SHORT COMMUNICATION

Effects of water quality on wheat (*Triticum durum* L. var Boussalem) irrigated with drainage water in a saline environment under palm grove conditions, southern Algeria

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Abstract

The main objective of this study was to find the performance of durum wheat (*Triticum durum* L. var Boussalem) irrigated with drainage water in a saline environment under palm grove conditions. A field trail on a saline sandy soil was carried out at agricultural farm of Technical Institute of Saharan Agriculture Development (ITDAS) in El-Arfiane during winter 2012. Throughout the cycle of wheat fourteen irrigations was applied. The drainage water was imposed with two irrigation frequencies (1 and 2 week intervals). In addition, nitrogen and phosphorus fertilizers were applied in 240 and 180 kg ha^{-1} respectively. The results showed that the wheat responded positively in this saline condition, the drainage water (EC 14.8 dS m^{-1}) produced high seedling emergence and good vegetative growth, which was followed by an acceptable grain yield (5.56 t ha^{-1}).These yields were not significantly different from those obtained with fresh irrigation water, thus water could be another alternative for irrigation under similar experimental conditions, especially with appropriate nitrogen and phosphorus fertilization at weekly irrigations intervals.

Keywords: Saline environment, Palm grove, Drainage water, Wheat, Triticum durum L, Grain yield, Southern Algeria.

Effets de la qualité de l'eau sur le blé (Triticum durum L. var Boussalem) irrigue par l'eau de drainage dans un environnement salin sous palmiers, sud Algérien

Résumé

L'objectif principal de cette étude était d'apprécier la performance d'une culture de blé dur (Triticum durum L. var Boussalem) cultivé sous palmeraie et irriguée par de l'eau de drainage. Une expérimentation sur un sol sablonneux salin a été effectuée dans la ferme agricole de l'institut technique de développent de l'agriculture saharienne (ITDAS) à El-Arfiane au cours de l'hiver 2012. Durant tou le cycle un nombre de quatorze irrigations a été appliqué. L'eau de drainage a été apportée à deux fréquences d'irrigation (1 à 2 semaines d'intervalle). En outre, la fertilisation azoto-phosphatée a été assurée en appliquant 240 kg N ha^{-1} et 180 kg P2O5 ha-1. Les résultats ont montré que le blé a répondu favorablement dans ces conditions salines, l'eau de drainage (EC=14.8 dS m^{-1}) a permet de produire un fort taux d'émergence des semences et une bonne croissance végétative des plants, qui a donné par conséquent un rendement en grain acceptable (5.56 t ha^{-1}). Ces rendements ne différaient pas largement de ceux obtenus avec de l'eau peu salée. De ce fait, l'eau de drainage pourrait être une autre solution alternative pour l'irrigation dans des conditions expérimentales similaires, surtout avec une bonne fertilisation azotée et phosphorée conjuguée avec des fréquences d'irrigation très proches.

Mots-clés: *Salinité, Palmeraie, Eau de drainage, Blé, Triticum durum L, Rendement en grain, Sud Algérien.*

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1. INTRODUCTION

One of the most important factors limiting crops yields is the quality of irrigation water; there is an increasing tendency to use more quality of irrigation water in arid and semi-arid regions, where supplemental water is needed to intensify agriculture.

In Algeria, the arid zone covers an incontestable area whose occupies nearly 90 % of the national territory. In southern of Algeria, the limited availability of water associated with arid and hostile environment are the main factors to practice the agriculture activities. The use of groundwater remains at present the most efficient solution for agriculture in these regions. The abuse and irrational groundwater pumping has caused a decline in the piezometric level of the terminal complex water (CT), the disappearance of artesian, the rise of groundwater and salinisation of CT. Drainage waters are source of undeniable water in the palm groves of the region of Oued Righ, availability all the time in the ecosystem and its easier accessibility for farmers. Using this water may be an alternative solution which helps to fight against exhaustion and preserve non-renewable groundwater resources. But this is possible with an intelligent and reasoned irrigation especially with monitoring the chemical environment of the soil.

