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Screening of pepper (*Capsicum* spp.) accessions for infestation by pests in open field conditions

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Abstract

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Pepper is a crop infested by a great number of pests during the vegetation period. The most frequently met pests are green peach aphid (*Myzus persicae* Sulz.), thrips (*Frankliniella occidentalis* Perg. and *Thrips tabaci* Lindeman) and cotton bollworm (*Helicoverpa armigera* Hubn.). The resistance of the plant-host to the pests is a desired feature that could ensure limitation of the infestation and obtaining of quality produce. It was made a screening for pest infestation in 98 pepper (*Capsicum* spp.) accessions– varieties, breeding line, local forms and local varieties, grown on open field at natural background of infestation. The percentage of damage plants, infestation degree and damaged fruit percentage are determined.

Keywords: Capsicum spp.; *Myzus persicae; Frankliniella occidentalis; Thrips tabaci; Helicoverpa armigera;* resistance

Introduction

Pepper (*Capsicum* spp.) is one of the most widespread vegetables in the world and it is being attacked by a large number of pests. The most common are aphids (*Aphididae*), thrips (*Thripidae*) and moths (*Noctuidae*). Damages caused by these pests result in production with worsen quality and significant losses. Green peach aphid (*Myzus persicae* Sulz.) is one of the main pepper pests. It causes both direct damage and serves as a carrier of virus diseases. Tolerant varieties could be an important element in the integrated control of *M. persicae*. Along this line, tests are carried out to determine the response of different pepper varieties and accessions (Frantz et al., 2004; Sun et al., 2019). Various biological parameters, such as population density, infestation rate, relative growth and generation time are reported. In the studied 9 varieties, the lowest infestation was found in the Anam variety, and the strongest in the Chergui variety (Mdellel & Ben Halima Kamel, 2014). The sources of resistance and tolerance give a possibility to limit damages.

The western flower thrips (*Frankliniella occidentalis* Perg.) causes serious problems among the thrips. These pests could cause direct damage by eating fruits, leaves or flowers, and indirectly by transferring viruses, such as the particularly dangerous one – *Tomato Spotted Wilt Virus* (TSWV). Leaf damages caused by the thrips can affect their size and reduce photosynthetic capacity (Tommasini & Maini, 1995). Once infected larvae and adult thrips usually transmit viruses for a whole life (Jones, 2005). The resistance of thrips may slow down and reduce the transmission of viruses. In fact, the most effective way to eliminate the problem of thrips is the use of highly resistant varieties (Maris et al., 2003). Studies are being conducted to develop practical and reliable methods for resistance screening (Maharijaya et al., 2011; Ozalp et al., 2019). The resistance of the plant-host to the thrips is a desirable feature and the disclosure of the mechanism is important for the breeding programs. The effect of resistance on the development of thrips is investigated and the metabolic compounds associated with resistance are identified (Maharijaya et al., 2012). The determination of the factors

contributing to resistance is continued, with consideration being given to other options such as proteinase inhibitors or other anatomical and morphological features of the leaves.

In order to avoid the harmful effects of chemical insecticides, the use of resistant varieties may be one of the efficient and reliable alternative approaches to pest control.

The aim of the study is to determine the degree of pest infestation in various pepper accessions grown on open field to find out sources of resistance to these important pests.

Materials and Methods

The studies were conducted in 2017 at the Maritsa Vegetable Crops Research Institute – Plovdiv. The studied pepper collection included 98 accessions from Bulgaria (72), Serbia (14), Romania (10) and Macedonia (2). 46 of them are varieties, 1 – breeding line, 47 – local forms and 4 – local varieties (Table 1). Eighteen of studied accessions are with pungent taste of the fruits. An evaluation of 98 pepper accessions was made on the natural background of infestation by pests in field conditions.

