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Phenotypic Correlation Between Selected Characters of Parent Trees and Progenies in Wild Service Tree (*Sorbus torminalis* L. Crantz.)

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Abstract: In this study, the phenotypic correlation between several seed source and seedling characters on wild service tree (*Sorbus torminalis* L. Crantz.) was investigated by a half-sib progeny test in North of Iran. Seeds of Ashak and Sangdeh Provenances (2100-2300 and 1600-1800 m a.s.l., respectively) were collected from the individual parent trees (20 single trees from each provenance) and sown in a mountain nursery (Orimelk, 1550 m a.s.l) based on a randomized complete block design with three replications. Both provenances showed a high and positive significant correlation between the characters measured on progenies. Although Sangdeh Provenance was selected as a proper site for seed collection and seedling production in this nursery, because of limitation of genetic variation and conservation of species, the selection of well-formed parent wild service trees of Ashak Provenance could be a good measure for this target. It can be concluded that at selection stage, if genotypes with greater collar diameter and height and less branch angles be selected as the parent trees, the seedlings (progenies) with higher survival and growth would be achieved.

Key words: Phenotypic correlation, progeny test, provenance, seedling, wild service tree

INTRODUCTION

Wild service tree (*Sorbus torminalis* L. Crantz) is one of the valuable economical (Piagnani Bassi, 2000; Demesure *et al*., 2000; Eriksson, 2001) and medicinal plant species in the North forests of Iran, distributed from Astara to Golidaghi more or less as small groups in mixed beech, hornbeam and oak stands (Espahbodi, 2005; Tabandeh *et al*., 2007). It is a tall tree and can get to 34 m in height and 100 cm in diameter at breast height (Espahbodi, 2005; Tabandeh *et al*., 2007). It enhances the biological values of forest and has the especial importance in afforestation and tree breeding (Demesure *et al*., 2000). Due to its high value and the hazards threatening it (Bednorz *et al*., 2006), seedling production of this species is promoted for afforestation programs. It should be noted that from point of view of the morphological characteristics for successful implementation of such programs, selection of better quality seed source (parent trees) by specific desirable morphological characters are required for seed collection and other practices, such as breeding.

It seems the populations of *Sorbus torminalis* tend to have different genetically characters along altitudinal gradients in response to natural selection (Saenz-Romero *et al*., 2006). In general, populations from mild environments at low altitudes have larger growth potential, longer period of shoot elongation and less resistance to frost damage, than population originated from colder environments at higher altitudes. It is expected that during provenance-progeny test of *Sorbus torminalis*, significant variation due to provenances and especially due to families within provenances is found in growth and wood density (Sotelo Montes *et al*., 2006). Likewise phenotypic and genotypic correlations may indicate that larger trees tend to have denser wood.

Tree growth is often evaluated by height, diameter at breast height and standing volume. In tree breeding, height of the tree is taken more important than the other growth characters. It is due to the ease of measurement (Adams *et al*., 2001), its high heritability (Espahbodi, 2005; Tabandeh *et al*., 2007) and its high correlation with diameter (Yanchuk and Kiss, 1993; Wu *et al*., 1995) is a common measure of wood production and marketing in forestry.

The decisive goal of the tree breeding projects is to improve tree species in terms of the quality and the

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quantity of wood production. This can be achieved through the selection of superior seed source and genotypes so that an indirect selection is performed (Chaturvedi and Pandey, 2004).

Correlation analysis, though frequently used in agricultural crops, has only recently been used on tree species (Gera *et al*., 1999). Due to long rotation of tree life span, the analysis of seedling characters is an important technique (Chaturvedi and Pandey, 2004). Present study aims to determine the better parent trees (seed origin) of wild service tree (*Sorbus torminalis* L. Crantz.), having the higher values in economical characteristics, based on the correlation between characters measured on parent trees and their progenies.

MATERIALS AND METHODS

In October 2002 seeds were collected on 40 parent trees (genotype) located in Ashak (53° 18' 0" N longitude, 36°7' 10" E latitude, 2100-2300 m a.s.l.) and Sangdeh forest (53° 10' 30" N longitude, 35°58' 30" E latitude, 1600-1800 m a.s.l.) North of Iran and sown in nursery bed of Orimelk (1550 m a.s.l.). Nursery climatic data based on Tabandeh *et al*. (2007) was as Table 1.

