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Morphometric features of local and foreign female pistachio cultivars and ecotypes in northeast Tunisian conditions

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Abstract. In the framework of the Tunisian pistachio research program, a number of orchards were created in different bio-climatic areas of the country. Local and foreign cultivars and ecotypes were planted to study their environmental adaptation, agronomic performance and nut quality. This study was performed in one of these orchards at the INRAT Unity of Agricultural Experimentations of Mornag. Local (7) and foreign (5) cultivars and ecotypes were installed since 1989 under rainfed conditions. Local accessions are 'Mateur', 'Meknassy', 'Guermazi', 'El Guettar', "6/6", "8/7" and "28/4", and foreign accessions are 'Amiri', 'Jawad', 'Lassen', 'Ohadi' and 'Mumtaz'. Growth habit, vigor, yield and nut weight and size were evaluated during 2014. The growth habit of studied accessions was semi-erected or spreading. 'El Guettar', 'Guermazi', and the "8/7" ecotypes were the most vigorous whereas 'Ohadi' and 'Amiri' exhibited the lowest tree vigor. The fresh nut yield per tree varied between 0.43 and 23.4 kg. Foreign cultivars exhibited the lowest nut yields. It seems to be the consequence of their low adaptation. The "28/4" accession had the longest in-shell nut size while 'Jawad' nuts were the widest.

Key words. *Pistacia vera* – Cultivars – Ecotypes – Yield – Nut weight – Nut size.

Caractéristiques morphométriques de variétés et écotypes locaux et étrangers de pistachier femelle dans les conditions du nord-est tunisien

Résumé. *Dans le cadre du programme de recherche sur le pistachier en Tunisie, plusieurs vergers ont été créés dans le pays. Des variétés et écotypes locaux et étrangers ont été plantés pour étudier leur adaptation, leur performance agronomique et la qualité de leurs fruits. Cette étude a été réalisée dans l'un de ces vergers à l'Unité d'Expérimentations Agricoles de l'INRAT à Mornag. Sept accessions locales ('Mateur', 'Meknassy', 'Guermazi', 'El Guettar', "6/6" , "8/7" et "28/4") et cinq introduites ('Amiri', 'Jawad', 'Lassen', 'Ohadi' et 'Mumtaz') ont été installées depuis 1989 dans des conditions pluviales. Le port de l'arbre, la vigueur, le rendement ainsi que le poids et la taille du fruit ont été évalués au cours de l'année 2014. Les accessions étudiées avaient un port semi-érigé ou étalé. 'El Guettar', 'Guermazi' et "8/7" étaient les plus vigoureux alors que 'Ohadi' et 'Amiri' étaient les moins vigoureux. Le rendement en fruits frais par arbre a varié de 0,43 à 23,4 kg. Les plus faibles rendements ont été enregistrés chez les variétés étrangères ce qui semble être la conséquence de leur faible adaptation. Les fruits en coque l'accession " 28/4" étaient les plus longs alors que ceux de 'Jawad' étaient les plus larges.*

Mots-clés. Pistacia vera – *Cultivars – Ecotypes – Production – Poids du fruit – Taille du fruit.*

I – Introduction

The heterozygosis and dioecy of *Pistacia vera* resulted in great genetic diversity. Many producing countries have studied these inter and intra-specific variability (Ghrab *et al*., 2010 and 2012, Kaska *et al*., 2006) to select suitable cultivars for specific growing conditions (Aktug Tahtaci *et al*. 2011, Vargas *et al*., 1997). The Tunisian agricultural services and the INRAT fruit tree Laboratory have encouraged, since 1935 and later in 1950, the farmers to grow pistachio (Jacquy, 1973). Tunisian

pistachio research gained more interest in the 1960's and 1970's years in the framework of the NUDP-FAO projects and the official agricultural services. Being aware of cultivars diversification impact on their adaptation, productivity and nut quality, local and foreign cultivars and rootstocks were planted in several geographic areas of the country to study their behaviors in these growing conditions. The most popular Tunisian cultivar and its two pollinators 25A and 40A were selected in 1974 and 1979, respectively. However, these cultivars have variable performances throughout cultivation areas (Chelli-Chaabouni *et al*. 2014). The aim of this study was to assess the performance and fruit quality of local and foreign (Iranian) *Pistacia vera* accessions growing in the North-east of Tunisia to select potential suitable cultivars for these environmental conditions.

