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Genetic Variation of Mahaleb (*Prunus mahaleb* L.) on Some Iranian Populations Using Morphological Characters

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Abstract: *Prunus mahaleb* L. and *Prunus avium* L. are the principal rootstocks used in Iran and world wide for sweet and sour cherries. This study was conducted at Khorasan Natural Resources and Agricultural Research Center with the main purpose of investigation of genetic variation and identification of mahaleb dwarf genotypes for cherry rootstock breeding. We evaluated morphological characters of 17 mahaleb populations. One-way analysis of variance was performed for determination of different regions genetic diversity, which indicated significant differences for most traits. Correlation coefficient showed significant correlation between tree vigor, crown width and crown volume and size index. Factor analysis detected that in the first factor, crown height, size index, crown width, trunk circumference and crown volume had highest factor loading, bark to wood ratio, internode and chlorophyll content were the second most important and third factor was leaf area. These factors contained 57.9% of total variance. Results also showed that mahaleb seedlings had vigor variation.

Key words: Mahaleb, cherry, genetic variation, dwarf rootstock, Mazard

INTRODUCTION

The best cherry rootstock for Iranian nurseries and orchards is *Prunus mahaleb* (L.) Mill. Mahaleb is tolerant to lime-induced iron chlorosis and zin deficiency. It is a good rootstock on light, calcareous soils and arid climates in Iran.

Improved rootstocks were needed for commercial production of cherries in Iran. Collection and research on *P. mahaleb* was initiated at the Horticultural Department in 1997 for mahaleb cherry rootstock. Iran represents a significant source of germplasm of different fruit species, especially for those from the genus *Prunus*.

The diversity of mahaleb is well illustrated by Hungarian findings that three distinct sub-species exist. Three sub-species of Mahaleb, sp. *Simonkai,* sp. *Cupaniana* and sp. *Mahaleb*[1] occur in Hungary with great natural variability. Collection and research on these sub-species started in the late 1950s[2]. From among them, one self-fertile clone and some clones with basitonic tendency were selected and tested as cherry rootstocks.

Genetic variations have been studied for sour cherry *(P. cerasus* L.), sweet cherry (*P. avium* L.) and Mahaleb (*Prunus mahaleb* L.) in different country[3-7].

In Italy, some clones of *Prunus mahaleb* are among the species proposed as cherry rootstocks for calcareous soils and droughty conditions[3,4,8,9].

In France, two *Prunus avium* selections, named Pontaviun® Fercahun and Pontaris® Fercadeu were introduced. These are also vigorous rootstocks. In France, also a dwarfing *Prunus cerasus* selection was made from Iranian material, called Tabel® Edabriz[10].

In Summerland, Canada, the less vigorus Mazzard selections have been found[11].

In Gremany, selection with *Prunus avium* and *Prunus mahaleb* resulted in several uniform seedling sources that have been used for a long time. Within *Prunus mahaleb.* Heimann 10 and within *Prunus avium,* Huttner 170*53 are renowed[12].

In Hungary, Turkey and probably in other areas, too, selection work was carried out with *Prunus mahaleb.*

The main objective of this research was to study morphological variation and correlationship between vigor and some morphological traits in the rootstock selection program at the Department of Horticultural in Iran.

MATERIALS AND METHODS

The study was carried out at the farm of Khorasan Agricultural Natural Resources Research Center during 1998-2005. In order to understand the extent of natural variation, 17 autochthonous populations of Mahaleb *(P. mahaleb* L.) have been collected from Iran. The seeds

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from 17 mahaleb populations were collected in 1998 and sown[13]. After three years evaluated in nursery, selected seedlings was propagated and plantlets were transplanted at a spacing of 1×2 m. Morphological characteristics of the trees were evaluated from 2000 to 2005. Plant height, branching, crown width, trunk circumference and crown volume, bark to wood ratio, chlorophyll content, leaf area and length of internodes were measured on one-year-old rootstock plants in the nursery. The specific leaf weight (mg dry matter per cm^2 leaf area), as defined by the method of Smith and Benitez[14], were measured on four-year-old rootstocks. We evaluated morphological characters of 17 mahaleb populations. One-way analysis of variance was performed for determination of different genetic diversity. Morphological variability in these populations was analysed. Correlation analyses of vigor versus other morphological characteristics were carried out using the correlation and regression programme in MINITAB 13.2 (Minitab 2002 Software Inc., Northampton, MA). Data were subjected to analysis of variance and means were compared by Least Significant Difference (LSD). Differences at $p<0.05$ were considered to be significant.

RESULTS AND DISCUSSION

Results showed, significant differences in morphological characters of 17 mahaleb populations. One-way analysis proved genetic variation between genotypes collected from areas (Table 1). Presented results was confirmed by some authors that consider genetic variations on *Prunus aviun, Prunus mahaleb* and *Prunus cerasus*[3-6].

