



The Response of Two Chokeberry Cultivars to the Influence of Climatic Factors in Bistrita Area, Romania

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RESEARCH ARTICLE

Abstract

Black chokeberry (*Aronia melanocarpa* Michx.) is one of the most cultivated species in recent years, gaining consumer appreciation due to its fruit's bioactive compounds. This aim of this paper was to study the behavior of two chokeberry cultivars 'Viking' and 'Galicjanka' under climatic factors in Bistrita area, within an experimental plot established at Fruit Research and Development Station Bistrita. Resistant to low temperatures but sensitive to drought, the two chokeberry cultivars 'Viking' and 'Galicjanka', have recorded a positive development evolution in pedoclimatic conditions in Bistrita area. For the success of this crop, it is necessary to ensure all the parameters to obtain a high-quality production, so that the deficiencies caused by insufficient water supply can be prevented by implementing technological measures that reduce the negative impact of the ever-changing environment.


Keywords: *Aronia melanocarpa*, Galicjanka, growth, Viking

INTRODUCTION

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Black chokeberry (*Aronia melanocarpa* Michx.) is a berry crop with valuable fruits but also an ornamental plant, grown for its fruit bioactive components with beneficial effects on human health (Ünal et al. 2023). The main compounds of the chokeberry fruits include proanthocyanins, anthocyanins and further phenolic compounds (Gurcık et al., 2023). The polyphenolic compounds, influence many proven chokeberry activities like antioxidative, anti-inflammatory, hypotensive, antiviral, anticancer, antiplatelet, antidiabetic and antiatherosclerotic, respectively (Jurendić et al, 2021). Chokeberry fruits based new nutrient rich food could be evaluated as innovative foods (Akdemir et al., 2023). It is currently one of the most investigated superfoods in Europe and throughout the world (Gurcık et al., 2023). Chokeberry cultivation is increasing and researches showed that consumption of the fruits has beneficial effects on health (Hwang and Lee, 2020) adding to various foods such as juice, yogurt, rice cakes, and cookies. From the farmers point of view the main advantages of this perennial crop are low condition requirements and superior ability to adapt to different soil types, soil management systems and pedoclimatic conditions (Dragomir et al., 2022). They tolerate drought short periods, but for in conditions of long drought period, the fruits lose their juiciness and become dehydrated (Negreanu-Pirjol et al., 2023). The success of a species depends mainly on pedoclimatic conditions and its ability to develop strategies for adapting to a constantly changing environment

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(Diaconescu-Dinu et al., 2022). The influence of climate factors on plants is an ever-growing research challenge facing scientists and growers in this period. In Romania, shrub fruit production is increasing due to the valuable pedo-climatic conditions and easy implementation (Negreanu-Pirjol et al., 2023). Therefore, this research was carried out to evaluate the behaviour of two chokeberry cultivars on the pedoclimatic conditions from Bistrita, Northern Transylvania, Romania.

MATERIALS AND METHODS

Biological material

The biological material was represented by two chokeberry cultivars, 'Viking' and 'Galicjanka' grown at Fruit Research and Development Station Bistrita (FRDS Bistrita) within an experimental plot established in 2022. 'Viking' is a cultivar obtained in Finland (Figure 1), very productive, resistant to drought with vertical stems growth and 'Galicjanka' cultivar originating from Poland (Figure 2), it grows in the form of a bush, it is characterized by a very high production with fruits that ripen simultaneously on the plant.



Figure 1. Viking cultivar



Figure 2. Galicjanka cultivar

Experimental plot

For a complete pedological characterization, soil samples were taken from the plot and the chemical analyzes were carried out at Office of Pedological and Agrochemical Studies Cluj-Napoca (OSPA). Experimental plot of aronia was organized in randomized blocks with spacing between rows was 1.5 m and 4 m inter-row, resulting 1667 plants/ha. The experimental variants established were: conventional (V1), ecologic (V2) and untreated (V3), 21 plants for each variant, distributed in three replicates. Chemical/organic products and fertilizers were used for the conventional and organic variants; no treatment products or fertilizers were used for the untreated variant. The meteorological data collected from the FRDS weather station were interpreted and correlated with the phenophases. Indicators such as plant height and total fruit production per variant for each cultivar were assessed. Visual observations were made every 3-4 days, the plant height was measured by using measuring tape and for phenological stages was used BBCH scale (Biologische, Bundessortenamt and Chemische Industrie).

Statistical analysis

Statistical analysis was performed for: (a) differences between variants; (b) differences between cultivars height (c) differences between years. Statistical data was analyzed using the XLSTAT – Addinsoft software (Addinsoft, 2022) which uses the MS Office Excel platform. All data collected from the field was subjected to the analysis of variance (ANOVA) (Fisher, 1925). Afterwards, Duncan's Multiple Range Test was used to analyze the differences degree of significance between variants (Duncan, 1955) at $p < 0.0001$.

