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STUDY OF GENETIC DIVERSITY IN SOME IRANIAN PLUM GENOTYPES BASED ON MORPHOLOGICAL CRITERIA

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Abstract

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Plums have a great diversity among temperate zone fruit trees. This experiment was conducted to assay the morphological diversity of 38 Iranian plum genotypes for qualitative and quantitative criteria based on IBPGR descriptor. Analysis of variance showed that all the traits studied had significant differences indicating the great variability for every trait. Simple correlation analysis showed significant negative and positive correlations for some important traits. Factor analysis revealed that fruit and stone shape, flower size and color, fertility range and flower opening time were related to the main factor components. Effective high lighted criteria were categorized into five groups accounted for 76% of total variance. Eigen values of more than 6% were considered significant for each factor. Cluster analysis at 9 distances at, divided genotypes to four main groups. These groups mainly had differences in stone and fruit shape, self fertility range and stone clinging.

Key words: plum, qualitative and quantitative criteria, cluster analysis, correlation

Introduction

Plums as one of the major temperate zone fruit trees have a widespread growing habit amongst other deciduous fruit trees (Blazek, 2007). Furthermore, this broad growth adaptability accompanies the great cultivar diversity in these species as well (Naotoshi et al., 1998). Inter and intra population genetic diversity is are wealthy pools for maintaining genetic resources of plants for present and future uses and breeding programs (Botu et al., 2002; Bouhadida et al., 2005). Knowledge on the level and structure of genetic diversity makes it possible the feasible characterization and survival maintenance of populations. Morphological traits are the primary markers utilized in germplasm management (Karimi et al., 2008). These traits are in common use for elucidation of wide genetic diversity in different field and horticultural crops (Blazek, 2007). Leaf flower and related fruit traits, have been used as main morphological traits in inter-specific hybrids characterization of plum trees (Naotoshi et al., 1998; Jakubowski, 2002; Ertekin et al., 2006). In wild plum cultivars, leaf related morphological criteria had great diversity and their fruit and stone characteristics had high

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structural similarity with other prunes (Naotoshi et al., 1998; Kaufmane et al., 2002).

Although newly developed molecular markers are valuable techniques in gene based diversity studies, however these procedures have disadvantage of high cost (Ahmed et al., 2004; Bouhadida et al., 2005). In contrast, morphological traits could feasibly be used for parental selection and along with molecular techniques are of highly appreciated procedures for description and germplasm classification of plants. Statistical method such as: factor and cluster analysis have been employed as powerful options for plant cultivar and accession screenings. Morphological criteria have been widely used as important markers in plant breeding programs (Kaufmane et al., 2002; Ogasanovic et al., 2007; Karimi et al., 2008).

The subject of the present study was to investigate the morphological traits diversity of 38 Iranian plum genotypes as an initial step aiming to the national and international germplasm characterization and preservation of these precious fruit tress for future breeding programs.

Material and Methods

This experiment was conducted in Maragheh (37˚23' North, 46˚16' East and 1476m) in Northwest of Iran. Thirty eight genotypes of plum with some distinct growing characteristics were selected from the fruit bearing orchards of the region.

A series of vegetative and reproductive traits were recorded based on IBPGR descriptor according to the different phenological growing stages of trees in a growing season. Theses traits were: canopy shape, fruit shape, stone shape, stone clinging, and total soluble solid (TSS) content, pulp acidity and pH, pulp and peel color and dried fruit quality. For assessing of fertility type, one hundred flowers in ballon stage from each genotype were enclosed in cellophane pockets. Fertility type was interpreted according to the number and percent of fruit set (Suranyi, 1978). Flower size and color were recorded at full bloom stage of individual flowers. After bloom and during vegetative growing stage, growth type, canopy shape and fruit bearing habit were characterized according to the descriptor. Qualitative criteria were evaluated in ripen fruits. TSS, titrable acidity and pH were measured using hand refractometer (Atago, Japan), titration with NaOH and pH meter (model..) respectively. Fruit and stone shape were determined by based on descriptor. Fruit and stone weight were recorded by 0.001 accurate balances. Pulp to stone ratio was determined based their dry weight.

