

THE VARIABILITY OF PECULIARITIES OF SAMARAS AND SEEDS BELONGING TO DIFFERENT GENOTYPES OF *FRAXINUS EXCELSIOR* (L.)

Valentina Floran, Lucica Mihalte

University of Agricultural Sciences and Veterinary Medicine, 3-5 Manastur St., Cluj-Napoca 400372, Romania; email: tina_f_1212@yahoo.com; mihaltelucica@yahoo.com

Abstract. Genus *Fraxinus* are the true ashes and are in *Oleaceae*, the olive family, along with olives and lilacs. The seeds, popularly known as keys are a type of fruit known as a samara. A samara is a type of fruit in which a flattened wing of fibrous, papery tissue develops from the ovary wall. A samara is a simple dry fruit and indehiscent (not opening along a seam). There were studied the main peculiarities of fruits: (length-cm, width-cm and weight-mg) and of seeds (length-cm, width-cm and weight-mg, and the thickness-mm) number of seeds. The fruits length had different values in each seven genotypes of *Fraxinus excelsior*, obtaining amplitude of variation between 3.30 cm (Valiug) and 4.67 cm (Arad UP1, Arad UP2) cm. The stands Arad UP1, Arad UP2, Berzeasca, Satu Mare, Valiug, Brasov has been registered with large values (0.18 mg, 0.16 mg, 0.17mg, 0.19mg, 0.18mg) regarding the samara weight. The seeds with largest length belong to Brasov (1.88 cm), Satu Mare (1.87 cm) and to Zalau (1.74 cm) all being recorded with superior differences, statistically assured. The seeds with large width belonged to: Arad UP1 (0.83cm) stands, the amplitude of variation were between 0.37 cm (Zalau) and 0.83 cm (Arad UP1). The seeds weight had different values at the studied genotypes of *Fraxinus excelsior* obtaining the amplitude of variation between 0.04 g (Valiug, Arad UP1, Arad UP2) and 0.08 g (Satu Mare). If there are correlations between germination percentage and length and width of seeds can be used in breeding programs like parental genotypes the following stands: Brasov (1.88 cm) for length of seeds and Arad UP1 (0.83cm) for width of seeds. In most of the *Fraxinus* fruits studied in the experiment, the variability was small to medium. The seeds width is the only traits that present the large variability in this study (CV=56.3%).

Keywords: *Fraxinus excelsior*, fruit, samara, seeds, phenotypic characteristic

INTRODUCTION

Fraxinus, is a genus of usually medium to large trees, mostly deciduous though a few subtropical species are evergreen. *Fraxinus* genus is the true ash belongs to *Oleaceae*, the olive family, along with olives and lilacs (Zaharia, 2005). The genus *Fraxinus* contains 45-65 species (Sofletea, 2001). The leaves are opposite and mostly pinnately-compound, simple in a few species. The seeds, popularly known as keys or helicopter seeds, are a type of fruit known as a samara. (Haralamb, 1965). The European Ash (*Fraxinus excelsior*) is a tall tree, native to most of Europe, with the exception of northern Scandinavia and southern Mediterranean

Europe. It is a deciduous tree 20-35 m tall. The bark is smooth and pale grey on young trees, becoming thick and vertically fissured on old trees. It has black buds, unlike the brown buds of most other ashes (De Jong, 1990.) The leaves are 20-35 cm long, pinnate compound, with 9-13 leaflets, sessile on the leaf rachis, and with a serrated margin. The leaves of the common ash are often among the last to open in spring, and the first to fall in autumn if an early frost strikes (Stanescu, 1979). The phylogeography of the species is now well described (Morand *et al.*, 2002; Heuertz *et al.*, 2004; Ferrazzini *et al.*, 2007). *F. excelsior* displays a complex, polygamous sexual system (FRAXIGEN, 2005) in which individuals may be classified phenotypically across a continuum from purely male to purely female with a whole range of hermaphroditic intermediates. Hermaphrodite individuals are self-fertile and levels of seed sets are similar in hermaphrodite and female trees, but in natural populations, *F. excelsior* is preferentially outcrossed and male fertility of hermaphrodite trees appears to be much lower than that of male trees (FRAXIGEN, 2005). Fruits are dry and winged, adapted to wind dispersal. Regular fruit bearing begins around 20 years of age but fruiting phenology will vary depending on latitude, altitude, temperature and between years with great variation from no seeding to masting (FRAXIGEN, 2005).

