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A CONTRIBUTION TO QUANTITATIVE REPRESENTATION AND DISTRIBUTION OF *EPITRIX HIRTIPENNIS* (MELSHEIMER, 1847) (COLEOPTERA: CHRYSOMELIDAE, ALTICINI) ON TOBACCO

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Abstract

Epitrix hirtipennis (Melsheimer, 1847) causes damage to tobacco plants throughout the growing season. The most severe damages were observed in the first three weeks after tobacco transplanting. It is very difficult for damaged plants to adapt after transplanting, often resulting in their death. The study was conducted in 2013-2014 in several villages in the southeast and Pelagonia region of the Republic of Macedonia, where tobacco is an abundant crop. During 2013, the major attack was registered in June on sand leaves (3212), bottom leaves (2584), and first middle leaves (1905), with the pest population gradually decreasing on second middle leaves (1218), third middle leaves (894), lower top leaves (649) and top leaves (411). The major attacks in 2013 were determined in Budakovo and Desovo. In 2014, the most intense attack of *E. hirtipennis* was in Konce on sand leaves with an average of 40.86%, and the average in all regions was 35.71%. The percentage of attacked bottom leaves and first middle leaves was on average 10.55%.

Keywords: *Epitrix hirtipennis*, tobacco, quantitative representation, distribution, Macedonia

Introduction

Epitrix hirtipennis (Melsheimer, 1847) belongs to the order Coleoptera, family Chrysomelidae, subfamily Galerucinae, tribe Alticini (Bouchard *et al.,* 2011). It is an oligophagous pest, known by different common names and mostly as tobacco flea beetle (Sannino *et al.,* 1984; Lykouressis, 1991; Piro *et al.,* 1991; Deseo *et al.*, 1993; Döberl, 1994). Flea beetles prefer the Solanaceae family, cultivated plants (tobacco, pepper, potato, tomato, egg-plant) and numerous plants of spontaneous flora: *Datura stramonium* L., *Atropa* sp., *Hyoscyamus* sp., *Petunia* sp., *Lycium* sp., etc. (Sannino *et al.,* 1984, 1985; Lykouressis, 1991; Piro *et al.,*

1991). In the absence of solanaceous plants, the beetles can be found on other weeds, like *Amaranthus retroflexus* L., *Chenopodium album* L., *Sinapis arvensis* L., etc. (Krsteska & Stojanoski, 2012).

Epitrix hirtipennis has a wide area of distribution and is highly adaptable. It is the first American species of the genus *Epitrix* introduced to Europe, and it was first observed in 1983 in the region of Benvento (Sannino *et al.,* 1984). The pest then spreads across Europe.

According to literature data, in the Balkans the flea beetle causes severe damage to tobacco: in Italy from 1984 (Sannino *et al.,* 1985, 1986; Sannino & Balbiani, 1990; Piro *et al.,* 1991; Balbiani *et al.,* 1992), Albania from 1986 (Gixhari, 1997), Greece from 1988 (Lykouressis, 1991; Lykouressis & Mentzos, 1992; Lykouressis *et al.,* 1994; Deligeorgidis *et al.,* 2007), Turkey from 1993 (Döberl, 1994), Macedonia from 1996 (Krsteska & Stojanoski, 2002; Krsteska *et al.,* 2009) and Bulgaria from 2000 (Dimitrov, 1997; Tomov *et al.,* 2007). It was also found in Syria in 2002 (Gruev & Döberl, 2005) and in Russia in 2013 (Orlova-Bienkowskaja, 2014).

Materials and Methods

During 2013-2014, observations were made in two tobacco-producing regions in Macedonia, the southeast and Pelagonia, where tobacco is abundant. Tests were conducted in the villages Zapolzani (near Prilep), Belo Pole (near Prilep), Ropotovo (near Prilep), Desovo (near Prilep), Dupjachani (near Prilep), Konce (near Strumica), Rakitec (near Strumica), Senokos (near Bitola), and Budakovo (near Bitola) in 2013, Musinci (near Bitola), Dolneni (near Prilep), Ropotovo (near Prilep), Konce (near Strumica), Rakitec (near Strumica) and Novo Vladevci (near Strumica) in 2014, throughout the growing period, from seedlings through field tobacco to suckers in the post-harvest period.

