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Variations among families in manna ash (*Fraxinus ornus L.*)

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ABSTRACT

Seedling height, root collar diameter, increments and survival were assessed in two-year-old seedlings in a progeny test of 22 Manna ash (*Fraxinus ornus* L.) families called as genotype in the paper. Variation, including narrow-sense heritability, and correlations among characters were estimated. While there were large differences within genotype and among genotypes for the characters; averages of the height and diameter were 21.7 cm, 6.30 mm; 73.2 cm and 15.0 mm in first and second year of field performance, respectively. Survivals were similar in end of first and second growing years (93% and 90%).

The coefficient of variations of the height, diameter and their increments within clone was higher than among clones. Estimated heritability was lower than 0.2 for the characters. Significant correlations ($p \leq 0.05$) between studied seed characters were found. Results of the study were discussed for new plantations and breeding of the species.

KEYWORDS

Fraxinus ornus;
Survival;
Heritability;
Seedling;
Afforestation.

INTRODUCTION

The Manna ash (*Fraxinus ornus*) has the most limited distribution of three Turkish ash species (*Fraxinus excelsior*, *F.ornus* and *F.angustifolia*), which cover 11700 hectares. It has also the most limited distribution of European ashes. The species occurs mainly in southern Europe and its main distribution range is in Italy (mostly in the south and Mediterranean Islands), Greece, and in kast regions of the Balkan Peninsula and Turkey[9]. While *Fraxinus excelsior* and *F. angustifolia* occupy in humid area, *F. ornus* occupy in arid zones of Mediterranean region in Turkey[12]. Wood of the species is an important material for such as furniture, ornamental, charcoal and music industries. Besides, oil is extracted from its bark used in medicinal purposes[1]. In addition to the species is very resistance to aridity, forest fire[4], and climate change[13]. These advantages of the species are getting importance for increasing of limited distribution by plantation forestry. Source of seedling material is one of the most important factors in success of biological and economical in plantation forestry. Quality and quantity of forest product such as wood could be increased by intensive silviculture and genetic improvement studies (i.e. progeny test). It could be also contributive for solution of environmental problems by resistance breeding. Global warming is one of the most important environmental problems in whole the world. It is getting importance for resistance of plant species to dry or unirrigated areas for forest regeneration and plantation materials. Genetic structure and morphology of seedling are very important for the re-

generation and plantations in these disadvantageous areas. However, while there are many silvicultural and genetic studies in nursery or field stages of other forest plant species for different purposes, it is limited on manna ash[3,9,15]. So, results of the study will play important roles in silvicultural and genetic managements of the species.

The purposes of this study were to estimate variation of growth performance among genotypes and within genotype, to evaluate narrow-sense heritability and to estimate correlations for growth performance of two years. The results of the study were also discussed with respect to the plantation of disadvantageous areas based on global warming, and to contribute breeding and plantation forestry of the species.

MATERIALS AND METHODS

Data collection

The growth data were collected in two year field performance of seedlings of 22 open-pollinated families (called as genotype in the paper) planted at an experimental area (latitude 37°452 N, longitude 30°352 E, altitude 1050 m) as three replicates 2x2 m spacing in 2009. Ten seedlings chosen randomly were sampled from each genotype for data collection at end of growth periods in 2010 and 2011. Height (H) and root collar diameter (RCD) were measured in sampled seedlings in first (H1, RCD1) and second (H2, RCD2) years of plantation. Increments of the Height (H_I) and root collar diameter (RCD_I) were also studied. Numbers of seedlings were also counted for estimation of survival.

Data analysis

The statistical analysis was carried out by SPSS statistical package[11] according to following model of ANOVA was used for the analysis:

$$Y_{i\,j\,k} = \mu + F_i + B(F)_{j(i)} + e_{ijk} \quad (1)$$

where Y_{ijk} is the observation from the k^{th} seedling of the j^{th} genotype in the i^{th} block, μ is overall mean, $B(F)_{j(i)}$ is effect of the j^{th} genotype in the i^{th} block, and e_{ijk} is random error.

Individual heritability (h^2; narrow-sense heritability) was estimated as:

$$h_i^2 = \sigma^2_A / \sigma^2_u \quad (2)$$

where σ^2_A is the additive genetic variance, σ^2_u is the phenotypic variance for the characters.