Wheat is the most important and widely cultivated crop of the entire world. It is principal food of human beings. Algeria is one of the important wheat importing countries in the world.

Considerable research has been directed towards defining the effects of salts upon crop growth (Shalhevet & Bernstein 1968; Hira & Singh 1973; Mass 1990; Osman et al. 1997).

The present study aimed to analyze the effects of drainage water on durum wheat productivity. This analysis was based on observations made in yield, and yield components.

2. MATERIALS AND METHODS

2.1. Study area

The experiment was conducted on an agriculture farm of Technical Institute of Saharan Agriculture Development (ITDAS) in El-Arfiane, southern Algeria (33◦63N, 5◦98E, 25 m above sea level). The regional climate is characterized by warm dry summers, with maximum air temperature some times higher than 40◦C. Therefore very low and erratic rainfall.

2.2. Soil analysis

The bulk sample of used soil was collected after crop harvest (winter wheat) from the upper layer of an Arenosol (IUSS Working Group WRB 2006) at depth of 0–30 cm sampled at five sampling points randomly selected along agricultural farm of Technical Institute of Saharan Agriculture Development (ITDAS) in El-Arfiane, southern Algeria.

Before analysis, the collected samples were air dried, crushed, sieved through a 2mm sieve and stored for chemical characteristics determination.

Soil pH and electrical conductivity were measured in deionized water (1:5 soil to solution ratio). The total $CaCO_3$ was measured by the gasometric method by using the calcimeter of Bernard. The total soil organic carbon was quantified by the Walkley–Black method modified (Yeomans & Bremner 1998), and total nitrogen was determined by digestion with sulphuric acid and Kjeldahl distillation (Bremner 1996).

2.3. Field experiment

A field experiments were conducted in 2012-2013 harvesting seasons on wheat. In the experimental area the land was cleared, ploughed, harrowed and leveled and the water channels were constructed. The set-up consisted of two rectangular plots and the gross plot size was 1.5m × 40m ($60m^2$). One meter (1m) lee-way was left between plots. Wheat variety "Boussalem" with seed rate of 180 kg ha^{-1} was sown in a sandy saline soil, the properties of this soil are presented in Table 1. Nitrogen as urea at the rate of 240 kg ha^{-1} applied in three fractions (40 kg ha^{-1} in Tillering start, 100 kg ha^{-1} in Stem elongation start and 100 Stem 100 kg ha^{-1} in Stem elongation end). A basal dose of phosphorus as Triple superphosphate (TSP 46%) at the rate of 180 kg ha^{-1}. All the other management practices were carried out as and when required.

The following plant parameters were recorded during the course of study:

i. Number of ears per m^2

ii. Number of grains per ear

Ten ears were selected randomly from each plot and grains per ear were counted at the time of harvesting. The values were averaged to obtain the mean value.

iii. 1000 grain weight (g)

A sample of 1000 seeds was taken randomly from the total seed lot of each plot and then weighed.

iv. Grain and straw yield (kg ha^{-1})

The data of grain and straw yields was recorded by harvesting 1 m^2 per plot. Grains and straw were threshed and weighed manually and the obtained data was then converted to get the final yield in kg ha^{-1}.

2.4. Irrigation conduit

To prepare the seed-bed one irrigation was given after land preparations. The second irrigation using a groundwater was given immediately after sowing. The drainage water was imposed with two irrigation frequencies (1 and 2 week intervals). Table 2 presents the chemical composition of the irrigation water. Throughout the cycle of wheat fourteen irrigations was applied using border irrigation method. Every time we irrigate the quantity of applied drainage water by a border irrigation system are estimated using a volumetric meter placed at the head of the experimental plots. Table 3 presents the irrigation frequencies and the quantity of applied drainage water.

3. RESULTS AND DISCUSSION

3.1. Physicochemical properties of Soil

Basic parameters of selected physical and chemical properties of soil samples are given in Table 01. The soil was sandy saline (EC= 4.18 dSm^{-1}), alkaline, low in organic matter content, and high in gypsum content.

