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VARIETAL VARIABILITY OF ARGAN TREE FOLIAGE *ARGANIA SPINOSA* (L) SKEELS IN VARIOUS BIOCLIMATIC STAGES IN ALGERIA

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Abstract

The study of the morphological difference of 628 leaves of the argan tree *Argania spinosa* (L.) Skeels was carried out by subjective sampling after a period of field data collection in spring 2017 through the various wilayas: Mascara, Mostaganem, Algiers, Bechar, Adrar, Tindouf. The objective was a varietal identification of foliage through the bioclimatic stages. However a measurement of two biometric criteria (length and width) was carried out, which shows a differentiation of forms between the samples studied by the significant differentiation at which with a low correlation $R^2 = 27.2\%$, the effect of climate on the shape of the leaves is noticeably well represented.

Keywords: Argan tree. Leaf. Morphometry. Varietal diversity. Bioclimate. Algeria.

Introduction

Argania spinosa (L.) Skeels, the only representative of the Sapotaceae family in North West Africa (Boudy, 1950; Peltier, 1983; Kechairi & Abdoun, 2016). This Moroccan-Algerian endemic (Peltier, 1983), is a survivor of tertiary flora (Nouaim *et* al. 1991). The argan tree plays an important ecological role in forestry, fodder and fruit. So, it is a multipurpose tree where every part is usable.

The argan tree, a xerothermophilous species (Fennane & Ibn Tattou, 2012) has a tropical affinity (Ozenda, 1975 ; Mhirit et al. 1998; Smedmark et al. 2006; Sanmartín et al. 2010). He is able to adapt to the arid conditions of his field of distribution (Boudy, 1952). He lives in a complex bioclimate where oceanity, mountain and desert combine (Mhirit & Blérot, 1999). It has an ecological amplitude since it is inserted between the sea level and 1400 m of (Benabid & Fennane, 1999; Benabid, 2000). It occurs in hot and temperate arid and semi-arid bioclimates on all types of geological substrates and in average annual rainfall between 100 and 400 (Emberger, 1938; Achhal et al. 1980; Benabid, 1986; Benabid, 2000). Being xerophilic, the argan tree is satisfied with a slice of rainfall plus deficit in Tindouf of about 45 mm/year (Kechairi, 2009). Also thermophilic supports the Saharan heat up to 50 °C (Thierry, 1987; Kechairi, 2009). It privileges the oceanic humidity that is fulfilled its southern and Eastern limits of the populations in the south-western Morocco towards the interior of continent determines its southern border to 222 km taking into account the Eastern limit about 28°N, thus we take an argan tree orchard 90 km south of nature reserve to the forest conservation nursery of Tindouf.

In Algeria there is only a lot of work on the species (Kechairi, 2009), compared with the progress of the immense multidisciplinary research carried out in Morocco. The lack of a thorough knowledge of the

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species in Algeria, we encourage research on its varietal diversity through an analysis of the morphometry of the leaves, in order to find a relationship between the argan tree and its environment, either by ecotypic adaptation or genes that seem to be responsible for the morphological differentiation of the subjects observed in various regions of the country.

Materials and methods

Region of study

Currently, argan tree planting trials are being done throughout Algeria (Kechairi et al. 2017), so the study areas considered in our work (Table 1) do not result in all the plantation of the country. Then, Table 1 represents the geographic coordinates of study regions:

Table 1. Geographic coordinates of the study areas.

Study zone	Geographic coordinates	Altitude (m)
Mostaganem (Stidia)	35°52'17.8"N 0°15'54.2"E	120
Mascara (Oggaz)	35°33.8226'N 000°15.4046°W	590
Tindouf	28°40'10.9"N 8°15'41.6"W	449
Tindouf city	28°00'43.8"N 8°15'41.6"W	449
Bechar	31°45'23.7"N 2°14'23.4"W	780
Timimoun	29°33'17.1"N 0°09'18.7"E	281
Adrar city	27°51.1489'N 000°18.8027'W	279
Algiers (El Harrach)	36°42'03.9"N 3°08'30.9"E	186

Methodology

The study of the morphometric diversity of the argan tree in Algeria is part of the research work of Mr. Kechairi Reda. Which we treat partially to the present the morphometric diversity of the argan leaves (taking two measured morphological criteria, the length and the width) after a period of collection of data on ground during the spring of 2017, through the various wilayas: Mascara, Mostaganem, Algiers, Bechar, Adrar, Tindouf (Beladjmi, 2017), generating successful seedling planting sites in north, northwest and southwest Algeria. Then, for the argan plantation of Tindouf, an exit on ground was carried out within the natural reserve of the argan tree in the northwest of the wilaya of Tindouf. However, this work was done after having technical support from many organizations from different regions of Algeria (forest conservations of: Béchar, Tindouf, Mostaganem, and Mascara, as well as the National Forest Research Institute INRF of Adrar, ITMAS Institute of Technology Specialized Agricultural Middle of Timimoun and the Botanical Garden of the National Agronomic School of Algiers).