The crop investigation was conducted using the routing method to determine the species composition of the pests and the degree of infestation. The following test pests and indexes have been reported:

– Green peach aphids (*Myzus persicae* Sulz.), damage plant percentage and degree of infestation of 5 ball scale, depending on the number of the pest (0 – no aphids, 1 – up to 5 aphids/ plant, 2 – from 6 to 25 aphids/plant, 3 – from 26 to 50 aphids/plant, 4 – over 50 aphids/plant) (Leclant & Remaudiere, 1970);

– Thrips (*Frankliniella occidentalis* Perg. и *Thrips tabaci* Lindeman), percentage of damaged plants, average number of mobile plant forms, degree of infestation on 5 rating scales, depending on the symptoms (0 – no symptoms, 1 – minimal symptoms, 2 – poorly expressed symptoms, 3 – average expressed symptoms, 4 – strongly expressed symptoms) (Fery & Schalk 1991);

– Cotton bollworm (*Helicoverpa armigera* Hubn.), percentage of damaged fruits (30 fruits from 10 plants).

Software products used for the investigation are "MS Excel Analysis Tool Pak Add-Ins" (https://support.office.com) and "R-3.1.3" in combination with "RStudio-1.1.447" and installed package "agricolae 1.2-2" (Mendiburu, 2015).

Results and Discussion

A core-collection (98 pepper accessions) was evaluated for damage caused by pests under natural background of infestation under field conditions. The crops investigation was carried out three times after field transplantation (budding, beginning of fruitage and mass fruitage) on the route method to determine the pest species composition and the degree of infestation. All three pests were found in crop investigation. The results obtained are given in Table 1.

Table 1. Infestation by pests in pepper accessions, grown in open field

CAPS №	Variety/ genotype	Population type	Pests				
			Green peach aphids		Thrips		Cotton bollworm
			Average% damaged plants	Average degree of infestation	Average% damaged plants	Average degree of infestation	Average % damaged fruit
1	Dekorativnibonbonki	Local form	31.48 a	1.00 n.s.	7.41 n.s.	0.33 n.s.	0.00 f
2	Chereshki	Local form	25.93 ab	0.67 n.s.	22.22 n.s.	0.67 n.s.	0.00 f
3	Chereshkamnogolyuta	Local form	25.93 ab	1.00 n.s.	3.70 n.s.	0.67 n.s.	0.00 f
4	Kambichki	Local form	29.63 ab	1.00 n.s.	12.96 n.s.	0.67 n.s.	0.00 f
5	Dzhulyunskashipka 1021	Variety	25.93 ab	1.00 n.s.	7.41 n.s.	0.67 n.s.	0.00 f
6	Byalashipka	Local variety	27.78 ab	1.00 n.s.	22.22 n.s.	1.00 n.s.	0.00 f
7	Byalashipka – limonka	Local form	31.48 a	1.00 n.s.	22.22 n.s.	1.00 n.s.	0.00 f
8	Ribki	Local form	31.48 a	1.00 n.s.	25.93 n.s.	1.00 n.s.	0.00 f
9	Kozi rog	Local form	20.37 ab	0.67 n.s.	24.07 n.s.	1.00 n.s.	0.00 f
10	Chorbadzhiyski	Local variety	20.37 ab	0.67 n.s.	24.07 n.s.	0.67 n.s.	0.00 f
11	Vosachnashipka	Local form	3.33 ab	0.33 n.s.	25.56 n.s.	0.33 n.s.	10.00 bc
12	Shipkasladka	Variety	1.11 b	0.33 n.s.	15.56 n.s.	0.67 n.s.	1.67 ef
13	Limonovashipka	Local form	1.11 b	0.33 n.s.	4.44 n.s.	0.33 n.s.	15.00 ab
14	IZK Delikates	Variety	2.22 ab	0.33 n.s.	16.67 n.s.	0.33 n.s.	3.33 def
15	Sivria	Local form	4.44 ab	0.33 n.s.	40.00 n.s.	1.33 n.s.	3.33 def

