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# VARIABILITY OF MORPHOLOGICAL CHARACTERISTICS IN HAWTHORN (*Crataegus monogyna* L.) FRUIT GENOTYPES

Ana-Maria STOENESCU[1] and Sina COSMULESCU[2]*

1. University of Craiova, Horticulture Faculty, Doctoral School of Plant and Animal Resources Engineering, A.I.Cuza Street 13, Craiova, Romania; E-mail: anamaria_stoenescu@yahoo.com
2. University of Craiova, Horticulture Faculty, Department of Horticulture & Food Science, A.I.Cuza Street 13, Craiova, Romania;
*Corresponding author, S. Cosmulescu, E-mail: sinacosmulescu@hotmail.com

***ABSTRACT.*** *The aim of this paper was to identify and evaluate the morphological characteristics of hawthorn fruits from a forest ecosystem in the southern area of Oltenia, Romania. These are important because of their use in food, pharmaceutical and cosmetics industries. 22 genotypes of Crataegus monogyna divided into three populations were analyzed to determine their variability within the forest ecosystem. The limits found for fruit morphology ranged from 0.18 g - 1.15 g for weight, 6.41 mm - 12.64 mm for fruit height, diameter varied between 5.75 mm - 13.94 mm, kernel weight between 0.04 g - 0.48 g and pulp weight between 0.06 g - 0.78 g. The largest coefficient of variation in height, diameter, weight, volume and kernel weight was recorded in the Jiu meadow population within the same genotype, G4. High variability identified from one genotype to another indicates a high potential for selection of genotypes with superior characteristics.*

***KEY WORDS:*** *fruit, hawthorn, morphology, population, variability.*

## INTRODUCTION

In Romania spontaneous flora, the genus *Crataegus* (*Rosaceae* family, subfamily *Maloideae*) is represented by 5 species: *C. monogyna* Jacq., *C. pentagyna* Waldst. et Kit., *C. laevigata* (Poir.) DC., *C. rhygophylla* Gand. and *C. nigra* Waldst. et Kit. (Ciocarlan, 2009; Sarbu et al., 2013). The popular name in Romania is "*păducel* or *gherghinar*". According to

Eisenreich et al. (2018) and Savulescu et al. (1956), the hawthorn is a thorny tree or shrub, up to 10 m tall, with green-olive bark, subsequently scaly and with longitudinal cracks. It has rough, alternate leaves, with 5-15 mm petiole, up to 6 cm, with 3-7 lobes, deeply indented. The base of the leaf is wide, conical, with uneven serrate edges. In May-June, white hermaphrodite flowers, up to 15 mm, in 6-10 umbels, at the end of the shoots, with 1 style/flower appear. The pollination is carried out by insects, and in September the red berries are 8-9 mm thick. The fruit is a fleshy pome (Hummer et Janick, 2009) with external receptacle, oval globe-shaped, red, coronated by persistent calyx, the carpelas transformed into hard, bony, one-seeded kernels (Savulescu et al., 1956). The pulp is floury and has an yellow colour. The hawthorn is found in bright fields, forests, hedges, edge of railways, roads, but also in parks and gardens ((Phipps, 1998). It is an invasive species, with rapid spread through birds (Herrera, 1984; Sobral et al., 2010) less demanding for climatic conditions. The variability of morphological characteristics of hawthorn genotypes in different regions has been studied in order to identify individuals with superior characteristics for practice and improvement. Türkoğlu et al. (2005), Yanar et al. (2011), Albarouki and Peterson (2007), Gundogdu et al. (2014), Özderin et Fakir (2015), analyzed the diversity of hawthorn genotypes in order to conserve the genetic background. Regarding the quality and quantity of fruits produced by a genotype, Sallabanks (1992) concluded that larger and older genotypes produce a higher amount of fruit and of better quality. The purpose of this work was to identify and evaluate the morphological characteristics of hawthorn fruits from a forest ecosystem in the southern Oltenia area in order to identify superior genotypes useful for practice and improvement.

