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Fruit and Seed Size Variability of *Fraxinus Ornus* Subsp. *Cilicica*

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ABSTRACT

In this exploratory study, the interpopulation variation of samaras (fruits) and seeds of *Fraxinus ornus* subsp. *cilicica*, an endemic tree in southern Turkey, and the effect of climate and geographical distribution on the samara and seed traits were investigated for eight provenances. Provenances varied greatly in terms of samara and seed traits. The average weight of samaras from the eight provenances was 0.030 g (weight of 1,000 seeds = 30 g). Provenances with the heaviest and lightest samaras, on average, were Menzelet (0.036 g) and Eğirdir (0.024 g), respectively. The average length and width of samaras were 24.11 mm and 4.89 mm, respectively. The greatest variability was observed in seed weight. The average weight, length, and thickness of seeds were 0.018 g, 9.16 mm, and 1.66 mm, respectively. Among the eight provenances, the widths of samaras decreased significantly with altitude. Precipitation did not significantly affect the traits of either fruits or seeds. Temperature significantly correlated only with the widths of samaras.

Key Words: Taurus Flowering Ash, Fraxinus, Seed

INTRODUCTION

Fraxinus ornus subsp. *cilicica,* the Taurus Flowering Ash, is an endemic tree that is scattered in the Taurus Mountains of Southern Turkey. Its height is usually 8–10 m, but it grows as high as 20 m [1, 2]. The tree prefers sunny southern slopes in karstic areas and grows between 350 and 1,500 m. Its ornamental value is a result of its beautiful flowers, foliage, and interesting crown shape [3].

F. ornus (Oleaceae), also known Manna ash [4], is an insect-pollinated tree [5]. Its fruits are elongated, winged, single-seeded samaras that are borne in clusters [6]. Breeding populations of *F. ornus* contain both males and hermaphrodites, and only hermaphrodites produce fruit [7, 8, 9].

Seed size varies greatly within the species. Many factors affect seed size, including genetic traits, plant height, growth form, dispersal mode, shade, environmental stresses, geographic location, and climate [10, 11, 12]. Basic knowledge of the seed morphology of a plant is necessary for proper seed handling and for the generative production of that species. Seed morphology can also aid in the identification of physiological characteristics. For example, the type of seed-covering structure often helps to predict tolerance or sensitivity of seeds to dehydration. Seed size often affects germination, initial seedling size, and seedling survival rate [13, 14].

The main objective of this exploratory study was to describe the interpopulational variation of fruits and seeds of *F. ornus* subsp. *cilicica* and the effects of climate and geographical distribution on *F.ornus* subsp. *cilicica* seeds.

MATERIALS AND METHODS

Samaras were collected from eight provenances in Turkey (Table 1) during the first week of November 2007. In the laboratory, samaras were dried to approximately 8% moisture content (MC). The MC of seeds was determined by incubation in a low-temperature oven for 17 hours at 104 ± 1ºC [15]. MC was expressed as a percentage of the fresh weight of the seed.

One hundred samaras from each provenance were randomly selected, and for each samara, seven traits were measured (Table 2; Figure 1). The weights, lengths, widths, and thicknesses of samaras were measured, the pericarps were removed, and the weights, lengths, and thicknesses of seeds were measured.

Table 1. Sources of seed material used in the study.

Provenance	Latitude	Longitude	Altitude (m)	Mean Precipitation (cm)	Mean Temperature (°C)
Menzelet	37°41'	36°50'	700	821.3	15.5
Çağşaklıoluk	37°36'	36°24'	1,150	1522.2	13.0
Boztoprak	37°32'	36°18'	950	1477.2	14.2
Düziçi	37°16'	36°30'	1,400	1362.9	11.2
Kozan	37°31'	35°52'	380	941.7	18.0
Pozantı	37°22'	34°53'	1,150	916.9	11.2
Gündoğmuş	36°49'	32°00'	950	1389.6	13.4
Eğirdir	37°44'	30°50'	1,450	1047.4	9.6

Table 2. Traits of samaras and seeds of F. *ornus* subsp. *cilicica*.

