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Seed Source Effects on Seed Emergence, Seedling Survival and Growth on Wild Service (*Sorbus torminalis*) Seedlings

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ABSTRACT

A study was conducted to determine the wild service tree (*Sorbus torminalis*) seed source effects on seed emergence, seedling establishment, survival and growth from two locations. Twenty healthy mother trees were randomly selected at each location. Two hundreds seed per tree were planted in a nursery. Seed emergence and seedling longevity were recorded. Thirty seedlings of each selected mother trees were planted and 10 seedlings of each mother tree were randomly allocated. The effect of seed sources on seed emergence and seedling survival was significant ($p < 0.05$) in nursery bed. Emergence rate from higher altitude seeds was greater than that at lower altitude. Seed source effect on seedling establishment and seedling growth was statistically significant. Seedlings showed better growth from lower altitude site than those from higher altitude.

Key Words: *Sorbus torminalis;* Seed sources; Emergence; Seedling growth

INTRODUCTION

Wild service tree (*Sorbus torminalis*) is a tall tree species with high economical values (Piagnani & Bassi, 2000; Demersure *et al*., 2000), as it is used as a medicinal plant (Tsitsa-Tzardi *et al*., 1991, 1992). Its natural distribution is rather large, from the north of Maghreb to the south of Sweden and from the east of Great Britain to the north of Iran (Demersure *et al*., 2000). The species is scattered on the south edge of Caspian Sea along with beech (*Fagus orientalis* Lipsky.), Caucasian oak (*Quercus castaneifolia* C.A.M.) and hornbeam (*Carpinus betulus* L.) in north forests of Iran. More density is seen with Caucasian oak on the steep foothills of west and south west of the mountain ranges of the area, where the soil is poor and usually stony (Zare *et al*., 2002). Best quality wild service tree grows in North to Northeast on the deep soil along beech. At these sites, it can grow as tall as 30 m and exceed a diameter at breast height larger than 100 cm (Espahbodi *et al*., 2002). In North forests of the country, its best habitat is the Fagetum, located on the foothills about 1500 to 1800 m high at slightly steep slopes of North and East-North.

In Iran the wild service tree is distributed from 1000 to 2400 m altitudes, but most of the nurseries are scattered from 700 to 1500 m altitudes. Documentations about the effect of *Sorbus torminalis* seed source on seedling production is not available, but seed sources condition is known to have correlation with seed emergence, seedling survival and growth on Aryzona cypress (Schoenike, 2002). Hunter and Lechowicz (1992) believe that variation in starting seed emergence is related to difference of early spring temperature in seed sources and planting place. Moreover, variation and seed emergence termination in beech, known as an ecotype pattern, altitude and latitude of seed sources usually influence (Chamura & Rozkowski, 2002).

Growth of seedlings originated from south, west provenances were more than that of north, and east originated ones. Kurt and John (1996) revealed that growth of black spruce seedlings of southern provenance was greater than that of northern provenance. Recently, Anneli *et al*. (2005) concluded that beech seedlings from northern provenance had shorter growth season than that of southern provenance. Moreover, seedling growth decreased with an increase in latitude. Presently reports on the effects of mother trees on seedling growth are limited. The aim of this research was to determine the effect of wild service tree seed sources on seed emergence and seedling growth and finding differences between individual mother trees in a population according to their seedlings characteristics.

MATERIALS AND METHODS

Seed sources and examination site. Two seed sources named Sangdeh (Site 1, 1600 to1800 m a.s.l.) and Ashak (Site 2, 2100 to 2300 m a.s.l.) were selected in Mazandaran forest in north of Iran. In site 1 soil was deep with neutral to slightly acidic pH of 4.8 to 7.3 and slop of 10 to 30% north and northeast exposure. Site 2 was a mountain forest, where the soil was poor and usually stony. Texture was clay-loam and pH 6.7 to 7.2 with an inclination of 20 to 40% and south and southwest exposure (Table I & II).