Results and Discussion

ANOVA results showed that there were significant differences ($p \leq 0.01$), between genotypes in respect to the all studied traits (Table 1). Some criteria with high coefficient variance had a wide

Table1

Variance analysis for qualitative traits of some plum cultivars

Sourced variation	MS								
	df	Flower size, mm	Stone weight, mg	Fruit weight, mg	Titrable acidity	Pulp/ Stone	Brix	Fertility, %	pH
Treatment	37	0.299**	0.354**	365.52**	0.137**	482.96**	55.52**	35.7**	0.96**
Error	152	0.05	0.014	15.54	0.0001	52.84	0.0001	0.021	0.0001
CV (%)		9.25	15.49	17.44	0.0001	24.11	0.06	2.3	0.34

** Significant in $p \leq 0.01$

Table 2

Correlation between qualitative and quantitative traits of some plum cultivars

	Fruit bearing organ	Flower size	Nut quality	Stone clinging	Acidity	pH	Brix	Pulp color	Peel color	Stone shape	Stone weight	Flower color	Fertility type	Canopy shape	Fruit shape	Fruit size	Flower opening time	Pulp to stone ratio
Fruit bearing organ	1																	
Flower size	-0.051	1																
Nut quality	-0.407*	0.264	1															
Stone clinging	0.124	0.025	-0.448**	1														
Acidity	-0.214	-0.054	0.121*	-0.173	1													
pH	0.12	0.114*	-0.11	0.286	-0.412**	1												
Brix	-0.141*	0.258	0.477**	-0.285	-0.136	0.170*	1											
Pulp color	0.106	-0.049	-0.067	-0.2	-0.093	-0.152	-0.167	1										
Peel color	0.1**	0.001	-0.313	0.07	-0.41**	0.137	-0.262	0.165**	1									
Stone shape	-0.146*	-0.178	0.112*	-0.167*	0.319	-0.44**	0.002	0.48**	-0.132	1								
Stone weight	-0.021	0.12	0.239	-0.152*	0.006	0.062	0.456*	-0.018	-0.196	0.139	1							
Flower color	0.204	-0.16**	-0.184	-0.172	0.233	-0.202	-0.278	-0.19	-0.144	-0.071	-0.085	1						
Fertility type	-0.005	0.05	0.202	-0.034	0.168*	-0.219	-0.124	0.077	-0.22	0.11*	0.137	0.194	1					
Canopy shape	-0.204	0.16**	0.184	0.172	-0.233	0.202	0.278	0.19	0.144	0.071	0.085	-1.0**	-0.194	1				
Fruit shape	-0.14*	-0.17	0.16*	-0.16*	0.319	-0.44**	0.002	0.48**	-0.132	1.00**	0.139	-0.071	0.11*	0.07	1			
Fruit size	-0.17	0.109	0.41**	-0.14*	0.11	0.129	0.51**-	-0.274	-0.12*	-0.071	0.12*	-0.076	-0.202	0.08	-0.07	1		
Flower opening time	0.15	0.244	0.05	-0.046	0.295	-0.11*	-0.213	0.11	0.025	0.098	0.225	-0.085	0.47**	0.09	0.098	0.11*	1	
Pulp to stone ratio	-0.01	-0.08	0.11	0.03	-0.099	0.248	0.264	-0.171	-0.03	-0.25	-0.031	-0.02	-0.44**	0.02	-0.25	0.61**	0.55**	1

**Significant in $p \leq 0.01$ *Significant in $p \leq 0.05$

range of quantitative data as well as wide array of selection opportunists. A number of these traits were included flower size, stone weight, titrable acidity, pH, Brix, fertility type and pulp to stone ratio (Sarkhosh et al., 2007; Usenik et al., 2008). An earlier investigation on the wild Iranian prune cultivars showed that leaf related criteria had significant morphological diversity. In contrast, stone and fruit related criteria had appreciable structural similarity with other prune species.

