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Heritability of Some Characteristics of *Sorbus torminalis* Seedling

[1]Afagh Tabandeh, [1]Masoud Tabari, [2]Hossein Mirzaei Nadoushan and [3]Kambiz Espahbodi
[1]Faculty of Natural Resources and Marine Science, Tarbiat Modares University, Noor, Iran
[2]Seed and Seedling Improvement Research Center, Tehran, Iran
[3]Research Center of Agriculture and Animal Affarirs, Mazandaran, Iran

Abstract: This research was conducted to determine the heritability of some characteristics of wild service (*Sorbus torminalis* L. Crantz) seedling by a half-sib progeny test in north of Iran. The seeds of Sangdeh provenance (1600-1800 m a.s.l.) were collected from twenty individual parent trees and planted in a mountainous nursery (Orimelk, 1550 m a.s.l) as randomized complete block design with three replications. At the end of third growing season heritability of some seedling characteristics was determined with using Falconer method. Analyses indicated that heritability of biggest branch ($h^2 = 0.003$) and branch number ($h^2 = 0.007$) was lower than those of other characteristics measured. Heritability of collar diameter, vitality and total height was $h^2 = 0.22$, $h^2 = 0.20$ and $h^2 = 0.17$, respectively. Among 20 parent trees the genotypes 2, 11, 18, 19 and 20 can be introduced as plus trees for seed providing and seedling production. It can be deduced that for seedling production of *Sorbus torminalis* in this nursery the parent trees should be benefited from a better collar diameter, vitality and total height in order to occurrence possibility of high-quality progenies.

Key words: Heritability, progeny test, seedling, selection, wild service tree

INTRODUCTION

Wild service tree is one of the valuable economical and medicinal species in the north forests of Iran distributing from Astara to Golidaghi as scattered and more or less as small groups in mixed beech, hornbeam and oak stands (Espahbodi *et al*., 2003). It is a tall tree and obtains 34 m in height and 100 cm in diameter at breast height (Poormajidian, 1999). Its economical importance is mainly due to wood quality, especially its attractive design (Lanier, 1993). It increases biological values of forest and has especial importance in afforestation and tree breeding (Demesure *et al*., 2000). Regarding to its high value and also the hazards threatening it, seedling production and afforestation with this species is of essential important. Breeding is a method that increases output and decreases production costs. Among different aspects of breeding, selection is one of the simplest ones. In tree improvement programs, selection of the best genotypes and using them as parents in producing high-quality trees is emphasized. Phenotype variance provides relative importance of genotype and environment and also their interaction effects (Tabaei Aghdaei and Jafari, 2000).

Heritability is a portion of phenotype variety in progenies (Mirmohammadi Meybodi and Mirlohi, 2000). The amount of heritability explains measure of variety which is related to genetic differences among individuals; it is also transferable to future generations. By determining heritability of each trait, the study of traits which have been mostly under control of gene can be limited. In the time of selection seed bearer trees, if attention is paid to higher heritability of seedling characteristics, superior and more qualified seedlings will be produced. Thus, costs decrease and production increase. Generally, this research by doing a 3-year progeny test with aim of determining heritability of qualitative and quantitative characteristics of wild service tree (*Sorbus torminalis* L. Crantz) tries to take a small step in order to reserve, improve and develop this valuable species.

MATERIALS AND METHODS

Research methodology: Seeds after collecting from 20 parent trees (genotype) located in Sangdeh forest (1600-1800 m a.s.l., north of Iran) were sown in Orimelk nursery (1550 m a.s.l.). The data of climate of nursery is given as Table 1. The seedlings grown were replanted in second year in the nursery as randomized complete blocks design

Table 1: Nursery climatic information

Average annual rainfall	821 mm
Minimum annual rainfall	645.5 mm
Maximum annual rainfall	1163 mm
Average annual temperature	9°C
Minimum absolute temperature	-26°C
Maximum absolute temperature	23.5°C
Average relative moisture	79.6%

Corresponding Author: Masoud Tabari, Faculty of Natural Resources and Marine Science, Tarbiat Modares University, Noor, Iran

with three replications. According to Cornelius *et al.* (1996a) in every replication from each genotype 10 seedlings (progeny) were replanted with distance of 0.5 m from each other. During doing the progeny test (years 2 and 3) weeds were removed four times per year and seedlings irrigated once a week. At the end of third growing season collar diameter (in millimeter), height (in centimeter), angle of longest branch (in degree) and branch number of seedlings were recorded. Vitality of seedlings was noted based on Savolainen *et al.* (2004).