Trait	Accuracy
Samara Weight	0.001 g
Samara Length	0.01 mm
Samara Width	0.01 mm
Samara Thickness	0.01 mm
Seed Weight	0.001 g
Seed Length	0.01 mm
Seed Thickness	0.01 mm

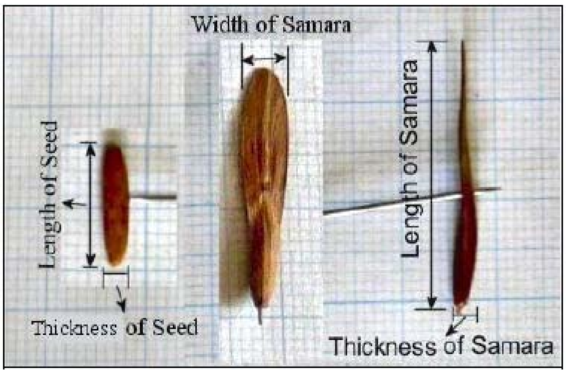

Figure 1. Measurement of traits of samaras and seeds.

Statistical Analysis

Mean values of traits for fruits and seeds were calculated for the eight provenances. Analysis of variance was applied to the calculations to test statistical hypotheses. Duncan's new multiple range test was used to demonstrate differences or similarities between studied populations.

Pearson's correlation coefficients were calculated to investigate the relationships between seed weights and the other traits for each provenance, as well as the relationships between seed traits and altitude, precipitation, and temperature.

RESULTS

The eight provenances exhibited great variability in terms of traits of both samaras and seeds (Figure 3). The average weight of samaras from the eight provenances was 0.030 g (weight of 1,000 seeds = 30 g). The provenances with the heaviest and lightest samaras, on average, were Menzelet (0.036 g) and Eğirdir (0.024 g), respectively.

The average length of samaras was 24.11 mm. The provenances with the shortest and longest samaras, on average, were Kozan (21.13 mm) and Eğirdir (27.97 mm), respectively. Eğirdir, the provenance with the longest samaras, also had the narrowest samaras (average of 3.94 mm). The average width and thickness of samaras were 4.89 mm and 1.91 mm, respectively.

The greatest variability was detected in seed weight. The provenance with the heaviest seeds, Düziçi. had an average seed weight that was almost twice that of the provenance with the lightest seeds, Eğirdir. The variation in seed length between provenances was relatively small. The longest and shortest seeds, on average, were from Menzelet (9.77 mm) and Kozan (8.49 mm), respectively.

Figure 2. Samaras and seeds of *F. ornus* subsp. c*ilicic*a from eight different provenances.

Table 3. Samara and seed size traits from eight provenances.

Provenances	Samara Weight (g)	Samara Length (mm)	Samara Width (mm)	Samara Thickness (mm)	Seed Weight (g)	Seed Length (mm)	Seed Thickness (mm)
Menzelet	0.036 a*	25.64 b	5.49 a	1.94 c	0.020 b	9.77 a	1.69 bc
Çağşaklıoluk	0.026 de	23.13 d	4.97 b	1.63 d	0.015 de	9.00 bc	1.39 d
Boztoprak	0.032 c	23.95 cd	5.14 b	2.09 a	0.020 b	9.34 ab	1.79 ab
Düziçi	0.035 ab	23.12 d	4.57 c	2.07 ab	0.024 a	9.66 a	1.90 a
Kozan	0.027 d	21.13 e	5.09 b	1.95 cb	0.015 de	8.49 c	1.62 c
Pozantı	0.033 bc	25.01 bc	5.02 b	2.03 abc	0.019 bc	8.67 c	1.78 ab
Gündoğmuş	0.027 d	22.97 d	4.89 b	1.91 c	0.017 cd	8.66 c	1.69 bc
Eğirdir	0.024 e	27.97 a	3.94 d	1.65 d	0.013 e	9.69 a	1.43 d
Average	0.030±0.078	24.11±3.26	4.89±0.73	1.91±0.031	0.018±0.006	9.16±1.24	1.66±0.32

* Values on the same column followed by the same small letter are not significantly different at $p < 0.05$, Duncan's test.