The level of *E. hirtipennis* attack in seed beds was determined using a scale with 5 degrees:

0 – no damaged tobacco plants in beds;

1 – weak attack, up to 5% damaged tobacco plants in tobacco beds;

2 – medium attack, from 5 to 15% damaged plants;

3 – strong attack, from 15 to 30% damaged plants;

4 – strongest attack, over 30% damaged plants.

To produce good-quality tobacco leaves, priming is the more appropriate method of harvesting. Priming involves the harvesting of leaves as and when they are fully developed and matured. There are generally seven primings in a tobacco plant, each tobacco priming representing a name of leaves according to their position on the plant from the bottom to the top are: sand leaf or ground leaf, bottom leaf, first middle leaf, second middle leaf, third middle leaf, lower top leaf, top leaf. The data in the tables are presented according to this classification.

Method of survey of 100 tobacco plants in 2013: The quantitative and percentage representation of plants attacked by *E. hirtipennis* was studied in nine villages. For each tobacco plant priming plants were sampled randomly from the whole area of the trial, from 10 manufacturers in each locality. We analyzed the number of tobacco leaves attacked by *E. hirtipennis* per priming and per locality. During our investigations, 700 plants per manufacturer and 1000 plants per priming were examined. Seven thousand tobacco plants in one locality and a total of 63,000 tobacco plants were examined by this method.

Method of survey of 10 tobacco plants in 2014: To establish the percentage of harmfulness of *E. hirtipennis* on the most attacked primings – sand leaves, bottom leaves and first middle leaves, we surveyed 10 randomly selected tobacco plants attacked by flea beetles in six villages. We examined the percentage of damaged leaves, the total number of tobacco leaves per plant and the number of attacked leaves per plant.

Climate conditions are an important factor for the development of *E. hirtipennis*. Data were obtained from the meteorology stations in Prilep, Bitola and Strumica (Tables I and II).

Table I. Mean monthly air temperatures (^{0}C) in 2013-2014.

Locality	Year	Months					
		IV	V	VI	VII	VIII	IX
Prilep	2013	13.3	17.3	19.8	22.4	23.8	17.7
Bitola		13.3	17.8	20.4	22.6	23.8	18.3
Strumica		15.3	20.1	22.1	24.3	25.7	19.0
Prilep	2014	11.0	15.2	19.7	22.1	22.2	16.8
Bitola		11.3	15.7	20.2	22.7	23.0	16.8
Strumica		12.8	17.5	21.7	24.1	24.1	18.2

Table II. Precipitation (mm) in 2013-2014.

Locality	Year	Months						Total
		IV	V	VI	VII	VIII	IX	
Prilep	2013	53.5	74.8	78.0	9.2	16.2	31.5	263.2
Bitola		83.4	61.3	50.8	17.2	6.3	18.7	237.7
Strumica		51.3	41.8	129.3	28.6	1.0	37.0	289.0
Prilep	2014	130.6	49.1	35.0	74.6	68.6	97.5	455.4
Bitola		114.0	35.5	53.8	65.2	28.8	213.1	510.4
Strumica		125.5	78.7	56.3	34.4	56.9	100.7	452.5

Results and Discussion

During 2013-2014, *E. hirtipennis* damaged seedlings and young transplanted tobacco plants up to the end of vegetation. According to the scale of level of attack, in 2013 in the villages Rakitec, Konce and Belo Pole were determined on average 5 to 15% of plants in separate tobacco beds were attacked by the tobacco flea beetle. In the village Rakitec, in 2014 the prevalence of tobacco flea beetles was of greater intensity with 15 to 30% of damaged plants in separate tobacco beds. However, in the village of Konce, the average attack of *E. hirtipennis* was observed to be 5 to 15% of damaged plants in separate tobacco beds in the phase of burgeoning growth of the seedlings. In other areas, the presence of the flea beetle on tobacco seedlings or damage caused by it, were not established, which is the result of timely protection.