II – Materials and methods

This study was carried out using 7 local and 5 foreign pistachio cultivars and ecotypes growing in the pistachio orchard of the Agricultural Experimentation Unity of the INRAT (National Institute of Agricultural Research of Tunisia) at Mornag (northern Tunisian area). This location has semi-arid Mediterranean climatic conditions with annual rainfall average of 450 mm. Twenty-five year old trees, grafted onto *P. vera* rootstock were growing under rainfed conditions with a spacing of 7 x 8 m. Visual evaluation was adopted to determine growth habit and tree vigor. Growth habit was defined according to the IPGRI Descriptors for *Pistacia vera* L. (IPGRI, 1997). Tree vigor was ranged in three classes: High, Medium and Low. Trees were harvested at the end of August 2014 at the maturity of the reference 'Mateur' cultivar and yield/tree was measured. The weight of in-hull and hulled fresh nuts, in-shell dry nuts and dried kernels were determined. The size (length (L), width (W) and thickness (T) of in-hull and in– shell nuts, and kernels was measured using a digital caliper. The geometric mean diameter and sphericity of nuts and kernels were calculated according to Mohsenin (1980) equations. Data were submitted to one-way ANOVA using SPSS software for Windows version 20. The multiple range test of Duncan was used for mean comparison. Cluster analysis was used to display the hierarchical classification of the studied accessions.

III – Results and discussions

Growth habit is an important trait to be considered in orchard management. It influences many physiological processes that have an impact on yield and nut quality. In this study, table 1 showed that all Tunisian pistachio accessions as well as 'Amiri' and 'Jabberi' Iranian accessions were spreading while 'Lassen', 'Jawad', 'Ohadi', and both 'Mumtaz' accessions "19/4" and "22/3" were semi-erect. Local accessions were characterized by high and medium vigor. 'El Guettar', 'Guermazi' and the "8/7" accession were particularly vigorous while 'Mateur', 'Meknassy', and "6/6" and "28/4" accessions had medium vigor. Among Iranian accessions, 'Jawad' was the most vigorous while 'Lassen', 'Ohadi' and 'Amiri' exhibited lower vigor. This evaluation is in part different from that of Rouskas (2002) in Greece environmental conditions who found that 'Mateur' accession was highly vigorous.

The local accessions showed a significantly higher yield per tree (Table 2). The average yields of all harvested trees were ranged between 0.43 and 23.4 kg. The local accession "8/7" gave the highest production followed by 'El Guettar' and 'Guermazi'. Foreign accessions yields did not exceed 2.4 kg/tree ('Amiri'). These results are not consistent with those found on 'Mateur' and 'Ohadi' in south-east conditions (Ghrab *et al*., 2005). Overall, in-hull and in-shell nut fresh weight of local accessions were low in comparison with foreign accessions. However, the in-shell/in-hull fresh weight ratio values of 'Mateur' and "6/6" accessions were significantly higher than 'Amiri' and 'Mumtaz' "19/4" accessions despite of the highest in-hull fresh weights of these latter. 'Amiri', 'Jawad' and 'Mateur' exhibited the highest in-shell dry weights among all studied accessions.

Table 1. Origin, growth habit, and vigor of accessions

Acs	N°	Origin	GH	Vigor	Acs	N°	Origin	GH	Vigor
'Mateur'	–	Tunisia	Spreading	Medium	Lassen	25/1	Iran	Semi-erect	Low
'El Guettar'	"3/5"	Tunisia	Spreading	High	Jawad	24/1	Iran	Semi-erect	High
'Meknassy'	–	Tunisia	Spreading	Medium	Ohadi	14/7	Iran	Semi-erect	Low
'Guermazi'	–	Tunisia	Spreading	High	Amiri	15/6	Iran	Spreading	Low
Local accession	"6/6"	Tunisia	Spreading	Medium	Mumtaz	19/4	Iran	Semi-erect	Medium
Local accession	"8/7"	Tunisia	Spreading	High	Mumtaz	22/3	Iran	Semi-erect	Medium
Local accession	"28/4"	Tunisia	Spreading	Medium					

Acs: Accessions, GH: Growth habit.