Seed emergence, was studied at a forest nursery named Orimelk, located 1550 m a.s.l. on a north exposure

(Table I). Seedlings survival and growth characteristics were recorded during 2 years after planting at a site along nursery, where the bed rock was limestone and its soil was forest brown with sandy-loam texture (Table II). The average of precipitation during last 30 years was 821 mm. The amount of precipitation during spring and fall were 27.5 and 27.1% of total annual rain, respectively. The average snow was 26.4% of the precipitations. Average of yearly temperature in the nursery was 9°C and average of humidity 79.6%. Based on Domarten method, the area was considered as a very humid climate and on the basis of Ivanove method it was considered as jungle humid climate.

Seed collection and seed emergence. Two hundred healthy seeds of selected mother trees from each source collected at the appearance of first color variation during early October were sown in plastic pots. Percentage of seedling emergence and mortality were recorded from the second week in spring 2001 continued up to December of the same year, and compared for the two seed sources.

Seedling establishment and growth characteristics. During winter 2001, 30 seedlings selected from 40 mother trees were planted in a randomised complete block design with three replications. Ten seedlings from each one of the mother trees were randomly allocated to each replication on a row with an interval between single plants and rows of 50 cm. Seedling freshness, collar diameter, height, growth and number of branches of seedlings were recorded during the winters of 2002 and 2003. Survival and growth characters were recorded at the end of growth season. Freshness was recorded at the end of warm season by scoring from 0.5 to 5. Score 0.5 was used for the seedlings with 90% damaged leaves due to warm whether of middle summer. Score 5 was recorded for the seedling with less than 10% damaged leaves. The rest of seedlings were scored in the range between 0.5 and 5.

Statistical analysis. Student *t-test* was used for comparing the two seed sources in their seed emergence, seedling survival, seedling growth, number of branches and freshness. Analysis of variance was carried out for testing the statistical differences between the 20 mother trees in each site. Mother tree means were compared using Duncan multiple comparison test.

RESULTS

Seed emergence. Nearly 38% and 45.11% of seed emergence was recorded on seeds originated from site 1 and site 2, respectively. Difference between the two seed sources was statistically significant ($p < 0.05$). Seedling mortality of site 2 was significantly more than that of site 1. However, over 90% of seedling in both sources survived during the first year (Table III).

Seedling establishment and growth. The average rate of seedling survival during 2002 (first year of plantation) was 89.7 and 80.5% for site 1 and site 2 seed sources, respectively. Survival rate dropped to 84.9% at site 1 and 70% at site 2 seedlings in 2003. Difference between the two seed sources was significant ($p < 0.01$) both in 2002 and 2003 (Table IV). The average rate of seedling freshness was 3.8 and 3.6 of 5 at site 1 and 2 respectively during 2002. During 2003, freshness of seedling increased to 4.13 at site 1 and 4.18 at site 2 seed sources. These differences were not statistically significant.

The average value of seedling collar diameter was 7.85 mm from site 1 and 6.79 mm from site 2 during 2002. Seedling collar diameter increased to 9.54 mm at site 2 and 10.98 mm at site 1 at the end of second year. Difference between collar diameters of the two seed sources was significantly ($p < 0.01$) greater both for site 1 compared to site 2 during both the years 2002 and 2003 (Table IV).

Average seedling height growth was 33.61 cm for site 1 and 24.02 cm for site 2 sources in 2002. Seedling height increased to 52.36 cm for seedlings originated from site 1 and 41.27 cm for site 2 in 2003. Difference between seedling height from two seed sources was significant ($p < 0.01$) for both years. Site 1 seedling height growth was more than that of site 2 both for 2002 and 2003. Difference between both seed sources was significant ($p < 0.05$) for number of branches. This attribute from site 1 seedlings was greater than that of site 2 for two years (Table IV).