The flea beetle is spread in the field through the transplantation of seedlings attacked by larvae. In the same manner, newly emerged adults from tobacco seedbeds and those from adjacent weeds continue to hatch on transplanted tobacco in the field. The attack continues to the end of harvest. The most severe damage on transplanted tobacco is caused by adult insects (Fig. 1). These injuries are characterized by small round

holes that give the leaf a sieve-like appearance (Fig. 2). When a higher population of the beetle is present, the holes coalesce and the leaf can disappear in a short time. The intensity of reproduction and attack is related to food availability and climatic variables such as average temperature, relative humidity and precipitation. Dimitrov (2007) indicated that adults are active in hot weather (25-30^{0}C) and when the temperature is above 35^{0}C the population is drastically reduced.

Figure 1. Adult *Epitrix hirtipennis* (photo by V. Krsteska).

Figure 2. Damages to tobacco plants caused by tobacco flea beetle (photo by V. Krsteska).

Damages are particularly pronounced in dry and windy weather (Krsteska & Stojanoski, 2012). On sunny days, when the temperature is moderate, *E. hirtipennis* adults are active and dwell on the front and reverse sides of the leaf, but in a period of strong heat, they hide in shady places or in the soil. According to basic climate parameters, average temperature and precipitation, in 2013 conditions were good for the development of tobacco plants and tobacco flea beetles.

Percentage representations of tobacco plants attacked by *E. hirtipennis* in 2013 in the villages Zapolzani, Belo Pole, Senokos, Ropotovo, Desovo, Dupjachani, Konce, Rakitec and Budakovo are presented in Table III. The *E. hirtipennis* population was largest in the first phases of tobacco development in all the villages. It is difficult for damaged plants to adapt after transplanting and they very often die. The most severe damages were in the first three weeks after tobacco transplanting (Fig. 3). According to our analysis, a major attack was registered in June on sand leaves, bottom leaves and first middle leaves, and then the population gradually decreased with the harvest of second middle leaves (Table III and Fig. 4).

Table III. Percentage representation of tobacco plants attacked by *E. hirtipennis* in 2013 per priming.

	Locality								
Tobacco plant priming	Zapolzani	Belo Pole	Senokos	Ropotovo	Desovo	Dupjachani	Konce	Rakitec	Budakovo
sand leaf	39.0	49.7	44.9	33.5	37.3	39.8	31.7	15.6	29.7
bottom leaf	31.3	33.3	28.5	22.9	36.2	30.4	34.8	12.4	28.6
first middle leaf	20.3	19.9	17.2	14.2	28.1	24.1	29.4	9.1	28.2
second middle leaf	8.1	8.7	7.6	7.7	25.6	13.9	17.7	6.2	26.3
third middle leaf	4.0	5.9	4.2	4.2	22.0	9.6	12.9	4.1	22.5
lower top leaf	1.5	2.8	1.5	2.1	14.1	6.1	12.0	3.0	21.8
top leaf	0.5	0.8	0.5	1.0	5.1	2.1	10.2	1.8	19.1

Figure 3. Damages on transplanted plants (photo by V. Krsteska).

Our investigations correspond to those of Gixhari (1997). He also states that the attack moves up the plant, but most of the damage is usually limited to the lower third of the stalk. According to Lykouressis (1991), adults are prevalent and feed on the lower leaves of the stalk as well as on plants with reduced growth. Unfortunately, *E. hirtipennis* attacks all leaf insertions, including suckers and top leaves, which are the best for tobacco aroma and quality. In the villages Budakovo, Konce and Desovo, *E. hirtipennis* is present in large numbers on lower top leaves and top leaves (Table III).