RESULTS AND DISCUSSIONS

The experimental plot was established on mollic eutric cambosol, with a pH slightly acid. The results of the carried-out chemical analyses indicate that the soil is adequately supplied with the main elements necessary for the harmonious development of the plants (Table 1).

In the study years (2022-2023), a warming of the climate was observed, which manifested through pedological and atmospheric drought, with negative impact on chokeberry development. Temperatures recorded in 2023 (up

to August) showed slightly different values compared to the same period of the 2022 (Table 2). Thus, the absolute minimum temperatures of January 2022 and February 2023 had no negative effect on the wood or buds of the chokeberry cultivars, being below the resistance threshold of the species.

Table 1. Soil chemical content

No.	pH	Humus%	Mobile Phosphorus ppm	Mobile Potassium ppm	Nitrogen %	N-NO3 ppm	N-NH4 ppm	Ca ²⁺ mg/me/100g sol	Mg ²⁺ Mg/me 100g sol	Gv g/cm
1	5.96	4.72	3	290	0.239	1.8	2.52	8.0/0.4	3.64/0.3	0.98
2	6.18	6.39	15	360	0.297	3.0	1.05	10.0/0.5	3.04/0.25	1.01

The maximum absolute temperature recorded in summer time, were beyond the threshold of tolerance (33°C), which caused imbalances in the fruit ripening process. In terms of rainfall, the year 2022 can be considered droughty because the precipitation volume was less than in 2023. Thus, according to the meteorological data, in June and July 2022, rainfall values were only between 18.0 mm and 35.4 mm, compared to the same period in 2023, when the recorded values were between 86.6 mm and 108.0 mm, with a total of 385.83 mm respectively 518.30mm precipitation. The lack of water during the periods of fruit development led to small, dehydrated fruits with a much more astringent taste.

Table 2. Climatic indicators (2022-2023)

Month	Average annual temp. (°C)		Min. absolute temp. (°C)		Max. absolute Temp. (°C)		Rainfall (mm)	
	2022	2023	2022	2023	2022	2023	2022	2023
Year								
January	-2.4	6.03	-17.4	-5.7	9.8	14.6	66.56	55.1
February	1.2	0.09	-7.1	-13.7	9.6	11.7	14.47	54.4
March	3.7	5.9	-10	-5.2	19.5	19.3	0.70	38.2
April	7.9	8.40	-2.2	-1.6	21.2	21.4	102	80.2
May	15.2	15.71	5.4	3.2	27.7	27.2	70.5	24.8
June	19.5	17.9	8.8	3.1	35.6	31.4	18.0	86.8
July	21.3	20.8	8.3	9.1	35.0	33.4	35.4	108.0
August	21.7	21.4	14.6	8.8	32.4	36.4	78.2	70.8

The phenophases of the chokeberry cultivars followed approximately in the same period, except for the initial stages (beginning of the vegetative stage BBCH 00-51 until the stage of pink buds BBCH 57), where differences of 5-7 days were observed, later the difference decreased at the time of flowering and ripening of fruits (BBCH 61 and BBCH 87), when simultaneous ripening was observed (Table 3).

Table 3. The phenophases of the chokeberry cultivars (2022- 2023)

No.	Phenological phase	Viking		Galicjanka	
		2022	2023	2022	2023
1.	Beginning of vegetative period- BBCH 00- 51	15.03	10.03	20.03	10.03
2.	Bus burst- mouse ear stage BBCH 53- 54	22.03	21.03	28.03	21.03
3.	Flower buds visible - BBCH 55	08.04	10.04	12.04	12.04
3.	Pink buds' stage- BBCH 57	02.05	02.05	06.05	02.05
3.	Beginning of flowering - BBCH 61	07.05	05.05	09.05	07.05
4.	Full flowering - BBCH 65	12.05	10.05	12.05	10.05
5.	Flower fading - BBCH- 67	15.05	12.05	15.05	13.05
6.	Fruits diameter up to 40 mm - BBCH 74	25.05	22.05	30.05	21.05
7.	Fruits about 90% final size - BBCH 79	19.07	17.07	19.07	19.07
8.	Fruits ripe for picking - BBCH 87	15.08	03.08	15.08	06.08

The phytosanitary condition of the chokeberry plantation was not affected by the diseases or pests, which has helped us to comply with the originally established treatment plan. The ecologic treatment plan included products based on copper, paraffinic oil, natural plant extract such as Ovipron top conc.0.2%, Champ 77WG conc.0.2%, Mimox conc.0.3%, Laser 240 SC 0.6l/ha, Prev-Am conc. 0.4%, Wetcit conc.0.25%. For conventional treatments were used products such as Toil conc. 0.5%, Merpan 80 WDG conc. 0.15%, Mavrik 2F conc. 0.05%, Champ 77WG conc.0.2%, Mospilan 20 SG/SP conc. 0.02% and Score 250 EC conc. 0.03%. Among pests, the hairy bug can be devastating to chokeberry, eating the flower organs (Figure 3). The extent of infestation with this pest was below the economic damage threshold, which means that no significant damage was recorded in this area.



