Improving Fruit Quality and Nutritional Value of Deglet Nour dates subjected to Salt Stress by using Phospho-Potassium Fertilization (Biskra south-east of Algeria)

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Abstract— *A field study was carried out during the two consecutive years (2015-2016) in the region of Biskra, southern east of Algeria on date palms of Deglet-Nour variety, grown in a salty environment. To study the combined effect of salinity and phospho-potassium fertilization on the quality and nutritional value of dates, two sites of different salinity, occupied by 54 date palms variety Deglet-Nour has been selected. The palms were fertilized by receiving three doses of potassium (0, 2 and 3 kg / palm) as potassium sulphate K_2SO_4 (50%) combined with three levels of phosphorus (0, 1 and 2 kg / palm) as superphosphate (TSP 46%). The results revealed that applying 2 kg of potassium/palm in an excessively salty environment and 3 kg/palm in a low or unsalted environment associated to 1 kg of phosphorus in the two different cases of salinity of the two sites S1 and S2 improving the fruit traits.*

Keywords— Salinity, dates, date palm, quality of dates, phosphorus, potassium.

I. INTRODUCTION

The problem of salinity is multiple, because in addition to the toxicity of Na^+ and Cl^- ions (dissolved in the irrigation water or present in the soil solution) and the perturbations of the mineral nutrition (following the interactions between ions), plants have difficulty absorbing soil water because of its high osmotic pressure, and this is justified by water stress in addition to salt stress, thus complicating and altering their physiological state exponentially and causing multiple perturbations on the metabolism, growth and development of plants at the molecular, biochemical and physiological levels **(Winicov 1998 Munns 2002, Tester and Davenport 2003).**

In arid regions in addition to drought and heat that inhibits growth and productivity of the date palm saline stress mainly affects its vitality**. Furr (1975)** reported that it is evident that the date palm is more salt tolerant than barley and that it can be the most salt-tolerant of all cultivated plants but increasing soil salinity is beginning to have a negative impact on the agro-ecosystem of date palm in the arid region, particularly in the Middle East **(Dakheel, 2005).** In Algeria in the Ziban oases (Biskra region) mismanagement of irrigation and drainage water has detrimental consequences on the phoenicultural environment **(Munier, 1973)**, it has led to soil salinization, falling yields and poor-quality dates **(Dutil, 1971; Dubost, 1991).** Relative yields become null if the farmer uses salted soils by the usual method and it allows to obtain some harvests, but extremely low and of poor quality because of the salt content.

In the context of improving fruit quality and the nutritional value of Deglet Nour dates, phospho-potassium fertilization is considered an important factor that affects fruit quality and date palm productivity.

The objective of this study is to spatialize salinity, characterize soil in an irrigated palm grove and then adapt a phospho-potassium fertilization program aimed at improving the production and quality of Deglet-Nour dates grown in saline soil.

II. MATERIALS AND METHODS

The present study was conducted during the successive seasons of 2015 and 2016 in private orchard with an area of 21, 90 ha located in Biskra in the southern east of Algeria (Fig.1).

- For this purpose, the salinity map was established to study the spatial distribution of salinity in the orchard to select the suitable site for the study. The thematic map of the "CE" is interpolated with spatial analyst of Surfer 14 (Golden Software, LLC) (Fig.2).
- To meet the objectives of our study, it was necessary to locate two sites S1 and S2 of different salinity class in the same plot (from the established salinity map):

Site S1: Soil salinity> 16 dS/m, occupied by 27 palms.

Site S2: Soil salinity between (4-8 dS/m), occupied by 27 palms (uniform as possible, healthy of any infection, subjected to the same cultural practices, palm tree were planted at spacing 9x9 meters apart and irrigated by drip system.

The palm was fertilized with superphosphate (46%) as a source of phosphorus and potassium sulphate (K_2SO_4 50%) as a source of potassium. The soil analysis of the two studied sites is presented in Table 1.

