Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 2, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

COMPARATIVE PERFORMANCE OF LOCAL CHERRY CULTIVARS IN PLOVDIV, BULGARIA

Svetoslav MALCHEV, Plamen IVANOV, Sashka SAVCHOVSKA, Vanya AKOVA

Fruit Growing Institute - Plovdiv, 12 Ostromila Dist., 4004, Plovdiv, Bulgaria

Corresponding author email: svetoslav.m@outlook.com

Abstract

In the conditions of global climate change and invasion of new pests, the utilisation of the local genepool is a vital step towards sustainable agriculture. Local cultivars and forms are generally considered better adapted to the conditions of the originating region than a widely spread cultivars bred elsewhere. In the current study, two old local cherry cultivars 'Kuklenska belitsa' and 'Ranna cherna edra' and two newly selected hybrids 'Asparukh' (El.17-90) and 'Tzvetina' (El.17-37) are compared to commercial cultivars 'Bigarreau Burlat', 'Van', 'Sunburst' and the FGI-Plovdiv cultivar 'Kossara' in order to assess their performance in terms of fruit characteristics (biometry and fruit chemical composition) and resistance to pests.

Key words*: cherry, local cultivars, hybrids, genetic resources.*

INTRODUCTION

Globally, it is recognised that global trade and competition has led to the use of a limited number of cultivars, often of a similar origin, which reinforces the pressure from the changing climate and the multiplication and transfer of pathogens from one country to another. The lack of genetic diversity can lead to vulnerability (susceptibility) to diseases and pests, as well as the emergence of new resistant races and pressures on the environment (Scott & Lawrence, 1975). According to Shelef et al. (2017), most food crops are currently produced, transported and consumed long distances from their country of origin. At the same time, research and practices are mainly focused on improving the productivity of a small number of existing crops that form the cornerstone of the global food economy, rather than increasing crop diversity. The result is a loss of agrobiological diversity, which leads to unsustainable practices in the food industry, and it is more susceptible to abiotic and biotic stressors and is at risk of catastrophic losses. People cultivate only around 150 of approximately 30 000 edible plant species globally, with only 30 plant species constituting the majority of our diets.

Plant Genetic Resources (PGR) are of fundamental importance for the agricultural science and in particular for fruit growing. They have a direct relationship with breeding programs and researches in the field of integrated plant protection and organic farming, as they are the basis for creating genetic diversity, bearing valuable biological, including agricultural qualities and resistance to pests and diseases (Haussmann et al., 2004; Nass et al., 2012).

In order to enrich the variety of cultivars grown in the country with well adapted sustainable and productive, it is obligatory in the breeding programs besides the newly introduced promising cultivars to include traditional local forms as donors of these desirable qualities. Additionally, it is necessary to preserve certain local foods or authentic tastes by preserving traditional cultivars associated with certain regions or even individual settlements (Altieri & Merrick, 1987).

During the development of project "Innovations and traditions in the conservation and use of old and local genetic resources in fruit growing and viticulture" funded by the National Science Fund of the Bulgarian Ministry of Education and Science, old and local genetic resources in fruit growing and viticulture were sought, preserved and studied, using modern methods and techniques in the field of fruit growing, viticulture, phytopathology, entomology, chemistry and

biotechnology. This study presents an analysis of local cultivars, both old and newly selected, compared to widely used commercial cultivars. The objectives set in this paper would contribute to both the conservation of local genetic resources and enhancement of the sweet cherry breeding programme in the Fruit Growing Institute - Plovdiv, Bulgaria (FGI).

MATERIALS AND METHODS

During the development of Project KP-06-PN46/3, many scientific expeditions were carried out resulting in a collection of specimens from different fruit crops including cherries. In this study two preserved old local cherry cultivars 'Kuklenska belitsa' (point of origin 42°00'47.8"N 24°48'24.6"E) and 'Ranna cherna edra' (point of origin 42°01'37.5"N 24°44'42.1"E) and two newly selected hybrids 'Asparukh' (El.17-90) and 'Tzvetina' (El.17-37) were compared to commercial cultivars 'Bigarreau Burlat', 'Van', 'Sunburst' and the FGI-Plovdiv cultivar 'Kossara' in order to assess their performance in terms of fruit characteristics (biometry and fruit chemical composition) and susceptibility to cherry fruit fly *Rhagoletis cerasi* (L.) (Diptera: Tephritidae).

