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Original Article

Effect of water salinity stress on dates biometric and biochemical characteristics

Krid Keltoum

Department of Agronomic Sciences , University of Kasdi Merbah, Ouargla, Algeria. krid.keltoum@univ-ouargla.dz

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ABSTRACT

The problem of water irrigationin palm groves led us to conduct this study based on the comparison of the quality of dates Deglet Nour and Ghars from two farming systems in the region of El Oued according to thesaline water irrigation degree. Salt stress in El Ghout causes in both varieties a regression of biometric characteristics, pH, EC, water content and dry matter, while total sugars are high. The dates of the farm are more voluminous, less acidic, with high ash content, dry matter and high electrical conductivity. According to standards Algerian of date classification reveals that the characteristics of Deglet Nour dates of El Ghout are more damaged by increasing the water salinity. The two varieties of the farm have better characteristics than those of El'Ghout. It's also appears that saline water irrigation improves the sugar content of dates.

Faculty of Natural Sciences and Life, University of El Oued

1. Introduction

Salinization of agricultural land in arid and semi-arid regions results from both high evaporation of water from the soil [1], natural phenomena such as insufficient rainfall [2], and agricultural phenomena such as irrigation systems [3, 4]. [5, 6] pose two major threats to plant growth: osmotic stress and ionic stress.

Plants that evolved in saline ecosystems differ from other plants in morphological, biochemical, anatomical, and functional traits. One of the mechanisms of salt stress tolerance in halophytic plants is their ability to prevent salt ions from entering, or their ability to sink them into gaps or interfaces. This is due to the presence of one or more salt tolerance mechanisms, which are proteomic, metabolomic, transcriptomic, or genomic systems [7].

Date palms have evolved through natural selection to be drought and salt tolerant plants [8], which is widely considered a salt tolerant crop [9]. This species may possess a range of salinity tolerance mechanisms [3]. [10]examined specific date palm varieties for their ability to adapt to salinity and found that some varieties can withstand a relatively high soil salinity level of 12.8 dS m-1 (1 dS m-1 = 640 mg l-1) with no visible effect on seedling phenotype. The tolerance of date palms to salt stress differs from one variety to another. Despite the great capacity of the date palm to cope with the increasing of saline water irrigation, this sensitivity decreases with increasing salt concentration. Longitudinal growth of the root and plant group decreases with increasing salt concentration in the growing medium, which also affects their nutrient content [10]

The objective of this study was to investigate the impact of irrigation water quality according to salinity level on the characteristics of two important dates' varieties, Deglet Nour and Ghars in the El Oued region (South-East Algeria).

2. Materials and Methods

2.1. Experimental sites

Two agricultural systems were chosen for this

* Corresponding author: Krid Keltoum Tel.: 00000000000000
E-mail address: krid.keltoum@univ-ouargla.dz
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experimental study. The first site is a traditional agricultural system named El Ghout. It has been known since ancient times in the El Oued region (4 or 5 centuries). Depressions free of sand dunes have been used to plant palm trees because of their proximity to groundwater, so that the palm tree absorbs water from the underground surface layer (water table), which varies from 6 to 7 meters deep without being irrigated by the farmer. The total area of the site is 1.5 hectares, exploited for the cultivation of date palms (90% Deglet Nour, 5% Ghars, and 4% other varieties), onion, bell pepper, mint, corn, pomegranates, etc. The saline water irrigation in this system is (EC = 6.15 dS/m).

The second site, represented by a modern farm, belongs to the oasis system. The area of the farm is 3-4 hectares and contains 150 date palms (90% Deglet Nour, 11%Ghars.), potato crops (which occupy 2 hectares), pomegranates, onions, carrots.....etc. Irrigation is based on groundwater from the terminal complex (from 100 to 500 m deep, with a flow rate of 25–45 L/s).The saline water irrigation in this system is(EC = 3.76 mS/cm).

*Experimental condition***:** Both systems have the same agricultural conditions (management and type of soil) to avoid all sources of heterogeneity. They both have the same soil (neighbors), use the same organic fertilizers, and the same age of the selected palms. The only difference is the irrigation water quality.

2.2. Preparation of samples (Dates)

Two varieties of dates were chosen for this study: Deglet Nour and Ghars. At each experimental site, seven date palms were selected for the variety Deglet Nour and three palms of Ghars according to their availability in each farming system From each palm, samples of 30 dates at full maturity were taken at random by palm and placed in kraft paper bags with all the coordinates related to the site, date of sampling, and variety. Arriving at the laboratory, the healthy dates were subjected to biometric measurements and biochemical analysis.