Nine soil application treatments were arranged in completely randomized design with three replicates (1replicate = 1 palm) per treatment (i.e :1x3x9 =27), the treatments were as follow:

T1: unfertilized tree (control), **T2**: 0kg K + 1kg P **T3** : 0kg K + 2kg **T4** : 2kg K + 0kg P	**T5**: 2kg K + 1kg P **T6**: 2kg K + 2kg P **T7**: 3kg K + 0kg P **T8**: 3kg K + 1kg P **T9**: 3kg K + 2kg P.

The treatments were added in either one dose to a depth of 40 cm from the soil surface and 50 cm apart from the palm trunk.

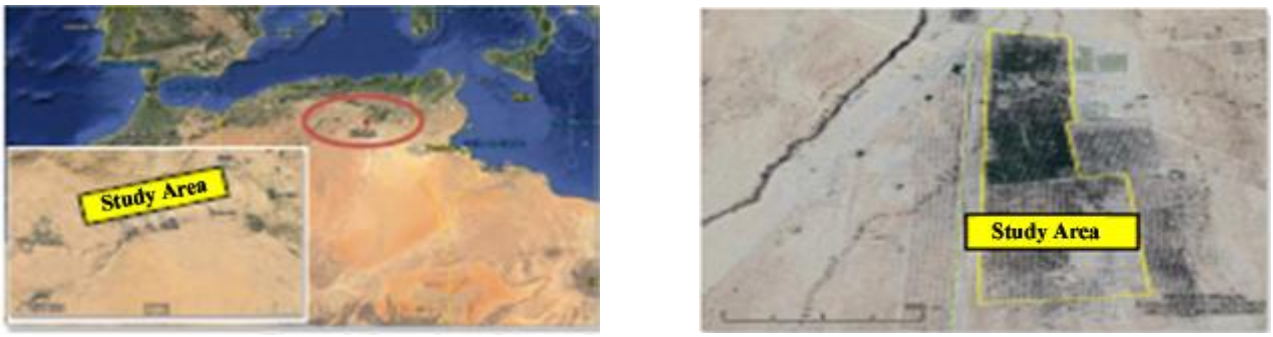

FIGURE 1: Location of the study plot (Extract from Google Earth)

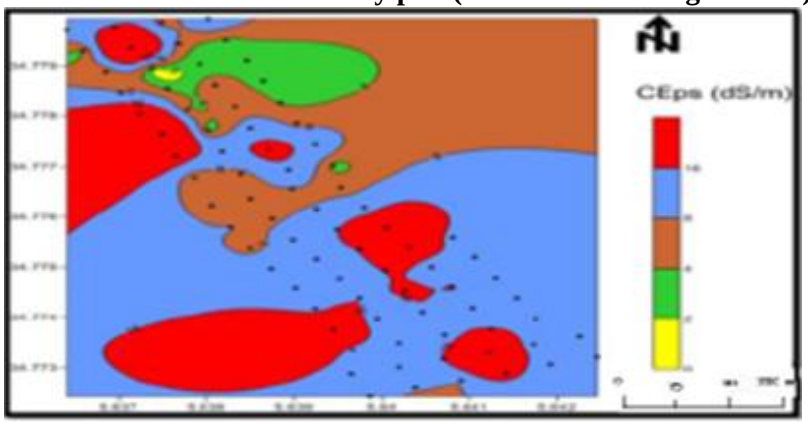

FIGURE 2: Salinity map of the study area (Interpolation of the EC)

TABLE 1
SOIL AND IRRIGATION WATER ANALYSIS OF THE TWO EXPERIMENTAL SITES

Properties	Site S1 (EC_{Soil}> 16dS/m)	Site S2 (EC_{Soil} 4-8dS/m)
pH	7.98	7.96
Na(meq/l)	37.3	6.87
Ca(meq/l)	6.8	11.06
Mg (meq/l)	30.53	24.2
K (meq/l)	2.06	0.6
Cl (meq/l)	67.33	7.66
SO_4 (meq/l)	17.78	12.56
HCO3(meq/l)	2.5	1.5
Gypsum%	60.10	57.33
Total calcareous %	13.01	9.45
OM%	0.53	1.19
$EC_{irrigation\ water}$ (ds/m)	5.5	