The biometric indicators were measured according to the standard methodology used in FGI-Plovdiv "Methodology for the study of plant resources in fruit plants" (Nedev et al., 1979) and updated in 2016 (Malchev, 2016).

The chemical analyses were carried out in the chemical laboratory of the Fruit Growing Institute - Plovdiv. Average samples were formed randomly at a time of consumptive maturity of the fruits. Determined are the chemical parameters: soluble solids content - refractometrically by Brix; sugars (inverted, sucrose and total) content - by Schoorl-Regenbogen; total acid content - titrimetrically, active acidity (pH) - potentiometrically.

The beginning and dynamics of the cherry fruit fly's flight were determined with the help of visual traps and attractants. Yellow visual traps were used - type Pherocon "AM" *Rhagoletis* sp. and attractant of the company CSALOMON®. Two traps are placed in the selection cherry orchard.

To account for the worminess of the cherry fly fruit, 100 fruits were taken for each cultivar immediately before harvest. The fruits were picked from different heights and parts of the canopy and are examined by opening the fruit flesh and visual inspection for the presence of larvae in them. Samples were also taken 10 days after the full ripening of the other fruits on the trees.

The results were subjected to statistical analysis using the methods of Multiple Range Test and correlation analysis using the software products "MS Excel 365 Analysis ToolPak Add-Ins" (https://support.office.com) and "R-4.1.2" in combination with "RStudio Desktop 2021.09.1+372" and installed package "agricolae 1.3 -5"(Mendiburu, 2021).

RESULTS AND DISCUSSIONS

The time of ripening differs between the cultivars covering the end of May and the beginning of June (Table 1).

Although fruit taste is the most important to the consumers, on the market they make their choice according to the fruit characteristics, appearance and attractiveness (Nesheva & Bozhkova, 2018). For the tested cultivars and hybrids, the predominant form of the fruit is reniform. Other forms are cordate in 'Ranna cherna edra' and 'Kuklenska belitsa' and oblate for 'Kossara'. The colour of fruit skin and juice cover a variety of consumer preferences (Bujdosó et al., 2020) (Table 1).

An important quality characteristic of the cherry fruit is the firmness of the flesh and the mass of the fruit. The highest firmness of the flesh was measured in 'Asparukh' (El.17-90) - 7.71 kgf/cm^2, 'Tzvetina' (El.17-37) and 'Sunburst' - all derived from the cultivar 'Van' (Zhivondov, 2008; Quero-García et al., 2017). The cultivar 'Kossara' with 3.65 kgf/cm^2 has soft fruit flesh in between its parents 'Bigarreau Burlat' (4.13 kgf/cm^2) and 'Ranna cherna edra' (3.30 kgf/cm^2) (Table 1).

The biometric analysis reveals that the largest fruit size and weight (10.83 g) is of the cultivar 'Sunburst'. It is followed by the other 'Van' progeny, 'Asparukh' (El.17-90) with 27.42 mm diameter and fruit weight of 10.01g. 'Kossara' is of medium size and relatively high fruit weight for the early ripening group, surpassing

its parents ‘Ranna cherna edra’ x ‘Bigarreau Burlat’ (Zhivondov & Gercheva, 2009). With the smallest fruit weight is the old local cultivar ‘Kuklenska belitsa’ with 5.04g. The two cultivars with the longest stalk are ‘Kuklenska belitsa’ and ‘Ranna cherna edra’. That could be explained by the modern consumer tendencies in Bulgaria, namely the preference of shorter fruit stalk (Bujdosó et al., 2020) (Table 2).

‘Sunburst’ and the new Bulgarian cultivars and hybrids have more favourable fruit/stone weight ratio compared to the old local cultivars ‘Kuklenska belitsa’ and ‘Ranna cherna edra’ (Table 3). Despite having softer fruits (Table 1), the old local cultivars ‘Kuklenska belitsa’ and ‘Ranna cherna edra’ have the highest soluble solids content - 19.30 Brix % and 19.20 Brix %, respectively (Table 4).