Table 1. Continued

16	Sivria type	Local form	0.00 b	0.00 n.s.	28.89 n.s.	0.67 n.s.	1.67 ef
17	Byal piper sivria	Local form	1.11 b	0.33 n.s.	43.33 n.s.	1.33 n.s.	1.67 ef
18	Byal piper	Local form	3.33 ab	0.33 n.s.	6.67 n.s.	0.33 n.s.	0.00 f
19	Sivria 600	Variety	5.56 ab	0.67 n.s.	32.22 n.s.	1.00 n.s.	1.67 ef
20	Zlaten medal 7	Variety	3.33 ab	0.33 n.s.	26.67 n.s.	0.67 n.s.	1.67 ef
21	Albena	Variety	2.22 ab	0.33 n.s.	7.78 n.s.	0.67 n.s.	0.00 f
22	Hebar	Variety	2.22 ab	0.33 n.s.	28.89 n.s.	0.67 n.s.	0.00 f
23	Stryama	Variety	3.33 ab	0.33 n.s.	28.89 n.s.	1.00 n.s.	6.67 cde
24	Milkana F1	Variety	5.56 ab	0.33 n.s.	15.56 n.s.	0.67 n.s.	1.67 ef
25	Yasen F1	Variety	5.56 ab	0.33 n.s.	5.56 n.s.	0.67 n.s.	1.67 ef
26	Romansa	Variety	3.33 ab	0.33 n.s.	31.11 n.s.	1.00 n.s.	3.33 def
27	Ekstaza	Variety	3.33 ab	0.33 n.s.	28.89 n.s.	1.00 n.s.	0.00 f
28	Vrazhdebski	Local form	10.00 ab	0.67 n.s.	17.78 n.s.	0.67 n.s.	3.33 def
29	Kalinkov 800/7	Variety	13.33 ab	0.33 n.s.	28.89 n.s.	1.00 n.s.	0.00 f
30	Byalkalinkov	Local variety	5.56 ab	0.67 n.s.	32.22 n.s.	0.67 n.s.	8.33 cd
31	Maritsa	Variety	10.00 ab	0.33 n.s.	21.11 n.s.	0.67 n.s.	1.67 ef
32	Kaloyan	Variety	7.78 ab	0.33 n.s.	25.56 n.s.	0.67 n.s.	0.00 f
33	RatundShabla	Local form	2.22 ab	0.67 n.s.	31.11 n.s.	1.00 n.s.	3.33 def
34	Kambi S-71	Local form	1.11 b	0.33 n.s.	24.44 n.s.	0.67 n.s.	3.33 def
35	Osmarskokambe	Local form	1.11 b	0.33 n.s.	18.89 n.s.	0.67 n.s.	0.00 f
36	Kambi	Local form	4.44 ab	0.33 n.s.	34.44 n.s.	0.67 n.s.	0.00 f
37	Kambi MSH-2	Local form	2.22 ab	0.33 n.s.	23.33 n.s.	0.67 n.s.	0.00 f
38	Bulgarskiratund	Local variety	3.33 ab	0.33 n.s.	16.67 n.s.	0.67 n.s.	1.67 ef
39	Kurtovskakapia 1619	Variety	1.11 b	0.33 n.s.	40.00 n.s.	1.00 n.s.	0.00 f
