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THE ADAPTABILITY OF SOME SWEET CHERRY CUTIVARS WITH HIGH AGRO-PRODUCTIVE POTENTIAL IN THE CLIMATIC CONDITIONS IN IASI COUNTY

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Abstract
The biological properties of the sweet cherry (Prunus avium L.), as well as the physico-chemical characteristics of the fruit were studied for 3 years within RSFG Iași (2018-2020). The investigations were carried out at the Sârca Research Base on six varieties of sweet cherries. These included following the phenological stages (flowering period and fruit ripening period), but also the particularities of the fruit in terms of physical characteristics and biochemical composition. The highest weight of the fruit was recorded in 2020 in the 'Regina' cultivar. 'Regina' is characterized by an average flowering period, lasting between April 11th and 28th. The earliest cultivar both in terms of flowering and fruit ripening is the 'Golia' cultivar. All other varieties have an average fruit ripening period (June 15th-30th). The soluble dry matter content was between 11.29 ('Hudson') and 18.61 ('Maria').
The researches carried out and the results obtained show that the studied varieties presented good results of adaptability in the pedoclimatic conditions in the area of Romania.

Keywords: BBCH scale, climatic conditions, fruit, phenology, Prunus avium L.

1. INTRODUCTION

Sweet cherry is a valuable crop and depends on the economic success of its cultivation not only on performance, but also on visual and quality attributes. Cherries are a special stone fruit, having an attractive appearance and intense aroma desired, a nutritious and phytochemical content that offers physiological benefits for human health (Garcia et al. 2017) The influence of consumer acceptability is also based on the performance of the fruit after harvest and the resistance to cracking (Basile et al., 2021).

The sweet cherry (Prunus avium L.) is a deciduous tree originary to the area between Black Sea and Caspian Sea. In the wild, it is found in Asia, North Africa, southern and eastern Europe (Grădinariu, 2002). Genetically, it is a diploid species (2n = 16), alogam, generally self-incompatible, which is grown mainly for its edible fruits (Webster, 1996, Marti et al. 2012). Sweet cherry is the species is commonly grown in the temperate climatic zones with cool temperatures to providing provide the chilling requirement necessary for flower induction (El Baji et al., 2021). The effects of global warming on the sexual reproduction of plants are appearing in more and more areas with a fruit tradition. Phenological stages and fruit-set problems which appear to be the main causes more and

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more common. (Fadon et al.,2015, Hehdly, 2011, Hehdly et al., 2009) According to Hehdly et al. (2003) cherry trees are particularly prone to these alterations since warm temperatures reduce fruit set and shorting stigmatic receptivity. All this reduces the effective pollination period (Sanzol and Herrero, 2001).

Currently, the global sweet cherry production increased from 1.8 to 2.5 million tons between 2008 and 2018 (Gençdağ et al., 2022). According to FAO dates, sweet cherries are a highly valuable crop (Lang, 2009) and the annual worldwide production of sweet cherry is over 2.56 million tonnes from an area of approximately 441,953 hectares (FAO, 2020). In terms of production, Romania is in the top ten countries worldwide, more precisely it ranks ninth, with a production of 682.010 tons recorded in the last ten years (Jakab-Ilyefalvi et al., 2021).

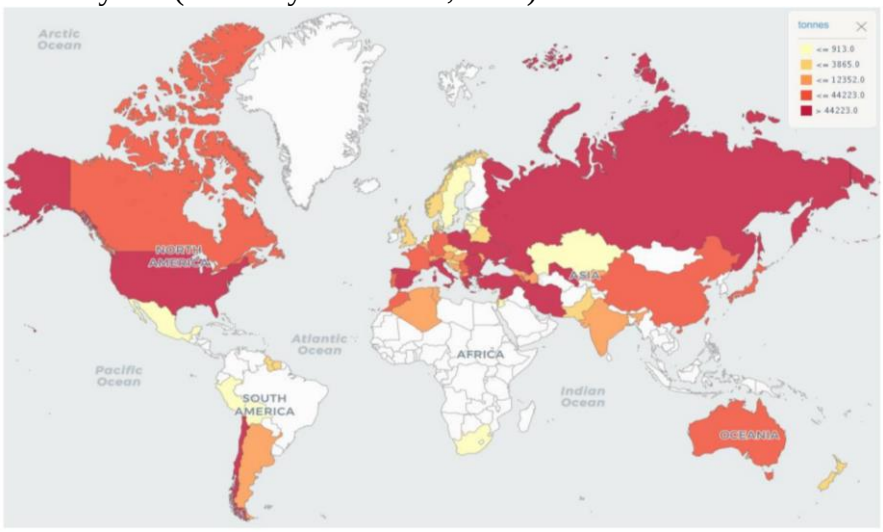

Figure 1. The main producing countries of sweet cherry (shown in red; darker shades indicate higher levels of sweet cherry production) (FAO, 2020)

Both figures have increased in recent years due to increased consumer demand. Based on consumer acceptance, the quality of sweet cherries is defined by several attributes, such as visual appearance (size, bright red colour, and green peduncle colour), sweetness, firmness, and flavour (Fierro, 2020). Objective of the research was to assess the phenological reponse to climate change and the ecological adaptability of six sweet cherry cultivars with a good combination of qualitative and quantitative parameters of the fruit.