Figure 3. Hairy bug (*Epicometis hirta*) flower damage

Aronia is a drought-resistant species but the extreme weather conditions such as drought and cold and heavy rains, can have a negative influence on the development processes of the plants and on the fruit formation. Based on the visual observations made regarding exposure to higher temperatures, we concluded that the temperatures exceeding 33°C could affect plant foliage and the fruits (Figure 4). Although, from a total of 63 plants studied for each cultivar, 18 plants from 'Viking' cultivar and 24 plants from 'Galicjanka' cultivar were affected by the drought, showing burns on the leaves, which represents approximately 28.58% respectively 38.10%. The highest temperatures recorded were in June, July and August each year, when the chokeberry cultivars are at the fruit development stages (BBCH 74- BBCH 87), which means that the effects on fruit development can be devastating, in the sense that they remain small and dehydrated and some chokeberry plants can be affected irreparably (Figure 4).

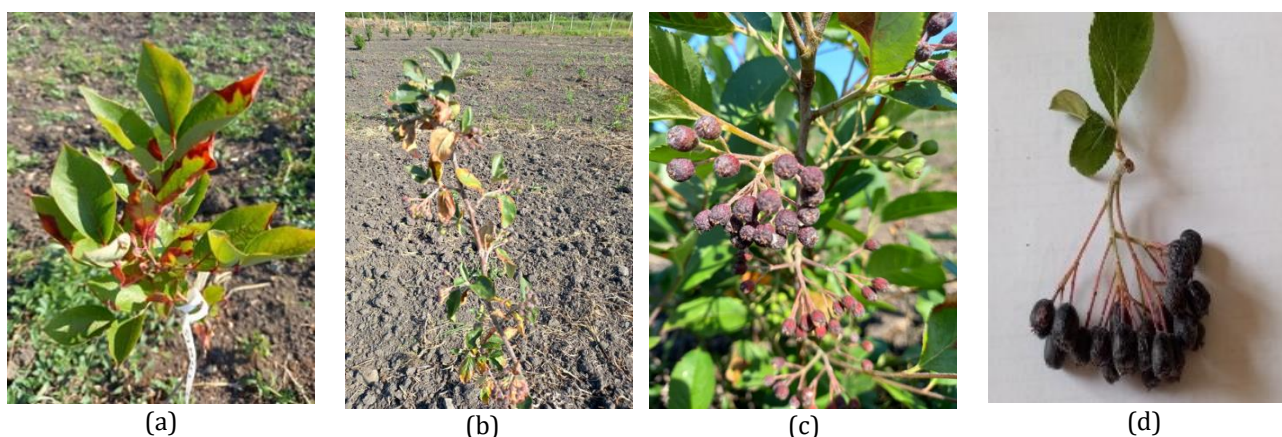


Figure 4. (a) and (b)- drought effects on leaves; (c) and (d)- drought effects on fruits

The second year after plantation, fruit production was relatively low. Although, the most productive cultivar was 'Viking' with a total of 2.879 kg in ecologic variant followed by conventional variant with a total of 2.425 kg and 2.285 kg for untreated variant. 'Galicjanka' had a total fruit production less than 1.00 kg/ variant, ecologic variant recorded 0.950 kg followed by untreated variant with 0.920 kg respectively 0.842 kg the conventional variant (Figure 5).