2.3. Applied qualitative analyses

2.3.1. Biometric measurements

Total date weight (TWin g) and of the pulp (PWin g) were measured by an analytical balance with an analytical precision of 0.001.Fruits dimensions (diameter (Dt) and length (Lg)) are measured in centimeters with a caliper (HOLEX O-100M, Digital calibrator).

2.3.2. Physicochemical measurements

Fruit moisture content (WC%) and dry matter (DM)

Fruit moisture content in the flesh of the fruits was determined as the difference between the weight of fresh fruits (M1) and the weight of dry fruits (M2) after drying at the temperature of 103 ± 2 °C, until a constant weight was obtained, using the following formula: H% = (M1-M2) * 100/ M2 [11].

Determination of pH and electrical conductivity (EC)

The pH and conductivity were measured in an aqueous solution of ground date pulp using a pH meter [12].and a conductivity meter.

Ash content

Samples (pulp) were burned at 550 °C in a muffle furnace for five hours until a whitish or gray ash of constant weight was obtained [13].

2.3.3. Biochemical measurements

Total sugar content (TS)

Total sugars of dates were determined with the method of Bertrand [14].

2.4. Statistical analysis

Using SPSS software (IPM 22), the data of the studied parameters for each variety were analyzed by one-factor ANOVAs (farming system) and a comparison of means where we consider that the farming system (Farm/El Ghout) is the independent factor with respect to the studied parameters as independent variables. The objective of statistical comparison between the averages of each parameter according to the agricultural system, is to know if there is a statistical significance of of water salinity degree on the quality of dates, including the proposal of

solutions to mitigate the consequences of this ecological problem in palm environment.

3. Results and Discussion

ANOVA's of theme assured parameters according to the agricultural system are presented in (Table.1). Thus averages of their presented in (Fig.1).

3.1. Impact on biometric measurements

The dates of the two varieties Deglet Nour and Ghars, have a whole weight and pulp, dimensions all the way higher than the dates of El' Ghout. In general, the size of Deglet Nour dates does not exceed 3.78 cm in length, 1.76 cm in diameter, and a maximum weight of 7.08 g (Fig. 1a). Ghars dates have a maximum length 4.09 cm, 1.70 cm for diameter, and weight of 7.75 g (Fig.1b).ANOVA'sshow a highly significant difference for these parameters (p= 0.050) according to the variety and the agricultural system (Tab.1). The good management of the palms according to the irrigation system and the quality of the water improves the growth of the palms and their fruits [15,16]High salinity water and soil create saline stress, which affects the morphology of palm fruits. [17, 18, 19, 20].

3.2. Impact on physicochemical and biochemical characteristics

Level of acidity

Deglet Nour dates were marked as more acidic than Ghars, with pH 5.4. In particular, the dates from the farm were less acidic than the dates from El'Ghout for both varieties (Fig.1). According to the classification of dates in the study of [21], our dates are considered neutral and slightly acidic. ANOVA sreveals that, non-significant results for the variety Deglet Nour (p = 0.200) and highly significant for Ghars (p = 0.000) (Tab.1). [22, 23] report that the increase in electrical conductivity of a nutrient solution or water led to increasing fruit acidity and vice versa. In cases of salt stress, the inorganic ions will diffuse into the fruits, which cause an increase in their cation-ion rate. This increase causes an increase in total acidity[24, 25, 26, 27]. [28]also record an increase in tomato juice acidity with the increasing in salinity of irrigation water and potassium fertilizer levels.

Electrical Conductivity

It seems that the EC of the dates from the farm is higher compar with the El'Ghout, which means their richness in mineral elements, especially the variety Deglet Nour of the farm (EC=. 3.82 dS/m) (Fig.1).

Comparison of means reveals a highly significant difference (p = 0.070) (Tab.1). [29] reported that palm yield is affected by water salinity when it exceeds 3 ds/m (optimum value). In cases of salt stress, as in the case of El'Ghout, plants such as date palms involve morphological and developmental changes as well as physiological and biochemical processes to withstand the high concentration of salts in the environment [30], grouping the excess salts in the spines and leaves, as an example, and away from the fruits.