We collected plant material from a total of 21 tree subjects inventoried by subjective sampling, which allowed us to select representative subjects from each study station. However, our method of work consists of a foliage sampling, and different sizes taken during the realization of field trips. So, the material was packaged under preservation to keep it fresh, and then brought to the laboratory, where we made the biometric measurements of the leaves. During this work was used the ruler and caliper for biometric measurements, and the electronic scale for weight.

Synthèse bioclimatique

For a period of 30 years of meteorological data, particularly temperature and precipitation, we interpret the bioclimatic situations of study areas where the argan tree develops after a successful experimental afforestation, which indicates a good acclimation of the species in the Saharan regions, arid and semi-arid.

The Emberger climagram makes it possible to determine the bioclimatic stage of a given station. It is determined from the formula:

$$Q2 = 2000P/ M^2 – m^2$$

- P: annual precipitation (mm);
- M: the maximum temperature of the hottest month in degrees Celsius (° C);
- m: the minimum temperature of the coldest month in degrees Celsius (° C);
- According to Stewart (1968) for Algeria and Morocco, applying the following formula:
- Q2 = 3.43 (P / M-m)
- Q: the rainfall quotient of Embrerge;
- P: Average annual rainfall in mm;
- M: Maximum average of the hottest month in Kelvin degrees (T ° C + 273.15);
- m: Minimum average of the coldest month in Kelvin degrees (T ° C + 273.15).

Results and discussion

Bioclimatic synthesis

Table 2 represents the two main bioclimatic data (Precipitation and temperature) to determine the bioclimatic stages of our study areas.

Table 2. Climatic data (P mm and T ° C) for the period (1986-2016).

Region	P (mm)	T (°C) Max	T (°C) min	Q2
Tindouf	60.3	43	7	6.55
Adrar	33.5	49	5	2.61
Mascara	303.2	34	4	34.66
Mostaganem	371.1	35	10	50.91
Algiers	557.6	31	9	50.33
Bechar	106.3	40	2	9.59

The Emberger climacteric specigal to the Mediterranean region, and applicable for the Saharan regions. It represents the bioclimatic situation of each study area where the argan tree has been well acclimatized, therefore, the wilayas Tindouf, Adrar and Bechar are located in the Saharan bioclimatic study, while the region of Mascara is in the floor arid, for Mostaganem and Algiers are classified in the semi-arid bioclimatic stage (Figure 1).

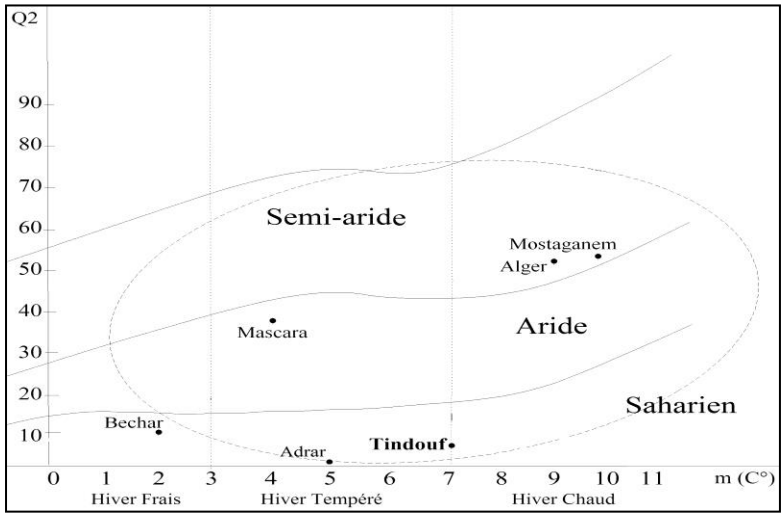

Figure 1. Location of study areas in the Emberger rainfall plume carrying the ecological area of the argan tree (Kechairi et al., 2017) modified.

Figure 2 shows the desert climate for the period 1996-2016, it relates to the Tindouf, Adrar and Bechar stations, where the dry period is spread all year round. The rains are rare and very weak. Then, the dry period spreads 6 months in Mascara and Mostaganem, for 4 months in Algiers. The latter shows the influence of the arid climate that threatens a large part of the country.