Variance components, expressed as coefficient of genetic (CV_g) and phenotypic (CV_p) variations were estimated as:

$$CV_g = 100\sigma_A / \bar{x} \text{ and } CV_p = 100\sigma_u / \bar{x} \quad (3)$$

where $\bar{x}$ is overall character mean.

Correlations among characters were also calculated at the levels of individual seedlings and genotype means.

RESULTS AND DISCUSSION

Survival

Averages of survival were 93% and 90% at end of first and second growing periods, respectively. While eleven genotypes had 100% survival in first year, it was six in second year. The lowest survival was 67% at some genotypes in both first and second years. It is known that survival is one of the most important criterions in economical and biological successes in plantations of disadvantageous lands such as arid areas (i.e., re-plantation). It is getting importance for resistance to aridity based on global warming. The survival could be increased by silvicultural treatments. For instance, while survival of *F. angustifolia* plantations were reported usually poor in traditional plantations[5], it was reported as 100% in first year of a plantation of *Fraxinus angustifolia* provenances by silvicultural managements[5]. Similar survival was reported in two year old seedlings of six seed sources of the species, while it had large differences for sites[9].

Seedling morphology

There were large differences for height and root collar diameter among genotypes and within genotype (TABLE 1). For instance, while average of seedling height was 73.2 cm in second year, it varied between 12 and 187 cm among seedlings and ranged from 43.3 cm to 104.3 cm among genotypes. Genotypes also differed significantly for root-collar diameter. The average root collar diameter was varied between 11.1 and 19.7 mm among genotypes (TABLE 1). Performances of studied species were generally higher than that of other forest tree species[2,8].

Variation among genotypes for the characters was greater in second year than that of first year (Figures 1 and 2).

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TABLE 1 : Averages and ranges of the characters.

	H1 (cm)	RCD1 (mm)	H2 (cm)	RCD2 (mm)	H_I (cm)	RCD_I (mm)
Average	21.7	6.3	73.2	15.0	51.5	8.8
Family range	12.0-30.5	5.1-7.7	43.3-104.3	11.1-19.7	30.3-74.1	6.0-12.0
Seedling range	2.0-67.0	2.0-11.8	12.0-187.0	6.0-41.0	5.0-132.0	0.8-30.9

Average seedling height increased from 21.7 cm to 73.2 cm in second growing period. It was from 6.3 mm to 15 mm for the root collar diameter. Averages of seedling height and root collar diameter were 7.05 cm and 2.95 mm, respectively, on 1+0 seedlings of the same genotypes[3]. They were reported 38.6 cm and 2.90 mm for one-year old Turkish manna ash seedlings, respectively[15]. Large differences of seedling morphology were also reported among genotypes in Manna ash[3,15]. Marginally differences were reported for height in 2 year old seedlings of six seed sources of the species[9]. Seedling height and root collar diameter were 59 cm and 10.3 mm in one-year old seedlings of *Fraxinus angustifolia*, respectively[6].They were 61 cm and 11 mm in first year of the plantation test. Significant differences were also reported among the provenances in the study[6]. There could be many genetic and environmental effects such as seed population, nursery location, soil texture on seedling morphology[7,14]. For instance, slope was one of the most important factors on seedling morphology of *Fraxinus ornus* at the field[3].

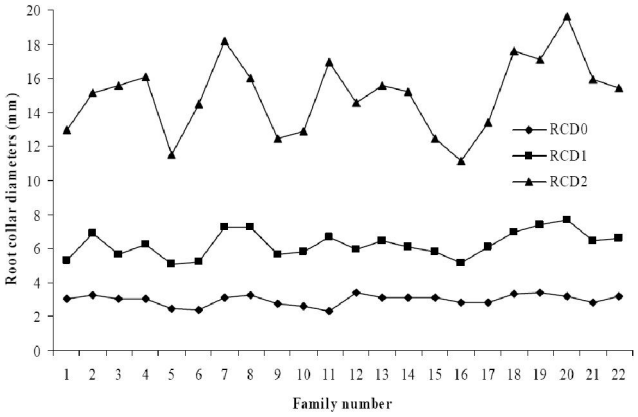

Figure 1 : Averages of root collar diameters in plantation period (RCD0), first (RCD1) and second (RCD2) years at the field.