Ash content

A regression of ash content in the dates of El'Ghout than exploitation with a highly significant difference (p<0.010) (Tab.1).The ash is the remainder of mineral compounds after the burning of plant or animal organic matter. [31] justifies the decrease of mineral element contents in leaves to the negative correlation between salinity of irrigation water and mineral content of leaves. Thus, the accumulation of ammonium and nitrate ions causes an increase in soil osmotic pressure and a reduction in water osmosity, thus discouraging the transmission of mineral nutrients to plant members.[32, 33]which disturbs the nutritional and hormonal balance [34] shows that the salinity of irrigation water due to the reduction of the levels of mineral elements (Fe, Mn, Ca, N, P and K) in the leaves which negatively influences the growth of fruits and therefore its compounds.

Fruit moisture contentand dry matter

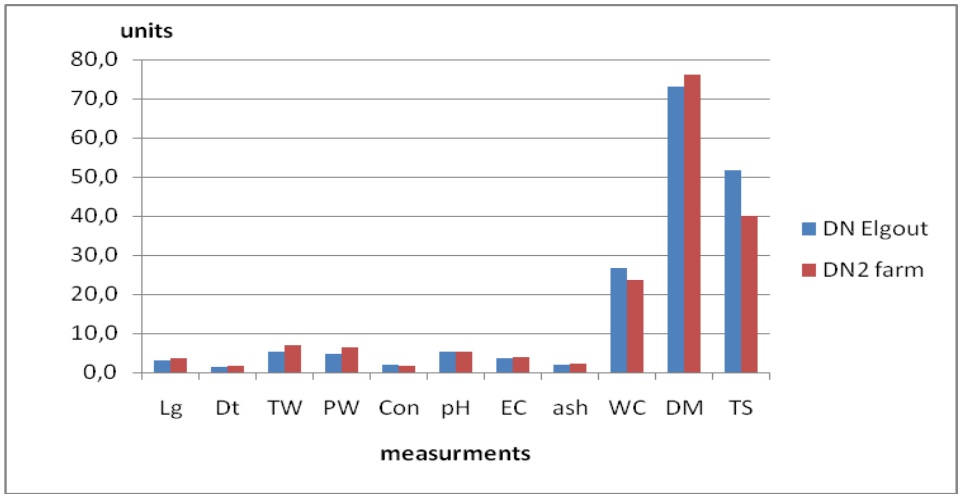
According to Fig.1, Deglet Nour and Ghars dates of El'Ghout have higher moisture content with lower dry matter

Table 1.ANOVA'sfor parameters measurements (average of 3 replications) of the qualitative analyses;

Varieté	Lg	Dt	TW	PW	pH	EC	ash	WC%	DM	ST
Sig (p) **DN[1] *DN[2]**	,004*	,025*	,001*	,001*	,200*	,002*	,008*	,008*	,000*	,000*
Sig (p) **G[1]*G[2]**	,002*	,011*	,031*	,038*	,000*	,070*	,000*	,041*	,000*	,000*

* The average difference is significant at the 0.05 level.

[1]farm varieties / [2]El'Ghoutvarieties/ DN: Deglet Nour/ G: Ghars



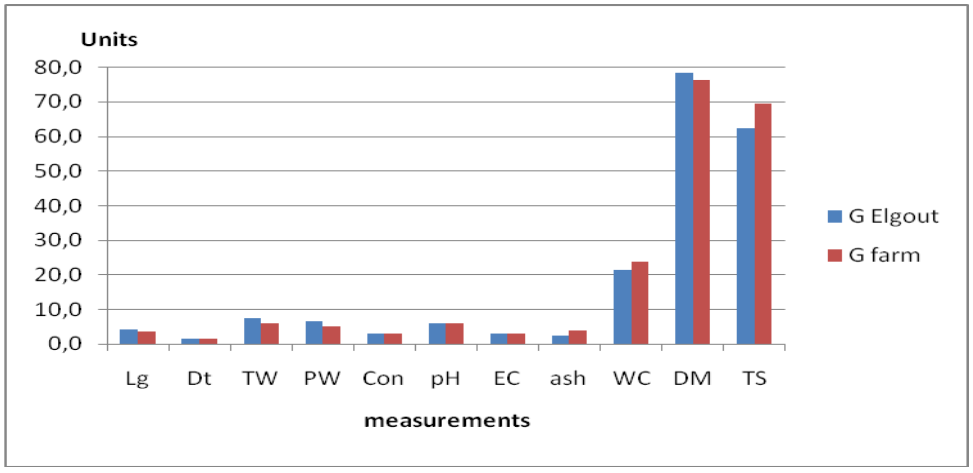


Fig 1.The average of the measured parameters

content than the dates of the farm. Also the results show that, water-rich Deglet Nour variety has a lower dry matter content than Ghars variety. Mean square values showed highly significant values for both parameters with p_{WC}<0,050 / p_{DM} = 0,000)(Tab.1).