2.1 Chemical characteristics of fruits

A sample of 20 mature dates for each replicate was used to determine the chemical characteristics of the fruits. The fruits were cut into pieces with a clean knife; five grams were taken from fresh fruits to extract reducing sugars with water at 85°C and 3,5- dinitrosalicylic acid to extract total sugar **(Barbin, 2006).** The percentage of reducing sugar and the amount of total carbohydrates were determined according to **AOAC (1995).** Acidity (as malic acid) was determined according to **AOAC (1995).**

2.2 Moisture and mineral elements of fruits

A sample of 20 fruits from each replicate was taken and washed with tap water, rinsed twice in distilled water cut into small pieces with a clean knife. Then, an amount of the fresh sample was weighed (fresh weight) and dried at a constant weight (g) in an air-drying oven at 70°C and weighed (dry weight). The moisture of the fruit was calculated as follows:

$$M\ \% = \frac{M1-M2}{P} \times 100 \quad (1)$$

Dried fruits were digested with H_2O_2 and H_2SO_4 according to **Evanhuis and Waard (1980).** Phosphorus was determined by ascorbic acid using the method of **Murphy and Riley (1962).** Potassium was determined with a flame photometer.

2.3 Statistical analyses

The data were processed by the analysis of variance technique (ANOVA) by Xlstat 2016 (Addinsoft, 2016, data analysis and statistical solution for Microsoft Excel). Treatment averages were separated and compared using significant differences at 0.05 level of significance according to **Snedecor and Cochran (1989).**

III. RESULTS AND DISCUSSION

The results obtained show the positive impact of phospho-potassium fertilization on chemical parameters by increasing levels of total and reducing sugar in both sites compared to control date palms (Figures 5.6, 7, 8, 9, and 10)

However, the differences are not significant between the treated date palms and the control, and this explains why the response of palms to nutrients may not be clear in the first years of addition, and this is even more so as trees that have not been fertilized for a fairly long time are beginning to normalize and compensate for nutritional deficiencies and then show the good effect of fertilization **(Ibrahim, 2008).**

André (1994) noted that in very poor soil, do not try to correct these soils quickly, poor soil quickly captures nutrients like a sponge but its redistribution to plants is not as fast and is partial. The example of phosphorus is the most demonstrative in this regard; it is better to make corrections over several years than over one or two years.

Similar results were found by **Hussein et al (1977)** on the Khunaizi and Sukkari varieties, by **Bacha et al (1982)** on the Khudari variety and by **Furr et al (1955)** on the Deglet Noor date variety. These same authors confirmed that the quality of

the fruit of palm trees fertilized by mineral fertilizers was not significantly different from that of the control date palm. On the other hand **Harhash (2000), El-Shazly (1999), Bliss and Mathez (1983), Sinclair et al (1981)** obtained the same results and reported the desirable effect of the different levels of phosphorus and potassium in the formation of sugars.

However, these results do not agree with those of **Al kharusi et al (2009), Saleh (2009), Dialami and Mohebi (2010)** who reported that the acidity of dates is positively affected by the application of fertilizing elements.

