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PHENOLOGY OF SWEET CHERRY CULTIVARS UNDER THE CLIMATE CHANGE EVENTS AT BISTRITA FRUIT REGION OF NORTHERN TRANSYLVANIA, ROMANIA

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Abstract

The cherry crop is one of the most important horticultural crops both nationally and internationally. 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. At Fruit Research and Development Station Bistrita, 12 varieties with different ripening periods were monitored during the last three years (2018-2020). Objective of the research was to assess the phenological response to climate change and the behavior of some Romanian and foreign bred sweet cherry cultivars. Observations were made throughout the year for each phenophase. Following the data obtained, the number of days assigned to each phenophase was determined, for each year studied (2018-2020). Results reveals that the instability of climatic factors directly influenced the vegetation period of the cherry crop. Data showed that in the inflorescence emergence and flowering period due to climate change events there is a possible risk for late frost events. Phenology datasets in relationship with weather data modelling are bioindicators for climate change events and are key elements in fruit crop technology.

Key words: *crop, cherry, climatic factors, fruits.*

INTRODUCTION

Sweet cherry (*Prunus avium* L.) is a diploid species, with origins in the Black Sea and the Caspian Sea region, native to south-eastern Europe and western Asia, being a fruit crop with a worldwide economic importance, due to the exceptional nutritional, technological and commercial value of its ovoid or heart-shaped fruits.

We assist nowadays to climate change phenomena throughout the world in the fruit producing areas, which dramatically influences yields, quality of fruits, economical sides of crop production, incomes and marketing prices and therefore the market is directly affected by these fluctuating negative events. The agro-climatical adaptability, ecological plasticity of cherry cultivars, are key elements of both successful research and farming.

Several researches were made in Romania some years ago regarding phenology and frost resistance of trees (Budan et al., 1995; Asanica et al, 2014) in the south zone of the country, but in the northern part of the country there is a lack of recent updated studies regarding phenology and weather impact on cherry fruit crop. Previous researches in Pitesti and Bucuresti area showed the climatic stress in some cultivars which occurred during 2005-2006 and had a great impact on the cherry crop (Budan et al. 2007). Adequate phenological models together with climatical modelling can show predictions regarding relationship of weather and cropping of cherry cultivars in local conditions.

The generative buds of cherries are very sensible and susceptible of freezing, injuring and frost. Frost resistance depends on many factors including age, genetical factors, tissue content of water, sap and soluble solids, environmental conditions (Proebsting, 1982; Melba R. Salazar & Gutierez, 2014). The main problem of cherry cultivation in Romania nowadays is the high age of plantations, with less frost resistance and the new plantations that are not yet in the fruiting period because a great amount of new cherry orchards were established during 2015-2020 in the PNDR reconversion program of Ministry of Agriculture and Rural Development.

Several researches studied the cherry and sour cherry crop and simulated predictions, charts and graphs on bud-brake and flowering dates

(Ladanyi et al., 2009; Apostol et al., 1990; Chitu et al., 2005, 2006), respectively on other woody plants (Davarnejad et al., 1993-apple, 1996; Davarnejad et al., 1996-pear; Hrotko, 1985-Prunus mahaleb; Rachko,1985-pear). Studies provided insights into how plant growth can be affected by such conditions but also possible outcomes of management options (Soltesz, 2004; Spano et al., 2002). The key element of the studies are the sum of the degree days (GDD) initially established by Baggiolini in the early 1952`s (Baggiolini, 1952) and several other studies contributed to the wider understanding of plant physiology terms of dormancy, thus the phenology models mostly had the basis that budding and flowering occurs after the chilling effect during the dormancy and subsequently after an amount of specific heat accumulation.
Objective of the research was to assess the phenological response to climate change and the behaviour of some Romanian bred and foreign-bred sweet cherry cultivars.

MATERIALS AND METHODS

The research was carried out at Fruit Resarch and Development Station Bistrita, in geomorphological unit of Bistrita hills, the climate is cold and temperate. There is significant rainfall during a year (757 mm) in the Bistrita area, the climate is considered Dfb according to Köppen-Geiger classification, with an average annual temperature of 9.6°C (1993-2019). Observations were made in the field throughout the year for each phenophase. Following the data obtained, the number of days assigned to each phenophase was determined, for each year studied.
Extreme climate change events (climatical accidents, hail), which occurred in the study period were assessed visually and weather data registration was made electronically by Adcon Telemetry weather station. Sum of the active temperatures were counted, based on existent weather data from the Bistrita Meteorological Station. We calculated the sum of daily active temperatures, growing degree days (GDD) taken above the basic temperature (5°C) and cumulated from the endodormancy until the begin of flowering. Twelve varieties with different maturation periods were monitored especially during the last three years (2018-2020) but also with a broader analysis of the last 10 years flowering data. The analysed cultivars were, 'Timpurii de Bistrita', 'Bigareau Burlat', 'Rosii de Bistrita', 'Negre de Bistrita', 'Uriase de Bistrita', 'Rubin', 'Germersdorf', 'Jubileu 30', 'Stela', 'Van', 'Kordia', 'Ana'.

