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# Preliminary Results Regarding the Behaviour of Two Chokeberry (*Aronia melanocarpa* Michx.) Cultivars in Environmental Conditions of Northern Transylvania

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RESEARCH ARTICLE

## Abstract

The paper presents preliminary results of the behaviour of two Aronia cultivars grown conventionally and organically. A*ronia melanocarpa Michx.* Elliott is a versatile, deciduous multistems shrub, which belongs to Rosaceae family. It is considered a rustic shrub due to its high capacity to adapt to different geographic areas, climatic conditions (temperature, rainfall, humidity) and various soil types. It originates from North America and Canada, chokeberry fruits have the highest antioxidant, polyphenols, anthocyans and vitamins content among many shrub species. 'Nero' and 'Melrom' chokeberry cultivars, found favourable environmental conditions for growth and fruit production in Northern Transylvania, with an average bush volume between 0.46m$^3$- 0.84m$^3$ and yield between 1.018t/ha- 1.674t/ha, in the first 3 years after planting.

**Keywords:** aronia, cultivars, fruits, growth, yield

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## INTRODUCTION

Aronia (*Aronia melanocarpa* Michx.) Elliott, is a member of the Rosaceae family, Maloideae subfamily, native from North America and Canada, and includes three types of shrubs: *Aronia arbutifolia* (L.) Pers. (red chokeberry), *Aronia melanocarpa* (Michx.) Ell. (black chokeberry), *Aronia prunifolia* (Purple chokeberry) (Kokotkiewicz et al. 2010) and the cultivars are used for fruit production. Their distribution across Europe occured around 19$^{th}$ century from Russian gardens via Germany, from where the genus name *Aronia* was replaced into the common name, chokeberry (Janković et al. 2017). Chokeberry mostly can be found in wet habitats: wetlands, wet forests, along streams and around lakes, in sandy lowlands, but also it can be found in dunes, on rocky slopes and steep cliffs, on overgrown or bare rocky outcrops (Hardin 1973). Chokeberry (*A. melanocarpa*) is a shrub, 90–180 cm high, with purple-black berries gathered in clusters of 8 to 14 fruits about 6 mm in diameter, on red pedicels. The leaves are glabrous, about 3–7 cm long with white-pink flowers open in May (Kokotkiewicz et al. 2010). Most information regarding aronia cultivation refers to the black chokeberry (*A. melanocarpa*), which is the most valuable as food and remedy (Slimestad et al. 2005), ingredient- berries are used for juice, jam, wine production, and as the source of natural dyes (Jeppsson 2000, Bridle 1987, Kask 1987). 'Nero' and 'Melrom' are two of the most commonly cultivated chokeberry

cultivars in Romania. The chokeberry cultivars are adapted to different environmental conditions in Romania, even the low temperatures during the dormancy stage (-14.1°C) and bud burst (-6.2°C), as well the high temperatures during the summer did not damage the flower buds as observed and reported by (Diaconescu et al. 2022). Chokeberry adaptation to different environmental conditions is a dynamic process, which is correlated with ambient temperatures, solar radiation, rainfall and soil type. The nutritional and biological values of chokeberry fruits depends on several factors such as genotype, environmental conditions, date of harvest and use of fertilizers (Jeppsson 2000, Skupien et al. 2007). Growth methods, among other agronomic practices, can influence the content of biochemical active compounds, phenols and pigments in chokeberry fruits (Nicola et al. 2020). The aim of this research article is to monitor the fruiting process and plant adaptation to the environmental conditions in Northern Transylvania.