Table 1. Pomological characteristics of cherry fruits

Cultivar	Ripening time	Fruit shape	Fruit skin colour	Fruit flesh colour	Juice colour	Fruit firmness (kgf/cm^2)	Stone shape in ventral view
‘Asparukh’ (El.17-90)	09-June	Reniform	Dark red	Medium red	Red	7.71	Medium elliptic
‘Bigarreau Burlat’	26-May	Reniform	Dark red	Dark red	Purple	4.13	Broad elliptic
‘Kossara’	25-May	Oblate	Dark red	Medium red	Red	3.65	Medium elliptic
‘Kuklenska belitsa’	21-May	Cordate	Yellow with blush	Cream	Colorless	3.89	Medium elliptic
‘Ranna cherna edra’	23-May	Cordate	Blackish	Dark red	Purple	3.30	Medium elliptic
‘Sunburst’	14-June	Reniform	Red	Pink	Pink	6.31	Circular
‘Tzvetina’ (El.17-37)	14-June	Reniform	Dark red	Medium red	Red	6.72	Broad elliptic
‘Van’	14-June	Reniform	Dark red	Dark red	Red	5.84	Circular

Table 2. Biometric characteristics of cherry fruits

Cultivar	Fruit height [mm]		Fruit diameter (cheeks) [mm]		Fruit diameter (suture) [mm]		Fruit weight [g]		Length of fruit stalk (mm)	
‘Asparukh’ (El.17-90)	23.26	c	27.42	b	22.37	bc	10.01	b	24.13	ef
‘Bigarreau Burlat’	22.52	d	23.27	e	19.61	e	6.98	e	24.63	e
‘Kossara’	24.13	b	25.77	d	21.28	d	8.47	d	34.55	c
‘Kuklenska belitsa’	22.64	d	20.23	g	17.28	f	5.04	g	40.30	b
‘Ranna cherna edra’	21.86	e	22.82	f	19.44	e	5.98	f	42.93	a
‘Sunburst’	25.44	a	28.12	a	24.02	a	10.83	a	31.90	d
‘Tzvetina’ (El.17-37)	22.79	d	26.93	c	22.57	b	9.35	c	21.72	g
‘Van’	24.24	b	26.92	c	22.04	c	9.59	c	22.23	fg

*Different letters in the same column means significant difference at P=0.05

Table 3. Biometric characteristics of cherry stones

Cultivar	Stone height [mm]		Stone width [mm]		Stone thickness [mm]		Stone weight [%]		Fruit / Stone weight ratio [%]	
‘Asparukh’ (El.17-90)	10.36	d	7.08	a	8.99	b	0.34	a	3.40	d
‘Bigarreau Burlat’	11.88	b	6.79	bc	8.65	c	0.33	ab	4.68	c
‘Kossara’	11.01	c	6.88	b	8.98	b	0.30	cd	3.54	d
‘Kuklenska belitsa’	12.98	a	6.28	d	8.51	cd	0.33	ab	6.52	a
‘Ranna cherna edra’	11.07	c	6.78	bc	8.55	c	0.31	bc	5.15	b
‘Sunburst’	9.97	e	6.66	c	9.26	a	0.31	bc	2.86	e
‘Tzvetina’ (El.17-37)	9.81	e	6.77	bc	8.35	d	0.28	d	2.98	e
‘Van’	9.70	e	7.07	a	9.03	b	0.34	a	3.56	d

*Different letters in the same column means significant difference at P=0.05

Table 4. Chemical composition of cherry fruits

Cultivar	Soluble Solids content Brix %	Sugars content %			Acids content %	Active acidity (pH)
		Total	Inverted	Sucrose		
'Asparukh' (El.17-90)	15.30	12.44	12.44	0.000	0.663	3.04
'Bigarreau Burlat'	18.60	13.26	13.26	0.000	0.714	3.57
'Kossara'	12.90	9.12	9.12	0.000	0.454	4.11
'Kuklenska belitsa'	19.30	na[1]	na[1]	na[1]	na[1]	na[1]
'Ranna cherna edra'	19.20	16.56	16.64	0.000	0.629	3.19
'Sunburst'	16.00	13.18	12.74	0.418	0.697	3.19
'Tzvetina' (El.17-37)	19.20	12.66	16.48	0.000	0.765	3.09
'Van'	17.60	13.56	12.88	0.646	0.834	3.13

