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# Morphometric characterization of plum (*Prunus domestica*.L) in the far west of Algeria

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**Abstract**

As part of the characterization morphometric and identification of 25 varieties of plum (*Prunus domestica*.L), we have undertaken prospecting and collection of plant material through five different agroecological regions from the far west of Algeria (Wilaya of Tlemcen and Wilaya of Naama). We studied 24 agromorphological characters, were the objects of a statistical study to determine phenotypic diversity of quantitative and qualitative traits. The results of the ANOVA, the Hierarchical Classification (CAH), Multiple Component Analysis (MCA) and Chi-Square Tests showed a clear distinction between the accessions, and significant phenotypic variability is recorded for the characteristics studied such as (length and width of leaves, time of start of fruit ripening, size of the fruit).

**Keywords:** morphometric charaterization, plum tree (*Prunus domestica*.L) , far west of Algeria.

## Introduction

A plum or gage is a stone fruit tree in the family Rosaseae of *Prunus* genus, is naturally distributed in the temperate regions of the Northern Hemisphere with some species occurring in the tropical and subtropical regions. (Mabberley, 2008).

According to the derivative systems of these polyploids, *Prunus domestica* L. (6x), one of the European plums, is considered to be derived from natural cross between *Prunus spinosa* L. (4x) and *Prunus cerasifera Ehrh* (2x). The term Japanese plum was applied originally for *Prunus salicina Lindl*. (2x) (Okie and Weinberger, 1996).

Plum has been cultivated for over 2000 years ago throughout the world and has an attractive colored fruit which are consumed both in fresh and processed form. Plum puree, paste, sauce, juice concentrate and prunes are some of the common processed products. The fruits are also dried and in developed countries, 50% of the produce is operated for processing, whereas commercial utilization of plums in the developing countries is minor (Ahmed et al., 2004). Plum fruit tastes sweet and/or tart; the skin may be particularly tart. It is juicy and can be eaten fresh or used in jam-making or other recipes.

Dried plums (or prunes) are also sweet and juicy and contain several antioxidants. Plums are known for their laxative effect. This effect has been attributed to various compounds present in the fruits, such as dietary fiber, sorbitol and isatin. Prunes and prune juice are often used to help regulate the functioning of the digestive system. (Shaymaa H et al., 2015).

In plum, varieties with dark purple colored skin showed 200% higher total phenolic than others (Rupasinghe et al., 2006). Plum species and cultivars are quite diverse in fruit characteristics such as size, shape, color, texture, aroma and quality. Plant characteristics are also very diverse, ranging from shrubs to large trees, spreading to upright, thick to thin leaves, and early to late blooming (Shaymaa H et al., 2015).

*Prunus* identification at the species level with traditional archaeobotanical methods is difficult due to the morphological range variation within the different taxa (Woldring, 2000; Pollmann et al., 2005; Depypere et al., 2007). According to Horvath et al. (2011), the taxonomic classification of *Prunus* is generally done on the phenotypic characteristics of their flowers and fruits.

Our objective of this research is to identify and morphometrically characterize varieties of plum (*Prunus domestica* L.) in the far west of Algeria in order to better manage and improve this phytogenetic resource, this can lead to an improvement in the production in quality and / or quantity of this fruit.

## Materials and Methods

*Study area*

In this study, 25 populations from five different agroecological regions (Tell, mountain, interior plain, and steppe) of plum trees were studied (Table 01). The collection was made in 2019 in the regions of Tlemcen (Ain Nehala, Maghnia, Ghazaouet, Henaya) and Naama (Sedrat Leghzel) (figure 01).

**Figure 1.** Location of different farmers' fields collection sites in western Algeria: Tlemcen and Naama.

**Table 1.** Origin of the accessions studied, and the characteristics of the sites prospected.

| Regions | Localisation | Longitude | Latitude | Altitude |
|---|---|---|---|---|
| Tlemcen | Ain Nehala | 0°58’16.9’’W | 35°00’27.7’’N | 658 m |
| | Maghnia | °146’18.1’’W | 34°50’34.5’’N | 403m |
| | Ghazaouet | 1°48’53.2’’W | 35°03’10.7’’N | 75m |
| | Henaya | 1°23’38.9’’W | 34°57’22.4’’N | 388m |
| Naama | Sedrat laghzal | 0°21’49.0’’W | 33°14’30.0’’N | 1177m |

*Plant materials*

The research focused on 5 cultivars of plum (*Prunus domestica* L.) from different agroecological regions (Tell, mountain, interior plain, and steppe). Each of them was represented in the collection by 5 plants grafted on the same rootstock of *Prunus dulcis* (Bitter Almond).

*Character observation*

Twenty-four agro-morphological characters (quantitative and qualitative) have been registered on the basis of international descriptors (UPOV 2002) in the table 2.