The flowers open before the leaves, the female flowers being somewhat longer than the male flowers (Lupe, 1962). Both male and female flowers can occur on the same tree, but it is common to find all male and all female trees (Valteva, 1953). The female flowers develop into fruits. The fruit is a samara 2.5-4.5 cm long and 5-8 mm broad, often hanging in bunches through the winter; they are often called “ash keys” (Lazarescu, 1965). Fruit fall is evenly distributed through the wood and continues for nearly a year from September to August. In some fruit, the seed is immature or absent (Holonec, 2007). Only a very small percentage of seed ultimately germinates; germination usually occurs eighteen to twenty months after seed has fallen, a long period of dormancy being involved (Gardner, 1977). The true seed is exposed only after wall or pericarp has been removed. (Ellis, 2003). Such seeds are quite easily germinated if they are first stratified for a period of one or two months at a temperature near 5°C (Steinbauer, 1937). Responses to environmental stimuli, such as light or stratification, cause an increase in promoter hormone levels or a decrease in inhibitor hormone levels (Villiers, 1964).

MATERIAL AND METHOD

This study was carried out in the laboratory from the University of Agricultural Science and Veterinary Medicine Cluj-Napoca, Romania. Data consisted of samaras and seeds from 10 adult trees of seven *Fraxinus excelsior* stands.

Arad UP1, Arad UP2, Berzeasca, Valiug, Brașov, Zalău, Satu Mare were the genotypes of *Fraxinus excelsior* that have been analyzed in this experiment. This sample size are pretty enough for genetic diversity studies and conservation programs (Miyamoto *et al.*, 2008). The main characteristics of this stands are displayed in Tab. 1. In generally the studied genotypes has the diameter between 38 and 52 cm, the height between 20 and 34 m. Arad UP1, Arad UP2 and Văliug are part of production class 1, that means wood of high quality, best fenotypic and genotypic characters, Berzeasca, Brașov, Satu Mare stand are part of production class 3, that means lowest quality of wood, low heredity characters, trees attacked by insects, deteriorating agents, disease.

There were studied the main peculiarities of fruits: (length-cm, width-cm and weight-mg) and of seeds (length-cm, width-cm and weight-mg, and the thickness-mm) number of seeds.

Traits like color of seeds and shape of seeds were not analyzed because these traits are uniform from this point of view.

Differences between the fruits weight, length and (breadth) width were analyzed statistically using ANOVA “t” test (Ardelean *et al.*, 2007) having the mean of experiment as control; also, the coefficient of variability (CV%) for seeds weight were computed.

Differences between the seeds weight, length, (breadth) width, thickness were analyzed statistically using ANOVA “t” test (Ardelean *et al.*, 2007) having the mean of experiment as control; also, the coefficient of variability (CV%) for seeds weight were computed.

Table 1.

The main peculiarities of the studied genotypes

Genotype	Mean of diameter (cm)	Mean of height (m)	Production class (scale)	Density (%)
Arad UP1	40	34	1	0.70
Arad UP2	50	34	1	0.35
Berzeasca	30	24	3	0.32
Valiug	52	31	1	0.16
Brasov	52	26	3	0.35
Zalau	32	20	2	0.40
Satu Mare	38	25	3	0.56

RESULTS AND DISCUSSION

When practising direct seeding, it is important to have a database with variability of fruits and seeds traits, to know the vegetation management and the potential for using the technique to establish a range of tree and shrub species used for new native woodland creation (Willoughby, 2009).

Seed ecotypes are able to affect seed germination, depending on the species and its position in a given environmental gradient (Rüdinger, 2008).

The fruits length (Tabel 2) had different values in each seven genotypes of *Fraxinus excelsior*, obtaining amplitude of variation between 3.30 cm (Valiug) and 4.67 cm (Arad UP1, Arad UP2) cm. Compare the mean of experiment (4.04), all the genotypes has been recorded with values, statistically assured. The standes Berzeasca (3.84 cm), Valiug (3.30 cm), Brasov (3.92 cm), Zalau (3.91 cm), Satu Mare (3.97 cm) have seeds with the lowest length compared to the mean of experiment. The fruits with the largest length belong to the Arad UP1 (4.67 cm), Arad UP2 (4.67 cm)

All the coefficients of variability (Tabel 2) computed for fruits length, in this experiment has been registered with low values (under 10%). The medium value s% was 12.5%, the variation limits for the fruits length oscillated between 2.5% (Brasov) and 9.8 % (Valiug). Brasov genotype with lowest coefficient of variability has the largest uniformity regarding their length.