Seed sources comparisons. Separate analysis of data for the two seed sources indicated significant differences between the trees originated from site 1 on their seedlings freshness, collar diameter and height ($p < 0.05$). Difference between trees was not significant for seedling survival and number of branches for site 1 in first year studies. Moreover, there were significant differences between trees from site 2 for seedlings survival, collar diameter and height ($p < 0.01$), but insignificant for the number of branches for the first year (Table V).

Site 1 trees were the same in their seedling survival, but there were statistically difference in seedling freshness, collar diameter, height growth and number of branches in the year 2003 ($p < 0.01$). Differences between site 2 trees were significant for their seedling survival, collar diameter, height growth and number of branches, but it was not significant for seedlings freshness (Table VI).

Classification of Mother Trees

Survival of seedlings. Duncan multiple comparison test indicated that trees number 14 and 19 of site 2 showed the maximum rate of survival (100%) on their seedling progenies and tree number 11 showed the minimum rate of survival both in 2002 and 2003. There were no significant differences between site 1 seed source trees in their seedling survival in both the two years (Table V & VI).

Freshness. The maximum freshness rate was observed on tree number 10 from site 1 and tree number 2 from site 2 and the minimum freshness rate was related to tree number 1 from site 1 and tree number 20 of site 2 in the first year of the study (Table V). There were no significant differences between site 2 trees in their seedling freshness in the second year. Regarding site 1 seed source, seedlings of trees

Table I. Geographic characteristics of seed sources and nursery site

Characters	Site 1	Site 2	Nursery
Longitude	53º,13´,51˝ to 53º,15´,18˝	53º,20´,28˝ to 53º,21´,51˝	53º,13´,27˝
Latitude	36º,01´,12˝ to 36º,02´,27˝	36º,04´,30˝ to 36º,06´,02˝	36º,01´,04˝
Aspect	north, north-east	south, south-west	north
Altitude(m)	1600 to 1800	2100 to 2300	1550
Slop (%)	10-30	20-40	5

Table II. Soil physico-chemical properties of seed sources and nursery site

Origin	Texture	Depth	pH	Organic carbon (%)
Site 1	Sandy-loam	Moderate to deep	4.8-7.3	1.1-3.3
Site 2	Clay -loam	Low	6.7-7.2	2-3.8
Nursery	Sandy-loam	Moderate	7-7.3	3.2
Origin	**N (%)**	**P (p.p.m)**	**K (p.p.m)**	**C/N**
Site 1	0.10-3.30	>8	>120	≈11
Site 2	0.20-0.30	<3	<60	≈11
Nursery	0.20-0.29	<3	<60	≈11

Table III. Percentage of seed emergence and one-year-old seedlings survival (in nursery bed)

Character	Seed sources	Means (%)	t student
Emergence	Site 1	37.90	1.78 *
	Site 2	45.11	
Survival	Site 1	96.98	2.73 *
	Site 2	94.07	

* = Difference between the two seed sources is significant at $p<0.05$

Table IV. Grand means of recorded characteristics of seedling from 20 trees of the two seed sources studied for the two years of studies

Year	Character	Site 1	Site 2	t student
	Survival (%)	89.70	80.5	4.49 **
	Freshness (Scores 0.5 to 5)	3.80	3.6	1.96 ns
2002	Collar diameter (mm)	7.85	6.79	8.20 **
	Height growth (cm)	33.61	24.02	11.77 **
	No. of branches	3.14	2.14	6.23**
	Survival (%)	84.9	70.00	6.24 **
	Freshness (Scores 0.5 to 5)	4.13	4.18	1.21 ns
2003	Collar diameter (mm)	10.98	9.54	5.20 **
	Height growth (cm)	52.36	41.27	8.5 **
	No. of branches	8.40	4.93	8.33*

* = significant at 5% level of probability, ** = significant at 1% level of probability, ns = non-significant

number 2 and 15 showed the most rate of freshness in 2003. Minimum rate related to the seedlings of tree number 18 of site 1 (Table VI).