Table 2. Yield average per tree (kg) and fruit weight (g): in-hull and in-shell fresh weight (FW), and In-shell dry weight (DW)

Accessions	Yield/tree	In-hull FW	In-shell FW	In-shell/in-hull FW	In-shell DW
'Mateur'	5.5^{c}	2^{bc}	1.2^{cd}	0.6^{ab}	0.9^{bc}
'El Guettar'	13.7^{b}	1.6^{d}	0.9^{ef}	0.6^{cd}	0.7^{ef}
'Meknassy'	6.1^{c}	2.1^{b}	1.2^{cd}	0.6^{b-d}	0.9^{b-d}
'Guermazi'	12.8^{b}	1.5^{d}	0.9^{f}	0.6^{b-d}	0.7^{ef}
'LA 6/6'	10.5^{b}	1.8^{cd}	1.1^{cd}	0.7^{a}	0.9^{b-d}
'LA 8/7'	23.4^{a}	1.8^{cd}	1.1^{de}	0.6^{bc}	0.8^{cd}
'LA 28/4'	11.5^{b}	2.1^{bc}	1.2^{cd}	0.6^{bc}	0.8^{cd}
'Lassen'	0.5^{d}	2.2^{b}	1.3^{bc}	0.6^{bc}	0.8^{de}
'Jawad'	0.8^{d}	2.7^{a}	1.6^{a}	0.6^{bc}	1^{ab}
'Ohadi'	2.2^{cd}	2.2^{b}	1.3^{cd}	0.6^{b-d}	0.9^{b-d}
'Amiri'	2.4^{cd}	2.8^{a}	1.6^{a}	0.6^{cd}	1.1^{a}
'Mumtaz 19/4'	2^{cd}	2.7^{a}	1.5^{ab}	0.6^{d}	0.9^{b-d}
'Mumtaz 22/3'	0.4^{d}	2^{bc}	1.1^{cd}	0.6^{b-d}	0.6^{f}

LA: Local accession. For the same parameter, different subscript letters mean significant differences (Duncan test; $p<0.05$) among accessions.

The size measurements data of in-hull fruits showed that 'Lassen' and 'Mumtaz' "19/4" had the longest and widest fruits while 'Guermazi' and "6/6" local accessions had the lowest fruit lengths. The "8/7" fruit accession had the lowest width and thickness (Table 3). Among the studied in-shell nuts, those of the "28/4" accession were the longest while 'Jawad' nuts were the widest. 'Guermazi' had the lowest nut length and width and 'Meknassy' nuts had the lowest thickness. 'Amiri' kernels were the longest and thickest. The "28/4"accession and 'Meknassy' nuts were ranged between the most long and wide. Those parameters could be interesting in fresh fruit market. The "8/7" accession nuts were the widest. 'Mumtaz' "22/3" accession had the smallest kernels in all size parameters (Table 3). Except of this latter accession, Iranian accessions had, generally, bigger nuts than Tunisian ones. These results are similar to those of Karaca and Nizamoglu (1995) describing Iranian varieties as having bigger sizes than Turkish ones.

Hierarchical classification of all accessions was established according to fruit characteristics described in tables 2 and 3 in addition to fruit mean diameter and sphericity values (data not shown). Apart from the "8/7" local accession that was the most distant from all other accessions, hierarchical cluster analysis subdivided the 12 remaining accessions into two major groups. The first group included foreign accessions 'Jawad', 'Amiri', 'Ohadi', 'Lassen', and 'Mumtaz' "19/4" and "22/3". The second one was

Table 3. In-hull, In-shell and kernel size in mm

	In-hull			In-shell			Kernel		
Accessions	**FL**	**FW**	**FT**	**FL**	**FW**	**FT**	**K L**	**K W**	**K T**
'Mateur'	24.1^{bc}	13.2^{d}	11.9^{cd}	19.8^{cd}	10.6^{c}	9.5^{cd}	15.1^{b}	7.8^{a-c}	7.7^{b-d}
'El Guettar'	22.7^{d}	13.1^{de}	11.4^{de}	18.3^{f}	10.6^{cd}	8.8^{de}	15.5^{ab}	8.5^{a}	7^{c-e}
'Meknassy'	23.1^{c}	13.6^{cd}	11.6^{cd}	20^{b-d}	10.9^{c}	8.7^{e}	16.2^{ab}	8.6^{a}	7.6^{b-d}
'Guermazi'	21.1^{d}	12.8^{de}	11.2^{d-f}	16.9^{g}	9.6^{e}	7.6^{f}	15.2^{a-c}	8.3^{ab}	6.7^{de}
'LA 6/6'	21.4^{d}	11.4^{f}	10.8^{ef}	18.3^{f}	10de	9.3^{c-e}	14.9^{bc}	7.4^{cd}	7.5^{cd}
'LA 8/7'	21.4^{d}	12.3^{e}	10.7^{f}	18.6^{ef}	10.7^{cd}	8.9^{de}	15.6^{a-c}	8.7^{a}	7^{c-e}
'LA 28/4'	23.2^{c}	13.5^{cd}	11.8^{cd}	21.4^{a}	11.6^{b}	9.8^{c}	16.4^{ab}	8.6^{a}	7.6^{b-d}
'Lassen'	25.8^{a}	15^{a}	13.5^{ab}	21.3^{a}	12.9^{a}	11.2^{ab}	15^{bc}	7.5^{b-d}	7.1^{c-e}
'Jawad'	23.6^{bc}	14.3^{a-c}	13.7^{ab}	20.8^{a-c}	12.3^{ab}	11.6^{a}	16.1^{ab}	7.9^{a-c}	7.9^{a-c}
'Ohadi'	21.8^{d}	13.4^{d}	13.1^{b}	19.4^{de}	11.7^{b}	11.1^{ab}	15.8^{ab}	8.1^{a-c}	8.6^{ab}
'Amiri'	24.4^{b}	14.5^{ab}	14.1^{a}	21.3^{a}	12.9^{a}	11.4^{ab}	17.3^{a}	8.4^{a}	8.8^{a}
'Mumtaz 19/4'	25.6^{a}	14.8^{a}	13.8^{ab}	21.0^{ab}	12^{b}	10.8^{ab}	16^{ab}	7.5^{bc}	7.2^{c-e}
'Mumtaz 22/3'	23^{c}	13.7^{b-d}	12.2^{c}	19.7^{d}	12.2^{ab}	10.7^{b}	13.6^{c}	6.6^{d}	6.2^{e}