2. MATERIALS AND METHODS

This study was conducted in the period 2018-2020 in the experimental fields of Research and Development Iasi Fruit Growing Plant (RSFG) using six cherry genotypes as research material: 'Regina', 'Kordia', 'Hudson', 'New Star', 'Maria' and 'Golia'. Four of them are cultivars created abroad: 'Regina', 'Kordia' are European cultivars, and 'Hudson', 'New Star' are native to North America. 'Maria' and 'Golia' are obtained through controlled hybridization in the breeding program of RSFG Iași (Corneanu et al., 2021).

All the genotypes were grafted on Prunus mahaleb L. seedlings as rootstock and planted on a mez-relief with a slightly sloping plateau and includes predominantly cambic chernozem soils with good natural drainage (Dumitru et al., 2009). The sweet cherry tree was planted in 2011 in an experimental design of randomized blocks with three replicates. Planting distance was of 5x4 m and training as open vase shape/ open center, without irrigation system. During the vegetation period,

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general maintenance works were carried out on the plantation, with the aim of pruning the fruit, mobilizing the soil with the help of the feeler disc, combating diseases and pests, typical for the Prunus avium L. cultivars.

During the study, the climatic conditions in the area (temperature and precipitation) were monitored with the help of the meteorological station located within the experimental field. The Iași area is characterized by the average multiannual temperature of 10.8 °C and 568.7 mm of the multiannual sum of precipitations (2010-2020). In the three years of study the average temperature was 11.4°C, with an absolute maximum of 36.2°C (2020) and an absolute minimum of -18.4 C (2018). The average annual rainfall was 476.4 mm, a deficit compared to the average of the last 10 years.

Observations were made in the field throughout the year for each phenophase. The following characteristics of the sweet cherry genotypes were recorded: the date of bud swelling (51 BBCH), the date of bud development (54 BBCH), the beginning of flowering (61 BBCH, stage 10% of flowers fully open), the end of flowering (69 BBCH, all petals fallen), the ripening time (89 BBCH, fruit ripe for consumption: fruit have typical taste and firmness). Based on this was determined the number of days between stage 61 BBCH and 69 BBCH assigned to the flowering phenophase and the number of days from stage 69 BBCH to 89 BBCH (Meier et al., 1994).

The biometric measurements in the study focused on the physical parameters of the fruit: equatorial diameter, thickness, length and weight of the fruit and stone, length, diameter and weight of the fruit stalk. Chemical properties included for analysis determination of soluble dry solids content (SDS%) of fruit. Physical parameters were measured individually on the fruit. As for the equatorial diameter, the measurement was performed in two perpendicular directions of the fruit and the stone, using gauges Lumytools instrument and average values were recorded (Radu et al., 1957). The weight of the fruit, the stone and the stalks were determined by weighing them with the analytical balance Radwag. The soluble dry solids content (SDS%) was determined using a Zeiss refractometer by adding clear drops of juice to the surface of the refractometer prism. Soluble percentage substances on the instrument scale was read directly (Cociu and Oprea, 1989). The research results were synthesized and interpreted statistically by Microsoft Excel Starter using the Duncan test ($p \leq 0.05$).

3. RESULTS AND DISCUSSIONS

The main phenophases of the studied sweet cherry cultivars are presented in table 1. The bud sweeling (51 BBCH) started between 9th March (‘Kordia’, ‘Maria’) and ended with the ‘New Star’, ‘Golia’ and ‘Maria’ on 28th March. Bud development is considered the moment when the buds crack and the green tips of the leaf appear. This phenophase is based on the elongation processes of the preformed cells and the rudimentary bud from the bud that has existed since the previous year (Ghena et al., 2010). The development of this phenophase is mainly influenced by the temperature, which triggers the fruit buds when the biological threshold is reached, but also by the state of supply of the trees with reserve substances (Cepoiu, 1999) This stage lasted in the study period between 20th March (‘Maria’) and 12th April (‘Hudson’, ‘New Star’). The beginning of flowering was triggered after the accumulation of a certain amount of heat. Sweet cherry is a species that needs a sum of biologically active temperatures starting from about 327°C (Sumedrea and Sumedrea, 2011), depending on cultivar. Thus, during the study, the beginning of flowering took place started after 5 - 20 days after bud developement. These results were recorded in 2019 for the cultivars ‘Maria’, respectively ‘Regina’, at an average temperature of 8,7°C. The duration of flowering was influenced by the temperatures of the period. Thus, in 2018, lower temperatures extended the flowering time of sweet cherry cultivars between 9-13 days, compared to the next two years. The