Data analysis: At first for studying the effect of genotype and progeny analysis of variance was conducted. Since for each parent tree in every replication 10 seedlings were measured in this model 10 progenies per each parent tree were nested as equation 1 (beneath formula):

$$Y_{ijl} = \mu + \beta_j + \alpha_I + (\beta\alpha)_{ij} + \rho(\alpha_I) + \varepsilon_{ijl}$$

By PROC GLM process (SAS institute, 1989) variance was analyzed and effects of replication, genotype and their mutual effects were investigated. Because progeny test was Half-sib and model of plan was as nested design, variances were analyzed into different components by calculating the expectation referring to nested plans. By using expectation formulas of each characteristic environment and genetic variances were separated and heritability of characteristics was calculated manually as Eq. 2 (beneath formula) using Falconer (1996) method. In this equation $\delta^2 p$ is Phenotype variance, $\delta^2 g$ is genetic variance and h^2 is heritability.

$$h^2 = 4\delta^2 g / \delta^2 p$$

SAS software (SAS Institute, 1989) was used to conduct the analyses.

RESULTS

Results indicated that difference of genotypes for angle of longest branch was significant among progenies ($p<0.05$). Vitality, collar diameter and branch number of genotypes did differ significantly ($p<0.05$) (Table 2).

High significance of differences of genotypes showed a suitable variety in characteristics measured. Comparison of means of genotypes showed that progenies of trees 3, 11 and 17 with grade of 4.5 had the highest vitality. Progenies of trees 2 and 18, respectively with 15.9 and 15.6 mm had the highest collar diameter. Progenies of trees 15, 19 and 20, respectively with 84.3, 86.9 and 84.5 cm in stem height produced tallest seedlings. Likewise, progenies of trees 10, 18 and 20, respectively with

Table 2: Results of analysis of variation for each seedling characteristic measured

Characteristic	Replication (MS)	Genotype (MS)	Replication×Genotype (MS)	Progeny (genotype) (MS)	Error (MS)	Total (MS)
Vitality	0.18	0.54 **	0.28	0.21ns	0.19	0.25
Collar diameter	16.87	37.58 **	21.23	12.01ns	11.26	15.93
Height	572.96	1960.07**	1279.04	700.28ns	762.04	892.10
Branches No.	1.86	67.31 **	57.49	21.43ns	19.31	31.59
Angle of longest branch	90.76	645.82*	565.07	424.59*	328.52	452.20

** Difference of means in level ($p<0.01$) was significant, *Difference of means in level ($p<0.05$) was significant, ns Difference of means was not significant

Table 3: Results of comparison of means for each seedling characteristic measured

No. of parent tree	Vitality	Collar diameter (mm)	Height (cm)	Branch No.	Angle of longest branch (degree)
1	4.2a-c	10.9d	53.7b	6.6c	62.4ab
2	4.4ab	15.9a	57.8ab	10.2a-c	67.2a
3	4.5a	12.3b-d	64.3ab	8.5a-c	49.1b
4	4.4ab	14.2a-c	78.5a	8.5a-c	53.4ab
5	4.3ab	13.6a-d	78.8a	6.6c	62.6ab
6	4.3a-c	11.7cd	66.6ab	7.8bc	61.9ab
7	4.3a-c	14.9ab	75.7ab	11.2a-c	59.0ab
8	4.2a-c	14.8a-c	71.0ab	11.7a-c	60.0ab
9	4.2a-c	12.9a-d	62.4ab	9.1a-c	52.4ab
10	4.0bc	15.1ab	81.3a	13.3a	58.2ab
11	4.5a	14.8a-c	78.7a	10.3a-c	64.1ab
12	4.4ab	14.8a-c	77.8ab	10.5a-c	56.5ab
13	3.9c	13.9a-d	81.7a	7.9bc	52.6ab
14	4.4ab	12.9a-d	63.5ab	8.1a-c	49.0b
15	4.4ab	14.0a-d	84.3a	9.9a-c	58.0ab
16	4.2a-c	13.3a-d	68.8ab	9.3a-c	56.2ab
17	4.5a	12.8a-d	68.8ab	10.0a-c	55.9ab
18	4.2a-c	15.6a	74.0ab	12.9ab	60.2ab
19	4.4ab	14.5a-c	86.9a	10.4a-c	55.0ab
20	4.4ab	14.9ab	84.5a	12.1ab	58.2ab

Different letter (s) in column are significantly different

Table 4: Separated variation of seedling characteristics

Characteristic	Replication (MS)	Genotype (MS)	Replication×Genotype (MS)	Progeny (genotype) (MS)	Error (MS)
Vitality	0.00	0.01	0.01	0.01	0.19
Collar diameter	-0.02	0.74	1.33	0.30	11.26
Height	-4.87	24.756	68.77	-25.17	762.04
Branch No.	-0.38	0.43	5.06	0.86	19.31
Angle of longest branch	-3.46	0.29	32.00	39.57	328.52