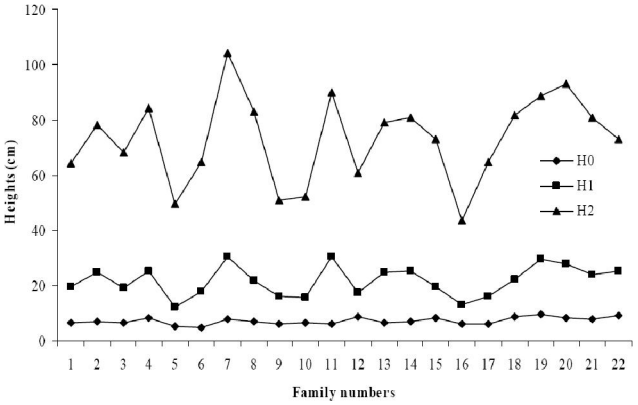

Figure 2 : Averages of seedling heights in plantation period (H0), first (H1) and second (H2) years at the field.

Relations among characters

Correlations for the studied characters are presented in TABLE 2. The correlations among the characters were positive and significant ($p \leq 0.05$) and rather high, both for individual seedling and for genotype averages as presented in TABLE 2.

The results of correlations between characters are mainly in accordance with previous study in the species[3].

Positive and significantly correlation (r=0.719, $p<0.05$) was reported between seedling height and root collar diameter on 1+0 seedlings of the same genotypes[3].

TABLE 2 : Genetic (above diagonal) and phenotypic correlations (below diagonal) among the characters.

	H1	RCD1	H2	RCD2	H_I	RCD_I
H1	-	0.810	0.935	0.854	0.855	0.793
RCD1	0.756	-	0.840	0.863	0.814	0.714
H2	0.746	0.656	-	0.898	0.983	0.839
RCD2	0.617	0.732	0.710	-	0.876	0.970
H_I	0.483	0.486	0.943	0.625	-	0.821
RCD_I	0.388	0.399	0.570	0.917	0.557	-

Heritability and variation

The heritability in narrow-sense reflects the share of the variation that depends on the genotypes was very low for all the characters (TABLE 3). Small genetic variations were reported in 36 populations of the species[9].

The genetic variation, here expressed as the coefficient of variation among genotypes (CV_g), was always lower than the variation among individual seedlings within

genotypes (CV_p) (TABLE 3). The environment seems to be more important for the performance of genotypes than their genetic constitution. That emphasizes the significance and importance of how plantation forestry and selection of seed source is managed for the biological and economic success. Development, growth, and reproduction in plants are influenced by both genetic and environmental factors. During growth, the entire morphology and the component characters of individual genotypes also show varied developmental relationships among themselves, and these relationships depend upon environmental conditions[10]. In the absence of any hard genetic evidence, countries without clear environmental criteria for delimitation of provenance zones have sometimes been forced to define rather arbitrary boundaries. There is therefore an urgent need for a better understanding of the true extent and significance of genetic variation in trees in these countries. In Germany, the number of provenance regions of *Fraxinus excelsior* was eight based on its ecological requirements[9].

TABLE 3 : Heritability (h^2), coefficient of variation among (CV_g, %) and within family (CV_p, %).

	H1	RCD1	H2	RCD2	H_I	RCD_I
h^2	0.130	0.096	0.164	0.191	0.119	0.176
CV_g	21.1	9.6	18.5	13.0	17.0	15.9
CV_p	54.5	29.5	41.8	26.7	46.3	34.3

CONCLUSIONS

Manna ash has large plantation potential because of its resistance to aridity, fast growing and commercial wood. However, the studied genotypes were sampled in limited area of the species; low variations were found among the genotypes for the studied characters. The differences could be higher when the studied number of larger individual and genotypes especially from different countries because of limited natural distribution. The species could be also used in private forestry; however the published material is very limited because of restricted natural distribution of the species. Special nursery practice should be applied for private forestry and plantation of disadvantageous areas (i.e. dry areas) such as vegetative propagation of seedlings. It is known that root collar diameter has positive effective on survival, so, new studies should be conducted mainly on root collar diameter. It is also supported by positive and significant correlations among the characters.

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