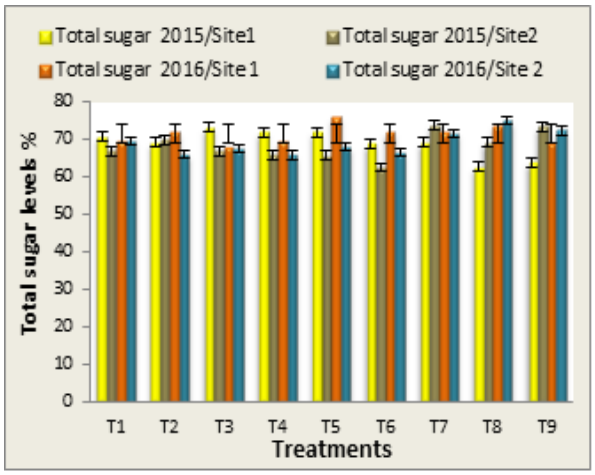

FIGURE 3: Total sugar levels of dates in both study dates in both study seasons

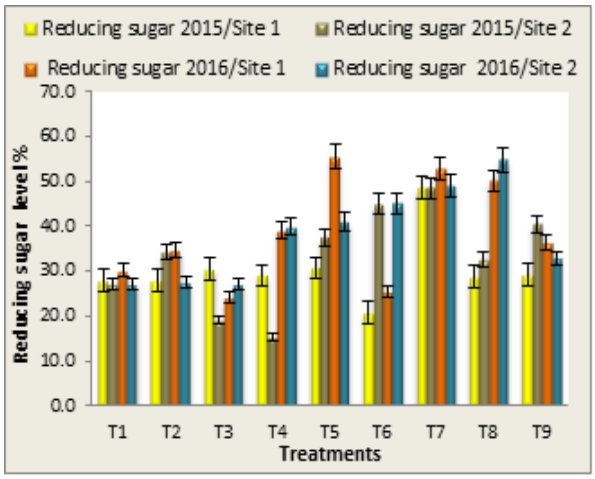

FIGURE 4: Reducing Sugar levels of seasons

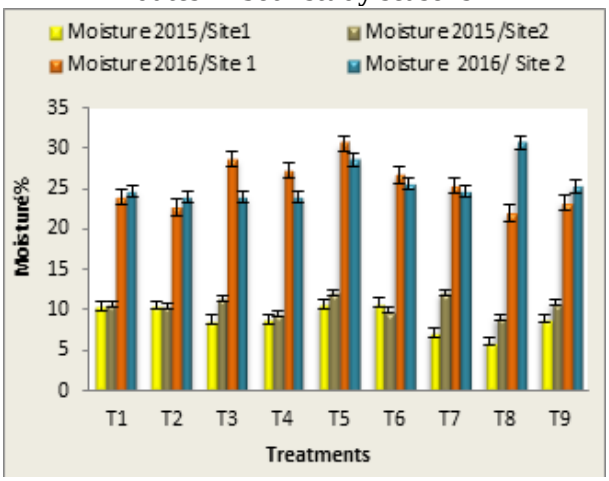

FIGURE 5: Water content of dates in both study seasons

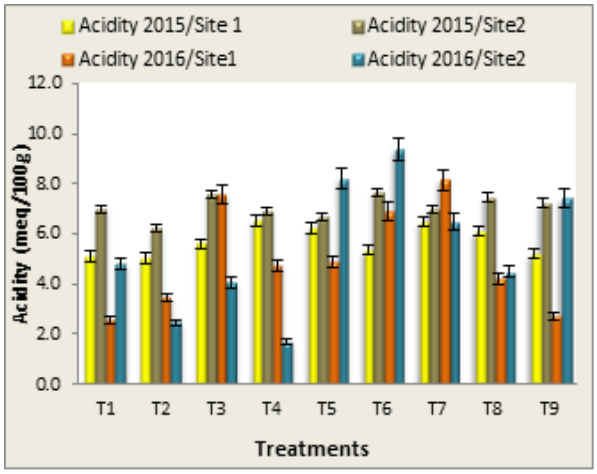

FIGURE 6: Acidity level of dates in both study seasons

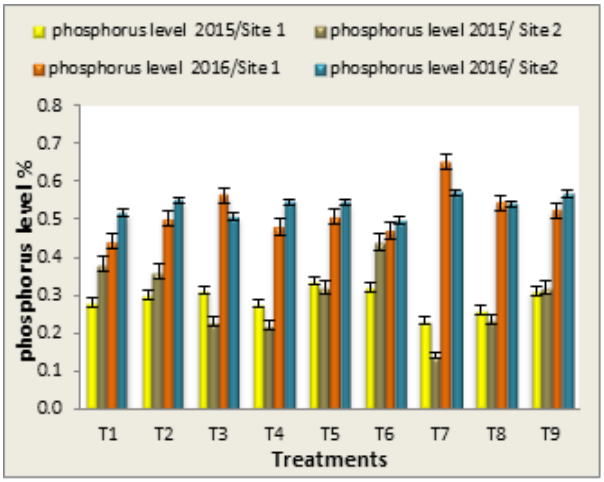

FIGURE 7: Phosphorus levels of dates in both study seasons

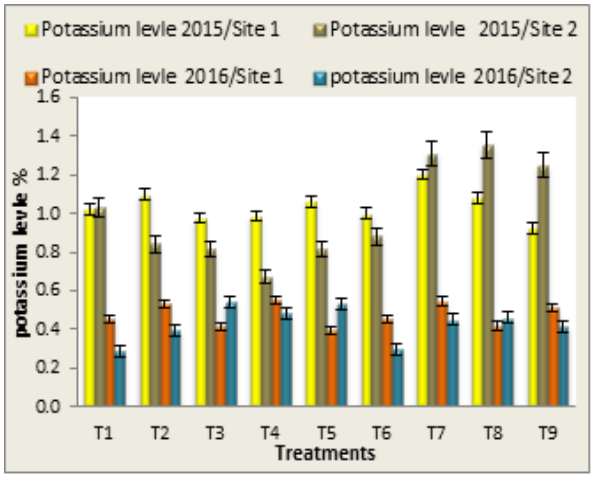

FIGURE 8: Potassium level in both study seasons

3.1 Moisture and mineral elements

The results obtained show a significant increase in the fruit's water content during the second year, which shows the effect of mineral fertilization on date palm from the second year.

The contribution of 2 kg of potassium sulphate and 1 kg of phosphorus (TSP) in the site S1 coincides with extremely high moisture level of 30%, while the contribution of 3 kg of potassium sulphate and 1 kg of phosphorus (TSP) to site S2 has moisture level of 28%. These results are similar or higher than those reported by other researchers in other countries **(Al-Shahib et Marshall, 2003; Aidoo et al, 1996; Ahmed et al, 1995; Youssif et al, 1989**).

The results obtained indicate a significant increase in the concentration of phosphorus contained in dates during the second season in the two sites studied; but no significant difference in phosphorus concentration is found between the two salinity classes; on the other hand, statistical analyses show a significant difference between the treatments on phosphorus concentration, the highest value is marked by the T7 treatment in site S1 with 0.65% followed by the T7 and T9 treatments in site S2 with 0.57%. The results also show that phosphorus concentration in fruits increased significantly after potassium sulphate contribution, these results are in agreement with those obtained by **Kassem (2012), Kassem et al (1997) and Epstein, (1972)** who reported that the content of N, P,K, Fe, Zn in