[1]na- data not available

Figure 1. European cherry fruit fly, *Rhagoletis cerasi* (L.) (Diptera: Tephritidae)

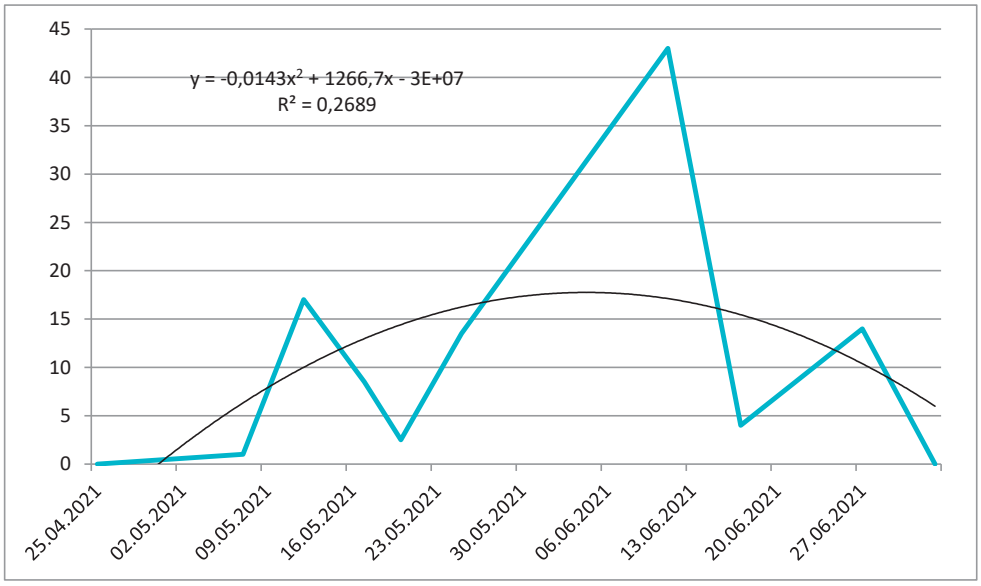

Figure 2. Dynamics of the cherry fruit fly's flight

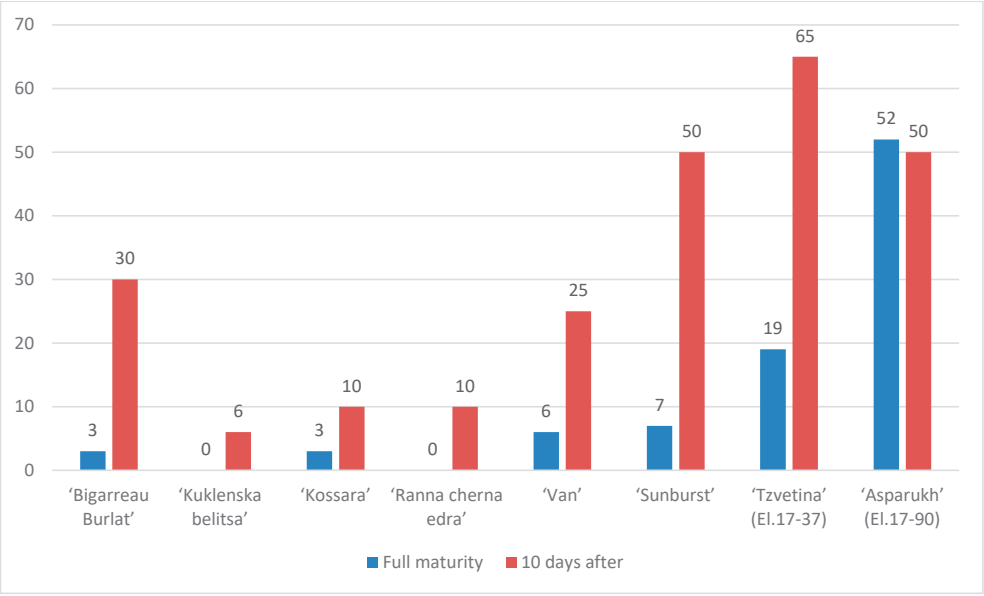

Figure 3. Rate of damage from the cherry fly at harvest and 10 days after