Table 02. **Character observation and their abbreviation**

| **Characters** | **Abbreviation** |
|---|---|
| Tree vigor | TV |
| Density of crown | DC |
| Time of beginning of flowering | TF |
| Attitude of sepals | AS |
| Sepal shape | SS |
| Arrangement of petals | AP |
| Petal shape | PS |
| Leaf blade shape | LS |
| Shape of leaf base | SL |
| Green color of upper side leaf | CL |
| Leaf attitude in relation to shoot | LA |
| Leaf incisions of margin | LM |
| Time of beginning of fruit ripening | TF |
| Fruit size | FS |
| Fruit shape in lateral view | FSL |
| Color of skin fruit | CSF |
| Color of flesh fruit | CFF |
| Stone shape in lateral view | SL |
| Stone shape in ventral view | SV |
| Development of keel stone | KS |
| Texture of lateral surfaces of stone | TS |
| Shape apex of stone | SAS |
| Leaf length | LL |
| Leaf width | LW |

*Data analysis*

Each character was categorized into specific class states. The 22 qualitative and 2 quantitative characters were assigned to classes based on characteristic number quoted from UPOV (Union for the Protection of New Varieties of Plants).

*Analysis of variance (ANOVA)*

Analysis of variance (quantitative parameters) was used to calculate variation among accessions, using the GensStat discovery program, Edition 3.

*Hierarchical Ascendante Classification (HAC) and Multiple -Component Analysis (MCA)*

Hierarchical Ascendante Classification or cluster analysis, was used to calculate the mean data and classify the 25 accessions of plum (*Prunus domestica* L.) using MATLAB R 2014a; the application of a multiple Components Analysis (MCA) as a Multivariate analysis model was done using the MATLAB R 2014a in order to group the homogeneous individuals with the qualitative characters.

*Chi-square tests*

Chi-square tests was performed using the SPSS Statistics,21 to interpret the relation between qualitative characters.

## Results and discussion

The effect of the genotype × environment interaction on the length and width of plum leaves was statistically significant at p-value <0.001 (Table 03).

The average lengths of plum leaves vary between 5.92 cm and 6 cm with standard error 0.16 cm and 0.34 cm for the mountainous regions like Ain Nehala and Henaya, and between 4.49 cm and 4.90 cm with standard error 0.09 cm and 0.20 cm for the tellian plain (Maghnia and Ghazaouet), however those of the steppe of Naama are longer with an average of 8.38 cm and 0.35cm standard error. (Figure 02).

The average widths of plum leaves are: 2.80 cm and 2.77 cm with standard error of 0.10 cm and 0.22 cm for the regions of Ain Nehala and Henaya; 1.93 cm and 1.65 cm for the regions of Maghnia and Ghazaouet with 0.06 cm and 0.07 cm standard error, infact, the average value found in the region of Naama is equal to 4.23 cm and 0.21 cm standart error. (Figure 03).

The dendrogram (Figure 04) shows heterogeneity of qualitative characteristics; where we have determined three main classes, perfectly distinguished by the shape and color of the fruit as well as the time of their maturity;

The first class contains the mountainous regions as Ain Nehala**,** this region is represented by a time of maturity of late fruits and fruits of oval shape and purple color. (Figure 06).

The second class is Ghazaouet a coastal town over the mediterraneen that characterized by red fruits and a period of early maturity. (Figure 07).

The third class includes the majority of the regions: Henaya, Maghnia and Naama which are characterized by fruits yellow and a normal period maturity of fruits. (Figure 08 & 09).

*Multiple Component Analysis (MCA)* (Figure 05) was performed on qualitative measurements. The result of this analysis showed that these variables presented 51,44 % of the total inertia on both axes (Dim1 and Dim2), which is average, we observe at the MCA in figure 07 that a correlation equal to one means that all the representatives of the characters are perfectly superimposed. This is the case for characters Fruit shape in lateral view (FSL), Stone shape in ventral view (SV), Texture of lateral surfaces of stone (TS); and a correlation slightly less than one means that some points are superimposed and others are far apart, this is the case with the characters: Time of beginning of flowering (TF), petal shape (PS).

*Chi-Square Tests:* Crosstabulation between petal shape and fruit ripening showed significant results with p-value < 0,05 (Table 04), who explain that there is a significant difference between these characters: plum trees with flower petals in oval shape give precocious fruit and plum trees with elliptical flower petals give late fruit.

According to (Vander Mijnsbrugge and al.,2013) there was a small but significant relationship between endocarp and leaf morphology (electronic appendix 5, linear regression with R2 of 0.12, p= 0.001): rounded endocarps correlated with relatively wider leaves whereas elongated endocarps correlated with relatively narrow leaves.