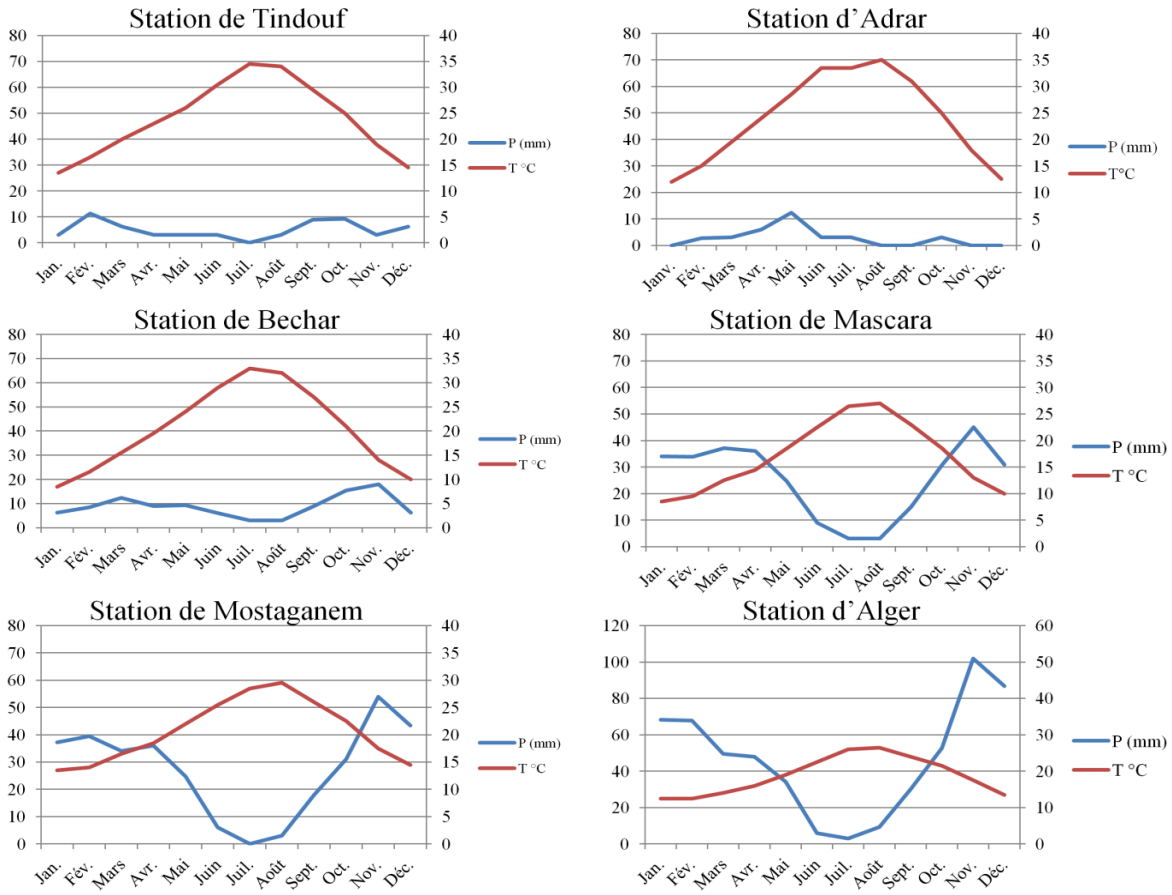

Figure 2. Ombrothermal diagrams of Bagnouls and Gaussen for study stations (1986-2016).

Measurement of leaves

The averages shown in Table 3 allowed us to have the interval and the differences between the measured characters. The average leaf length is remarkably more varied from 1.97 cm at the Tindouf argan tree reserve to 4.27 cm at the forest arboretum of Bechar. To this last, the leaves having a minimum thickness is that of the region of Algiers (0.51 cm) to reach a maximum thickness (1.03 cm).

Table 3. Measurements of length and width and number of leaves inventoried.

Station	length (cm)	width (cm)	number of leaves inventoried
Alger	2,31 ±0,49	0,51±0,09	30
Bechar	4,27±0,74	1,03±0,18	89
INRA Adrar	2,6±0,3	1,01±0,15	60
ITMAS Timimoun	2,56±0,41	0,86±0,09	60
Oggaz	4,13±0,83	0,86±0,16	30
Oued El Ma	1,97±0,31	0,67±0,15	149
Tindouf-ville	2,58±0,56	0,76±0,15	60
Mostaganem	3,38±0,5	0,73±0,17	150