## MATERIALS AND METHODS

The present research follows the growth and fruiting processes of two aronia cultivars, in Northern Transylvania, Bistrita region. The biological material was represented by two chokeberry (*Aronia melanocarpa*) Michx. cultivars, 'Nero' and 'Melrom', grown at Fruit Research and Development Station Bistrita (FRDS Bistrita). Bistrita is located at $47^0$10' North latitude and 24°30' east longitude, at 358 m altitude with an average annual temperature around $10^0$ Celsius and multiannual average of 720 mm of rainfall. The climate is temperate-continental, with relatively hot summers, and less dry cold winters. The chokeberry cultivars studied are two of the most commonly cultivated in Romania. 'Nero' is a cultivar obtained in Poland, can reach 1.5-2 m heights, 1.2-1.4 m bush diameter, having black drupe-type fruits, weighing up to 1.5 g, astringent taste and bright red pulp color. The ripening period is the end of July and the beginning of August and the yield can reach more than 5 kg/plant. 'Melrom' cultivar is obtained at the Research Institute for Fruit Growing Pitesti- Maracineni. it is very similar to 'Nero', with the difference that the size of the fruits is much larger, many more berries in a cluster and less astringent taste (Sumedrea et al. 2014).

The plantation was established in 2020 on eutricambosoil molic, with pH-6.21 (slightly acid), humus between 4.72-6.39%, nitrogen between 0.239-0.297 %, an amount of potassium between 290-360 ppm and poorly in phosphorus with values between 3-15 ppm, calcium and magnesium in normal doses, values between 8-10 mg/100g soil respectively 3.04-3.64 mg/100g soil. Indicators such as bush volume, fruit production per plant, total fruit production per variant for each cultivar were assessed.

The experimental field is organized in randomized blocks, the plant canopy is a bush shaped in a geometrical form such as reverse truncated cone. Planting dinstaces are 1.5 m in-row and 4 m inter-row spacing, resulting 1667 plants/ha. The variants consisted of organic, conventional and untreated control. Each variant had three replicates with 7 plants per replication. The 3 replicates within the same row were separated from each other by leaving one untreated plant (isolation). The phenological phases were calculated using BBCH scale (Biologische, Bundessortenamt and Chemische Industrie) and the meteorological data were collected from the FRDS weather station which is located close to the experimental lots Table 1. The data analysis was performed with XLSTAT 2019.1.1. (Add-in soft France) using using one-way analysis of variance (ANOVA), Duncan's multiple comparison test and Dunett's two-sided comparison with a control test.

**Table 1**. Organic/ conventional treatments plan

| Phenological phase | Organic treatment plan | Conventional treatment plan |
|---|---|---|
| **Beginning of vegetative period(BBCH 00- 51)** | Ovipron top conc. 0.2% | Toil conc. 0.5% |
| **Bus burst- mouse ear stage BBCH 53- 54** | Champ 77WG conc. 0.2% | Champ 77WG conc. 0.2% |
| **Beginning of flowering (BBCH 60)** | Mimox conc. 0.3%<br>Laser 240 SC 0.6l/ha | Merpan 80 WDG conc. 0.15%<br>Mavrik 2F conc. 0.05% |
| **Flower fading (BBCH- 67)** | Mimox conc. 0.3%<br>Laser 240 SC 0.6l/ha | Merpan 80 WDG conc. 0.15%<br>Mospilan 20 SG/SP conc. 0.02% |
| **Growing fruits (BBCH71)** | Prev-Am conc. 0.4% | Score 250 EC conc. 0.03% |
| **After picking** | Champ 77 WG- conc. 0.2%<br>Wetcit conc. 0.25% | Merpan 80 WDG conc. 0.15% |
| **End of vegetative period** | Bouille bordelaise WDG conc. 0.5% | Bouille bordelaise WDG conc. 0.5% |

## RESULTS AND DISCUTIONS

The phenological stages for the chokeberry cultivars lasted 171 days (BBCH 51- 87) and occurred between March and October, the dormancy stage (BBCH 00) lasted 116 days from November untill 25 February. The monthly average temperatures recorded by weather station were between 3.77 °C at the start of the vegetation period (BBCH 51- 54), 7.95°C - flower buds' stages (BBCH 55-59), 15.25°C - beginning of flowering- end of flowering (BBCH 60 -71), 19.52°C - fruit development stages (BBCH 72-77) and 21.29°C – final fruit size - advanced ripening (BBCH 79- 87). The absolute maximum temperature 33.9 °C has been registreted in July and the absolute minimum temperature - 17.4 °C were recorded in January. In second decade of April, a late spring frost was registered (-2.2°C), not causing any damages on the flower's buds. The phenological observations were made every 3 days, it indicated that inflorescence bud swelling (BBCH 51) occurred between 25 February and 10 March, budburst (BBCH 53) occurred between 13 March and 23 March and flowering stages (BBCH 60- 71) were between 30 of April and 14 of May, fruits development stages (BBCH 72- 77) were in June and July, and the ripening was between 10th and 15th of August for both cultivars Figure 1.