## MATERIALS AND METHODS

### Materials

22 hawthorn genotypes (*C. monogyna*) from Bratovoeşti forest, located in the South-West of Romania, Oltenia region, Dolj County (44°05'19.5"N 23°54'03.5"E) were studied. The 22 genotypes were divided into three populations depending on the area where they were selected: Jiu meadow (G1, G2, G3, G4, G5, G6, G7, G8, G9, G10) the national road DN55 (G11, G12, G15, G16, G17, G18, G20) and the central forest population (G21, G24, G25, G26, G28). This division was made due to the location of the forest ecosystem, between an important tributary of the

Danube and the national road linking Craiova to Bechet city. The third population was chosen as the central part of the forest precisely to better reflect the influence of abiotic factors on fruit morphology of *Crataegus*. Fruits were harvested from each genotype for morphological laboratory analyses.

**Methods**

The study was conducted on a total of 100 fresh fruits harvested from each genotype. Measurements such as height, diameter, weight, volume, kernel weight and pulp weight were made. The height and diameter were determined with the high precision electronic calliper, the volume with a graduated cylinder, and the total weight and kernel weight with the KERN EMB 200-2 analytical balance. The weight of the pulp was subsequently determined by the ratio of kernel weight to total weight (Ionica et al., 2018).

**Statistical Analysis**

The obtained data from the measurements was processed in the Excel descriptive statistical program.

## RESULTS AND DISCUSSIONS

All identified genotypes are trees with trunks and crowns well defined. The altitude ranged from 56 m at G25 up to 64 m at G24 both genotypes corresponding to the same population of the central part of the forest (Table 1). The results obtained from the statistical analysis can be found in Tables 2, 3 and 4 corresponding to each population. According to the obtained data, a minimum of 6.41 mm for fruit height resulted, corresponding to G25 from the central part of the forest population and a maximum of 12.64 mm for G5 of the population near the Jiu meadow. The mean height varied between 8.66 mm at G25 genotype and 11.04 mm at G5. Similar studies by Yanar et al. (2011) in Malatya, Turkey, showed values ranging from 11.62 mm to 13.38 mm. Also resemblig values were reported by Türkoğlu et al. (2005) following the study in the Van region of Turkey (the values for height were between 7.96 mm - 12.74 mm). Albarouki et Peterson (2007), following the study conducted in Syria, recorded heights ranging from 5 mm to 11 mm. Related values also identified Özderin et Fakir (2015), between 7.00 mm - 10.00 mm. Regarding the fruit diameter, the minimum was identified at G26, with a value of 5.75 mm, and the maximum was reached by G8, with a value of 13.94 mm. Average values for this feature ranged

Table 1. Hawthorn genotypes clasification.

| Genotype | Plant habit | Root flare diameter (cm) | Coordinates ** | Plot* | Altitude** (m) |
|---|---|---|---|---|---|
| 1 | Tree | 14.96 | 44°05'55.5"N23°52'45.1"E | 41 | 57 |
| 2 | Tree | 6.68 | 44°05'59.4"N 3°52'43.7"E | 41 | 57 |
| 3 | Tree | 9.23 | 44°05'58.6"N23°52'43.3"E | 41 | 57 |
| 4 | Tree | 9.7 | 44°05'58.6"N23°52'43.8"E | 41 | 57 |
| 5 | Tree | 5.41 | 44°05'57.7"N23°52'44.0"E | 41 | 57 |
| 6 | Tree | 6.68 | 44°05'57.6"N23°52'43.9"E | 41 | 57 |
| 7 | Tree | 5.41 | 44°05'57.6"N23°52'44.0"E | 41 | 57 |
| 8 | Tree | 5.41 | 44°05'57.2"N3°52'44.2"E | 41 | 57 |
| 9 | Tree | 15.91 | 44°05'57.3"N23°52'44.7"E | 41 | 57 |
| 10 | Tree | 7.63 | 44°05'57.3"N23°52'44.4"E | 41 | 57 |
| 11 | Tree | 7.95 | 44°06'12.2"N23°54'33.4"E | 81 | 57 |
| 12 | Tree | 8.27 | 44°06'12.2"N23°54'33.5"E | 81 | 57 |
| 15 | Tree | 15.91 | 44°06'13.5"N23°54'26.6"E | 81 | 60 |
| 16 | Tree | 10.5 | 44°06'13.5"N23°54'26.9"E | 81 | 60 |
| 17 | Tree | 7 | 44°06'13.3"N23°54'25.7"E | 81 | 60 |
| 18 | Tree | 10.18 | 44°06'13.1"N23°54'27.7"E | 81 | 58 |
| 20 | Tree | 6.36 | 44°06'13.4"N23°54'23.3"E | 81 | 63 |
| 21 | Tree | 10.18 | 44°05'28.9"N23°53'56.7"E | 68 | 61 |
| 24 | Tree | 8.91 | 44°05'33.0"N23°53'57.1"E | 68 | 64 |
| 25 | Tree | 9.86 | 44°05'17.2"N23°53'40.4"E | 56 | 56 |
| 26 | Tree | 8.91 | 44°05'17.7"N23°53'41.7"E | 57 | 58 |
| 28 | Tree | 8.59 | 44°05'17.8"N23°53'42.2"E | 57 | 58 |