The linear correlation between the two measured sheet criteria (length, width) is represented by the regression adjustment formula of the sheets: Length = 1.425 + 1.939 Width, with a R^2 = 27.2% allowed us to deduce the diversity of shapes measured at which the argan tree has significant polymorphism across the regions studied (Figure 3)

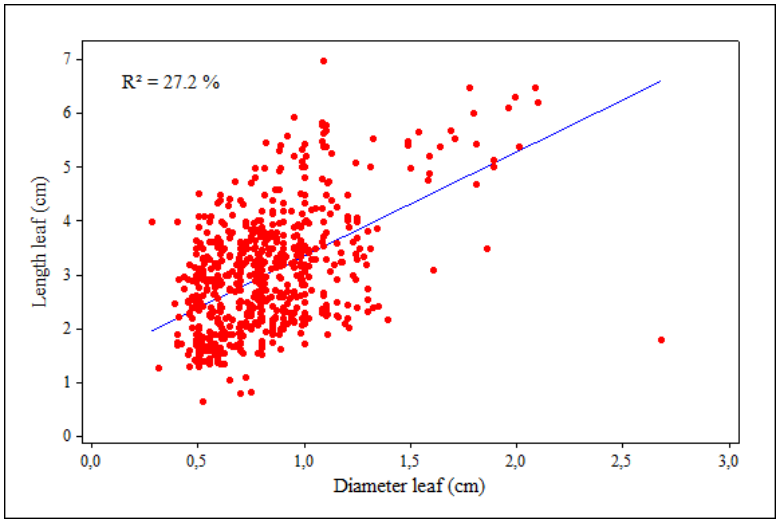

Figure 3. Correlation between the length and width of the sampled sheets.

The larger leaf sizes of Bechar (4.27 and 1.03 cm) and of Oggaz (4.13 and 0.86 cm). The effect of the age of the tree is well represented in the leaf dimensions of the Oggaz station, because among all subjects planted only the subject of Oggaz tree is the oldest. In Bechar the irrigation regime and the annual precipitation of about 106 mm/year and the fertile soil contribute to the good growth of the tree, whose foliage increases remarkably. Other, the influence of the precipitation is observed for the subjects of Algiers, to which the leaves are very much the annual precipitation exceeds 557 mm/year, which can be explained by Maire and Wilczek (1935), said the rainfall rate greater than 500 mm caused the growth of the argan tree. However, at INRA Adrar experimental planting stations, IITMAS Timimoun and Tindouf-ville under Saharan climate dimension values appear closer. Then, in Mostaganem the argan tree adapts well to the semi-arid climate, the leaves seem better developed with a precipitation 371 mm/year. At the station of the nature reserve and under extreme weather conditions, the subjects are no longer irrigated for this reason the leaves take the minimum values (Figure 4).

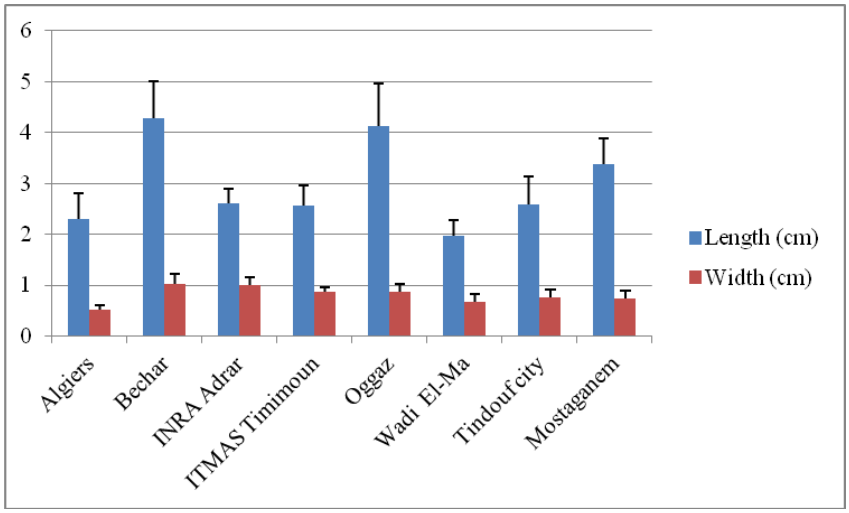

Figure 4. Averages of leaf length and width to regions studied.

Conclusion

The species, which opens an axis of research on the physiological behavior, at the level of these various regions in relation to their plasticity of genetic characteristics. These results obtained allowed us to suggest that the specific genes that control the morphology of leaf length and width are adaptation genes influenced by physiological change under climate persuasion. As a result, all the results obtained show that there is an experimental possibility of planting the argan tree at arid regions oily seedlings with its ecological plasticity under various bioclimatic stages.

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