**Figure 1.** Chokeberry phenophases (a)- bud swelling (BBCH 51); (b)- bud burst (BBCH 53); (c)- mouse ear stage (BBCH 54); (d)Flower buds visible (BBC5 55); (e)- flower hollow ball (BBCH 59); (f)- beginning of flowering (BBCH 61); (g)- full flowering (BBCH 65); (h)- fruit size up to 40 mm (BBCH 74); (i) - fruit about 90% final size (BBCH 79); (j)- advanced ripening (BBCH 85); (k) (l)- fruit ripe for picking (BBCH 87).

During the vegetative growth 7 treatments were applied for the organic plot with products based on paraffinic oil, copper, natural oil and extracts from *Mimosa* plant and orange. In the conventional plot the 7 treatments included products based on vegetable oil, copper, captan and acetamiprid Table 1. Organic soil fertilizers (Biohumussol) were applied in spring time in a dose of 2l/ha and granulated chemical fertilizers NPK 16:16:16 in a dose of 50 kg/ha. Foliar fertilizers were applied twice to both cultivars, in the organic variant we used Cropmax in 1.5 l/ha dose and the conventional variant has been used Agroleaf Total Power 4kg/ha dose.

The observations made during the vegetation phases indicate that there's no differences between the phenological phases of the 'Nero' cultivar compared to the 'Melrom' cultivar, that makes us believe that their stages development occurred approximately in the same time. The development of the aerial part of chokeberry plant was achieved in optimal parameters, such as the number of annual vegetative shoots was between 5-12, which causes the increase of the bush volume. 'Nero' bush volume registered values between 0.540 $m^3$ untreated plot, 0.715 $m^3$ and 0.843 $m^3$ for conventional and organic plot, while 'Melrom' cultivar registered bush volume values between 0.470$m^3$ untreated plot, 0.540 $m^3$ and 0.753 $m^3$- in organic respectively conventional plot Figure 2. The chokeberry cultivars are in third year of planting. Similar to our research, Diaconescu et al. (2021) reported an average volume of the aerial part of the plant to 'Nero' cultivar 1.98 $m^3$ in 10$^{th}$ year of planting and 0.72 $m^3$ to 'Melrom'in 4$^{th}$ year of planting, 1.41 $m^3$ bush volume was reported by Pandelea at al. (2021) to 'Nero' cultivar in 4$^{th}$ year of planting.