The samara width (Tabel 2) has different values in all seven studied stands obtaining the amplitude of variation between 0.62 cm (Valiug) and 1.14 cm (Arad UP1).

Compare the mean of experiment, considered as control (0.87 cm) the stands Valiug (0.62 cm), Zalau (0.77 cm), Berzeasca (0.78 cm), have fruits with the lowest width.

At the other side, the fruits with largest width belong to the Arad UP1 (1.14 cm), Arad UP2 (1.06 cm).

Based on the variability coefficients calculated (Tab 2.) the variability of samara width is small (CV=8.8% at Arad UP1 stand) to medium (CV=23.4% at Valiug stand).

Tabel 2.
Length, width and weight of fruits, significance values* and coefficient of variability (CV%) at different *Fraxinus excelsior* stands

Genotype	Samara length (cm)			Samara width (cm)			Samara weight (mg)		
	Mean± sx	“t”/ Signif.	CV %	Mean ± sx	“t”/ Signif.	CV %	Mean ± sx	“t”/ Signif.	.CV %
Arad UP1	4.67±0.06	11.83 ^{xxx}	6.7	1.14±0.02	14.60 ^{xxx}	8.8	0.18±0.00	5.39 ^{xxx}	3.4
Arad UP2	4.67±0.04	14.05 ^{xxx}	5.2	1.06±0.03	6.71 ^{xxx}	16.7	0.16±0.00	-4.58 ^{xxx}	8.0
Berzeasca	3.84±0.04	-4.62 ^{ooo}	5.9	0.78±0.02	-5.05 ^{ooo}	13.2	0.17±0.00	3.45 ^{xxx}	6.4
Satu Mare	3.97±0.02	-2.12 ^o	2.7	0.88±0.01	0.15 ⁻	8.8	0.19±0.00	12.41 ^{xxx}	2.5
Valiug	3.30±0.06	-13.59 ^{ooo}	9.8	0.62±0.03	-10.97 ^{ooo}	23.4	0.19±0.00	13.88 ^{xxx}	2.4
Brasov	3.92±0.02	-3.69 ^{ooo}	2.5	0.88±0.02	0.13 ⁻	10.7	0.18±0.00	4.66 ^{xxx}	3.7
Zalau	3.91±0.03	-3.39 ^{ooo}	4.8	0.77±0.02	-6.29 ^{ooo}	11.5	0.10±0.00	33.55 ^{ooo}	5.9
Mean of exp.	4.04	-	12.5	0,874		23.2	0.17		17.6

* , ** , ***/ o, oo, ooo Significant at P<0.05, 0.01 and 0.001 (positive, respectively negative)

The amplitude of variation of *Fraxinus* fruits weight (Tab 2.) has been recorded between 0.10 mg (Zalau) and 0.19 mg (Valiug, Satu Mare).

The fruits with the lowest weight compared to the mean of experiment (0.17 mg) belonging to: Zalau genotype (0.10mg). All the other stands (Arad UP1, Arad UP2, Berzeasca, Satu Mare, Valiug, Brasov) has been registered with large values (0.18 mg, 0.16 mg, 0.17mg, 0.19mg, 0.18mg).

The variability coefficients (Tab. 2.) calculated, registered low values (under 10%) in all the cases. The variation limits for the fruits weight oscillated between 2.4% (Valiug) and 8.0 % (Arad UP2). The Valiug genotype, with lowest variability, fruits had the largest uniformity regarding their weight, while the stands Arad UP2 have the largest uniformity about their weight.

The seeds length (Tab. 3) had different values in each seven genotypes of *Fraxinus excelsior*, obtaining the amplitude of variation between 1.51 cm (Valiug) and 1.88 cm (Brasov). The stands Valiug (1.16 cm), has seeds with lowest length compared to the mean of experiment (1.62) cm. The seeds with largest length belong to Brasov (1.88 cm), Satu Mare (1.87 cm) and to Zalau (1.74 cm) all being recorded with superior differences, statistically assured.

The limit of coefficients of variability (Tab. 3) calculated were CV=5.2% (the lowest limit) at Valiug genotype and CV=16.3 % (the highest limit) at Arad UP1

The seeds with large width (Tab. 3) belonged to: Arad UP1 (0.83cm) stnds, obtaining amplitude of variation between 0.37 cm (Zalau) and 0.83 cm (Arad UP1). The seeds with a small width (Tab. 3) belonged to: Zalau (0.37 cm), Valiug (0.39 cm), Arad UP2 (0.40cm) stands.