*U.P. IV Bratovoeşti, GoogleEarth ** source GoogleEarth

from 7.77 mm at G26 and 10.34 mm at G8. The genotypes studied by Yanar et al. (2011) had a diameter between 10.45 mm and 12.69 mm, those studied by Türkoğlu et al. (2005), had registered values between 7.32 mm - 13.24 mm, therefore relatively similar results, and the ones studied by Özderin et Fakir (2015) had values ranging between 7.00 mm - 10.00 mm. Fruit weight also registered variations of 0.18 g for genotype G4 and a maximum of 1.15 g for G8 (both genotypes from Jiu meadow population), values similar to those obtained by Türkoğlu et al. (2005) at genotypes from Turkey (0.29 g - 1.17 g) and those obtained by Özderin et Fakir (2015), in

Table 2. Morphological characteristics of the Jiu meadow population genotypes.

| Genotypes | Descriptive analysis | Fruit height (mm) | Fruit diameter (mm) | Fruit weight (g) | Fruit volume ($cm^3$) | Kernel weight (g) | Pulp weight (g) |
|---|---|---|---|---|---|---|---|
| 1 | X ± SD | 10.85 ± 0.68 | 9.51 ± 0.51 | 0.61 ± 0.09 | | 0.17 ± 0.03 | 0.44 ± 0.07 |
| | Variation limits | 9.34 - 12.25 | 7.93 - 10.52 | 0.42 - 0.86 | 0.6 - 1.2 | 0.1 - 0.32 | 0.22 - 0.61 |
| | CV% | 6.27 | 5.36 | 14.75 | 15.85 | 17.65 | 15.91 |
| 2 | X ± SD | 10.71 ± 0.65 | 8.82 ± 0.39 | 0.52 ± 0.06 | 0.73 ± 0.12 | 0.20 ± 0.02 | 0.31 ± 0.04 |
| | Variation limits | 9.07 - 12.6 | 7.78 - 9.77 | 0.35 - 0.74 | 0.4 - 1 | 0.14 - 0.28 | 0.18 - 0.46 |
| | CV% | 6.07 | 4.42 | 11.54 | 16.44 | 10 | 12.9 |
| 3 | X ± SD | 10.99 ± 0.68 | 9.30 ± 0.57 | 0.55 ± 0.08 | 0.76 ± 0.14 | 0.15 ± 0.02 | 0.40 ± 0.06 |
| | Variation limits | 9.4 - 10.08 | 7.74 - 11.1 | 0.35 - 0.77 | 0.4 - 0.2 | 0.08 - 0.26 | 0.25 - 0.57 |
| | CV% | 6.19 | 6.13 | 14.55 | 18.42 | 13.33 | 15 |
| 4 | X ± SD | 10.22 ± 0.82 | 8.91 ± 0.9 | 0.47 ± 0.11 | 0.59 ± 0.15 | 0.12 ± 0.04 | 0.35 ± 0.09 |
| | Variation limits | 8.3 - 11.79 | 6.75 - 10.69 | 0.18 - 0.73 | 0.2 - 0.8 | 0.04 - 0.22 | 0.12 - 0.55 |
| | CV% | 8.02 | 10.1 | 23.4 | 25.42 | 33.33 | 25.71 |
| 5 | X ± SD | 11.04 ± 0.80 | 8.76 ± 0.57 | 0.54 ± 0.10 | 0.68 ± 0.17 | 0.22 ± 0.06 | 0.31 ± 0.08 |
| | Variation limits | 9.01 - 12.64 | 7.15 - 10.02 | 0.31 - 0.79 | 0.4 - 1 | 0.1 - 0.38 | 0.12 - 0.5 |
| | CV% | 7.25 | 6.51 | 18.52 | 25 | 27.27 | 25.81 |