Collar diameter. Regarding seedlings collar diameter, Duncan multiple comparison test indicated that trees number 10 and 1 from site 1, constitute the first and last trees respectively. Maximum rate of collar diameter was observed on tree 1 and minimum rate of collar diameter was observed on tree 9 for site 2 in 2002 (Table V). In the second year, maximum collar diameter was observed on tree number 18 of site 1 and tree number 2 from site 2. Minimum collar diameter was observed on tree number 1 from site 1 and tree 4 from site 2 in 2003 (Table VI).

Seedling height. Maximum seedling height growth was observed on tree number 10 from site 1 and tree number 1 from site 2 in first studied year. Minimum height growth observed on trees 1 of site 1 and tree 9 from site 2 in 2002 (Table V). Regarding second year of the studies, seedling of tree number 15 from site 1, showed the most rate of height growth (61.20 cm). Minimum rate related to seedlings of tree number 1 (34.60 cm). For site 2, maximum and minimum rate of seedling height growth were 60.80 and 26.70 cm observed on trees 1 and 9 respectively (Table IV).

Number of branches. Mother trees of both site 1 and site 2 were classified in one group in the first year based on their number of branches (Table V). Regarding second year, maximum number of branches of seedlings from seed sources 1 was 11.2 observed on seedlings of tree 10 from site 1. Minimum rate was 2.60, observed on seedlings of tree 4 from site 2 (Table IV).

DISCUSSION

Seed emergence of higher altitude source (Site 2) was more than that of lower altitude (Site 1). It is in accordance with the research on *Podocarpus totara* by Bergin and Kimberley (1992). Seed emergence was related to seed physiology in relation to light, moisture and heat requirements. Seed emerges, when such requirements are available. According to Chamura and Rozkowski (2002), (*Fagus sylvatica* L.) starting and ending dates of emergence are known as ecotype characteristics. These are usually influenced by latitude and altitude changes. It seems that site 2 seeds had shorter dormancy and can emerge earlier than site 1 seeds. Different seed sources also may affect aging in *Sorbus* seeds, due to different temperature and humidity. In line with this, Basra *et al.* (2000) studied effects of accelerated aging in cottonseed.

Significant differences were noted between seedling survival from the two seed sources in the first year (in nursery bed), two and three year old seedlings survival and freshness. Survival of site 1 seedlings was greater than that of site 2 seedlings for all ages, which confirmed the source effects on seed and seedling characteristics. Eiche (1996) reported that transporting seedling from lower to higher latitude increased the seedlings mortality. This study implied that even seed from different latitude would alter the seedling performance of the same species. Climatic conditions are very important in seedling transportation. On the other hand, drought is important on transporting across latitude (Wells, 1983) and cool season is important in transporting across altitude (Schmidtling, 1994 & 2001). However, wild service tree is both drought and low temperature resistant species and its habitat is at higher latitudes. Summer season withered and burned leaves of

Table V. Means of seedling freshness, collar diameter, height growth and number of branches of the two sources in 2002