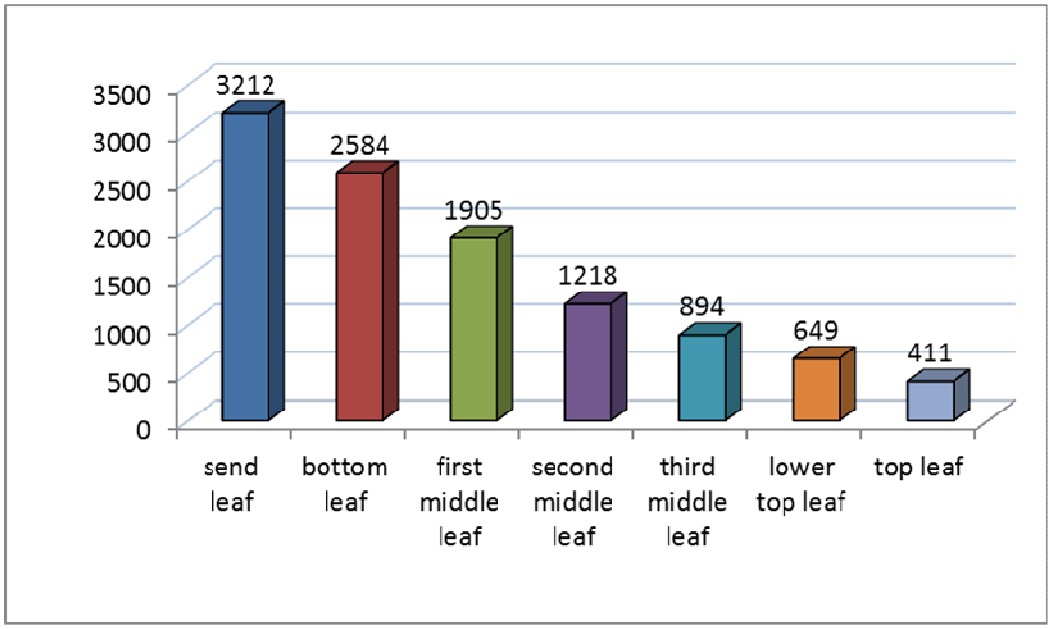

Figure 4. Number of tobacco leaves attacked by *Epitrix hirtipennis* in 2013.

The quantitative representation of tobacco leaves attacked by *E. hirtipennis* in nine villages is presented in Fig. 5. In 2013, the flea beetle was mostly represented in Budakovo, followed by Desovo, while the lowest population was in Rakitec. Significant differences were found in the number of holes caused by adult feeding and population density (Fig. 6). Sand leaves, bottom leaves and first middle leaves are the most attacked primings. According to investigations, in 2014 the percentage of harmfulness of *E. hirtipennis* on these primings was great. On sand leaves the percentage of damage varied from 27.13% in Musinci to 41.30% in Dolneni, with 6 to 15 holes on average on leaves (Table IV). On bottom leaves and first middle leaves, the percentage of damage varied from 7.19% to 13.95%, with 4 to 7 holes on average (Table V).