*X ± SD –mean and standard deviation, CV% - coefficient of variation

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Table 2. (continued)

| Genotypes | Descriptive analysis | Fruit height (mm) | Fruit diameter (mm) | Fruit weight (g) | Fruit volume ($cm^3$) | Kernel weight (g) | Pulp weight (g) |
|---|---|---|---|---|---|---|---|
| 6 | X ± SD | 8.76 ± 0.44 | 8.39 ± 0.48 | 0.40 ± 0.05 | 0.53 ± 0.09 | 0.13 ± 0.03 | 0.26 ± 0.04 |
| | Variation limits | 7.45 - 9.86 | 7.01 - 9.54 | 0.27 - 0.53 | 0.4 - 0.6 | 0.08 - 0.27 | 0.13 - 0.35 |
| | CV% | 5.02 | 5.72 | 12.5 | 16.98 | 23.08 | 15.38 |
| 7 | X ± SD | 9.18 ± 0.56 | 8.04 ± 0.58 | 0.41 ± 0.07 | 0.52 ± 0.10 | 0.14 ± 0.02 | 0.26 ± 0.05 |
| | Variation limits | 7.6 - 10.55 | 6.79 - 9.39 | 0.26 - 0.58 | 0.2 - 0.6 | 0.08 - 0.22 | 0.06 - 0.4 |
| | CV% | 6.1 | 7.21 | 17.07 | 19.23 | 14.29 | 19.23 |
| 8 | X ± SD | 10.08 ± 0.59 | 10.34 ± 0.82 | 0.70 ± 0.13 | 0.78 ± 0.12 | 0.18 ± 0.04 | 0.52 ± 0.11 |
| | Variation limits | 8.45 - 11.58 | 8.41 - 13.94 | 0.32 - 1.15 | 0.4 - 1.2 | 0.1 - 0.37 | 0.19 - 0.78 |
| | CV% | 5.85 | 7.93 | 18.57 | 15.38 | 22.22 | 21.15 |
| 9 | X ± SD | 10.29 ± 0.66 | 8.89 ± 0.54 | 0.50 ± 0.06 | 0.56 ± 0.12 | 0.11 ± 0.01 | 0.39 ± 0.05 |
| | Variation limits | 8.58 - 12.09 | 7.63 - 10.2 | 0.33 - 0.67 | 0.2 - 0.8 | 0.07 - 0.2 | 0.26 - 0.55 |
| | CV% | 6.41 | 6.07 | 12 | 21.43 | 9.09 | 12.82 |
| 10 | X ± SD | 9.75 ± 0.58 | 8.63 ± 0.40 | 0.46 ± 0.05 | 0.53 ± 0.10 | 0.20 ± 0.02 | 0.26 ± 0.04 |
| | Variation limits | 8.14 - 11.31 | 7.27 - 9.4 | 0.29 - 0.59 | 0.2 - 0.8 | 0.15 - 0.27 | 0.14 - 0.36 |
| | CV% | 5.95 | 4.63 | 10.87 | 18.87 | 10 | 15.38 |