Increasing of soil salinity reducing the soil osmotic water potential, which reduces evapo-transpiration and, as a result, fruit water loss [35], the same results was reported by Al-Nadjar (2009).This result agrees with those of [31]. The fruit's values dry matter content showed the opposite behavior to its water content, where the fruit dry matter content increases more as we approach the maturity stage [36]. Salinity also reduces the plant's uptake of mineral elements such as nitrogen, potassium, and phosphorus, which leads to a decrease in the level of organic and nuclear acids, proteins, and carbohydrates, and thus a decrease in the dry matter of the plant exposed to salt stress [37]. According to the scale of [21], our dates are generally classified as semi-soft to semi-dry.

Sugar content

Sugar content values showed that, El'Ghout dates is high, 51.83 and 69.43% for Deglet Nour and Ghars varieties, respectively (Fig.1), with high significant difference (p = 0.000) (Tab.1). Overall, Deglet Nour dates are classified as moderately sweet, while Ghars dates are sweet. Soil and water salinity degree plays an important role in improving the quality. Indeed, total sugars migrate and accumulate in plant organs such as leaves and fruits [38, 39] to tolerate saline stress given the important role of sugars in osmo-regulation [40]. These strategies involve different mechanisms, including the production of compatible solutes such as sugars and sugar alcohols [3] According to theauthors, the increasing in sugar content would be due to a modification of enzymatic activities related to carbohydrate metabolism where the activity of the enzymes sucrose-phosphate-synthase and sucrose synthase would increase, thus contributing to the increase in salt tolerance. [41,42]. Thus, [43] observed in stressed rice plants a decrease in fructose 2-6-bisphosphate (F26BP) activity, leading to sucrose accumulation and thus contributing to increased salt tolerance in some varieties by increasing internal cell osmolarity and available carbon reserves. [28] Also record an increase in total sugar levels in tomato fruits under salt water stress and under different levels of potassium fertilizer.

The projection of results on the standard Algerian norms of classification of dates according to table 2 reveals that the characteristics of Deglet Nour dates of El'Ghout are more damaged by the increasing of saline water irrigation. The two varieties of the farm have better characteristics than those of El'Ghout.

Table 2. Standard Algerian norms of classification of dates

Character	Good character	Acceptable	Bad character
fruit length	Greaterthan 4cm	From 3.5 to 4 cm	lessthan 3.5cm
fruit weight	Greaterthan 8g	From 6 to 8g	Lessthan 6g
pulpweight	Greaterthan 7g	5 to 7cm	Lessthan 5g
fruit diameter	Greaterthan 1.8cm	From 1.5 to 1.8 cm	lessthan 1.5cm
Humidity	From 10 to 24%	25 to 30cm	<10% or > 30%
pH	Greaterthan 5.8	From 5.4 to 5.8	Lowerthan 5.4
Total sugars	Greaterthan 70%	60 to 70%	From 50 to 60%

4. Conclusion

Date production in Algeria is considered among the main economic and commercial axes in this country. Large phoenicicole areas in arid and semi-arid regions suffer from drought and salinity of soils and groundwater. The quality of irrigation water from underground sources has an effect on the quality of plant products such as dates. Our experiments have allowed us to obtain results, of which we quote here the most important ones:

- Increasing saline water irrigation causes the regression of the weight of the date (the consumable part) and its dimensions following the inhibition of the activities of growth, thus the

reduction of yields in quantity,

- Among the negative effects of saline water irrigation on the palm is an increase in the acidity of dates to levels that are unacceptable to consumers and exporters. The studies showed that, the acidity of the fruit promotes the development of microbial flora phytopathogenic, which destroys the quality of the product.

- The richness of the date in mineral and organic elements will reduce when the salinity of the water and environment increases. This is due to the exclusion of the absorption of soil ions by the roots and to the decrease of biosynthetic processes in the plant suffering from salt stress.
- Nevertheless, this factor improves the fruit quality. With increasing salinity, sugar and water content increase with salinity. Some people prefer fruit that is rich in water but within acceptable limits.
- Finally, this work confirms the great importance of the applied sciences mentioned in the previous articles. This prompts us to find solutions that will solve the problem of water salinity by using special irrigation equipment such as delta water which reduces the salinity of water through magnetization, or the application agricultural methods such as surrounding the crops with drainage to collect the excess water and therefore the escape of salts in it and in the soil. It is also possible to add chemicals or organic substances which break down salts.

Conflict of Interest

No potential conflict of interest was reported by the author(s)/

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