The variability of seeds width (Tab. 3) was large at almost all the genotypes (CV=71.5 %-Arad UP1, Valiug-CV=22.7%, CV=18.1%-Satu Mare).

Table 3
Length and width of seeds, significance values* and coefficient of variability (CV%) at different

No. of entry	Genotype	Seeds length (cm)			Seeds width (cm)		
		Mean±sx	“t”/Signif.	CV %	Mean± sx	“t”/Signif. f.	CV %
1	Arad UP1	1.51±0.4	-2.66 ^{oo}	16.3	0.83±0.11	4.03 ^{xxx}	71.5
2	Arad UP2	1.54±0.4	-2.07 ^o	14.9	0.40±0.01	-4.52 ^{ooo}	17.4
3	Berzeasca	1.61±0.2	-0.37 [~]	7.3	0.48±0.01	-0.03 [~]	14.5
4	Satu Mare	1.87±0.2	10.85 ^{xxx}	6.5	0.45±0.01	-1.56 [~]	18.1
5	Valiug	1.16±0.2	-19.78 ^{ooo}	10.0	0.39±0.02	-4.67 ^{ooo}	22.7
6	Brasov	1.88±0.2	12.35 ^{xxx}	5.2	0.46±0.01	-1.27 [~]	15.7
7	Zalau	1.74±0.2	5.73 ^{xxx}	6.0	0.37±0.01	-6.22 ^{ooo}	15.6
Media experienței (Mt.)		1.62		17.3	0.48		56.3

Fraxinus excelsior stands

*, **, ***/ o, oo, ooo Significant at P<0.05, 0.01 and 0.001 (positive, respectively negative)

Tabel 4

Weight and thickness of seeds, significance values* and coefficient of variability (CV%) at different *Fraxinus excelsior* stands

No. of entry	Genotype	Seeds weight (g)			Seeds thickness (mm)		
		Mean± sx	“t”/Signif	CV (s%)	Mean± sx	t”/Signif	CV (s%)
1	Arad UP1	0.04±0.00	-15.99±ooo	13.2	1.36±0.04	-3.70±ooo	17.0
2	Arad UP2	0.04±0.00	-12.03±ooo	11.8	1.35±0.04	-4.71±ooo	15.0
3	Berzeasca	0.06±0.00	3.42±xxx	23.5	1.58±0.03	3.57±xxx	9.7
4	Satu Mare	0.08±0.00	20.33±xxx	4.1	1.63±0.03	5.99±xxx	8.9
5	Valiug	0.04±0.00	-11.19±ooo	6.5	1.44±0.02	-2.79±oo	6.5
6	Brasov	0.07±0.00	11.55±xxx	10.0	1.64±0.02	7.10±xxx	7.4
7	Zalau	0.06±0.00	-0.85±-	4.9	1.44±0.03	-1.95±o	11.9
Mean of experiment		0.06		28.1	1.49		13.4

* , ** , ***/ o, oo, ooo Significant at $P < 0.05$, 0.01 and 0.001 (positive, respectively negative)

The seeds weight (Tabel 4) had different values at the studied genotypes of *Fraxinus excelsior* obtaining the amplitude of variation between 0.04 g (Valiug, Arad UP1, Arad UP2) and 0.08 g (Satu Mare). Compare the mean of experiment (0.06 g) the Brasov (0.07 g), Satu Mare (0.08 g) genotypes were recorded with superior differences, statistically assured.

The stands Arad UP1 (0.04 g), Arad UP2 (0.04 g), Valiug (0.04 g), Berzeasca (0.06 g), had seeds with lowest values of weight.

The coefficients of variability (Tab. 4.) calculated has values under 23.5% in all cases, so the variability of the peculiarities was medium to small. (CV=4.1%, at Satu Mare)

The amplitude of variation of seeds thickness (Tab. 4.) at the genotypes of *Fraxinus excelsior* was 1.35 mm (Arad UP2) and 1.64 mm (Brasov). Compare the mean of experiment (1.49 mm), the stands Berzeasca (1.58mm), Satu Mare (1.63mm) and Brasov (1,64mm) have been recorded with superior differences, statistically assured

The coefficients of variability registered values under 17.0% in all cases (Tab. 4). The limits of variation for the seeds weight oscillated between CV=6.5% (Valiug) and CV=17.0 % (Arad UP1). The Valiug genotype, with lowest variability, seeds had the largest uniformity regarding their weight.