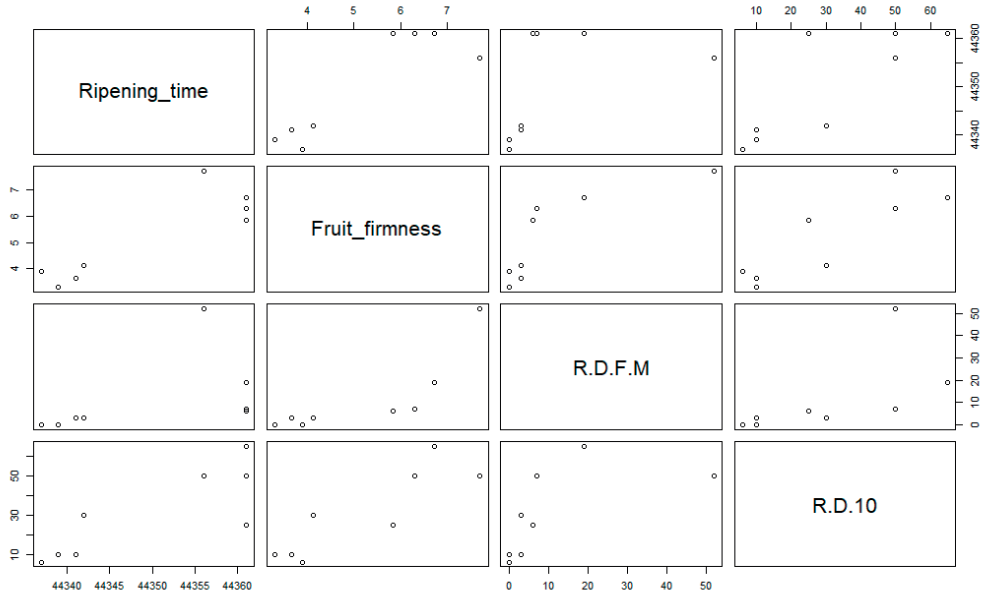

Figure 4. Correlation between ripening time, fruit firmness and rate of damage (R.D.) at full maturity and 10 days after

.

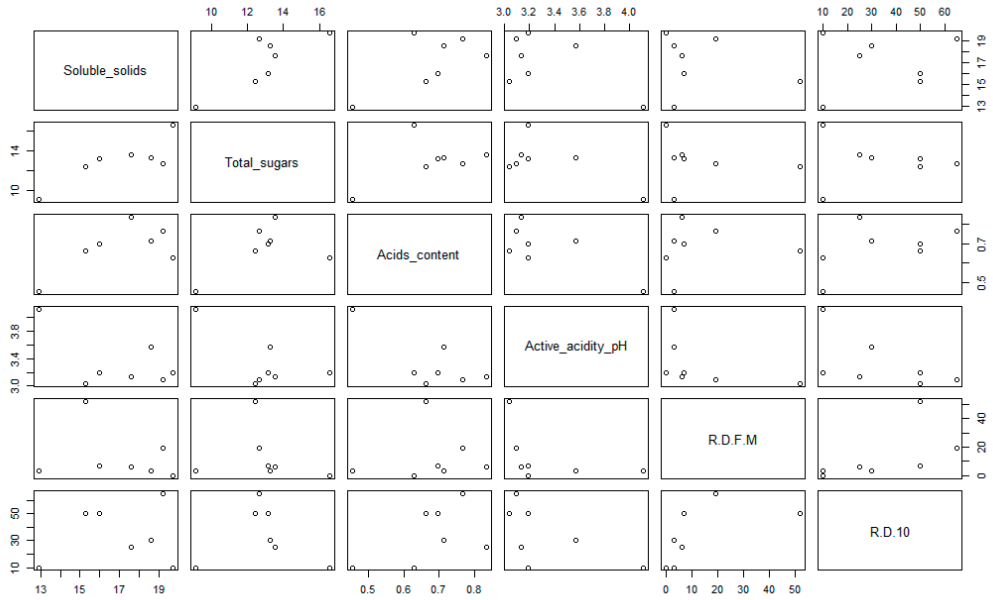

Figure 5. Correlation between fruit chemical characteristics and rate of damage (R.D.) at full maturity and 10 days after