*X ± SD –mean and standard deviation, CV% - coefficient of variation

Table 3. Morphological characteristics of DN55 population genotypes

| Genotypes | Descriptive analysis | Fruit height (mm) | Fruit diameter (mm) | Fruit weight (g) | Fruit volume ($cm^3$) | Kernel weight (g) | Pulp weight (g) |
|---|---|---|---|---|---|---|---|
| 11 | X ± SD | 9.37 ± 0.60 | 8.49 ± 0.51 | 0.48 ± 0.07 | 0.55 ± 0.11 | 0.13 ± 0.02 | 0.35 ± 0.05 |
| | Variation limits | 6.97 - 10.64 | 7.01 - 10.12 | 0.29 - 0.68 | 0.2 - 0.8 | 0.08 - 0.2 | 0.2 - 0.48 |
| | CV% | 6.4 | 6.01 | 14.58 | 20 | 15.38 | 14.29 |
| 12 | X ± SD | 10.01 ± 0.72 | 9.47 ± 0.62 | 0.59 ± 0.10 | 0.76 ± 0.18 | 0.19 ± 0.03 | 0.39 ± 0.07 |
| | Variation limits | 8.19 - 11.44 | 7.63 - 11.12 | 0.36 - 0.79 | 0.4 - 1 | 0.1 - 0.3 | 0.18 - 0.54 |
| | CV% | 7.19 | 6.55 | 16.95 | 23.68 | 15.79 | 17.95 |
| 15 | X ± SD | 10.34 ± 0.65 | 9.78 ± 0.45 | 0.57 ± 0.07 | 0.68 ± 0.10 | 0.14 ± 0.02 | 0.42 ± 0.07 |
| | Variation limits | 8.9 - 11.86 | 8.60 - 10.94 | 0.39 - 0.81 | 0.4 - 1 | 0.08 - 0.22 | 0.23 - 0.62 |
| | CV% | 6.29 | 4.6 | 12.28 | 14.71 | 14.29 | 16.67 |
| 16 | X ± SD | 9.33 ± 0.54 | 8.54 ± 0.36 | 0.42 ± 0.05 | 0.53 ± 0.1 | 0.16 ± 0.02 | 0.25 ± 0.04 |
| | Variation limits | 7.8 - 10.64 | 7.54 - 9.42 | 0.28 - 0.56 | 0.2 - 0.6 | 0.11 - 0.23 | 0.15 - 0.36 |
| | CV% | 5.79 | 4.22 | 11.9 | 18.87 | 12.5 | 16 |
| 17 | X ± SD | 9.45 ± 0.42 | 8.41 ± 0.43 | 0.44 ± 0.05 | 0.55 ± 0.08 | 0.14 ± 0.02 | 0.29 ± 0.04 |
| | Variation limits | 8.61 - 10.34 | 7.56 - 9.58 | 0.31 - 0.54 | 0.4 - 0.6 | 0.09 - 0.21 | 0.19 - 0.43 |
| | CV% | 4.44 | 5.11 | 11.36 | 14.55 | 14.29 | 13.79 |
| 18 | X ± SD | 10.09 ± 0.53 | 8.84 ± 0.55 | 0.50 ± 0.07 | 0.61 ± 0.08 | 0.20 ± 0.02 | 0.29 ± 0.05 |
| | Variation limits | 8.99 - 11.37 | 7.77 - 10.95 | 0.34 - 0.8 | 0.4 - 1 | 0.15 - 0.3 | 0.18 - 0.5 |
| | CV% | 5.25 | 6.22 | 14 | 13.11 | 10 | 17.24 |
| 20 | X ± SD | 10.32 ± 0.68 | 9.97 ± 0.62 | 0.64 ± 0.09 | 0.77 ± 0.15 | 0.32 ± 0.06 | 0.31 ± 0.05 |
| | Variation limits | 8.5 - 12.11 | 8.66 - 11.59 | 0.38 - 0.83 | 0.4 - 1 | 0.18 - 0.48 | 0.19 - 0.44 |
| | CV% | 6.59 | 6.22 | 14.06 | 19.48 | 18.75 | 16.13 |

*X ± SD –mean and standard deviation, CV% - coefficient of variation

Table 4. Morphological characteristics of the central part of the forest population