The grown seedlings were replanted in the second year in the field experiment based on a randomized complete blocks design with 3 replications. According to Cornelius *et al*. (1996) in each replication from each genotype 10 seedlings (progenies) were replanted with distance of 0.5 m from each other. During the progeny test (years 2 and 3) weeds were removed four times per year and seedlings irrigated once a week. At the end of the third growing season (in October 2005) collar diameter (in mm), height and length of longest branch (cm), angle of the longest branch (degree) and number of branches of the progenies were recorded. Vitality of seedlings was recorded based on Savolainen *et al*. (2004) as given in Table 2.

PROCE MEANS (SAS Institute, 1989) was used for determining the means characteristic. Then, correlation coefficient analysis was conducted for studying the effect of provenance on progenies characteristics.

Table 1: Nursery climatic parameters

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

Table 2: Classification of leaf vitality (Savolainen *et al*., 2004)

Percentage of dry leaf on seedling	Vitality (Score)
<10	5.0
10-20	4.5
20-30	4.0
30-40	3.5
40-50	3.0
50-60	2.5
60-70	2.0
70-80	1.5
80-90	1.0
>90	0.5

RESULTS

The means of survival, vitality, collar diameter, height, number of branches, angle and length of the greatest branch in Ashak provenance are 69.67%, 4.41 (Score), 12.38 mm, 60.38 cm, 6.24 units, 60.22° and 17.58 cm, respectively (Table 3, 4). The means for the characters on Sangdeh provenance are 83.67%, 4.31 (Score), 13.96 mm, 74.65 cm, 9.78 units, 57.61° and 22.67 cm, respectively. The coefficient of variation for survival, vitality, collar diameter, height, number of branch, angle and length of the longest branch in Ashak provenance are 29.66%, 11.45 (score), 30.66 mm, 44.47 cm, 54.06 units, 28.94° and 53.04 cm, respectively. The coefficient of variation for these characters in Sangdeh provenance is 22.44%, 10.83 (score), 26.31 mm, 38.45 cm, 51.26 units, 34.20° and 46.85 cm, respectively.

In both provenances, there was mostly positive significant correlation between the characters measured on the progenies (Table 5, 6). Based on Ashak provenance a negatively significant phenotypic correlation was found between vitality and other characters measured (except branch number and angle of the longest branch), between survival and angle of the longest branch and between length of the longest branch and angle of the longest branch. Correlations were

Table 3: Minimum, maximum, Mean±SD of seedling characters of Ashak provenance

Character	Minimum	Maximum	Mean±SD
Survival (%)	30.00	100.00	69.67±20.66
Vitality (Scored 1 to 5)	1.00	5.00	4.41±0.50
Collar diameter (mm)	1.24	22.87	12.38±3.80
Height (cm)	2.50	134.50	60.38±26.85
Number of branches	0.00	20.00	6.24±3.37
Angle of the longest branch (°)	5.00	110.00	60.22±17.43
Length of the longest branch (cm)	1.00	50.00	17.58±9.32

Table 4: Minimum, maximum, Mean±SD in characters of seedlings (progenies) Sangdeh provenance

Character	Minimum	Maximum	Mean±SD
Survival (%)	20.00	100.00	83.67±18.77
Vitality (Score)	2.00	5.00	4.31±0.47
Collar diameter (mm)	0.50	25.15	13.96±3.68
Height (cm)	5.00	213.00	74.65±28.70
Number of branches	0.00	34.00	9.78±5.02
Angle of the longest branch (°)	1.00	110.00	57.61±19.70
Length of the longest branch (cm)	1.00	75.50	22.67±10.62

Table 5: Phenotypic correlation coefficients of the recorded characters, between progenies of Ashak provenance

Character	Survival	Vitality	Collar diameter	Height	Branch number	Angle of the longest branch
Vitality	-0.21**					
Collar diameter	0.28**	-0.12*				
Height	0.35**	-0.16**	0.82**			
No. of branches	0.22**	-0.05ns	0.66**	0.56**		
Angle of the longest branch	-0.26**	0.01 ns	0.19**	0.23**	0.15**	
Length of the longest branch	0.44**	-0.13**	0.62**	0.53**	0.42**	-0.13**

Table 6: Phenotypic correlation of characters estimated between progenies of Sangdeh provenance

Character	Survival	Vitality	Collar diameter	Height	Branch number	Angle of the longest branch
Vitality	0.23**					
Collar diameter	0.59**	0.11ns				
Height	0.57**	-0.16**	0.75**			
No. of branches	0.53**	-0.14**	0.66**	0.54**		
Angle of the longest branch	-0.07ns	-0.07ns	0.17**	0.22**	0.22**	
Length of the longest branch	0.45**	0.02ns	0.54**	0.43**	0.31**	-0.31**

Table 7: Phenotypic correlation of characters estimated between seedling (progenies) and provenances

Character	Phenotypic correlation
Survival	-0.17**
Vitality	0.10**
Collar diameter	-0.21**
Height	-0.25**
Number of branch	-0.37**
Angle of the longest branch	0.07*
Length of the longest branch	-0.24**

**Significant at 1% probability. *Significant at 5% probability. ns: Non-significant

insignificant only between branch number with vitality and angle of the longest branch with vitality.