40	Kapia UV	Variety	3.33 ab	0.33 n.s.	18.89 n.s.	0.67 n.s.	1.67 ef
41	Sofiyskakapia	Variety	7.78 ab	0.33 n.s.	17.78 n.s.	0.67 n.s.	1.67 ef
42	Kapia 1300	Variety	5.56 ab	0.33 n.s.	34.44 n.s.	0.67 n.s.	1.67 ef
43	Kurtovskakapia 1	Variety	10.00 ab	0.33 n.s.	15.56 n.s.	1.00 n.s.	5.00 cdef
44	Delfina	Variety	8.89 ab	0.33 n.s.	47.78 n.s.	1.00 n.s.	0.00 f
45	Belo uvo	Variety	6.67 ab	0.33 n.s.	31.11 n.s.	1.00 n.s.	0.00 f
46	Prizrenka	Variety	4.44 ab	0.33 n.s.	31.11 n.s.	1.00 n.s.	1.67 ef
47	Slonovouvo	Variety	4.44 ab	0.67 n.s.	27.78 n.s.	1.00 n.s.	3.33 def
48	Palanachkochudo	Variety	6.67 ab	0.33 n.s.	27.78 n.s.	1.00 n.s.	0.00 f
49	Popovskiednovurh	Local form	3.33 ab	0.33 n.s.	40.00 n.s.	1.00 n.s.	3.33 def
50	KapiaTodora	Local form	5.56 ab	0.33 n.s.	32.22 n.s.	0.67 n.s.	1.67 ef
51	Oranzhevakapia	Local form	5.56 ab	0.33 n.s.	35.56 n.s.	0.67 n.s.	8.33 cd
52	Baldovskakapia	Local form	3.33 ab	0.33 n.s.	18.89 n.s.	0.67 n.s.	5.00 cdef
53	Manolskakapia	Local form	2.22 ab	0.33 n.s.	30.00 n.s.	0.67 n.s.	5.00 cdef
54	Rannakapia	Local form	4.44 ab	0.33 n.s.	32.22 n.s.	0.67 n.s.	1.67 cdef
55	KapiaStryama	Local form	4.44 ab	0.33 n.s.	28.89 n.s.	0.67 n.s.	0.00 f
56	Kapia 1300 oranzheva	Local form	2.22 ab	0.33 n.s.	32.22 n.s.	0.67 n.s.	0.00 f
57	KapiaByalareka	Local form	0.00 b	0.00 n.s.	7.78 n.s.	0.67 n.s.	3.33 def
58	Dulgakapia	Local form	3.33 ab	0.33 n.s.	24.44 n.s.	0.67 n.s.	6.67 cde
59	Kurtovskakapia	Local form	7.78 ab	0.33 n.s.	26.67 n.s.	1.00 n.s.	0.00 f
60	Kapiaedra	Local form	5.56 ab	0.33 n.s.	34.44 n.s.	0.67 n.s.	0.00 f
61	KapiaBelozem	Local form	7.78 ab	0.33 n.s.	38.89 n.s.	0.67 n.s.	0.00 f
62	Buketen 3	Variety	5.56 ab	0.33 n.s.	33.33 n.s.	0.67 n.s.	16.67 a
63	Buketen 50	Variety	4.44 ab	0.33 n.s.	33.33 n.s.	1.00 n.s.	20.00 a