The European cherry fruit fly, *Rhagoletis cerasi* (L.) (Diptera: Tephritidae) is the most important pest of sweet cherries in Europe affecting the fruit quality (Figure 1). According to CABI, 2021 it is reported in Asia (8 countries), Europe (34 countries) and North America. In unmanaged orchards and solitary trees, the infestation rate can reach 100%, whereas infestation rates usually remain below 20% in commercial production (Stamenkovic et al., 2012). However, fruit fly infested fruit cannot be sorted out, therefore the whole lot is rejected if tolerance levels are exceeded (Daniel & Grunder, 2012). The level of infestation mainly is influenced by the ripening time of cherry cultivar: very early ripening cultivars are not affected, whereas later ripening cultivars show high infestation rates (Bandzo et al., 2012). Warm and sunny weather conditions during the oviposition period lead to higher infestation levels.

The cherry fly is a monovoltine species, but in the general dynamics of its flight in 2021, there are three distinguishable peaks. In our opinion, this is probably due to several reasons. The first is the unfavourable meteorological factors for the flight, which depress the activity of the cherry fly until the flight stops. The second reason is translocation, respectively concentrations of flies on late varieties after ripening and harvesting of medium-early varieties of cherries. The beginning of the flight was observed on 07.05.2021. Maximum of the first peak was reported on 16.05., the second peak on 13.06., and the third - 30.06.2021 (Figure 2).

Tracking the percentage of worming in individual cultivars confirms the opinion of several authors that the rate of damage from the cherry fly depends on the ripening period of the fruits. The first reporting of the percentage of worming in the early varieties was made on 26.05.2021. and for later ripening cultivars of 09.06.2021. For the cultivars ‘Bigarreau Burlat’ and ‘Kossara’ the percentage were 3%, while ‘Ranna cherna edra’ and ‘Kuklenska belitsa’ were - 0%. The two newly selected hybrids ‘Asparukh’ (El.17-90) and ‘Tzvetina’ (El.17-37) show the highest percentage, respectively 52% and 19%. For comparison the commercial cultivars, ‘Van’ and ‘Sunburst’ have a percentage of worming 6% and 7% respectively (Figure 3).

The results of the re-testing of the percentage of cherry fly infestation, 10 days after the period of full maturity, show a significant

increase in values. The two hybrids 'Asparukh' (El.17-90) and 'Tzvetina' (El.17-37) have the highest percentage again. A significant increase in the percentage is observed in the early cultivar 'Bigarreau Burlat' - 30% and the commercial cultivar 'Sunburst' - 50% (Figure 3).

The results of the re-testing confirm the conclusion made by Sredkov (2000) that the cherry fly lays in ripe fruits as well.

Analysing the correlation data between the rate of damage at full maturity and 10 days after, ripening time, fruit firmness and the fruit chemical characteristics (Figures 4 and 5), a tendency that needs further investigation was noticed. There is a correlation between the rate of damage and fruit firmness - stronger at full maturity and as time passes on the tenth day after full maturity - acid content plays a role for the increase in damage.

CONCLUSIONS

The fruit size, colour of fruit skin and juice cover a variety of consumer preferences, enriching sweet cherry breeding programme in the Fruit Growing Institute - Plovdiv, Bulgaria (FGI).

The level of infestation is influenced by the ripening time of cherry cultivar: very early ripening cultivars are not affected, whereas later ripening later ripening cultivars show high infestation rates. Re-testing confirm that the cherry fly lays in ripe fruits as well.

A tendency is noticeable for correlation between the rate of damage from European fruit fly, fruit firmness and acid content that needs further investigation.

ACKNOWLEDGEMENTS

This research work was carried out with the support of the National Science Fund of the Bulgarian Ministry of Education and Science and was financed from Project KP-06-PN46/3 "Innovations and traditions in the conservation and use of old and local genetic resources in fruit growing and viticulture".