**Table 03**. Effect of the environment and / or genotype on the length and width of plum leaves

| | | *p-value < 0,001* | *p-value < 0,001* |
|---|---|---|---|
| **Régions** | **Variables** | **Leaf length *** (Average ± e.s)*** | **Leaf width *** (Average ± e.s)*** |
| Ain Nehala | | 5,92 ± 0,16 [a] | 2,80 ± 0,10 [a] |
| Maghnia | | 4,49 ± 0,09 [b] | 1,93 ± 0,06 [b] |
| Ghazaouet | | 4,90 ± 0,20 [b] | 1,65 ± 0,07 [b] |
| Henaya | | 6,00 ± 0,34 [a] | 2,77 ± 0,22 [a] |
| Naama | | 8,38 ± 0,35 [c] | 4,23 ± 0,21 [c] |

*** : Highly significant statistical test (*p-value* < 0,001) at a level of significance α = 0,05.
* Separate letters indicate significant differences between means according to the "Duncan" separation of means test at significance level α = 0.05.

**Table 4**: Cross Tabulation of petal shape * fruit ripening (Chi-Square Tests)

Petal shape * fruit ripening Crosstabulation

| | | Fruit ripening | | | Total |
|---|---|---|---|---|---|
| | | precocious | average | late | |
| Petal shape | elliptical | 0 | 0 | 3 | 3 |
| | wide elliptical | 5 | 10 | 2 | 17 |
| | oval | 5 | 0 | 0 | 5 |
| Total | | 10 | 10 | 5 | 25 |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 22,059[a] | 4 | ,000 |
| Likelihood Ratio | 21,335 | 4 | ,000 |
| Linear-by-Linear Association | 10,964 | 1 | ,001 |
| N of Valid Cases | 25 | | |

*a7 cells (77,8%) have expected count less than 5. The minimum expected count is ,60*.

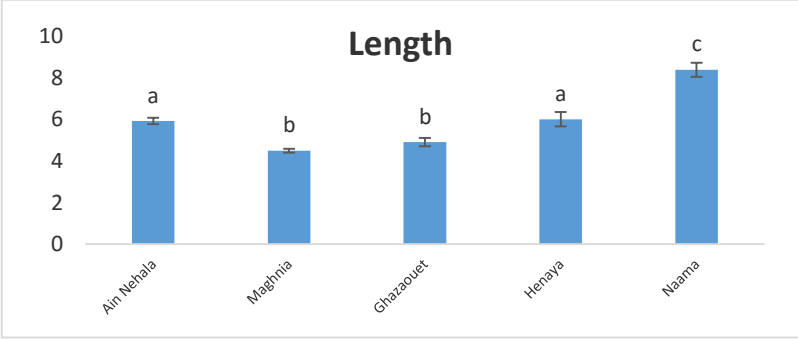


**Figure 2**. Effect of environment and / or genotype on the length of plum leaves.
*(The bars with different letters indicate a significant difference between the means (l.s.d) according to the ANOVA statistical test at a significance level (5%) The vertical bars show the standard error of the mean).*

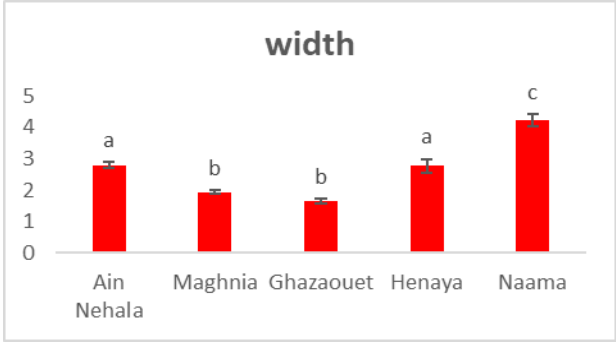


**Figure 3**. Effect of environment and / or genotype on plum leaf width.
*(The bars with different letters indicate a significant difference between the means (l.s.d) according to the ANOVA statistical test at a significance level (5%) The vertical bars show the standard error of the mean).*