Table 5: Plus trees for seed selection

No. of parent tree	Vitality	Collar diameter (mm)	Height (cm)
1	4.2a-c	10.9d	53.7b
2	4.4ab	15.9a	57.8ab
3	4.5a	12.3b-d	64.3ab
4	4.4ab	14.2a-c	78.5a
5	4.3ab	13.6a-d	78.8a
6	4.3a-c	11.7cd	66.6ab
7	4.3a-c	14.9ab	75.7ab
8	4.2a-c	14.8a-c	71.0ab
9	4.2a-c	12.9a-d	62.4ab
10	4.0bc	15.1ab	81.3a
11	4.5a	14.8a-c	78.7a
12	4.4ab	14.8a-c	77.8ab
13	3.9c	13.9a-d	81.7a
14	4.4ab	12.9a-d	63.5ab
15	4.4ab	14.0a-d	84.3a
16	4.2a-c	13.3a-d	68.8ab
17	4.5a	12.8a-d	68.8ab
18	4.2a-c	15.6a	74.0ab
19	4.4ab	14.5a-c	86.9a
20	4.4ab	14.9ab	84.5a

Different letter (s) in column are significantly different

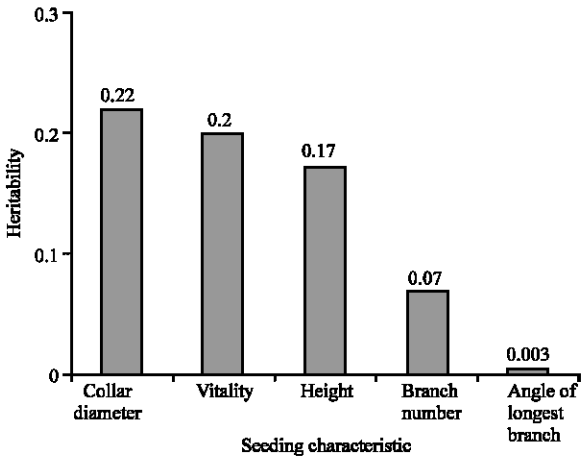

Fig. 1: Heritability of seedling characteristics

13.3 and 12.9 had the most frequent branch number and progenies of tree 2 with 67.2 degree had the greatest angle of longest branch (Table 3).

By using expectation formulas of each characteristic, variances were separated (Table 4). Results indicated that the lowest heritability allocated to angle of the longest branch (0.003) and branch number (0.07). Heritability of collar diameter, vitality quality and stem height was 0.22, 0.20 and 0.17, respectively (Fig. 1).

As the results indicated in Table 5 progenies of trees 2, 11, 12, 18, 19 and 20 compared to other progenies of trees are in better situation. Therefore these trees can be introduced as plus trees for sowing seed and producing seedling.

DISCUSSION

Heritability of branch number and angle of longest branch was lower in comparison with heritability of other characteristics recorded. Such a result related to branch number was reported for many species. Toky *et al.* (1996) about three-year progeny test of *Albizia lebbek* (L.) Benth reported that heritability was lower in branch number than in height and collar diameter and biomass. In other hands, heritability in angle of branch was relatively high.

Cornelius *et al.* (1996b) in a 2-3-year progeny test on *Alnus acuminata* Kunth. displayed that heritability of branch angle (0.62) was higher than those of height (0.45) and diameter at breast height (0.15). One of the reasons for low heritability of branch number was high environment effects especially competition for receiving light available. Most of branches are destroyed as affecting the competition and natural pruning. Under environmental competition variance severely increases. Since *sorbus torminalis* has high tendency to light, therefore under competition conditions heritability changes.

Because amount of heritability explains capacity for transferring the existing genetic variety to progenies, its high quantities in studying characteristics confirm the possibility of characteristic improvement using individual selection. Related to this matter collar diameter, height and vitality have suitable genetic variety. High heritability in these characteristics reveals that heritability is transferable to progenies and if tree improvement projects are performed, especially using different selection procedures, promotion in poverty of created populations will be expected.

Regarding to our short time (3-year) study we are not able to judge surely on introducing plus tree. But according to Wu view (1998) and Danusevicius and Lindgern (2003) very weak genotypes can be identified and eliminated. This reality besides of genetic gain can decrease the costs of plantation and maintenance and field preparation for progeny test. Thus, considering the results of this research, if seeds are provided from

genotypes of 2, 11, 12, 18, 19 and 20 of Sangdeh population, genetic gain as well as production of high quality seedlings will be promising.

At the end it should be declared that this study needs to repeat measurement in next years and up to sexual maturity (near 20 years). Thus the trend of heritability variations of seedling characteristics and early selection of genotypes (parent trees) will be assessed.

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