| Genotypes | Descriptive analysis | Fruit height (mm) | Fruit diameter (mm) | Fruit weight (g) | Fruit volume ($cm^3$) | Kernel weight (g) | Pulp weight (g) |
|---|---|---|---|---|---|---|---|
| 21 | X ± SD | 9.69 ± 0.61 | 8.66 ± 0.59 | 0.49 ± 0.07 | 0.60 ± 0.10 | 0.13 ± 0.02 | 0.35 ± 0.05 |
| | Variation limits | 8.12 - 10.98 | 7.08 - 9.95 | 0.34 - 0.66 | 0.4 - 0.8 | 0.08 - 0.2 | 0.21 - 0.47 |
| | CV% | 6.3 | 6.81 | 14.29 | 16.67 | 15.38 | 14.29 |
| 24 | X ± SD | 8.80 ± 0.64 | 8.16 ± 0.57 | 0.39 ± 0.07 | 0.48 ± 0.14 | 0.13 ± 0.02 | 0.25 ± 0.05 |
| | Variation limits | 6.87 - 10.18 | 5.79 - 9.32 | 0.25 - 0.58 | 0.2 - 0.8 | 0.06 - 0.2 | 0.12 - 0.39 |
| | CV% | 7.27 | 6.99 | 17.95 | 29.17 | 15.38 | 20 |
| 25 | X ± SD | 8.66 ± 0.60 | 8.41 ± 0.64 | 0.37 ± 0.07 | 0.46 ± 0.14 | 0.15 ± 0.02 | 0.22 ± 0.05 |
| | Variation limits | 6.41 - 9.86 | 6.15 - 10.07 | 0.21 - 0.55 | 0.2 - 0.8 | 0.09 - 0.2 | 0.11 - 0.36 |
| | CV% | 6.93 | 7.61 | 18.92 | 30.43 | 13.33 | 22.73 |
| 26 | X ± SD | 9.61 ± 0.60 | 7.77 ± 0.63 | 0.38 ± 0.07 | 0.45 ± 0.14 | 0.12 ± 0.02 | 0.25 ± 0.06 |
| | Variation limits | 7.42 - 11.37 | 5.75 - 8.85 | 0.21 - 0.55 | 0.2 - 0.6 | 0.07 - 0.2 | 0.13 - 0.44 |
| | CV% | 6.24 | 8.11 | 18.42 | 31.11 | 16.67 | 24 |
| 28 | X ± SD | 10.18 ± 0.75 | 8.79 ± 0.61 | 0.47 ± 0.08 | 0.67 ± 0.15 | 0.18 ± 0.03 | 0.29 ± 0.07 |
| | Variation limits | 8.54 - 11.72 | 7.17 - 10.37 | 0.29 - 0.66 | 0.2 - 1 | 0.1 - 0.27 | 0.11 - 0.48 |
| | CV% | 7.37 | 6.94 | 17.02 | 22.39 | 16.67 | 24.14 |

*X ± SD –mean and standard deviation, CV% - coefficient of variation

the same country (0.26 g - 0.89 g). All fruits had a single kernel feature of the species *C. monogyna*. In terms of kernel weight, the minimum was 0.04 g at G4 and a maximum of 0.48 g at G20, kernels with relatively higher values than those studied by Türkoğlu et al. (2005), which ranged from 0.034 g to 0.26 g and those studied by Özderin et Fakir (2015), betwen 0.05 g - 0.19 g. Similar results have also been obtained by Gundogdu et al. (2014), which recorded maximum values of 1.35 g for weight, 13.12 mm for fruit height, 12.55 mm for fruit diameter and 0.29 g for kernel weight. The pulp of the fruits varied according to its size, the ones with large kernels often had a small amount of pulp. Thus, the minimum and maximum in terms of pulp weight was recorded in the Jiu meadow population, G7 with a value of 0.06 g and G8 with 0.78 g. In terms of fruit volume, it did not show significant differences due to the small size, but the minimum was 0.2 $cm^3$ identified for genotypes in all three populations and the maximum of 1.2 $cm^3$ for genotypes in the Jiu meadow population. The coefficient of variation (CV%) for fruit height ranged between 4.44% at G17 and 8.02% at G12, indicating uniform fruits for this characteristic within the three populations. For fruit diameter, the variation coefficient varied between 4.22% at G16 and 10.1% at G4. The coefficient of variation for fruit weight had values between 10.87% at G10 and 23.4% at G4, indicating heterogeneousness between the genotypes studied for the weight of the fruit. Mean to large differences indicates the values of the coefficient of variation for fruit volume (13.11% at G18 and 25.42% at G4), kernel weight (9.09% at G9 and 33.33% at G4) and pulp weight (12.82% at G9 and 25.81% at G5). The color of *C. monogyna* fruits is red, characteristic of the species. We can talk about some small differences in this aspect, namely in the population of the Jiu meadow, the fruits have a shiny red color, the berries harvested from the center of the forest were dark red matte and the ones in DN55 were both glossy and matte. These differences can be attributed to the quality and intensity of light (Dussi et al., 1995; Cox et al., 2003). As a high quality genotypes population according to the studied morphological characteristics, the population of the Jiu meadow with the highest values for fruit height, volume, pulp weight and the lowest values of the kernel weight is noted. It is followed by DN55 population with the highest values of the diameter and total weight of the fruit. The least representative being the central population, these results can be correlated with the location of the three populations and the differences in temperature, light and humidity. It is known that temperate forests show moderate cooling during the summer