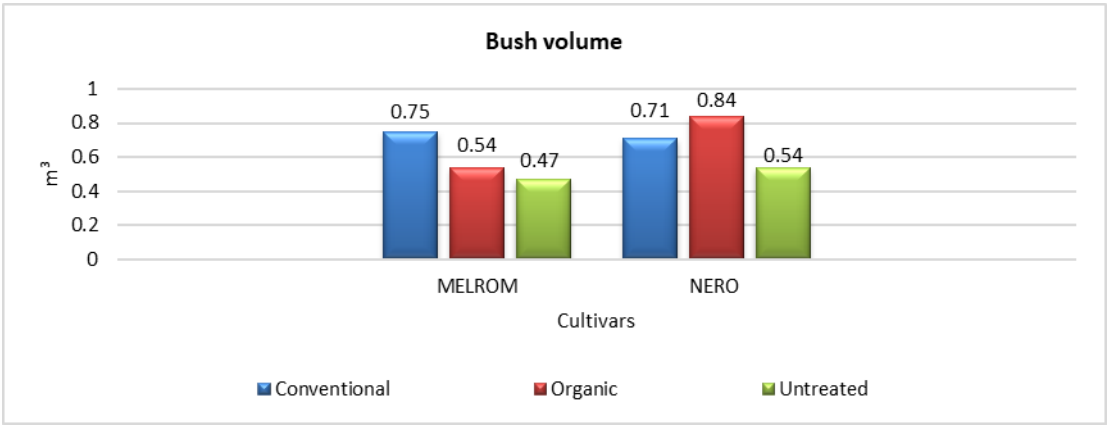


**Figure 2**. Nero/ Melrom bush volume

Fruit production has been remarkable to 'Nero' cultivar, were we obtained values between 0.611 kg/plant untreated plot, 0.817 kg/plant and 1.005 kg/plant conventional and organic plot, while for the 'Melrom' cultivar, were obtained values between 0.647 kg/plant in untreated plot, 0.893 kg and 0.937 kg/ plant in organic and conventional plot Figure 3. Similar to our research, Diaconescu and the collaborators (2021) obtained an average fruit production, values of 3.44 kg/plant to 'Nero' cultivar and 1.88 kg/plant to 'Melrom' cultivar, in 10$^{th}$ respectivly 4$^{th}$ year of planting. Also, Stick et al. (2003) reported an average fruit production to'Nero' (in five year old plants) up to 24.1 kg/bush, Jeppsson (2000) 0.44 kg/plant (three year old plants), Radanović et al. (2012) obtained 4.2 kg/bush and Pandelea et al. (2021) 4.29 kg/bush in 4$^{th}$ year of planting.

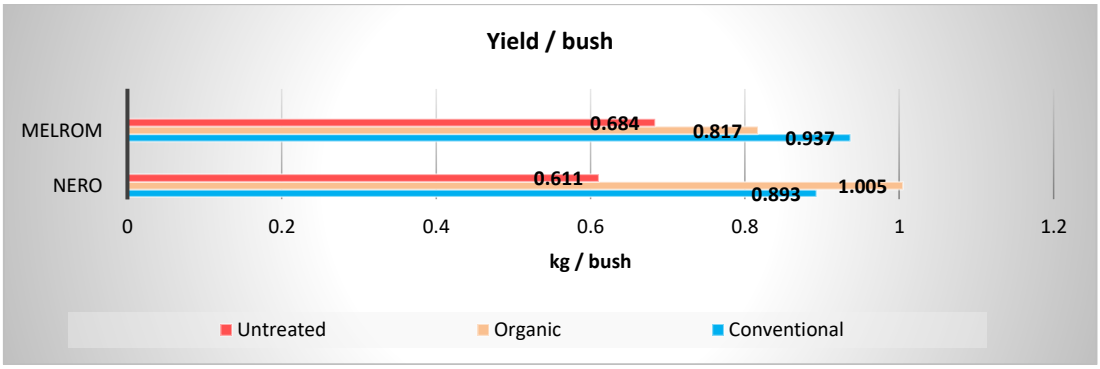


**Figure 3.** Nero/Melrom fruit yield/bush

**Statistical analysis**

Statistical comparisons of the mean values were performed using one-way ANOVA analysis of variance, LSMeans Student's t-test was used to find significant differences between variants within the same cultivar, Pairwise correlations were determined using the same software, where $P < 0.05$ were considered statistically significant. Differences between treatment variants were rated by Duncan's multiple range test, at the 99% confidence level After analyzing the data, Duncan's multiple comparison test revealed that it is significant differences between organic and conventional variant regarding bush volume within the cultivar. Comparison with the untreated variant, statistical analysis indicates that there is no significant diferences between organic and untreated to 'Melrom' but significant diferences to 'Nero' (Table 2).

**Table 2** Duncan multiple comparison test

| **Summary of all pairwise comparisons (LS means) - MELROM** | | **Summary of all pairwise comparisons (LS means) - NERO** | |
|---|---|---|---|
| | **Bush volume** | | **Bush Volume** |
| **CONVENTIONAL** | 0.753 **a** | **ORGANIC** | 0.844 **a** |
| **ORGANIC** | 0.541 **b** | **CONVENTIONAL** | 0.715 **ab** |
| **UNTREATED** | 0.469 **b** | **UNTREATED** | 0.544 **b** |
| **Pr > F(Model)** | 0.001 | **Pr > F(Model)** | 0.004 |
| **Significant** | Yes | **Significant** | Yes |

Also, comparing the organic variants of the two cultivars, the Duncan test revealed that 'Nero' organic variant is significantly different from organic variant to 'Melrom' cultivar regarding bush volume, but no differences were observed in the variants regarding yielding/bush (Table 3).