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warm spring of 2019 made the flowering of the six cultivars last between 6-9 days. The cultivar with shortest flowering period was 'Hudson' (6-9 days) and 'Maria' was the cultivar which recorded the longest flowering period (7-13 days). The harvest maturity was recorded after 49-70 days. All the studied cultivars with middle fruit maturation season. In the first decade of June 'Golia' was the first cultivar to ripen, while foreign cultivars ('Regina', 'Kordia', 'Hudson', 'New Star') ripened in the last decade of the month.

Table 1. The main fructification phenophases of studied sweet cherry cultivars (RSFG Iași, 2022, n=3)

Cultivars	Bud sweeling (51)	Bud development (54)	Beginning of flowering (61)	End of flowering (69)	No days from 61 to 69	Ripening time (89)	No days from 69 to 89
Regina	11.03-20.03	21.03-29.03	11.04 - 16.04	19.04-28.04	9-10	27.06-30.06	62-70
Kordia	9.03-16.03	18.03-26.03	6.04-13.04	11.04-19.04	6-12	18.06-26.06	61-69
Hudson	16.03-21.03	8.04-12.04	17.04-19.04	23.04-25.04	6-9	25.06-30.06	65-68
New Star	10.03-28.08	29.03-12.04	9.04-20.04	19.04-28.04	9-13	24.06-27.06	60-69
Golia	11.03-28.03	24.03-4.04	6.04-10.04	12.04-19.04	6-10	6.06-15.06	49-65
Maria	9.03-28.03	20.03-7.04	6.04-9.04	12.04-19.04	7-13	15.06-20.06	61-66

Different letters after the numbering within a column corresponds with statistically significant differences for P≤0,05 according to Duncan's multiple range test

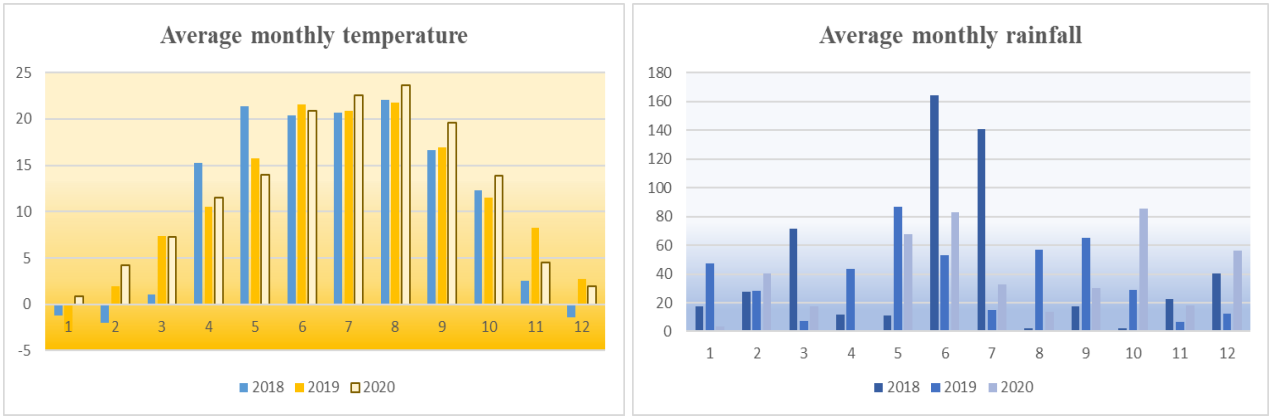

Figure 2. Climatic situation during the study period (2018-2020), RSFG Iași

The ripening process of the fruits is characterized by biochemical changes that lead to the achievement of optimal taste properties regarding the taste, color, firmness and aroma (Elhadi, 2019). The biometric measurements of the physical and chemical characteristics of the fruit were performed regarding the degree of adaptability of the sweet cherry genotypes studied to the ecological conditions of NE Romania.

