

Influence of the time of first fruit color change and the duration of fruit ripening of cherry varieties on the infestation by *R. cerasi*

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Summary

The aim of this research is to analyse the influence of the time of first fruit colour change and duration of fruit ripening of 19 cherry varieties on the infestation percentage by the European cherry fruit fly (*Rhagoletis cerasi* L.) for 2008/2009. The infestation percentage grew proportionally depending on the time of first fruit colour change from 3% for the group of varieties which started earlier with the fruit colour change to 46.2% for the group of varieties which started later with the fruit colour change for 2008, and from 0% to 65.7% for 2009, respectively. The infestation percentage grew proportionally with the duration of fruit ripening of the cherry varieties, from 10.3% for the group of varieties with a short ripening period to 55.2% for the group of varieties with a long ripening period.

Key words: European cherry fruit fly, *Rhagoletis cerasi* L., cherry varieties, cherry characteristics

Introduction

Cherry (*Prunus avium* L.) represents one of the most significant fruit tree cultures in the world and in the R. Macedonia. Cherry trees have a wide range of distribution because they are very adaptable to different ecological factors.

The European cherry fruit fly (*Rhagoletis cerasi* L.) is the most significant economic pest of cherry orchards in Europe and Turkey because of its direct damage to the fruit. The larvae of the fly develop in the cherry fruit and feed with its inside, causing serious economic damage (Ozdem & Kilincer, 2005).

The economic threshold in many European countries is 4% of infested fruits (Stamenković, Garić et al., 1993), while in Turkey there is zero tolerance for infested fruits by *R. cerasi* for cherry fruit production intended for export to foreign markets. In unprotected cherry orchards, the fly can cause 100% damage to some varieties (Stamenković, Garić et al., 1993).

There are many publications concerning the biology of *R. cerasi* (Ozdem & Kilincer, 2005; Stamenković, Milenković et al., 1993), its control (Baric, Paukovic et al., 2007; Daniel, 2008; Katsoyannos, Papadopoulos et al., 2000), and the influence of ecological factors on this pest (Kovanci & Kovanci, 2006), but there are few publications about the influence of some characteristics of cherry varieties on the infestation caused by *R. cerasi* (Stamenković, Garić et al., 1993; Bandzo, Popovska et al., 2011).

Bandzo, Popovska et al. (2011) have established that the time of fruit ripening influences the infestation percentage by *R. cerasi*, while the fruit firmness and colour of the fruit's skin do not have any influence.

The European cherry fruit fly (*R. cerasi*) lays its eggs on the cherry fruit at the time of first fruit colour change, from green to yellowish or reddish, depending on the cherry variety (Ozdem & Kilincer, 2005). That is why the aim of this research is to establish a correlation between the time of first fruit colour change and duration of fruit ripening of the cherry varieties and infestation percentage of cherry fruits by the European cherry fruit fly.

Materials and methods

The research was conducted in 2008 and 2009 on the cherry collection field of the Agricultural Institute, near Skopje. The cherry field was not chemically treated against the fly during the analysis. The influence of the time of first fruit colour change and the duration of fruit ripening on infestation percentage by the European cherry fruit fly was tested on 19 cherry varieties. Eight of them are early-ripening (Primavera, Anone, Ranna Cherna Edra, Bigareau Burlat, Bigareau Jaboulay, Asenova rana, Junskača ranaja, Valeska), 6 are medium-ripening (Vega, Bing, Pobeda krimskaja, Charna, Bianca di Verona, Sunburst) and 5 are late-ripening (Bigareau Napoleon, Chrzastka kozerska, Grosse Germersdorfer, Hedelfingen Reisenkirche and Star).

The time of first fruit colour change was determined by standard pomological methods by noting the date when the cherry fruit was starting to change its colour from green to yellowish or reddish. The categorisation of the varieties for this characteristic was in accordance to the eclosion time of the fly. In 2008, because the flight of the fly had two picks, the cherry varieties were divided in 3 groups:

- Varieties at the stage of first colour change before the flight of the fly;
- Varieties at the stage of first colour change during the first pick of the flight of the fly;
- Varieties at the stage of first colour change during the second pick of the flight of the fly.