For the same parameter, different subscript letters mean significant differences (Duncan test; p<0.05) among accessions. LA: Local accession, FL: Fruit length; FW: Fruit width; FT: Fruit thickness; KL: Kernel length; KW: Kernel width; KT: Kernel thickness.

composed by the local accessions 'Mateur', 'Meknassy', 'El Guettar', 'Guermazi', and both accessions "6/6" and "28/4". The most closely related accessions were, in pairs, 'Jawad' and 'Amiri'; 'Lassen' and 'Mumtaz' "19/4"; 'Mateur' and 'Meknassy'; and 'El Guettar' and 'Guermazi'. The 'Mateur' reference accession was located at mid-distance between foreign and local accessions. On the opposite sides, 'Jawad' and "28/4" were the most distant accessions from 'Mateur' reference cultivar.

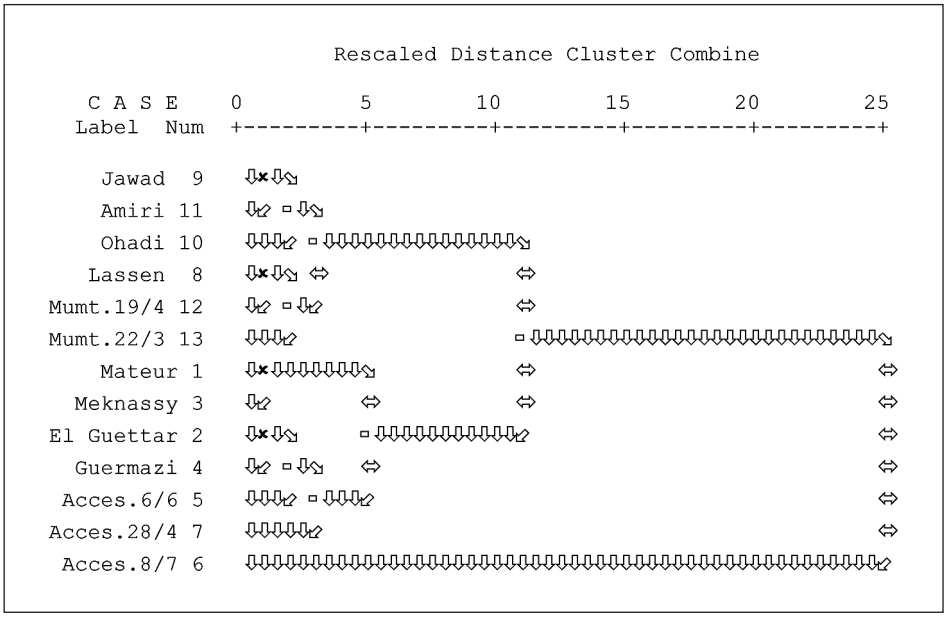

Fig. 1. Dendrogram using average linkage between groups according to fruit characteristics.

These preliminary results revealed the great adaptation of local accessions to the north-east Tunisian conditions in comparison with Iranian accessions. It should be pointed out that nut size of the studied foreign accessions showed good characteristics despite having been harvested before full maturity. This experiment is scheduled to continue for more few years for better evaluation results.

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