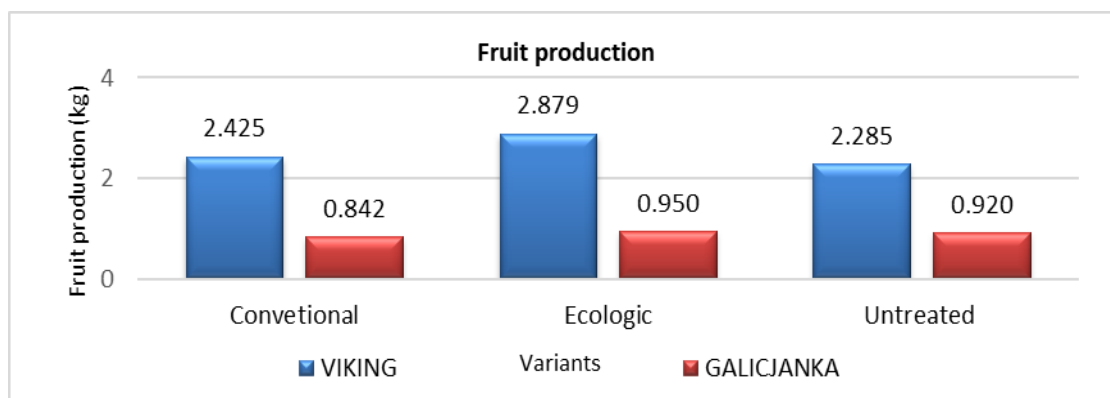


Figure 5. Total fruit production in 2023

Statistical analysis

The development of the aerial part of chokeberry plant were evaluated and measured with measuring tape for each cultivar. The technological variants comparison in 'Viking' cultivar, revealed that was a significant difference between them, regarding the height of the plants. Duncan's multiple comparison range test showed that the ecologic variant had the most vigorous plants compared to the untreated variant (Table 4).

Table 4. The average plant height in all studied variants for 'Viking' cultivar (2022-2023)

Variant	Plant height
(2023) Viking eco	1.038 ± 0.091 a
(2023) Viking conv.	0.999 ± 0.152 a
(2022) Viking conv.	0.953 ± 0.257 a
(2022) Viking eco	0.946 ± 0.070 ab
(2023) Viking untreated	0.940 ± 0.111 ab
(2022) Viking untreated	0.851 ± 0.109 b
Pr > F(Model)	0.003
Significant	Yes

Note: Averages followed by different letters indicate differences at $p < 0.001$ according to Duncan's Multiple Range Test

For 'Galicjanka', the untreated variant recorded a significant positive difference regarding height of the plants when compared with the other two variants in both study years. Because some parts of the research plot the soil was more humid than other parts, we concluded that this aspect could influence in positive way the development of the plants (Table 5).

Table 5. The average plant height in all studied variants for 'Galicjanka' cultivar (2022-2023)

Variant	Plant height
(2023) GALICJANKA untreated	0.691 ± 0.078 a
(2023) GALICJANKA conv.	0.681 ± 0.125 a
(2022) GALICJANKA untreated	0.668 ± 0.078 ab
(2023) GALICJANKA ecologic	0.662 ± 0.116 ab
(2022) GALICJANKA conv	0.592 ± 0.113 bc
(2022) GALICJANKA eco	0.571 ± 0.173 c
Pr > F(Model)	0.004
Significant	Yes

Note: Averages followed by different letters indicate differences at $p < 0.001$ according to Duncan's Multiple Range Test.

The measurements made for each plant indicate that 'Viking' registered the highest plants than 'Galicjanka' confirmed statistically by Duncan's Multiple Range Test (Figure 6).

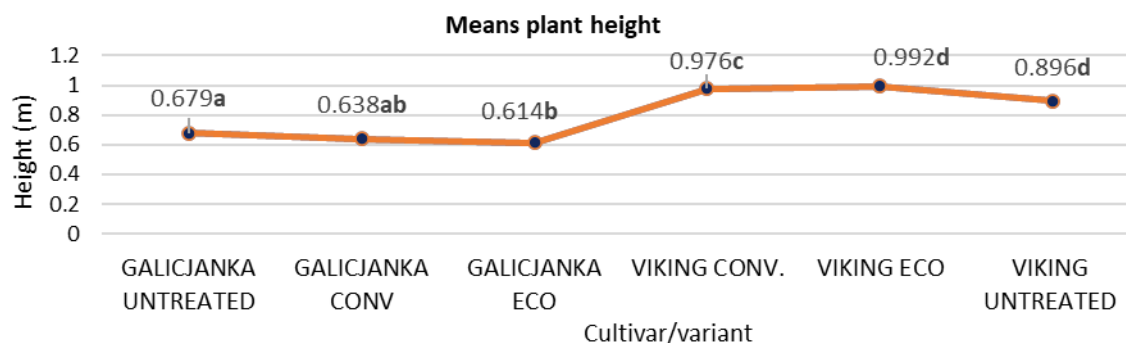


Figure 6. Comparison between cultivars

CONCLUSIONS

The results indicated the cultivars showed resistance to low temperatures, pests and diseases but were slightly sensitive to drought and high temperature, 'Galicjanka' proved to be more sensitive to drought when compared with 'Viking'. In the future, adapted technological measures will be taken to improve the growing conditions of the two chokeberry cultivars especially at drought, so that the production potential could be maximized and valuable yields could be obtained.

Author Contributions:

C.A.M. performed the experiments, recorded the scientific data, and wrote the paper, RM S., Z.J.I. and C.M. contributed to the writing of the paper and performed the statistical analysis of data, Z.I and C.M.I. contributed to the writing of the paper.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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