3.2. Characteristics of irrigation water

They are classified as C4S1 class classification by the U.S. in 1954 and their use would present severe problems according to FAO classification (Durand 1983) (Table 2).

3.3. Short-term monitoring soil salinity

To monitor the effect of irrigation with drainage water on the soil salinity, the variation of electrical conductivity values was followed during different growth stage of wheat. The mean of all the results is mention in table 4.

Table 1: Some important proprieties of soil

a). Particle size (% of mineral parts)	
Sand	91
Silt	5
Clay	4
Textural class	Sandy soil
b). Physico-chemical properties	
Soil reaction (pH) (1:5 soil water extract)	7.6
EC (dS m-1) (1:5 soil water extract)	4.18
Lime content (%)	4.2
Gypsum content (%)	14.8
Organic matter (%)	1.08
c). Bulk density (kg dm-3)	1.25

According to these results, the drainage water has not a significant effect on the soil salinity; and the salinity remained stable during the growing season, this can be explained by the leaching fraction applied during irrigation, especially in the case of border irrigation method.

3.4. Effect of drainage water on wheat yield and yield components

Table 5 indicated that the obtained yields components were encouraging; the results showed that the wheat (Triticum durum L. var Boussalem) responded positively in these saline environments, the drainage water (EC 14,8 $dS.m^{-1}$) produced an acceptable grain yield (5,56 $t.ha^{-1}$) and a high straw yield (90 $t.ha^{-1}$). These yields were not significantly different from those obtained with fresh irrigation water.

3.5. Financial performance of drainage water

Using drainage water to produce durum wheat under palm grove system has an important benefit for the farmers who wish to cultivate wheat crops. A profit of about 1298,61 USD per hectare can be obtained. An economic analysis has been established to demonstrate this beneficial effect (Table 6).

Table 2: Chemical composition of drainage water (mmol L−1) and electrical conductivity (dS m−1)

pH 1:5	EC 1:5 (dS m-1)	Ca+2	Mg+2	k+	Na+	Cl-	SO4-2	HCO3-
7.9	14.8	631	832	35	2150	3900	4050	324

Table 3: Quantity of applied drainage water

Irrigations dates	Drainage water quantity (m3 ha-1)
04-11-2012	312.5
08-11-2012	312.5
18-11-2012	312.5
25-11-2012	312.5
11-12-2012	239.2
23-12-2012	258.3
03-01-2013	260.0
28-01-2013	300.0
07-02-2013	325.0
04-03-2013	208.3
12-03-2013	350.0
19-03-2013	327.5
02-04-2013	391.7
09-04-2013	366.7
Total	**4276.7**

Table 5: Mean value of yield and yield components

No. of plants per m2	550
No. of ears per m-2	513
No. of grains per ears	27.17
(grain weight (g 1000	39.94
(Grain yield (t.ha-1	5.56
(Straw yield (t.ha-1	9
harvest index	1.61

Table 6: Economic analysis

		Units
Obtained Yield	55.6	Quintal
Total charges per hectare	1944.39	USD
Cost (1 quintal)	34.93	
Sale price (1 quintal)	58.25	
Profit (1 hectare)	1298.61	

Table 4: Average soil salinity (EC, dS m-1) according to growth stage of wheat

Growth stages	Seeding emergence	Tillering	Stem elongation	Ear emergence	Ripening
EC1:5 (dSm-1)	4.25	4.05	3.2	3.74	4.33

CONCLUSION

In Algerian Saharan conditions, using drainage water in these conditions could be another alternative for irrigation, which could eventually save more fresh water for a sustainable development. Application of this quality of water in these sandy saline soils has introduced some beneficial effects on wheat crop grown under palm grove systems. With high rates of nitrogen (210-240 kg.ha^{-1}) and phosphorus (180 kg.ha^{-1}), especially using a border irrigation method at weekly irrigations intervals.

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