Character	Seedling survival (%)		Freshness (Scores 0.5 to 5)		Collar diameter (mm)		Height growth (cm)		No. of Branches Per seedling	
Trees	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
1	66.70 a	53.30 c-d	2.70 d	3.90 a-d	5.90 c	8.70 a	19.80 e	35.50 a	3.00 a	2.90 a
2	100.00 a	93.30 ab	4.20 a-c	4.40 a	8.30 ab	8.00 a-c	32.20 a-d	31.40 ab	3.70 a	2.87 a
3	73.30 a	60.00 b-d	3.40 b-d	3.60 a-d	7.10 bc	6.20 c-f	25.60 de	24.10 b-e	3.50 a	1.75 a
4	100.00 a	80.00 a-c	4.10 a-c	3.70 a-d	7.90 ab	5.60 ef	35.30 a-d	17.00 e	2.60 a	1.33 a
5	80.00 a	72.30 a-d	3.90 a-c	3.80 a-d	7.50 ab	6.00 c-f	38.20 a-c	19.30 c-e	2.60 a	1.86 a
6	80.00 a	64.30 a-d	3.90 a-c	3.70 a-d	7.70 ab	6.30 b-f	35.00 a-d	17.60 d-e	2.40 a	1.50 a
7	93.30 a	80.00 a-c	3.80 a-c	4.10 a-c	7.80 ab	6.90 a-f	30.30 b-d	19.60 c-e	2.60 a	2.00a
8	93.30 a	53.30 cd	3.30 cd	3.70 a-d	8.00 ab	5.70 ef	31.40 a-d	17.20 d-e	4.10 a	2.54 a
9	80.00 a	53.30 cd	3.80 a-c	3.80 a-d	8.00 ab	4.90 f	31.10 a-d	15.60 e	2.70 a	1.90 a
10	80.00 a	53.30 cd	4.40 a	3.50 a-d	8.90 a	7.10 a-e	41.30 a	19.70 c-e	3.70 a	1.88 a
11	93.30 a	40.00 d	4.30 ab	3.40 a-d	8.20 ab	6.90 a-f	37.40 a-c	19.30 c-e	2.90 a	2.70 a
12	93.30 a	80.00 a-c	3.90 a-c	3.40 a-d	8.50 ab	6.60 b-f	36.70 a-c	23.00 b-e	3.80 a	2.36 a
13	100.00 a	73.30 a-d	4.20 a-c	3.90 a-d	7.60 ab	6.70 a-f	37.40 a-c	27.10 a-d	2.40 a	1.86 a
14	73.30 a	100.00 a	3.60 a-c	4.30 ab	7.40 ab	7.80 a-d	29.10 cd	32.70 ab	2.70 a	2.00 a
15	93.30 a	93.30 ab	4.20 a-c	4.10 a-c	8.10 ab	7.90 a-c	40.40 ab	28.80 a-c	2.90 a	2.36 a
16	93.30 a	64.30 a-d	3.90 a-c	3.30 cd	7.50 ab	5.90 d-f	31.40 a-d	18.80 d-e	3.10 a	2.11 a
17	73.30 a	86.70 a-c	3.50 a-d	3.70 a-d	7.80 ab	6.70 a-f	29.70 cd	23.80 b-e	3.60 a	1.80 a
18	80.00 a	80.00 a-c	4.20 a-c	4.10 a-c	8.40 ab	6.90 a-e	33.00 a-d	25.40 b-e	3.10 a	2.00 a
19	93.30 a	100.00 a	4.10 a-c	3.80 a-d	8.00 ab	8.20 ab	35.00 a-d	32.00 ab	4.10 a	2.90 a
20	93.30 a	66.70 a-d	4.20 a-c	3.10 d	8.20 ab	5.70 ef	37.90 a-c	23.40 b-e	3.30 a	2.25 a

Means with different letters are significantly different ($p<0.05$).

Table VI. Means of seedling freshness, collar diameter, height growth and number of branches of the two sources in 2003