Comparison means of stone weight showed Kordestan-1 (K-1) and Khorasan-7 (KH-7) populations had lowest and highest weight stone, respectively (Table 1).

From among the vigor parameters, height, width and crown volume of plants had significantly differed. So that K-1 and KH-7 populations had lowest and highest height, width and crown volume, respectively (Table 1).

In branching, bark to wood ratio, chlorophyll content, leaf area, leaf specific weight, start of flowering and current season vegetative growth populations differed (Table 1).

Correlation coefficient a among characteristics are mostly high, with the exception of those between tree vigor and branching (0.05), branch angel (0.17), bark to wood ratio (0.38) and leaf area (-0.07) (Table 2).

These data agree with that of Hortko[15] and Faust and Zagaja[16] who reported that among the vigor parameters a positive correlation between tree vigor, height and crown volume.

In sweet cherry, Faust and Zagaja[16] reported, tree vigor correlated with internod length and vigor of sour cherry with branching and branching angel. These results also confirmed by present finding.

This trial demonstrated that positive correlation between tree vigor, crown volume, trunk cross sectional, crown width and internod length. However, our conclusion needs to be proved in further trials set on grafted rootstocks with commercial cherry cultivars.

Factor analysis detected that in the first factor, crown height, size index, crown width, trunk circumference and crown volume had highest factor loading, bark to wood

Table 1: Mean comparison of some morphological traits of different mahaleb (*P. mahaleb* L.) populations

	Region																
Traits	K1	KH1	KH2	M1	K2	K3	I1	I2	KH3	M2	KH4	O1	K4	KH6	SH1	SH2	KH7
Trunkcircum-ferance (cm^2)	1.48h	5.95gh	7.29f-h	11.27e-g	12.40d-g	15.33c-f	16.69c-e	19.26c-e	16.74c-e	19.67c-e	17.99c-e	18.67c-e	23.63bc	30.18b	31.32ab	20.81cd	38.89a
Leaf specific weight (g cm^{-2})	0.08a	0.12a	0.11a	0.106a	0.103a	0.108a	0.087a	0.084a	0.158a	0.11a	0.09a	0.11a	0.107a	0.085a	0.100a	0.108a	0.113a
Leaf area (cm^2)	5.20c	5.17c	5.50bc	6.39a-c	5.81a-c	5.61bc	5.45bc	7.20bc	6.57a-c	5.63bc	6.17a-c	6.43a-c	6.14a-c	7.67a	7.30ab	5.16c	6.33a-c
Chlorophyle (SPAD)	36.10a	39.9a	37.10a	36.80a	38.84a	42.08a	44.11a	36.08a	41.48a	40.47a	42.5a	43.72a	40.38a	43.78a	44.30a	41.70a	44.28a
Scaffold angle	2.0b	4.0a	4.0a	5.0a	3.8a	3.5ab	4.3a	4.0a	4.2a	4.4a	4.5a	4.4a	4.6a	4.6a	4.3a	4.0a	4.6a
Vegetative growth (cm)	10.03b-d	10.66b-d	13.55ab	13.19a-c	13.10a-c	11.67bc	7.71d	11.88bc	10.60b-d	10.8b-d	11.00b-d	10.89b-d	9.84b-d	11.77bc	10.36bc	15.51a	9.5cd
Period of flowering	6.0a	4.67a	5.8a	6.5a	5.0a	5.0a	6.0a	5.7a	6.0a	5.8a	5.54a	7.0a	6.6a	6.6a	6.8a	6.5a	6.9a
Start of flowering	1-6c	1-15ab	1-12b	1-13ab	1-13ab	1-13ab	1-15ab	1-13ab	1-12ab	1-13ab	1-13ab	1-12ab	1-14ab	1-15ab	1-17ab	1-14ab	1-14ab
Branching height	40ab	33.7a-e	39a-c	27b-e	33.2a-e	31.2b-e	17.9e	23.6c-e	20.1de	31.1b-e	31.5b-e	31.9bc-e	29.7b-e	35.7a-d	23.3c-e	47.5a	23c-e
Bark/wood ratio	0.29de	0.36b-e	0.35c-e	0.39a-e	0.43a-e	0.36a-e	0.47a-d	0.40a-e	.50a-c	0.49a-c	0.50a-c	0.45a-d	0.55a	0.54ab	0.47a-d	0.26e	0.53a-c
Wight stone (g)	0.041i	0.044hi	0.046g-i	0.048f-i	0.05e-i	0.051e-i	0.052e-i	0.054d-h	0.054d-h	0.056d-h	0.058c-g	0.06b-f	0.062b-e	0.062b-d	0.068bc	0.071ab	0.08a
Hieght (cn)	80l	104.7k	112jk	120ij	128.5i	130i	132.9hi	157.1ef	143.5gh	153.9fg	160d-f	169.4c-e	172.5cd	180bc	187.5b	190b	210.8a
Crown volum (cm^3)	0.07j	0.3ij	0.39h-j	0.50h-j	0.89f-i	0.80g-i	0.91f-h	1.62d-f	1.09f-h	1.37e-g	1.59d-f	1.86de	2.15cd	2.61bc	2.72bc	3.03b	4.25a
Size index	3200j	8660ij	9020ij	11180hi	15060g-i	14200g-i	15700f-h	20910de-g	18000e-g	19660e-g	22010d-f	24160de	27240cd	30840bc	30600bc	34000b	41470a