Samara weight was the trait that had the greatest effect on seed weight in all provenances. Samara length was positively correlated with the seed weight in three provenances, Pozantı, Düziçi, and Çağşaklıoluk. Although the width of samaras generally had no effect on seed weight, one provenance, Menzelet, showed a positive correlation between the two. Thickness of samaras, and length and thickness of seeds, was positively correlated with seed weight in all provenances.

Table 4. Correlation of seed weight and quantitative traits of *F. ornus* subsp. *cilicic*a.

Provenance	Correlation coefficient						
	N	Samara Weight	Samara Length	Samara Width	Samara Thickness	Seed Length	Seed Thickness
Eğirdir	100	0.94*	0.05	-0.11	0.87*	0.70*	0.85*
Menzelet	100	0.91*	-0.17	0.55*	0.66*	0.67*	0.67*
Gündoğmuş	100	0.96*	0.15	0.20	0.73*	0.40*	0.80*
Kozan	100	0.87*	0.08	-0.03	0.63*	0.70*	0.56*
Pozantı	100	0.95*	0.30*	0.19	0.86*	0.70*	0.85*
Düziçi	100	0.93*	0.50*	-0.13	0.40*	0.66*	0.58*
Boztoprak	100	0.94*	0.08	-0.00	0.70*	0.59*	0.67*
Çağşaklıoluk	100	0.94*	0.58*	0.02	0.79*	0.72*	0.82*
Overall	800						

*Correlation is significant at the 0.01 level.

Among the eight provenances, samara widths significantly decreased with altitude. Precipitation did not significantly affect either fruit or seed traits. Among the samara and seed traits, seed weight had the highest correlation with precipitation (r = 0.50). Temperature had a significant positive correlation with samsara width. A relatively strong negative correlation was observed between temperature and samara length.

Table 5. Correlation of quantitative traits of *F. ornus* subsp. *cilicic*a seeds with altitude, precipitation, and temperature.

	Samara Weight	Samara Length	Samara Width	Samara Thickness	Seed Weight	Seed Length	Seed Thickness
Altitude	-0.07	0.54	-0.73*	-0.27	0.17	0.46	-0.05
Precipitation	-0.22	-0.34	-0.14	-0.09	0.50	-0.02	-0.02
Mean Temperature	0.09	-0.63	0.74*	0.26	-0.04	-0.37	0.05

*Correlation is significant at the 0.05 level.

DISCUSSION

Seed size plays a vital role in the ecology of plant species [11]. Both the shape and size of seeds varies greatly both across and within species [16, 17, 18]. Genetic traits and environmental factors are the major determinants of seed size and shape [11, 12].

Based on the metric traits of both samaras and seeds of *F. ornus* subsp. *cilicica*, the eight provenances differ significantly (Figure 2; Table 3). Both samara and seed weights particularly varied between provenances. This result is consistent with the hypothesis that variation within a habitat is one of the factors that shapes seed morphology [11].

One factor affecting seed size is the amount of exposure to solar radiation [17, 19]. In some studies, larger seeds were associated with shaded habitats [20, 11]. In agreement with this hypothesis, the heaviest seeds (from the Düziçi provenance) were collected in mixed forests from shady regions on a northern slope.

Seed mass affects germination ability [21]. Consistent with this hypothesis, the provenance with the lightest seeds, Eğirdir, demonstrated the lowest germination rate (unpublished data). The eight provenances generally exhibited similar samara shape (Figure 2). Based on biometric values, the seeds of *F.ornus*. subsp. *cilicica* from the Eğirdir provenance can be easily distinguished from those of the other provenances.

Seed mass is highly dependent on environmental conditions during seed development [22, 23]. For example, drought stress during seed development decreases seed size [24]. Further studies are needed to determine the effects of environmental conditions on *F. ornus* subsp. *cilicica* fruits and seeds.

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REFERENCES

[1] Yaltırık F. 1978. Türkiye'de Doğal Oleaceae Taksonlarının Sistematik Revizyonu. İ.Ü. Orman Fak. Yay.:2404/250, Çelikcilt Matbaası, İstanbul, 118p.

[2] Browicz K. 1984. *Chorology of Trees and Shrubs in South-West Asia and Adjacent Regions.* Volume Three, Polish Academy of Sciences, Institute of Dendrology, Poznan, Polish Scientific Publishers, p.20-21.