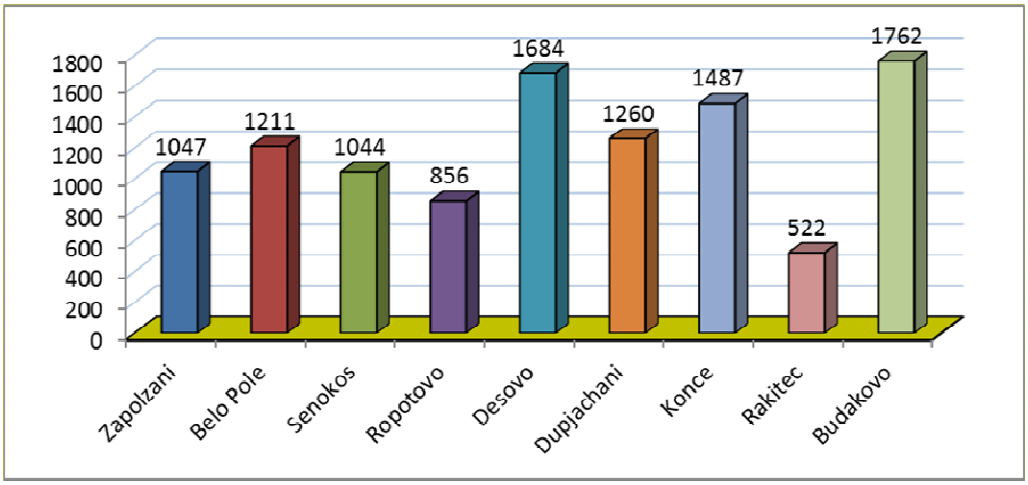

Figure 5. Number of tobacco leaves attacked by *Epitrix hirtipennis* in 2013.

Table IV. Harmfulness of *Epitrix hirtipennis* on sand leaves in 2014.

Tobacco plant priming	Musinci		Dolneni		Konce		Rakitec		Novo Vladevci	
	% of damaged leaves	Number of holes on each leaf	% of damaged leaves	Number of holes on each leaf	% of damaged leaves	Number of holes on each leaf	% of damaged leaves	Number of hole on each leaf	% of damaged leaves	Number of holes on each leaf
Sand leaf	20.0	8+1+17	50.0	9+23+48+8	54.6	13+5+7+1+5+1+4+6	27.3	10+14+2	18.2	17+10
	23.1	4+4+9	22.2	20+10+5	50.0	2+3+5+1+4	44.4	4+2+6+3	27.3	13+4+3
	30.0	2+10+4	45.5	7+13+21+38+19	44.4	3+3+4+2	50.0	13+25+2+7+3	30.0	6+15+10
	33.3	9+9+3+4	40.0	3+2+16+7	33.3	6+5+2	44.4	3+20+13+2	44.4	10+15+30+3
	21.4	6+7+1	62.5	3+2+2+4+30	30.0	5+3+2	44.4	5+2+3+6	45.5	10+10+7+8+8
	36.4	7+2+5+6	37.5	3+5+31	33.3	13+2+3	50.0	3+7+3+13+4	25.0	9+9
	23.1	6+9+7	33.3	15+2+37	37.5	5+3+2	30.0	15+6+4	16.7	17+2
	26.7	8+10+3+1+2	50.0	10+3+4+2+8+3	37.5	4+11+3	41.7	25+7+3+5+3	25.0	5+7
	41.7	3+6+5+8+12	44.4	31+35+10+3	44.4	9+19+7+5	20.0	10+12	60.0	7+15+8+21+2+0+4
	21.4	9+6+4	30.0	30+17+8	40.0	3+5+8+9	37.5	10+6+3	25.0	3+10
Average holes on leaf		7		15		6		8		10
% of attacked leaves	27.13		41.30		40.86		38.78		31.63	

Table V. Harmfulness of *Epitrix hirtipennis* on bottom and first middle leaves in 2014.

Tobacco plant priming	Musinci		Ropotovo		Konce		Rakitec	
	% of damaged leaves	Number of holes on each leaf	% of damaged leaves	Number of holes on each leaf	% of damaged leaves	Number of holes on each leaf	% of damaged leaves	Number of hole on each leaf
Sand leaf	7.1	5+7	12.5	6+7+9+10	6.3	5+4	9.7	3+5+2
	10.7	6+5+8	12.1	7+5+8+8	10.0	3+4+4	10.3	6+3+2
	13.3	5+3+4+3	16.7	3+7+6+8+9	9.7	4+5+3	6.3	6+4
	10.3	6+8+3	12.9	8+8+9+7	7.1	6+3	7.1	2+5
	11.1	3+5+4	16.7	7+9+6+8+8	3.5	6	12.1	3+2+3+5
	15.4	2+3+6	14.3	5+8+8+9	10.0	3+3+5	10.7	3+6+3
	17.9	2+2+4+3+3	11.1	9+9+4	6.7	4+3	6.7	5+3
	16.7	5+7+8+6+6	12.9	6+6+8+8	9.4	2+6+3	6.9	6+3
	11.5	7+8+9	16.7	3+8+10+4+7	8.8	3+2+5	6.5	5+4
	10.3	8+10+9	13.8	7+7+10+8	0	0	12.9	2+2+5+6
Average holes on leaf		5		7		4		4
% of attacked leaves	12.46		13.95		7.19		8.94	