Abbreviations: K= Kordestan, KH = Khorasan, M = Meshkin shahr, I = Isfahan, O = Orumieh, SH = Shahroud

Table 2: Correlation coefficient between some traits of different mahaleb populations

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Height	1														
Crown width	0.955**	1													
Trunk diameter	0.755**	0.747**	1												
Trunk circumference	0.717**	0.706**	0.984**	1											
Size index	0.977**	0.932**	0.739**	0.713**	1										
Crown volume	0.946**	0.905**	0.693**	0.681**	0.983**	1									
Internode length	-0.255**	-0.248**	-0.202**	-0.181**	-0.251^{ns}	-0.248**	1								
Leaf area	-0.073^{ns}	-0.035^{ns}	0.026^{ns}	-0.035^{ns}	-0.068^{ns}	-0.058^{ns}	-0.030^{ns}	1							
Leaf chlorophyll	0.229*	0.225*	0.217*	0.197*	0.215*	0.193*	0.202^{ns}	-0.026^{ns}	1						
Specific leaf weight	0.086^{ns}	0.045^{ns}	0.124^{ns}	0.162^{ns}	0.100^{ns}	0.109^{ns}	0.022^{ns}	-0.318**	0.97^{ns}	1					
Branching hieght	0.52^{ns}	-0.078^{ns}	0.188^{ns}	-0.178*	-0.029^{ns}	-0.019^{ns}	0.135^{ns}	-0.098^{ns}	0.088^{ns}	0.17^{ns}	1				
Bark/wood ratio	0.383^{ns}	0.392**	.343**	0.301**	0.362**	0.335**	-0.316**	-0.028^{ns}	-0.239**	-0.039^{ns}	-0.068^{ns}	1			
Branching angel	0.174^{ns}	0.241**	0.103^{ns}	0.081^{ns}	0.155^{ns}	0.147^{ns}	-0.089^{ns}	0.026^{ns}	0.108^{ns}	0.071^{ns}	0.071^{ns}	0.218^{ns}	1		
Leaf drop	0.117^{ns}	0.054^{ns}	0.033^{ns}	0.050^{ns}	0.123^{ns}	0.135^{ns}	0.022^{ns}	-0.098^{ns}	0.030^{ns}	0.017^{ns}	0.025^{ns}	0.019^{ns}	0.175^{ns}	1	
Stone weight	0.374**	0.373**	0.249**	0.253**	0.359**	0.437**	-0.108^{ns}	-0.018^{ns}	-0.015^{ns}	0.064^{ns}	0.039^{ns}	0.145^{ns}	-0.034^{ns}	0.221*	1

†p = 5% significant probability level ,*p = 1% significant probability level**

Table 3: Factor loading of 3 primary factors of different mahaleb (*P. mahaleb* L.) populations

Traits	Factor 1	Factor 2	Factor 3
Height (cm)	0.937	0.188	-0.051
Size index	0.947	0.156	-0.066
Crown volume (m^3)	0.952	0.128	-0.060
Crown width (cm)	0.911	0.217	0.006
Trunk circumferance (cm^2)	0.829	0.082	0.120
Trunk diameter (mm)	0.855	0.129	0.127
Internode lenght (cm)	0.083	-0.652	-0.103
Stone weight (g)	0.391	-0.080	-0.052
Leaf specific weight (g cm^{-2})	-0.012	-0.046	-0.746
(Leaf area (cm^2)	-0.058	0.002	0.687
Leaf chlorophyll (SPAD)	0.138	0.551	0.200
Scaffold angle	-0.037	-0.027	-0.56
Bark/wood ratio	0.266	0.712	-0.015
Branching height	0.091	0.525	-0.259
Cumulative variance	37.1	49	59.7

ratio, internode and chlorophyll content were the second most important and third factor was leaf area. These factors contained 57.9% of total variance (Table 3).

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