RESULTS AND DISCUSSION

Woody fruit species synchronize their physiology including blooming and their annual growth patterns in accordance with environmental conditions, mainly the temperature factor. Stone fruit species are the earliest in the blooming process.
Figure 1 shows the accumulated sum of active temperatures above 5°C between 2012-2020, according the Julian day of the year until the beginning of flowering.

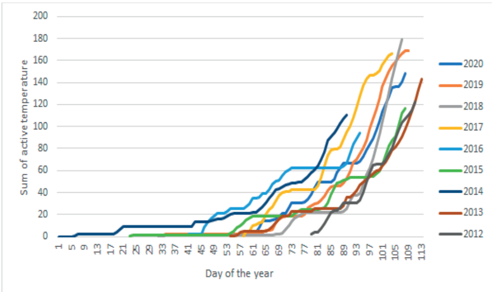

Figure 1. Relationship of the sum of active temperatures and Julian days of the year until flowering

We see very different degree day accumulation patterns with very fast uprising of cumulated temperatures (2012) starting at the 79th day of the year, much later than the coming years. This means that the early 2012-2013 year winter periods were harsher in comparison with the 2018-2020 period. Smoother, progressive accumulation of GDD`s were observed in 2014 (90^{th} Julian day), 2015 (108^{th} Julian day), 2016 (94^{th} Julian day) with much earlier flowering in these years.

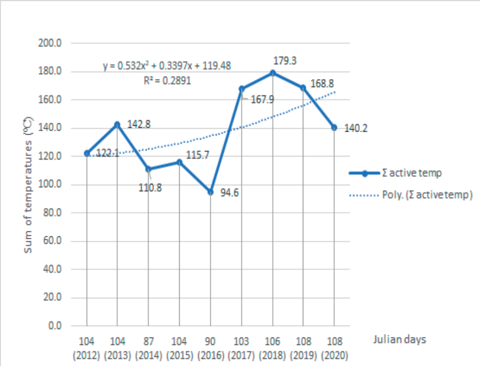

Figure2. Dynamics of the sum of active temperatures in the study period (2012-2020)

Figure 2 shows higher active temperature values until flowering in the last 4 years (2017-2020) at 103-108 Julian days, values ranged from 140.2 to 179.3°C. In the period of 2012-2016 flowering occurred at lower sum of temperatures with a minimum value of 94.6°C at the 90[th] Julian day.

Data showed in Figure 3 presents the relationship between the Julian day of the year and the average daily temperatures at which flowering occurred. Data showed that values varied between from 87 to 115 Julian days with average of daily temperatures ranging 6.9°C to 12.6°C, average beginning of flowering in research period was at 103 days at 10°C.

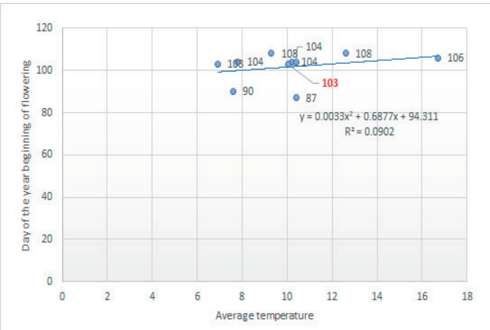

Figure 3. Average daily temperatures and the day of the year at the beginning of flowering

Phenology data for the early variety 'Timpurii de Bistrita' showed (Figure 4) a great variation in duration, in 2014 and 2016 flowering begun early at the end of March and beginning of April. With the coming years study showed that the flowering was shifted from March to the middle and end of April in Northern Transylvania in Bistrita Fruit Region, mainly with 16-17 April during 2018-2020.

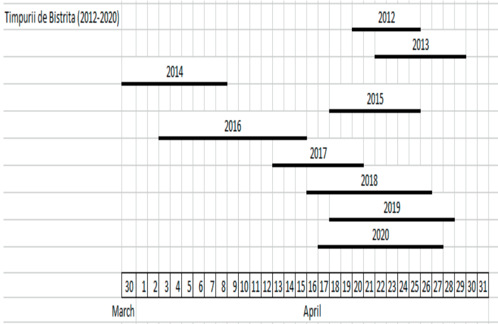

Figure 4. Phenology data for 'Timpurii de Bistrita' cherry cultivar during 2012-2020 at FRDS Bistrita

When analysing the whole range of 12 cultivars, results showed that in 2018 at early cultivar 'Timpurii de Bistrita' and 'Bigareau Burlat' flowering begun on 16[th] of April and had a duration of 11 days until 26[th] of April, with 'Rosii de Bistrita' and 'Negre de Bistrita' cultivars, which seem to be in the same flowering category of early cultivars, but with a shorter flowering period (5 days for 'Rosii de Bistrita').