leaves and fruits increases through the application of potassium which strongly influences nutrient absorption and the translocation and distribution of other cations. The T9 treatment shows a concentration equal to that obtained by the T7 treatment in the S2 site, which may explain why the plant uses the minimum of the phosphorus brought by the fertilizers compared to the reserve phosphorus in the soil **(Anonymous, 1985)**; it also appears that the addition of potassium stimulates the absorption of reserve phosphorus compared to the phosphorus of the fertilizer compared to the phosphorus of the fertilizer which is exposed to precipitation reaction stresses in the alkaline and calcic medium hence the need to use fertilizer phosphorus in the low-salt environment.

The potassium analysis results showed a significant decrease in the potassium level in the fruits during the second season and this can be explained by the incomplete maturation of the dates and by the role of this element in the complete maturation of the fruits.

IV. CONCLUSION

It is therefore necessary to emphasize that date palms, like other trees, need to be fertilized, especially since the palm tree needs nutrients continuously without any specific period, because its growth continues throughout year. At the end of this study, we were able to highlight the effect of phospho-potassium fertilization in improving date quality as an integrated action to minimize the consequences of different constraints.

The quality of the dates obtained in this study complies with the criteria for the qualitative evaluation of dates of Algerian, Moroccan, Tunisian, Egyptian and Iraqi cultivars reported by **Rygg, (1953);Meligi and Sourial, (1982) and Mohamed et al, (1983); Rayens et al (1994);Othman (1995).**

To improve the quality and nutritional value of the fruits, it is recommended to apply 2kg of potassium sulphate/palm in an excessively salty environment and 3kg/palm in a non-salty environment with 1 kg of phosphorus in both situations.

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