Character	Seedling survival (%)		Freshness (Scores 0.5 to 5)		Collar diameter (mm)		Height growth (cm)		No. of Branches Per seedling	
Trees	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
1	80.00 a	73.30 ab	3.90 bc	4.20 a	9.10 b	11.80 ab	34.60 d	60.80 a	6.20 bc	6.40 a-c
2	100.00 a	93.30 ab	4.50 a	4.40 a	10.90 ab	12.20 a	53.50 a-c	52.60 a-c	8.30 a-c	6.80 ab
3	80.00 a	73.30 ab	4.20 a-c	4.30 a	10.00 ab	9.20 b-h	41.20 c-d	45.50 a-e	8.60 a-c	2.70 c-e
4	100.00 a	80.00 ab	4.10 a-c	4.50 a	11.00 ab	7.00 h	55.40 a-c	26.90 f	8.10 a-c	2.60 e
5	93.30 a	86.70 ab	4.00 a-c	4.00 a	10.40 ab	9.70 a-g	54.60 a-c	35.10 d-f	7.80 a-c	4.20 b-e
6	86.70 a	66.70 ab	4.40 ab	4.00 a	10.70 ab	9.00 c-h	51.30 a-d	36.90 c-f	7.50 a-c	3.10 de
7	93.20 a	93.30 ab	4.30 ab	4.20 a	11.40 ab	9.20 c-h	51.00 a-d	34.20 ef	9.30 ab	3.30 de
8	80.00 a	66.70 ab	4.00 a-c	4.40 a	11.00 ab	8.50 d-h	50.70 a-d	32.40 ef	9.40 ab	5.10 a-e
9	80.00 a	80.00 ab	4.00 a-c	4.00 a	10.70 ab	7.20 gh	42.90 b-d	26.70 f	7.30 a-c	4.50 b-e
10	80.00 a	73.30 ab	4.20 a-c	4.00 a	11.50 ab	10.30a-e	57.90 a-c	32.90 ef	11.20 a	5.70 a-d
11	100.00 a	60.00 b	4.30 ab	4.30 a	10.80 ab	9.30 b-h	57.80 a-c	33.90 ef	9.50 ab	6.10 a-c
12	93.30 a	86.70 ab	4.00 a-c	4.00 a	11.00 ab	9.30 b-h	53.10 a-c	41.90 b-f	8.70 a-c	4.10 c-e
13	100.00 a	73.30 ab	4.00 a-c	4.20 a	9.40 ab	9.40 b-h	58.20 a-c	42.80 b-f	4.90 c	4.90 a-e
14	73.30 a	100.00 a	4.20 a-c	4.00a	10.40 ab	11.00a-d	42.80 b-d	53.40 ab	8.30 a-c	5.10 a-e
15	100.00 a	93.30 ab	4.40 a	4.50 a	11.00 ab	11.10a-c	61.20 a	51.20 a-d	8.10 a-c	5.30 a-e
16	93.30 a	66.70 ab	4.10 a-c	4.30 a	10.30 ab	7.60 f-h	47.00 a-d	33.00 ef	9.00 a-c	4.70 a-e
17	93.30 a	100.00 a	4.10 a-c	4.10 a	11.00 ab	8.00 e-h	48.90 a-d	35.30 d-f	9.60 ab	5.50 a-d
18	86.70 a	86.70 ab	3.80 c	4.30 a	11.60 a	9.30 b-h	55.60 a-c	43.80 b-e	8.40 a-c	5.70 a-d
19	100.00 a	100.00 a	4.20 a-c	4.20 a	11.40 ab	9.90 a-f	60.00 ab	47.00 a-e	9.40 ab	7.25 a
20	93.30 a	86.70 ab	4.00 a-c	4.20 a	11.40 ab	8.00 e-h	58.70 a-c	31.80 ef	8.30 a-c	5.50 a-d

Means with different letters are significantly different ($p<0.05$).

many seedlings from site 2, which confirmed the sensitivity of wild service trees seedling to heat warm season.

Collar diameter and seedling height growth of site 1 sources were more than those of site 2 both in 2002 and 2003. It is in accordance to Liepe (1993), Schmidtling (1994), Kurt and John (1996) and Joyce *et al.* (2001), who believe warm origin seedlings usually, grow better than cold origin seedlings. Anneli *et al.* (2005) reported the same results on *Betula pendula.* Based on their report, seedlings of northern origins have a shorter growth time than those of southern origins and seedling height growth dropped systemically with latitude increment. It is worth mentioning that collecting seed from the sources close to nursery and planting seedling close to seed origin (site 1, in this study), will give more appropriate and suitable results. Based on these results, several trees from site 2 can be candidates for seed collection. Using these mother trees as seed collecting stands would protect the genetic diversity as well as increasing valuable characteristics in the population.

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