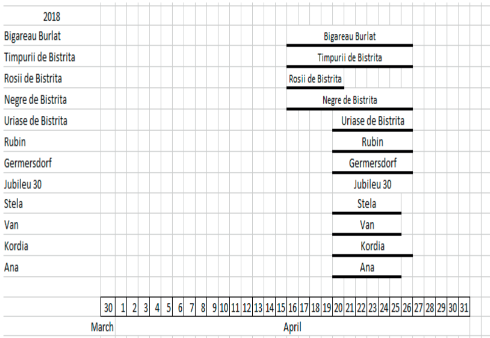

Figure 5. Phenology data for cherry cultivars during 2018 at FRDS Bistrita

Late maturation cultivars begun flowering at 20.04.2018 with a duration of 7 days of flowering. In 2019 (Figure 6) flowering occurred between 17-28[th] of April for the early cultivars ('Bigareau Burlat', 'Timpurii de Bistrita', 'Rosii de Bistrita', 'Negre de Bistrita') and some of the late maturation cultivars ('Jubileu 30', 'Stela', 'Van' , 'Kordia', 'Ana'). The late maturation cultivars begun the flowering 2 days later (‘Uriase de Bistrita’, ‘Rubin’, ‘Germersdorf’).

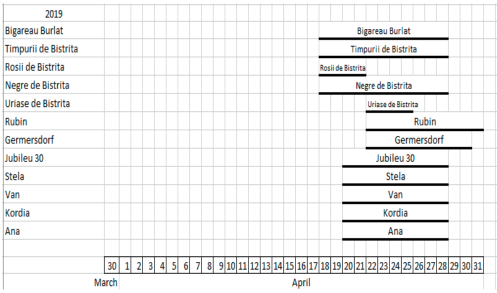

Figure 6. Phenology data for cherry cultivars during 2019 at FRDS Bistrita

Significant changes occurred in 2020 regarding flowering (Figure7), early ripening cultivars begun the flowering almost in the same time period as in 2018-2019 period (17-27th of April) but the late maturation cultivars ‘Uriase de Bistrita’, ‘Rubin’, ‘Germersdorf’, begun the flowering much later, between 27th of April and05th of May.

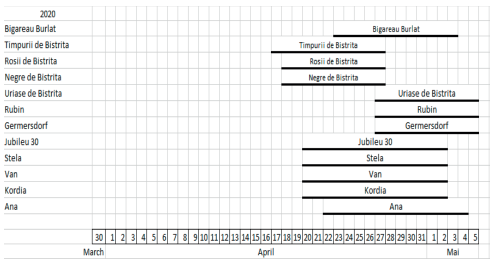

Figure 7. Phenology data for cherry cultivars during 2020 at FRDS Bistrita

A frost event occurred in April 2020 in April, and the early cultivars were seriously affected, yield being significantly reduced. Oppositely, the late maturation cultivars ‘Uriase de Bistrita’, ‘Rubin’, ‘Germersdorf’ begun the blooming later, so they escaped the early frost events, yield was not affected at these cultivars. In the last three experimental years (2018-2020), the blooming of cherry cultivars was between 16-28th of April and had a duration of 11-13 days, with average blooming date of 20th April. When analysing the 2012-2017 period, we can observe that the blooming occurred much earlier, between 30th March – 08th of April in 2014 and between 03-15th of April in 2016; the years 2012, 2013, 2015, 2017 had overlapping blooming periods between 13-29th of April, and in these years the average blooming date was 16th of April. The general analysis on the whole experimental period showed that the average blooming date for time period 2012-2017 (16.04) shifted with about four days (20.04) in the last 3 years (2018-2020) which clearly is due to climate change phenomena. This tendency will be more pronounced, if we will assist to a much more heat accumulation and warming up phenomena of the weather, especially in the winter period, before blooming in spring.

CONCLUSIONS

This study shows the shifting process of flowering into more lately dates, especially for late cultivars which bloomed till the beginning of May, climate changing events, such as, warmer winter periods influenced the blooming, promoting the appearance of first flowers in later Julian days. The great variation of temperatures in spring affects mainly the early cultivars, which has an impact on market prices and the investment costs of farmers in the technology. Temperature factors cannot be influenced directly, thus appropriate establishment of orchards with cultivars according flowering period, detailed phenology modelling is the key for proper choosing of the optimum cultivars in a specific geographic area.

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