In Sangdeh provenance a negatively significant phenotypic correlation was found between vitality and other characters (except angle of the longest branch), between survival and angle of the longest branch and between length of the longest branch and angle of the longest branch. Correlations were insignificant only between collar diameter, angle of the longest branch, length of the longest branch with vitality.

The values show a negatively significant correlation between the altitudes of the provenances and survival, collar diameter, height, branches number, length of longest branch. Provenance was positive and significantly correlated with vitality and angle of the longest branch (Table 7). In fact the seedlings from the lower elevation seed source (Sangdeh provenance), compared to those from higher elevation seed source (Ashak provenance), showed greater values in survival, collar diameter, height, number and length of branch and smaller value in vitality and angle of the longest branch. It can be stated that Sangdeh provenance is more suitable than Ashak provenance for seed collection and also seedling production at the nursery.

DISCUSSION

Results showed that quantitative and qualitative characteristics of the progenies (seedlings) originated from different seed sources are different. Most of the characters recorded on the progenies produced from lower elevation seed source, nearer to nursery location, were higher than those at higher elevation seed source. This finding is completely similar to those of the first and the second years reported by Espahbodi (2005).

Joyce *et al*. (2002), on *Pinus strobus* and Schmidtling (1994) showed the temperature of seed source area is the most decisive factor on qualitative and quantitative characters of progenies and in most cases the seedlings produced from warmer provenances grow faster than those from colder provenances. Likewise, Nienstaedt and Olson (1961), as well as Saenz-Romero *et al*. (2006), on *Pinus occarpa*), considered height growth is greater in progenies created from longer-growth season (warmer areas) populations than those from shorter-growth season (colder area) populations. These results also are in agreement with Sebbenn *et al*. (2003) who emphasis that growth performance of South provenances is generally better than other regions. As Schoenike (2002)' finding, in present study a significant correlation between seedlings survival and altitude of seed source (provenance) was found.

It can be emphasized that local provenances have higher priority for seedling plantation than provenances with further distances from planting area. The reasons might be due to the genetic adaptations of the seedlings produced from the local seeds with desired environmental conditions. It is basically accepted that the progenies produced from Southern (warmer) areas have a faster growth than those from Northern (colder) areas.

One of the important reasons could be the longer period of growth season in warmer areas compared with those in colder areas (higher altitudes and or Northern longitudes).

Present investigation showed that Sangdeh provenance, compared to Ashak provenance, is of better conditions for seedling production of wild service tree. On the other hand, it should be declared that *Sorbus torminalis* is not a species having high genetic variation in the area. It is generally regarded as an extinct risk species (Espahbodi, 2005). Therefore, it is necessary to use the seed sources of this species even those of further distances from the nursery location.

Based on these results there is a significant correlation between the seedling characters such as survival, collar diameter, height, length and number of branches in both of Ashak and Sangdeh provenances. Such results were also observed during the first and second years of the study (Espahbodi, 2005). In fact, increased collar diameter positively affects height growth and branches. Vargaz-Hernantez *et al*. (2003) conducted a progeny test of Douglas-fir, reported similar results.

Significant correlation between two characters could be due to several reasons. The most important reasons might be linkage between the controlling genes and pleiotropy function of the genes (Makarechian, 2002). In the case of linkage between the controlling genes of two or more characters, a few genes control the desired characters but all of them are located on the same chromosome near each other. So, the closer genes have the higher correlation. If the genes responsible for increasing the characters have a close linkage, the correlation of the characters would be positive. In contrast, if the gene responsible for increasing a character is linked with a decreasing gene, the correlation would be negative. In the case of pleiotropy, a gene controls several characters.

Generally, we concluded that in the selection time of parent trees for seedling production, if the genotypes with greater collar diameter and height with less angle of branches be used as the seed stands the higher survival and growth would be gained. By improving one characters conducted by the tree breeding programs other characters might be improved, provided a close correlation between the characters.

REFERENCES

Adams, W.T., S.N. Aitken, D.G. Joyce, G.T. Howe and J.V. Hernandez, 2001. Evaluating efficacy of early testing for stem growth in Douglas-fir. Silvae Genet., 50: 167-175.