Correlation

There was a significant simple correlation between some important traits. Positive correlation was observed between Brix and stone weight as well as fruit size (Table 2). In contrast, pH had negative correlation with stone weight, fruit shape and flower opening time. There was no significant correlation between fruit size, pH and titrable acidity, as well as between fruit shape, Brix and titrable acidity (Botu et al., 2002). Pollination type whether self and cross-pollination or intermediate type may greatly be affected by flower opening time and dichogamy (Arbeloa et al., 2006). Fruit bearing organ type had negative correlation with dried fruit quality, Brix and stone and fruit shape. Dried fruit quality negatively correlated with fruit and stone shape.

Table 3

Eigen values, relative variance and cumulative variance percentage for five main factors of some plum cultivars

Factors	Eigen values	Relative variance, %	Cumulative variance percentage
1	3.98	22.14	22.14
2	3.72	20.68	42.83
3	2.73	15.21	58.04
4	1.79	9.98	68.03
5	1.49	8.28	76.31

Factor analysis

In factor analysis, relative variance of any factor indicates the percent importance of related factor in total variance of studied traits.

In the present experiment, five main and independent factors with Gigen values ≥ 1 interpreted 76% of total variance (Table 3). In the first factor, fruit and stone shape with positive coefficients interpreted 22.4% of variance.

In the second factor, flower size and canopy shape with positive efficient as well as flower color with negative coefficient interpreted about 20.68% of total variance. The third factor demonstrated 15.21% of total variance. Fertility type, flower opening time, stone weight, Brix and dried fruit quality with positive coefficients, and stone clinging with negative Eigen values interpreted 9.98%

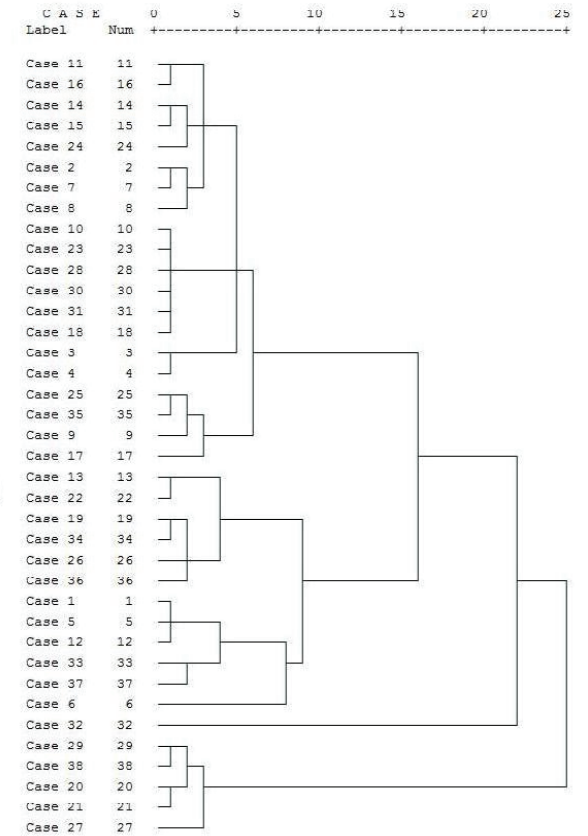

Fig. 1. Cluster analysis (based on Ward's method) for five selective factors of some plum cultivars

of total variance. Pulp and peel color, and fruit bearing organ type explained 8.28% of variance in fifth factor. Factor analysis had great potential to differentiate the highlighted distinctions between studied genotypes (Kaufmane et al., 2002; Ogasanovic et al., 2007). Since in the present experiment most of the studied traits were related to the fruits and flowers, the majority of the encountered variations were explained by these two organs.

Cluster analysis

In the present study cluster analysis was carried out based on 5 main factors which demonstrated 76.31% of total variance.

At 9 distances, genotypes were categorized into 4 main groups with differences in fruit shape, flower opening time, fertility type, stone shape, and stone clinging (Figure 1). First group was distinguished with distinct fruit shape and round stone. In this group, flower opening occurred sooner than other genotypes but self-fertility was lower than others. The fourth group was characterized with spindle shaped fruits and stretched stones. This group was in bloom later and had higher self-fertility compared with other genotypes (Arbeloa et al., 2006; Ertekin et al., 2006). Other groups were in medium range regarding these traits.

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