Table 1. Continued

64	Gorogled 6	Variety	2.22 ab	0.33 n.s.	36.67 n.s.	1.00 n.s.	1.67 ef
65	IZK Rubin	Variety	2.22 ab	0.33 n.s.	14.44 n.s.	0.67 n.s.	0.00 f
66	Mandra K-95	Local form	3.33 ab	0.33 n.s.	25.56 n.s.	0.67 n.s.	5.00 cdef
67	IZK Kalin	Variety	2.22 ab	0.33 n.s.	8.89 n.s.	0.33 n.s.	0.00 f
68	Ratundcheta	Local form	22.22 ab	0.67 n.s.	5.56 n.s.	0.67 n.s.	0.00 f
69	Vezen	Local form	14.81 ab	0.67 n.s.	14.81 n.s.	0.67 n.s.	0.00 f
70	Kozi rog (P)	Local form	20.37 ab	0.67 n.s.	31.48 n.s.	0.67 n.s.	0.00 f
71	Dzinka	Variety	18.52 ab	0.67 n.s.	29.63 n.s.	1.00 n.s.	0.00 f
72	Pintea	Variety	22.22 ab	0.67 n.s.	27.78 n.s.	1.00 n.s.	0.00 f
73	Dracula	Variety	27.78 ab	1.00 n.s.	27.78 n.s.	1.00 n.s.	0.00 f
74	Bananica №36	Local form	20.37 ab	0.67 n.s.	18.52 n.s.	0.67 n.s.	0.00 f
75	89E471	Local form	25.93 ab	0.33 n.s.	12.96 n.s.	0.33 n.s.	0.00 f
76	7125	Local form	5.56 ab	0.33 n.s.	22.22 n.s.	0.67 n.s.	1.67 ef
77	Oranzhevisladkiribki	Variety	18.52 ab	0.67 n.s.	18.52 n.s.	1.00 n.s.	0.00 f
78	Zhultisladkiribki	Variety	12.96 ab	0.67 n.s.	5.56 n.s.	0.33 n.s.	1.67 ef
79	Silvia	Variety	2.22 ab	0.33 n.s.	30.00 n.s.	1.00 n.s.	0.00 f
80	Artim	Variety	3.33 ab	0.33 n.s.	28.89 n.s.	1.33 n.s.	1.67 ef
81	Amfora	Variety	3.33 ab	0.33 n.s.	24.44 n.s.	0.33 n.s.	0.00 f
82	KapiaParvenets	Local form	4.44 ab	0.33 n.s.	17.78 n.s.	1.00 n.s.	6.67 cde
83	Zvinishkakapia	Local form	0.00 b	0.00 n.s.	17.78 n.s.	1.00 n.s.	0.00 f
84	Zubovskakapia	Local form	2.22 ab	0.33 n.s.	34.44 n.s.	0.67 n.s.	0.00 f
85	Rosenskakapia	Local form	2.22 ab	0.33 n.s.	37.78 n.s.	0.67 n.s.	1.67 ef
86	Ajvarka	Variety	0.00 b	0.00 n.s.	38.89 n.s.	0.67 n.s.	1.67 ef
87	Ivaylovskakapia	Variety	2.22 ab	0.33 n.s.	41.11 n.s.	0.67 n.s.	6.67 cde
88	OSPZ 4to	Breeding line	4.44 ab	0.33 n.s.	24.44 n.s.	0.67 n.s.	6.67 cde
89	Alexandru	Variety	6.67 ab	0.33 n.s.	16.67 n.s.	0.67 n.s.	0.00 f
90	Oranzhevakapia (P)	Local form	2.22 ab	0.33 n.s.	25.56 n.s.	0.67 n.s.	0.00 f
91	Bananica №35	Local form	4.44 ab	0.33 n.s.	27.78 n.s.	0.67 n.s.	6.67 cde
92	Export	Variety	10.00 ab	0.33 n.s.	31.11 n.s.	0.67 n.s.	1.67 ef
93	Andreyka	Variety	10.00 ab	0.33 n.s.	32.22 n.s.	1.00 n.s.	0.00 f
94	Barbara	Variety	11.11 ab	0.33 n.s.	26.67 n.s.	0.67 n.s.	3.33 def
95	Belinda	Variety	15.56 ab	0.33 n.s.	17.78 n.s.	0.67 n.s.	10.00 bc
96	Splendid	Variety	13.32 ab	0.67 n.s.	6.66 n.s.	0.33 n.s.	0.00 f
97	ZelenRatund	Variety	1.11 b	0.33 n.s.	34.44 n.s.	0.67 n.s.	0.00 f
98	Bukur	Variety	4.44 ab	0.33 n.s.	18.89 n.s.	0.67 n.s.	0.00 f
Alpha:			0.5	0.5	0.5	0.5	0.5
DF Error:			292	292	292	292	390
Critical Value of t:			1.97	1.97	1.97	1.97	1.97
Least Significant Difference:			30.32	1.11	49.38	1.15	6.57

*Treatments with the same letter are not significantly different.

Green peach aphids (*Myzus persicae* Sulz.): The infestation degree varies from 0 to 1, and the percentage of damaged plants reaches 31.48%. It was not established an infestation in three local forms: CAPS-16 Sivria type; CAPS-57 Kapia Byala reka; CAPS-83 Zvinishka kapia and Serbian variety – CAPS-86 Ajvarka. A weak infestation was reported in the accessions Bulgarian varieties and forms – CAPS-12 Shipka sladka; CAPS-13 Limonova shipka; CAPS-17 Byal piper sivria; CAPS-34 Kambi S-71; CAPS-35 Osmarsko kambe; CAPS-39 Kurtovska kapia 1619 and Serbian va-

riety CAPS-97 Zelen Ratund. The percentage of damaged plants was 1.11% and the infestation rate – 0.33. The percentage of damaged plants was above 25% in highly infested 10 accessions (7 local forms, 2 variety and 1 local variety): CAPS-1 Dekorativni bonbonki (31.48%); CAPS-2 Chereshki (25.93%); CAPS-3 Chereshka mnogo lyuta (25.93%); CAPS-4 Kambichki (29.63%); CAPS-5 Dzhulyunska shipka 1021 (25.93%); CAPS-6 Byala shipka (27.78%); CAPS-7 Byala shipka – limonka (31.48%); CAPS-8 Ribki (31.48%), CAPS-73 Dracula (27.78%) and CAPS-75 89E471 (25.93%).