Table 2 shows several characteristics of the fruit by physical and chemical analysis. From the statistical analysis it is observed that the cultivars 'Regina' and 'New Star' show significant

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differences in terms of fruit weight, compared to the other varieties. 'Regina' recorded an average fruit weight of 8.88 g. The fruit with the lowest weight of 6.19 g recorded 'Hudson' cultivar. The equatorial diameter of fruit was between 22.17 mm ('Hudson') and 25.36 mm ('Regina').
The dry matter content is very important for sweet cherries, because consumers appreciate it for its sensory characteristics and health benefits (Silvia et. al, 2021). In this study the sweet cherry cultivars had SDS % values between 13.72 % ('Hudson') and 16.16 % ('Maria'). The high values for 'Maria' were previously reported by Sîrbu et al. (2012).

Table 2. Physico-chemical properties of studied sweet cherry' cultivars (RSFG Iași, 2022, n=3)

Cultivars	Fruit's weight (g)	Fruit's equatorial diameter (mm)	Fruit's thickness (mm)	Fruit's lenght (mm)	S.D.S (%)
Regina	8.88 ^{a}	25.36 ^{ab}	21.85 ^{a}	23.58 ^{a}	14.22 ^{ab}
Kordia	7.87 ^{b}	24.60 ^{ab}	19.86 ^{b}	23.20 ^{b}	14.58 ^{ab}
Hudson	6.19 ^{d}	22.17 ^{b}	20.08 ^{b}	21.16 ^{c}	13.72 ^{b}
New Star	8.43 ^{a}	26.15 ^{a}	21.70 ^{a}	23.83 ^{a}	14.58 ^{ab}
Golia	7.74 ^{c}	24.28 ^{ab}	20.01 ^{b}	22.52 ^{c}	15.47 ^{ab}
Maria	7.29 ^{c}	23.98 ^{ab}	19.88 ^{b}	22.12 ^{c}	16.16 ^{a}

Different letters after the numbering within a column corresponds with statistically significant differences for P≤0,05 according to Duncan's multiple range test

The table 3 presented the stone and stalk traits. It was evaluated physical parameters such as weight, thickness, lenght or width. Regarding the stone weight turned to be between 0.26 g and 0.44 g, with the smallest value of 'Maria', and the largest of 'Regina'. The studied sweet cherries cultivars showed fruit with medium to long stalk length, with values varied between 30.09 mm and 48.00 mm. The researches showed that growers prefer long stalk to speed up the hand picking, but the medium stalk length is enough for that task and for accomplish consumers preferences. The stalk is a good marker of freshness and because the sweet cherry is one of the most appreciated fruits for fresh consumption, this is a marketing reason for having stalk on cherries (Bujdosó et al., 2020).

Table 3. Physical properties of stone and stalk of studied sweet cherry' cultivars (RSFG Iași, 2022, n=3)

Cultivars	Stone				Stalk		
	Weight (g)	Thickness (mm)	Length (mm)	Width (mm)	Length (mm)	Weight (g)	Diameter (mm)
Regina	0.44 ^{a}	9.73 ^{a}	8.02 ^{a}	11.15 ^{a}	40.73 ^{b}	0.13 ^{a}	1.84 ^{a}
Kordia	0.39 ^{ab}	8.79 ^{ab}	6.96 ^{ab}	11.30 ^{a}	48.00 ^{a}	0.13 ^{a}	0.91 ^{b}
Hudson	0.29 ^{bc}	8.26 ^{b}	6.56 ^{b}	10.14 ^{a}	41.00 ^{b}	0.10 ^{a}	0.81 ^{b}
New Star	0.31 ^{bc}	9.35 ^{ab}	7.40 ^{ab}	10.48 ^{a}	39.15 ^{b}	0.07 ^{a}	0.96 ^{b}
Golia	0.31 ^{c}	8.60 ^{b}	7.05 ^{ab}	10.21 ^{a}	38.40 ^{b}	0.07 ^{a}	1.01 ^{b}
Maria	0.26 ^{c}	8.39 ^{b}	6.75 ^{b}	10.05 ^{a}	30.09 ^{c}	0.06 ^{a}	0.99 ^{b}

Different letters after the numbering within a column corresponds with statistically signifiant differences for P≤0,05 according to Duncan's multiple range test.

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4. CONCLUSIONS

- This study shows that climatic factors have a special influence on the development of the cherry. Temperature is one of the vegetation factors that conditions all the processes of transformation and circulation of substances in the plant organism as well as the completion of the stages and phenophases of growth and fruiting.
- The studied sweet cherry cultivars (‘Regina’, ‘Kordia’, ‘Hudson’, ‘New Star’,‘Golia’ and ‘Maria’) showed a good ecological adaptability to the conditions in NE of Romania and a good combination of qualitative and quantitative parameters of the fruits determined and analyzed.

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