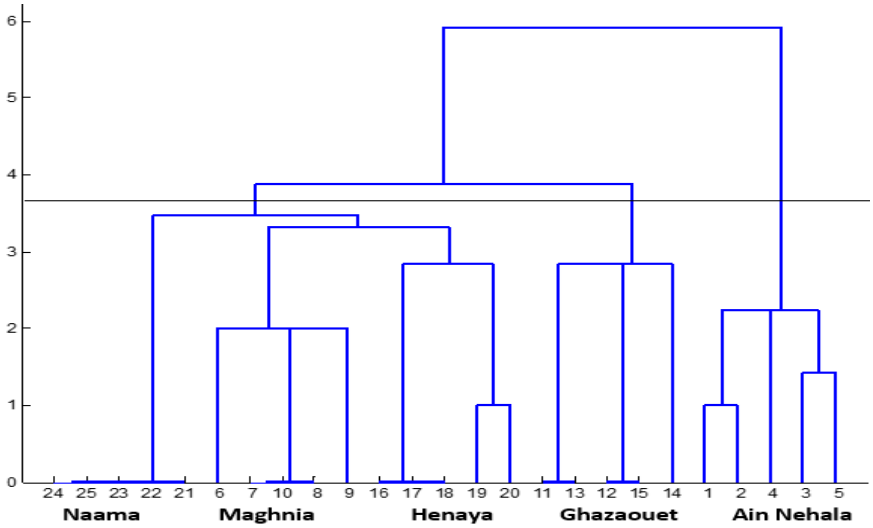


**Figure 4**. Hierarchical ascending classification (HAC) for the qualitative characteristics of plum trees.

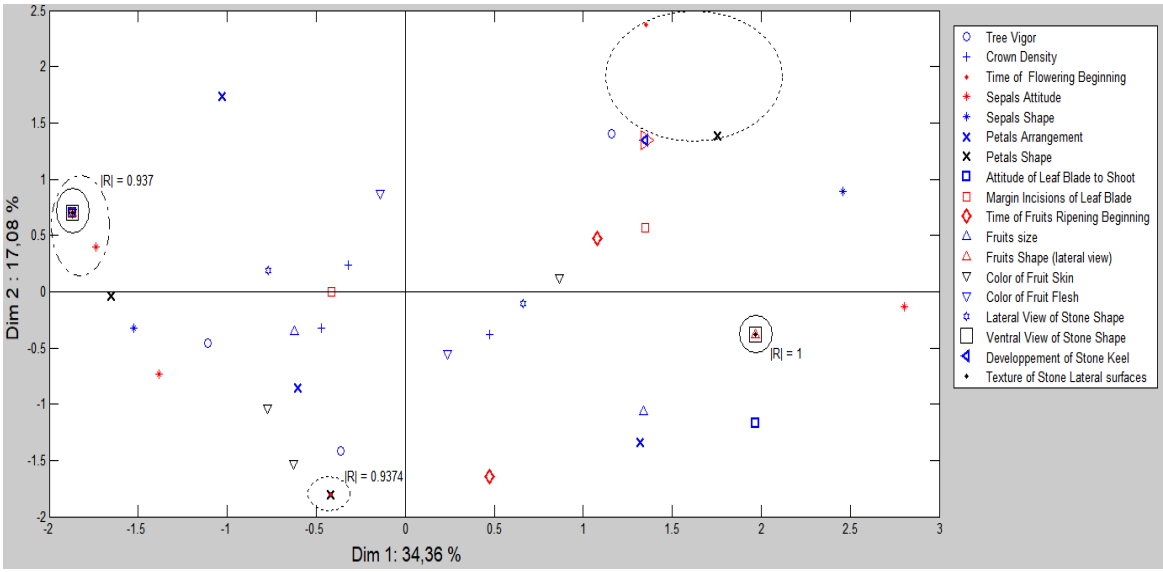


**Figure 5**. Multiple Component Analysis (MCA) for the qualitative characteristics of plum trees.

**Figure 6.** Plum fruit Ain Nehala

**Figure 7**. Plum fruit Ghazaouet

**Figure 8**. Plum fruit Maghnia

**Figure 9**. Plum fruit Henaya & Naama

**Figure 10**. Plum blossom

## Conclusion

It's the first time where researcher do morphometric characterization on this resource. In this work we have studied the biodiversity of the plum tree in the extreme West of Algeria. The samples were taken from five regions spread over two different wilaya from an agroecological point of view Tlemcen (mountainous area, coastal town, tellian plain with a Mediterranean and semi-arid climate) and Naama (steppe with a hot Mediterranean climate with dry summer). During our experiments, this work has shown that a significant phenotypic variability is recorded for the characteristics studied such as: (length of leaves, width of leaves, time of start of fruit ripening, size of the fruit, fruit: background color skin, fruit: flesh color, Stone: texture of the lateral surfaces, Stone: shape in ventral view). The results of ANOVA (quantitative traits), Ascending Hierarchical Classification (AHC) , multiple Components Analysis (MCA) and Chi-square tests (qualitative traits) showed a clear distinction between plum accessions. Througth this study it's apear that the caracters : Sepal: shape , Flower: arrangement of petals, Time of beginning of fruit ripening , Fruit size and Fruit: color of flesh are very important to choose like a key of varietal identification. In the future we hope do this work on more varieties, prospect more regions, used more morphometric characters and do molecular characterization.

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