Thrips (*Frankliniella occidentalis* Perg. and *Thrips tabaci* Lindeman): An infestation by these pests has been reported in all accessions. The degree of infestation ranges from 0.33 to 1, the percentage of damaged plants is from 2.22% to 47.78%. Slight infestation (up to 5% damaged plants) was observed in CAPS-3 Chereshka mnogo lyuta (3.70%) and CAPS-13 Limonova shipka (4.44%). A strong infestation by these pests with a percentage of damaged plants above 40% was found in: CAPS-15 Sivria (40%); CAPS-17 Byal piper sivria (43.33%); CAPS-39 Kurtovska kapia 1619 (40.00%); CAPS-44 Delfina (47.78%); CAPS-49 Popovski ednovurh (40.00%) and CAPS-87 Ivaylovska kapia (41.11%).

Cotton bollworm (*Helicoverpa armigera* Hubn.): The percentage of damaged fruit reported in the cotton bollworm, ranges from 0 to 20%. There is no infestation by this pest in 43.88% of the tested accessions. These are the following accessions: CAPS-1 Dekorativni bonbonki; CAPS-2 Chereshki; CAPS-3 Chereshka mnogo lyuta; CAPS-4 Kambichki; CAPS-5 Dzhulyunska shipka 1021; CAPS-6 Byala shipka; CAPS-7 Byala shipka – limonka; CAPS-8 Ribki; CAPS-9 Kozi rog; CAPS-10 Chorbadzhiyski; CAPS-18 Byal piper; CAPS-21 Albena; CAPS-22 Hebar; CAPS-27 Ekstaza; CAPS-29 Kalinkov 800/7; CAPS-36 Kambi; CAPS-39 Kurtovska kapia 1619; CAPS-44 Delfina; CAPS-45 Belo uvo; CAPS-55 Kapia Stryama; CAPS-56 Kapia 1300 oranzheva; CAPS-60 Kapia edra; CAPS-61 Kapia Belozem; CAPS-65 IZK Rubin; CAPS-67 IZK Kalin; CAPS-68 Ratundcheta; CAPS-69 Vezen; CAPS-70 Kozi rog (P); CAPS-71 Dzinka; CAPS-72 Pintea; CAPS-73 Dracula; CAPS-74 Bananica №36; CAPS-75 89E471; CAPS-77 Oranzhevi sladki ribki; CAPS-79 Silvia; CAPS-81 Amfora; CAPS-83 Zvinishka kapia; CAPS-84 Zubovska kapia; CAPS-89 Alexandru; CAPS-90 Oranzheva kapia (P); CAPS-96 Splendid; CAPS-97 Zelen Ratund; CAPS-98 Bukur. All accessions with pungent fruit taste are without infestation by this pest. The accessions: CAPS-11 Vosachna shipka; CAPS-13 Limonova shipka; CAPS-62 Buketen 3; CAPS-63 Buketen 50 and CAPS-95 Belinda are with a strong infestation rate of damaged plants above 5% and a percentage of damaged fruits above 10% are respectively.

The accessions with Bulgarian origin – CAPS-18 Byal piper; CAPS-21 Albena; CAPS-25 Yasen F_1; CAPS-57 Kapia Byala reka and CAPS-67 IZK Kalin, with a relatively low infestation rate by all three types of pests are of interest. These materials will also be subject to research for the next vegetation period. The accessions that were non-infested by the green peach aphid will also be tested under artificial infestation background.

Conclusions

Infestation by green peach aphid (*Myzus persicae* Sulz.) was not established in three local forms – CAPS-16 Sivria type; CAPS-57 Kapia Byala reka; CAPS-83 Zvinishka kapia and Serbian variety – CAPS-86 Ajvarka.

In the accessions – two Bulgarian local forms: CAPS-18 Byal piper; CAPS-57 Kapia Byala reka and three Bulgarian varieties: CAPS-21 Albena; CAPS-25 Yasen F_1; CAPS-67 IZK Kalin a relatively low infestation was observed by the three pests (green peach aphid, thrips and cotton bollworm).

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