Bednorz, L., L. Myczko and P. Kosinski, 2006. Genetic variability and structure of the wild service tree (*Sorbus torminalis* (L.) Crantz) in Poland. Silvae Genet., 55: 197-202.

Chaturvedi, O.P. and N. Pandey, 2004. Correlation and path analysis studies between biomass and other characters in *Bombax ceiba* L. Silva Genet., 53: 269-271.

Cornelius, J., L. Apedaile and F. Mesen, 1996. Provenance and family variation in height and diameter growth of *Cupressus lusitanica* Mill. in Costa Rica. Silvae Genet., 45: 82-85.

Demesure, B., BL. Guerroue, G. Lucchi, D. Part and R.J. Petit, 2000. Genetic variability of a scattered temperate forest tree: *Sorbus torminalis* L. Ann. For. Sci., 57: 63-71.

Eriksson, G., 2001. Conservation of noble hardwoods in Europe. Can. J. For. Res., 31: 577-587.

Espahbodi, K., 2005. Genetic variation and the effects of genotype and habitat on growth and seedling survival in wild service tree (*Sorbus torminalis* L. Crantz). Ph.D. Thesis. Tarbiat Modarres University, Iran.

Gera, M., N. Gera and R. Aggalawal, 1999. Path analysis in *Dalbergia sissoo* Roxb. Ind. For., 125: 660-664.

Joyce, D.G., P. Lu and R.W. Sinclair, 2002. Genetic variation in height growth among population of Eastern white pine (*Pinus strobus* L.) in Ontario. Silvae Genet., 51: 136-142.

Makarechian, M., 2002. Application of Animal Genetics in Animal Production. 1st Edn., Shiraz University Press, Iran, ISBN: 964-462-342-8, pp: 573.

Nienstaedt, H. and J.S. Olson, 1961. Effects of photoperiod and source on seedling growth of Eastern Hemlock. Forest Sci., 7: 81-96.

Piagnani, C. and D. Bassi, 2000. *In vivo* and *in vitro* propagation of *Sorbus torminalis* from juvenile material. Italus-Hortus, 7: 3-7.

SAS institute, 1989. SAS Users Guide Statistics. Version 6. SAS Institute, Cary, NC., pp: 943.

Saenz-Romero, C., R.R. Guzman-Reyna and G.E. Rehfeldt, 2006. Altitudinal genetic variation among *Pinus oocarpa* populations in Michoacan, Mexico. For. Ecol. Manage., 229: 340-350.

Savolainen, O., F. Bokma, R. Garcia-Gil, P. Komulainen and T. Repo, 2004. Genetic variation in cessation of growth and frost hardiness and consequences for adaptation of *Pinus sylvestris* to climatic changes. For. Ecol. Manage., 197: 79-89.

Schmidtling, R.C., 1994. Using provenance test to predict response to climatic change: Loblolly pine and Norway spruce. Tree Physiol., 14: 805-817.

Schoenike, E.R., 2002. Effect of variety and seed source on survival of Arizona cypress planted in South Carolina. For. Ecol. Manage., 158: 273-289.

Sebbenn, A.M., A.S.S. Pontinha, E. Giannotti and P.Y. Kageyama, 2003. Genetic variation in provenance-progeny test of *Araucaria angustifolia* (bert.) O. Ktze. in Sao Paulo, Brazil. Silvae Genet., 52: 181-184.

Sotelo Montes, C., R.E. Hernandez, J. Beaulieu and J.C. Weber, 2006. Genetic variation and correlations between growth and wood density of *Calycophyllum spruceanum* at an early Age in the Peruvian Amazon. Silvae Genet., 55: 217-228.

Tabandeh, A., M. Tabari, H.M. Nadoushan and K. Espahbodi, 2007. Heritability of some characteristics of *Sorbus torminalis* seedling. Pak. J. Biol. Sci., 10: 2760-2763.

Vargaz-Hernantez, J.J., W.T. Adams and D.G. Joyce, 2003. Quantitative genetic structure of stem, form and branching traits in Douglas-fir seedling and implication for early selection. Silvae Genet., 52: 36-44.

Wu, H.X., F.C. Yeh, R.P. Pharis, B.P. Dancik, I.B. Jiang, I. Dymock and N.K. Dhir, 1995. Genetic parameters of greenhouse growth and performance of 2-year *Pinus contorta* sub sp. *latifolia*. Scand. J. For. Res., 10: 12-21.

Yanchuk, A.D. and G.K. Kiss, 1993. Genetic variation in growth and wood specific gravity and its utility in the improvement of interior spruce in British Columbia. Silvae Genet., 42: 141-148.