The increased number of leaf holes reduces the assimilation capacity of leaves, thereby slowing down plant growth. Sometimes the holes on tobacco leaves coalesce and occupy a larger area, which reduces the quality of tobacco (Fig. 7), so we were not able to estimate the number of the characteristic holes in Ropotovo, Dolneni and Novo Vladevci (Tables IV and V). This tobacco was not suitable for manipulation and processing.

For successful protection of tobacco from this pest it is necessary to have basic knowledge on its morphology, life cycle, dwelling place, damages caused on tobacco, presence or absence of natural enemies and, finally, monitoring.

Continuous visual monitoring of tobacco in seed beds and control of *E. hirtipennis* is necessary because seed beds are often the source of field infestations and because healthy seedlings are important for a good crop. After tobacco transplanting in the field, regular checks are necessary to determine the presence of E. hirtipennis and their characteristic damages.

Abiotic factors (high temperatures, wind, etc.), some cultural practices and natural controls help to reduce E. hirtipennis outbreaks.

It is almost impossible to grow top quality, high-yielding tobacco without using some insecticides. Chemical control is still indispensable in keeping the population rate within economically acceptable frames.

Figure 6. Strong attack of *Epitrix hirtipennis* on tobacco leaf (photo by A. Spirkoski).

Figure 7. Damaged tobacco leaf (photo by V. Krsteska).

Conclusions

E. hirtipennis adults can cause serious economic damage both to young seedlings and to plants transplanted in the field.

During 2013, the major attack was registered in June on sand leaves (3212), bottom leaves (2584) and first middle leaves (1905), with the population gradually decreasing on second middle leaves (1218), third middle leaves (894), lower top leaves (649) and top leaves (411).

According to the number of tobacco leaves attacked by *E. hirtipennis* per locality and priming in 2013, the major attacks were registered in Budakovo and Desovo.

Population density correlates positively with the number of holes and percentage of damage. In 2014, the most intense attack of tobacco flea beetle on sand leaves was in Konce with a ratio of 40.86%, and an average of 35.71% in all regions. The percentage of attacked bottom leaves and first middle leaves was on average 10.55%.

Having in mind that the number of *E. hirtipennis* is greatest in the first phases of tobacco development in all localities, precise and timely measures for control of this pest are necessary.

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ДОПРИНОС КВАНТИТАТИВНОЈ ЗАСТУПЉЕНОСТИ И ДИСТРИБУЦИЈИ *EPITRIX HIRTIPENNIS* (MELSHEIMER, 1847) (COLEOPTERA: CHRYSOMELIDAE, ALTICINI) НА ДУВАНУ

ВЕСНА КРСТЕСКА и АЛЕКСАНДАР СПИРКОСКИ

Извод

Дуванска бува *Epitrix hirtipennis* проузрокује штету током вегетације дувана. Оштећене биљке тешко се адаптирају након пресађивања у пољу и често увену. Адулти проузрокују економску штету како на младицама тако и на пресађеним биљкама у пољу. Током 2013 године, највећи напад је регистрован у јуну на лишћу: подбир (3212), надподбир (2584) и доњи средњи лист (1905), затим се популација постепено смањује на прави средњи лист (1218), горњи средњи лист (894), подовршак (649) и овршак (411). Највећи напади у 2013 години, регистровани су у Будакову и Десову. Током 2014 године најинтензивнији напад *E. hirtipennis* на лишћу подбир био је у Конче 40,86% а у осталим регионима просечно 35,71%. Процентуална вредност нападнутог лишћа надподбир и доњи средњи лист, у просеку је 10,55%.

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