults, females were dominant, except for *H. aculeatus* sampled on 1st of August in 2007, when males dominated (Fig. 6).

DISCUSSION

Various species of *Frankliniella* and *Haplothrips* genera were reported as pests on Poaceae plants (among them on maize) in different regions of the world (Zawirska 1969; Obrist *et al*. 2005; Ecker *et al*. 2006; Flanders *et al*. 2009; Mound and Azidah 2009; Gaafar *et al*. 2010; Wang *et al*. 2010). In Poland, *F. tenuicornis*, *H. aculeatus* and *H. tritici* have been referred to as "cereal thrips" only (Zawirska and Wałkowski 2000), and two former species have been recognized by Zawirska (1969) as potentially harmful for maize.

In spring, the first specimens of graminivorous taxa are: *F. tenuicornis*, *H. aculeatus, A. obscurus* and *L. denticornis.* These taxa probably migrate on maize plants from wild areas adjacent to the fields or crops growing nearby. Winter wheat grew in the sampled location (Puche *et al*. 1995; Kirk 1997; Szénási *et al*. 2002). Also, winter and spring wheat were the source of *H. tritici*. This species was collected more often on maize fields in 2007.

The presented results are in agreement with the observations of Zawirska (1969). During the study carried out forty years ago in different regions of Poland, among them in the same Krzeczowice location, Zawirska determined the same dominant taxa. Apart from these species, she collected numerous specimens of *A. obscurus* and *L. denticornis*, and also frequently but singly *Stenothrips graminum* Uzel, *Chirothrips manicatus* Haliday, *Aptinothrips rufus* Haliday and *A. stylifer* Trybom. Zawirska recognized their presence as accidental on maize stems and leaves. Only individual specimens of two former species were also noted in samples collected by us. The last two species were absent in our samples. During the second season, *A. obscurus, L. denticornis* and *H. tritici* appeared more numerously in our collected samples. The former two were observed mainly in spring while the latter in late summer, probably after the wheat (their host plant) harvest.

F. tenuicornis was recognized as the main pest of leaves and stems of maize in the field experiments reported by Obrist *et al*. (2005, 2006) in Spain. In inflorescences, the western flower thrips – *Frankliniella occidentalis* (Pergande) was identified as the most numerous species. The latter one was also listed as the most common herbivorous thrips species collected by Habuštowá and Sehnal (2007) on maize in České Budějovice (Czech Republic), during their four-year field experiment. Habuštowá and Sehnal found both adults and immature stages on this crop. Moreover, the predatory species – *Aeolothrips fasciatus* (Linnaeus) was observed by Habuštowá and Sehnal numerously in 2004. *A. intermedius* took the place of that zoophagous species in Poland. *A. intermedius* was found in about 50% of the samples collected by Zawirska (1969). In our research it was classified as recedent (1.2%) in the second season.

The dominant species were recognized as pests of cereals, causing a negative impact on yield (Gaafar *et al*. 2010). Because there are few studies on Thysanoptera of maize, this species influence on this crop is not yet well known. Neither *F. tenuicornis* nor *H. aculeatus* are classified in the group of tospoviruses vectors (Mound 2003). Nonetheless, they may transmit bacteria or fungi from one plant to another and their mass abundance may cause physical damage to maize plants (Tommassini and Maini 1995).

In conclusion, *F. teniucornis* and *H. aculeatus* were identified as the most abundant species of thrips found on maize and they may be classified as harmful organisms for this crop. The presence of frequent and numerous *F. tenuicornis* immature stages confirmed maize as the important host plant for this species. *H. aculeatus* was recognized as the main pest of cereals. *H. aculeatus* probably chose maize as its food source and as a substitute plant for breeding. No immature stages of the other graminicolous species have been collected on maize plants, indicating that the other graminicolous species used maize as a temporary feeding site.

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POLISH SUMMARY

SKŁAD GATUNKOWY ORAZ SEZONOWA DYNAMIKA POPULACJI WCIORNASTKÓW (THYSANOPTERA) NA KUKURYDZY (*ZEA MAYS* L.) W POŁUDNIOWO-WSCHODNIEJ POLSCE

Wciornastki (Thysanoptera) zaliczane są do grupy około 30 szkodników kukurydzy. Stwierdzenie, że pobierają one toksyczne białko Cry z roślin zmodyfikowanych genetycznie i mogą je przekazywać na wyższe poziomy układów troficznych, powtórnie zwróciło uwagę entomologów na tę grupę roślinożerców.

Celem badań było określenie składu gatunkowego oraz sezonowej dynamiki populacji wciornastków występujących w uprawach kukurydzy.

Badania prowadzono w latach 2006–2007 na plantacjach kukurydzy w Krzeczowicach koło Przeworska. Stwierdzono obecność 21 gatunków wciornastków (12 w pierwszym i 20 w drugim roku badań), – dominującymi były *Frankliniella tenuicornis* (Uzel) i *Haplothrips aculeatus* (Fabr.). Ich osobniki stanowiły odpowiednio 96,8% i 82,0% wszystkich zebranych w latach 2006 i 2007. Najliczniej owady zbierane były w drugiej połowie lipca i na początku sierpnia. Wśród zebranych przeważały postaci dojrzałe, a wśród nich samice, z wyjątkiem populacji *F. tenuicornis* w 2007 r., kiedy to larwy notowano liczniej w drugiej dekadzie lipca i powtórnie w drugiej dekadzie sierpnia. Obecność licznych postaci larwalnych *F. tenuicornis* na kukurydzy świadczy o jej roli jako rośliny żywicielskiej dla tego gatunku, zaś dla *H. aculeatus*, jak i pozostałych stwierdzonych gatunków, jest ona głównie źródłem pokarmu.

Uszkadzanie roślin na skutek żerowania oraz składania jaj do tkanek liści może doprowadzić do wtórnych chorób bakteryjnych i grzybowych przenoszonych przez wciornastki oraz zahamować wzrost, a także rozwój kwiatostanów u młodszych roślin, dlatego masowo występujące *F. tenuicornis* i *H. aculeatus* można uznać za potencjalne szkodniki kukurydzy.