REFERENCES

Altieri, M. A., & Merrick, L. (1987). *In situ* conservation of crop genetic resources through maintenance of traditional farming systems. Economic Botany, 41(1), 86-96.

Bandzo, K., Popovska, M. and Bandzo, S. (2012). Influence of the time of first fruit color change and the duration of fruit ripening of cherry varieties on the infestation by *R. cerasi*. *Agroznanje*, 13(1), 39-46.

Bujdosó, G., Hrotkó, K., Feldmane, D., Giovannini, D., Demirsoy, H., Tao, R., Ercisli, S., Ertek, N., & Malchev, S. (2020). What kind of sweet cherries do the final consumers prefer? *South-Western Journal of Horticulture, Biology and Environment*, 11(1), 37–48.

CABI (2021). Crop Protection Compendium. (CABI). (Last accessed January 2021).

Daniel, C., & Grunder, J. (2012). Integrated management of European cherry fruit fly *Rhagoletis cerasi* (L.): Situation in Switzerland and Europe. *Insects*, 3(4), 956-988.

Haussmann, B.I.G., Parzies, H.K., Presterl, T., Susic, Z., & Miedaner, T. (2004). Plant genetic resources in crop improvement. Plant genetic resources, 2(1), 3-21.

Malchev, S. (2016). *Research of selected hybrids and new cultivars in sweet cherry breeding.* Doctoral dissertation, Fruit Growing Institute - Plovdiv, Agricultural Academy, Bulgaria.

Mendiburu, F. (2021). Statistical Procedures for Agricultural Research. Retrieved from https://cran.r-project.org/web/packages/agricolae.

Nass, L.L., Sigrist, M.S., Ribeiro, C.S.D.C., & Reifschneider, F.J.B. (2012). Genetic resources: the basis for sustainable and competitive plant breeding. Crop Breeding and Applied Biotechnology, 12(SPE), 75-86.

Nedev, N., Grigorov, J., Baev, Hr., Serafimov S., Strandjev, Al., and Kavardjikov, L. (1979). *Methodology for the study of plant resources in fruit plants.* Plovdiv, Fruit Growing Institute - Plovdiv.

Nesheva, M., & Bozhkova, V. (2018). *Inheritance of some apricot fruit attractiveness characteristics*. *Journal of Mountain Agriculture on the Balkans*, 21(2), 182-193.

Quero-García, J., Iezzoni, A., Pulawska, J., Lang, G.A. (eds.) (2017). Cherries: botany, production and uses. CABI.

Scott, D.H., and Lawrence, F.J. (1975). Strawberries. In Janick, J., and Moore, J.N. (Ed.). *Advances in fruit breeding* (pp. 71-97) Indiana, Purdue University Press.

Shelef, O., Weisberg, P. J. and Provenza, F. D. (2017). The Value of Native Plants and Local Production in an Era of Global Agriculture. Frontiers in Plant Science, 8, Article 2069 Retrieved from https://www.frontiersin.org/articles/10.3389/fpls.2017.02069/full.

Sredkov, I. (2000). *Biological and ecological bases of the control against the cherry fly Rhagoletis cerasi* L. (Diptera: Tephritidae). Doctoral dissertation, Fruit Growing Research Institute - Kyustendil.

Stamenković, S., Perić, P. and Milošević, D. (2012). *Rhagoletis cerasi* Loew (Diptera: Tephritidae) - Biological Characteristics, Harmfulness and Control. *Pestic. Phytomed*., 27(4), 269-281.

Use the Analysis ToolPak to perform complex data analysis (n.d.) Retrieved from https://support.office.com/en-us/article/Use-the-Analysis-ToolPak-to-perform-complex-data-analysis-f77cbd44-fdce-4c4e-872b-898f4c90c007.

Zhivondov, A. (2008). Some results of using 'Van' to improve the range of sweet cherry cultivars in Bulgaria. *ActaHortic*,795, 93-96.

Zhivondov, A. and Gercheva, P. (2009). 'Kossara' - new very early sweet cherry, *Acta Horticulturae*, 814, 357-360.