and moderate warming during winter (Li et al., 2015). Thus, we can say that the fruits analyzed in the population of Jiu meadow benefit from a lower humidity than the other genotypes and therefor due to the exposure of the terrain, with a much lighter intensity. They are much more airy, surrounded by species such as *Populus alba*, *Populus nigra*, *Salix alba*, *Salix caprea*, *Amorpha fruticosa*, *Prunus spinosa*, *Rosa canina*. In the population of the central part of the forest, genotypes have a lower vigour, although they are more protected from cold temperatures during winter, they benefit from less light due to the other species *Tilia spp.*, *Quercus spp.*, *Fraxinus spp.*, but with a higher degree of humidity. The genotypes identified in DN55 have sunlight, are not suffocated by other species but are found alongside *Taxodium distichum*, *Salix caprea*, *Prunus spinosa*, *Rosa canina*, *Gleditsia triacanthos*, *Alnus glutinosa*, *Fraxinus excelsior, Pyrus pyraster*, *Robinia pseudoacacia*, *Sambucus nigra*. The feature of this population is that it is next to a swampy area. It can be discussed about a variability inside the populations due to abiotic factors, land exposure, luminous intensity, humidity, but also biotic factors, referring here to the competition between species (hawthorn and other forest species, the ones mentioned previously). At the same time from the obtained coefficient of variation, there is a heterogeneousness within the genotypes, and uniformity within each population. For the Jiu meadow population the coefficient of variation for height was between 5.02% - 8.02%, the diameter between 4.42% - 10.1%, the weight 10.87% - 23.4%, the volume 15.38% - 25.42%, the kernel weight 9.09% - 33.33% pulp weight ranged from 12.82% to 25.81%. The CV% limits for the DN55 population ranged from 4.44% to 7.19% in terms of fruit height, 4.22% to 6.55% in diameter, 11.36% to 16.95% in fruit weight, 13.11% to 23.68% kernel weight and 13.79% - 17.95% for fruit pulp weight. The five genotypes analyzed from the central forest population recorded a coefficient of variation between 6.24% - 7.37% for fruit height, 6.81% - 8.11% for diameter, 14.29% - 18.92% for weight, 16.67% - 31.11% in volume, 13.33% - 16.67% for kernel weight and 14.29% - 24.14% pulp weight. The calculation of the existing correlations (Table 5) between the morphological characteristics of the hawthorn fruits shows that the weight of the fruit is largely influenced by the diameter of the fruit (r = 0.885) and the weight of the fruit influences the volume (r = 0.853) and the pulp weight (r = 0873).

Table 5. Corelation analysis of the morphological characteristics from identified genotypes.

| Characteristics | Fruit height (mm) | Fruit diameter (mm) | Fruit weight (g) | Fruit volume ($cm^3$) | Kernel weight (g) | Pulp weight (g) |
|---|---|---|---|---|---|---|
| Fruit height (mm) | 1.000 | | | | | |
| Fruit diameter (mm) | 0.568 | 1.000 | | | | |
| Fruit weight (g) | 0.686 | 0.885 | 1.000 | | | |
| Fruit volume ($cm^3$) | 0.696 | 0.755 | 0.853 | 1.000 | | |
| Kernel weight (g) | 0.408 | 0.503 | 0.568 | 0.522 | 1.000 | |
| Pulp weight (g) | 0.588 | 0.772 | 0.873 | 0.723 | 0.096 | 1.000 |

## CONCLUSIONS

Being a species less demanding for environmental conditions and growing relatively easily, these characteristics can be successfully harvested and hawthorn fruits can be beneficial from several points of view. Following the analyses performed, the variability of genotypes within the forest ecosystem and the variability of the three studied populations was demonstrated. The morphological characteristics of hawthorn fruits are important for selecting the best genotypes for practice and improvement.

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