In 2009, because dynamics of the flight of the Cherry fruit fly was different from the one in 2008 and the flight had only one pick, the varieties were divided into 3 following groups:

- Varieties at the stage of first colour change before the flight of the fly;
- Varieties at the stage of first colour change during the first decade of the flight of the fly;
- Varieties at the stage of first colour change during the pick of the flight of the fly.

The classification of the cherry varieties according to the duration of fruit ripening was determined according to the average values for 2008/2009 and it divided the varieties in 3 groups:

- Varieties with short ripening period (shorter than 20 days);
- Varieties with medium long ripening period (from 20 to 23 days);
- Varieties with long ripening period (longer than 24 days).

The percentage of infestation by the Cherry fruit fly was examined on 100 fully ripened fruits in three repetitions of each analysed variety. The fruits were flooded in 10% salty water and after one hour, the number of larvae that exited from the fruits was established. The statistical analysis of variation of average values on the percentage of infested fruits between different groups was performed by using LSD and t – tests with significance level of 95% and 99%.

Results and discussion

The infestation percentages of the cherry varieties according to the time of first fruit colour change in 2008 and 2009 are given in Table 1.

In 2008, six of the 19 analysed cherry varieties started with the fruit colour change before the emergence of the fly. The average infestation percentage in this group was 3%. Primavera, Anone, Ranna Cherna Edra and Bigareau Burlat varieties were not infested at all by the fly, so their infestation percentage was 0%. The most infested variety was Asenova rana with 11%. All of these are varieties with early time of fruit ripening.

In the second group were varieties which started with the first fruit colour change during the first pick of the flight of *R. cerasi*. In 2008, this group consisted of 4 varieties, two of them were early-ripening (Junskaja ranaja and Valeska) and two were medium-ripening (Vega and Bing). The average infestation percentage was 34.3% and it varied from 23% (Junskaja ranaja) and 24% (Vega) to 58% (Bing).

In 2008, there were 9 varieties in the group of cherry varieties which started to change fruit colour during the second pick of the flight of *R. cerasi*, 4 were medium-ripening (Pobeda krimskaja, Charna, Bianca di Verona and Sunburst) and 5 were late-ripening (Bigareau Napoleon, Chrzastka kozerska, Grosse Germersdorfer, Hedelfingen Reisenkirche and Star). The average infestation percentage was 46.2% and it varied from 32% (Sunburst and Bigareau Napoleon) to 67% (Grosse Germersdorfer).

The results given for 2008 showed that the infestation percentage of the cherry varieties grew proportionally from the first (3%) to the third group (46.2%). This means that the infestation percentage was rising proportionally from the varieties which started with the first fruit colour change earlier, before the emergence of the fly, to the varieties which started with the first fruit colour change later, during the pick of the flight of *R. cerasi*.

The statistical analysis of variation of average values on the percentage of infested fruits between different variety groups for 2008 was examined by the t – test. A statistically significant difference was observed among all of the tested groups, which confirmed a correlation between the infestation of cherry fruits and the time of first fruit colour change.

Tab. 1. Infestation of cherry varieties by *R. cerasi*, according to first fruit color change time

Zaraza kod sorti trešnje od R. cerasi, zavisno od vremena prve promene boje ploda

		Variety	Time of first fruit color change	Infestation % 2008
till 04.05	1	Primavera	27.04	0
	2	Anone	28.04	0
	3	Bigareau Jaboulay	01.05	7
	4	Ranna Cherna Edra	03.05	0
	5	Asenova rana	03.05	11
	6	Bigareau Burlat	04.05	0
Average				3,0
05.05-10.05	7	Junskaja ranaja	06.05	23
	8	Vega	06.05	24
	9	Valeska	08.05	32
	10	Bing	10.05	58
Average				34,3
17.05-23.05	11	Pobeda krimskaja	17.05	43
	12	Sunburst	17.05	32
	13	Charna	18.05	34
	14	Bianca di Verona	19.05	54
	15	Grosse Germersdorfer	20.05	67
	16	Star	20.05	62
	17	Bigareau Napoleon	22.05	32
	18	Chrzastka kozerska	22.05	57
	19	Hedelfingen Reisenkirsche	23.05	35
Average				46,2