[3] Dirr MA, Heuser CW. 1987. The reference manual of woody plant propagation. Athens, GA: Varsity Press. 239 p.

[4] Fraxigen 2005. Ash species in Europe: biological characteristics and practical guidelines for sustainable use. Oxford Forestry Institute, University of Oxford, UK, 128p.

[5] Verdú M, González-Martínez, SV, Montilla AI, Mateu I, Pannell JR. 2006. Ovule discounting in an outcrossing, cryptically dioecious tree. Evolution 60: 2056–2063.

[6] Bonner FT. 2002. Fraxinus. *Woody Plants Seed Manual*, Ed: F.T. Bonner and R.G. Nisley, USDA Forest Service, Pp: 416.

[7] Dommée B, Geslot A, Thompson JD, Reille M, Denelle N. 1999. Androdioecy in the entomophilous tree *Fraxinus ornus* (Oleaceae). New Phytol. 143:419–426.

[8] Verdú M. 2004. Physiological and reproductive differences between hermaphrodites and males in the androdioecious plant Fraxinus ornus. Oikos 105: 239-246.

[9] Verdú M, Spanos K, Čaňová I, Slobodník B, Paule L. 2007. Similar Gender Dimorphism in the Costs of Reproduction across the Geographic Range of*Fraxinus ornus***.** Annals of Botany, 99(1):183-191

[10] Harper JL, Lovell PH, Moore KG. 1970. The shapes and sizes of seeds. *Annual Review of Ecology and Systematics*, 1: 327–356.

[11] Leishman MR, Wright IJ, Moles AT, Westoby M. 2000. The evolutionary ecology of seed size. In: Seeds: The Ecology of Regeneration in Plant Communities (edt: M. Fenner), CABI Pub., NY, pp.31-58.

[12] Schmidt L. 2000. *Guide To Handling of Tropical and Subtropical Forest Seed,* Danida Forest Seed Centre, Denmark, Pp: 511.

[13] Tripathi RS, Khan ML. 1990. Effects of seed weight and microsite characteristics on germination and seedling fitness in two species of Quercus in a subtropical wet hill forest. Oikos, 57:289-296.

[14] Moegenburg SM. 1996. Sabal palmetto seed size – causes of variation, choices of predators, and consequences for seedlings. Oecologia, 106:539-543.

[15] ISTA 1996. International Rules for Seed Testing. *Seed Sci. & Technol.* (Supplement), 24, 1-335.

[16] Bewley JD, Black M. 1994. *Seeds: Physiology of Development and Germination* . Plenum Press, New York, 445p.

[17] Baskin CC, Baskin JM.. 1998. Seeds. Ecology, biogeography, and evolution of dormancy and germination. San Diego: Academic Press., 666 pp.

[18] Yılmaz M. 2005. Doğu kayını (Fagus orientalis Lipsky.) tohumlarının fizyolojisi üzerine araştırmalar [The Researches On The Physiology of Oriental Beechnuts (Fagus orientalis Lipsky.)] PhD Thesis, Istanbul University, Institute of Science, 170p.

[19] Murray BR, Brown AHD, Dickman CR, Crowther MS. 2004. Geographical gradients in seed mass in relation to climate. Journal of Biogeography, 31, 379–388

[20] Leishman MR, Westoby M. 1994. The role of large seed size in shaded conditions: experimental evidence. Functional Ecology, 8:205-214.

[21] Milberg P, Andersson L, Elfverson C, Regnér S. 1996. Germination characteristics of seeds differing in mass. Seed Science Research, 6:191-198.

[22] Michaels HJ, Benner B, Hartgerink AP, Lee TD, Rice S, Willson MF, Bertin RI. 1988. Seed size variation: magnitude, distribution, and ecological correlates, Evolutionary Ecology, 2(2):157-166.

[23] Castro J, Hódar JA, Gómez JM. 2006. Seed size. In: Handbook of Seed Science and Technology (Basra, A.S., Edt.), Haworth Press, NY, pp. 397-427.

[24] Copeland LO, McDonald MB. 1999. *Seed Science and Technology*. Kluwer Ac. Pub. Boston. Pp: 409.