**Table 3**. Duncan analysis of the differences between the categories

**Duncan Analysis of the differences between the categories with a confidence interval of 99% (Bush volume):**

| **Contrast** | **Difference** | **Standardized difference** | **Critical value** | **Pr > Diff** | **alpha (Modified)** | **Significant** |
|---|---|---|---|---|---|---|
| **ECO -NERO vs ECO-MELROM** | 0.303 | 4.605 | 2.704 | < 0.0001 | 0.010 | Yes |

**Duncan Analysis of the differences between the categories with a confidence interval of 99% (Yield/bush)**

| **Contrast** | **Difference** | **Standardized difference** | **Critical value** | **Pr > Diff** | **alpha (Modified)** | **Significant** |
|---|---|---|---|---|---|---|
| **ECO -NERO vs ECO-MELROM** | 0.214 | 1.727 | 2.708 | 0.092 | 0.010 | No |

Analysing the differences between the same variants to 'Nero' and 'Melrom' cultivar, ANOVA test indicate that there no significant differences regarding bush volume or yield/bush (Figure 6).

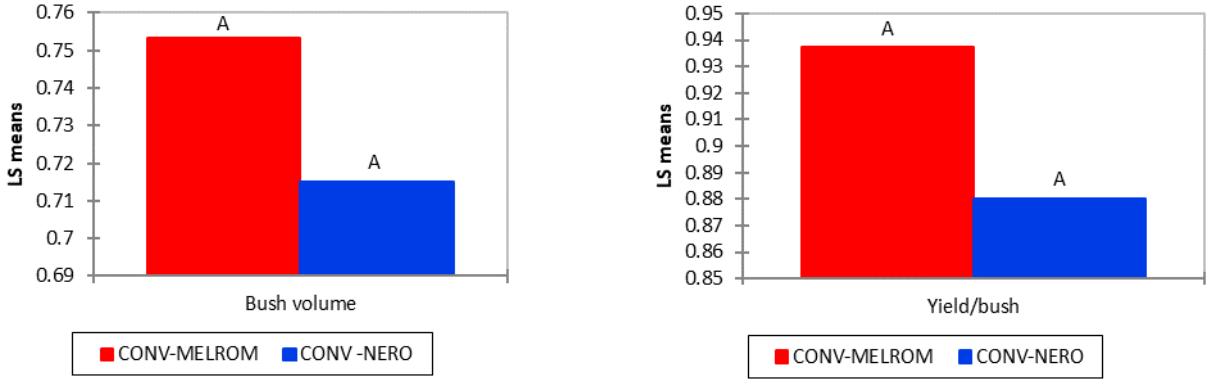


**Figure 6.** ANOVA between the categories

The growth and fruit production has been evaluated and the conclusion indicated that 'Nero' in the organic variant has been remarkable, obtaining values such as 0,84 $m^3$ bush volume, 1,005 kg of fruits/bush and 1,67 t/ha production while 'Melrom' in the conventional plot registered significantly high values regarding bush volume 0,75$m^3$, 0,937 kg of fruits/bush and 1,56 t/ha fruit production compared to the untreated variant.

## CONCLUSIONS

The preliminary results indicate that chokeberry cultivars 'Nero' and 'Melrom' found favourable conditions for growth and development in Bistrita region, Northern Transylvania. The statistical analysis revealed that there are no significant differences between cultivars regarding fruit production but there are differences regarding bush volume. The research continues in order to establish the best performing cultivars in terms of the adaptability of the plant, yield and the quality of the fruits.

**Author Contributions**:

C.A.M. Performed the analysis and wrote the paper, S. RM. and Z.JI. Contributed data or analysis tools and wrote the paper; and V.M and E.B. conceived and wrote the paper and C.M. - designed the article.

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**Conflicts of Interest**

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

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