		Variety	Time of first fruit color change	Infestation % 2009
till 04.05	1	Anone	02.05	0
	2	Primavera	03.05	0
Average				0,0
10.05-20.05	3	Bigareau Jaboulay	11.05	8
	4	Asenova rana	12.05	2
	5	Ranna Cherna Edra	13.05	2
	6	Bigareau Burlat	14.05	2
	7	Junskaja ranaja	16.05	4
	8	Valeska	18.05	64
	9	Vega	20.05	30
	10	Bing	20.05	45
Average				19,6
22.05-30.05	11	Sunburst	22.05	72
	12	Pobeda krimskaja	23.05	55
	13	Charna	25.05	62
	14	Bianca di Verona	26.05	40
	15	Grosse Germersdorfer	26.05	36
	16	Star	26.05	80
	17	Bigareau Napoleon	26.05	94
	18	Chrzastka kozerska	26.05	52
	19	Hedelfingen Reisenkirsche	30.05	100
Average				65,7

A statistically very significant difference was observed between the infestation percentages in the varieties of the first and second group with a significance level of 0.01. Moreover, a statistically very high significant difference was observed between the infestation percentages in the varieties of the first and third group with a level of significance of 0.001. Also, a statistically significant difference was observed between the infestation percentages of the varieties of the second and third group, with a significance level of 0.05.

In 2009, in the first group were only two early-ripening varieties (Primavera and Anone), which were not infested and the average infestation percentage of the group was 0%.

The second group comprised cherry varieties which started with the fruit colour change during the first decade of the flight of *R. cerasi*. Six were early-ripening and two were medium-ripening varieties. The infestation percentage in this group varied from 2% (Asenova rana, Ranna Cherna Edra, Bigareau Burlat) to 64% (Valeska) with an average infestation of 19.6%.

In the third group were cherry varieties which were at the stage of first fruit colour change during the pick of the flight of the European cherry fruit fly. There were the same nine varieties in this group that were in the third group in 2008. The average infestation percentage of this group was 65.7% and it was the highest among all of the groups. The infestation percentage varied from 36% (Grosse Germersdorfer) to total infestation of 100% (Hedelfingen Reisenkirche).

The results given for 2009 had the same pattern as the results from 2008, that is, the infestation percentage of the cherry varieties grew proportionally from the first (0%) to the third (65.7%) group. This means that the infestation percentage was rising proportionally from varieties which started with the first fruit colour change earlier, before the emergence of the fly, to varieties which started with the first fruit colour change later, during the pick of the flight of *R. cerasi*.

The statistical analysis of variation of average values on the percentage of infested fruits between different variety groups was also examined for 2009 by the t-test. A statistically significant difference was observed among all of the tested groups, as it was detected in 2008.

A statistically significant difference was observed between the infestation percentages of the varieties of the first and second group with a significance level of 0.05 whereas a statistically very high significant difference was observed between the infestation percentages of the varieties of the first and third group with a level of significance of 0.001 and a statistically very significant difference was observed between the infestation percentages of the varieties of the second and third group with a significance level of 0.01.

In Table 2, the results are given which show the infestation percentage of the cherry varieties according to duration of fruit ripening for 2008 and 2009.

Seven varieties were in the group of cherry varieties with short ripening period for the period 2008/2009. Six of them were early-ripening and one was medium-ripening. The average infestation percentage of this group was 10.3% and it varied from 0% (Primavera and Anone) to 49% (Pobeda krimskaja).