Analyzing the mean of samara peculiarities among the *Fraxinus excelsior* stands, it has been noticed that the average of the samara length present a large value (4.04 cm) among the studied traits. (Fig. 1).

A large variability of fruits traits among has been noticed in the present experiment, to the samara weight (CV=17.6%), and samara width (CV=23.2%) (Fig. 1).

Among the seeds peculiarities (Fig. 1)., seeds thickness and seeds length present the largest values (1.49 mm and 1.62 cm).

The higher coefficient of variability regarding the seeds characteristics was registered at seeds width trait (CV=56.3%) also, seeds weight present a high variability (CV=28.1%).

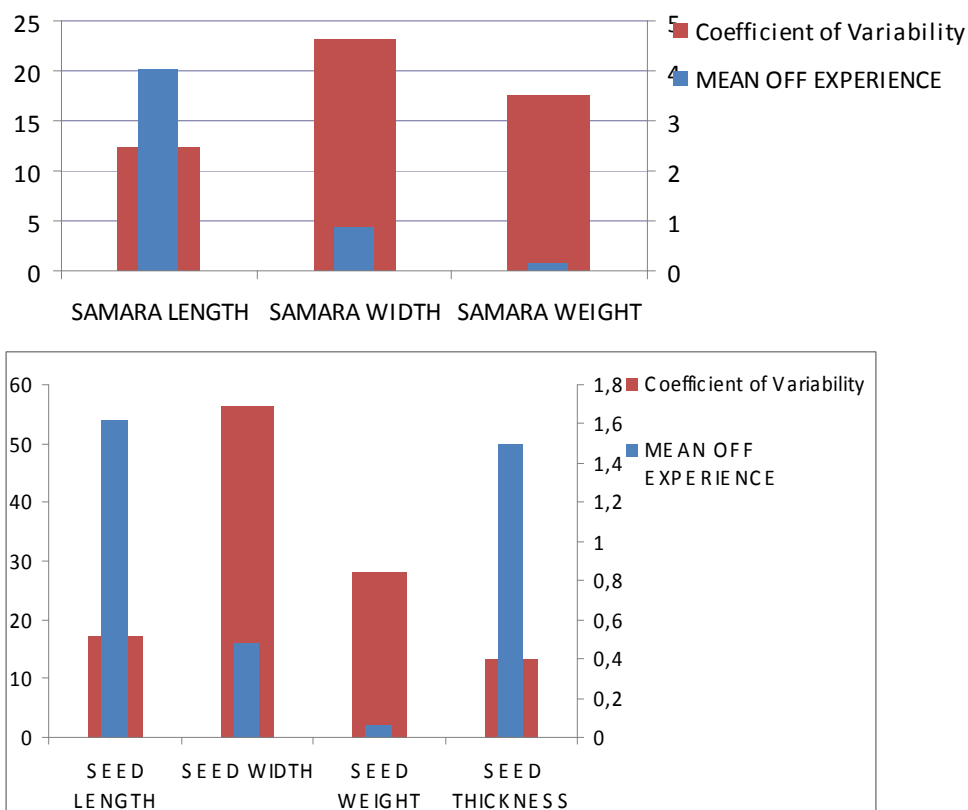


Fig. 1. The mean of fruits (up to page) and seeds (down) traits and the coefficient of variability among the *Fraxinus excelsior* stands

CONCLUSIONS

The above result may explain that geographical variation in that different stands and different values samaras and seeds of some characteristics, may influence germination/dormancy phenomena. After Zhang (2009) the germination percentage increase with different treatments of plant growth substances (100 mg-L⁻¹ kinetin for 1 day have better effects on the germination of *Fraxinus mandshurica* seeds.

Creating a database regarding the morphological peculiarities of the fruits (samara) and seeds of *Fraxinus excelsior* can be useful in identifying genotypes. In this way stands like: Arad UP1, Arad UP2, can be used in breeding programs for a largest length, width and weight of fruits. If there are correlations between germination percentage and length and width of seeds can be used in breeding programs like parental genotypes the following stands: Brasov (1.88 cm) for length of seeds and Arad UP1 (0.83cm) for width of seeds. In most of the *Fraxinus excelsior* fruits studied in the experiment, the variability was small to medium. The seeds width is the only traits that present the large variability in this study (CV=56.3%).

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