Tab. 2. Infestation of cherry varieties by *R. cerasi*, according to the duration of fruit ripening

Zarazba ploda sorti trešnjice od R. cerasi, zavisno od dužine zrenja ploda

	Variety	Period of ripening			Infestation %		Average 2008/2009
		2008	2009	Average	2008	2009	
Short period	1 Bigareau Jaboulay	16	15	16	7	8	7,5
	2 Bigareau Burlat	19	13	16	0	2	1,0
	3 Anone	16	18	17	0	0	0,0
	4 Primavera	17	18	18	0	0	0,0
	5 Ranna Cherna Edra	21	14	18	0	2	1,0
	6 Junskača ranaja	21	15	18	23	4	13,5
	7 Pobeda krimskaja	19	19	19	43	55	49,0
Average					10,4	10,1	10,3
Medium long period	8 Valeska	23	16	20	32	64	48,0
	9 Bianca di Verona	22	22	22	54	40	47,0
	10 Charna	23	21	22	34	62	48,0
	11 Asenova rana	25	19	22	11	2	6,5
	12 Bing	25	20	23	58	45	51,5
Average					37,8	42,6	40,2
Long period	13 Bigareau Napoleon	23	24	24	32	94	63,0
	14 Chrzastka kozerska	23	24	24	57	52	54,5
	15 Hedelfingen Reisenkirsche	24	23	24	35	100	67,5
	16 Vega	29	20	25	24	30	27,0
	17 Grosse Germersdorfer	26	24	25	67	36	51,5
	18 Sunburst	25	26	26	32	72	52,0
	19 Star	28	27	28	62	80	71,0
Average					44,1	66,3	55,2

LSD_{0.05} = 22.427 LSD_{0.01} = 60.961

The varieties with medium ripening period included 5 cherry varieties. Two of them were early-ripening and three medium-ripening. The average infestation percentage was 40.2%. The least infected of the varieties was Asenova rana (6.5%) and the most infected was Bing (51.5%).

The other 7 cherry varieties were in the group of varieties with long ripening period. There were all of the late varieties and two medium-ripening varieties in this group. The infestation percentage of this group varied from 27% (Vega) to 71% (Star). The average infestation percentage of this group for the two analysed years was 55.2%.

A statistically significant difference was observed between the infestation percentages of the group of varieties with short ripening period and medium ripening period and also between the groups of varieties with short and long ripening period with a significance level of 0.05.

The results given for the two analysed years showed that the infestation percentage of the cherry varieties grew proportionally from varieties with short (10.3%) to varieties with long ripening period (55.2%). A strong positive linear correlation was observed between these two characteristics. The coefficient of correlation r for 2008/2009 was $r = 0.511340$.

Conclusion

The time of first fruit colour change influences the infestation percentage by *R. cerasi*.

The infestation percentage grew proportionally from 3% in 2008 and 0% in 2009 for the group of varieties which started with the first fruit colour change earlier, before the emergence of the fly, to 46.2% in 2008 and 65.7% in 2009 for the group of varieties which started with the first fruit colour change later, during the pick of the flight of *R. cerasi*.

Duration of fruit ripening influences the infestation percentage by *R. cerasi*.

The average infestation percentage grew proportionally from 10.3% for the group of varieties with short ripening period to 55.2% for the group of varieties with long ripening period. A strong positive linear correlation was observed between these two characteristics.

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Uticaj vremena prve promene boje ploda i vreme trajanja zrenja kod nekih sorti trešnje na zarazu sa *R. cerasi*

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Sažetak

Cilj istraživanja je analiza uticaja vremena prve pojave promene boje ploda i vremena trajanja zrenja kod 19 sorata trešnje na procenat zaraze ploda od trešnjine muve (*Rhagoletis cerasi* L.) u toku 2008 i 2009 godine. Procenat zaraze plodova u 2008 raste proporcionalno zavisno od vremena prve promene boje ploda i to od 3% za grupu sorata sa ranijim početkom promene boje do 46.2% za grupu sorata sa kasnijim početkom promene boje plodova, da bi to za 2009 godinu iznosilo od 0% do 65.7%. Obe godine, procenat zaraze proporcionalno raste sa porastom dužine vremena zrenja ispitivanih sorti. Procenat zaraze proporcionalno raste od 10.3% za grupu sorti sa kratkim periodom zrenja do 55.2% za grupu sorti sa dugim periodom zrenja plodova.

Ključne reči: Trešnjina muva, *Rhagoletis cerasi* L., sorte trešanja, karakteristike sorata trešnje