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EFFECT OF IRRIGATION WATER SALINITY ON A WHEAT CULTURE (*TRITICUM DURUM*) IN THE PRESENCE OF ORGANIC MATTER

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ABSTRACT

Salinity is one of the most important problems that agriculture faces in the arid and semi-arid areas. That was motivated us to look at one of its aspects, which is irrigation water salinity, but with organic matter amounts to reduce the deterioration caused by this kind of water, and to come out with the right doses of organic matter at different levels of irrigation water salinity. We have applied three levels of irrigation water salinity: S1= 5 dS m^{-1}, S2= 9 dS m^{-1} and S3=13 dS m^{-1}, with three organic matter doses: F0= 0 t/ha, F1= 30 t/ha and F2= 60 t/ha. The results obtained were very encouraging and important through the noticeable impact of the measures studied. The positive impact of organic matter amounts on the saltiest treatments has been manifested, unlike the less salty treatments that they lack and we can say that the dose of 60 t/ ha of poultry manure is the best to increase the production of grains yield and straw yield, but the dose of 30 t/ha is the optimal dose to increase the weight of 1000 grains. This confirms the effectiveness of it responding to the irrigation water salinity effects, which is manifested in better plant yield.

Keywords: salinity; wheat; poultry manure; irrigation; organic matter amounts; grain yield; straw yield.

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1. INTRODUCTION

Salinity is a major constraint to productivity and agricultural development, reducing plant growth and development (Ashraf, 1994; Subbaro and Johansen, 1994) in [1] ;(Hussain et al., 2009) in [2];[3];[4]; [5]; [2]; [6]. In arid and semiarid areas, the problem is more serious because the waters, in general, have higher salt content and therefore more compromising to the soil and plants (Mesquita et al., 2012) in [7];[8]; [9]; [10].

Also, salinity is one of the impoverishment processes of the soil most largely widespread on the Earth. This salinization is regarded as a major cause of desertification and thus constitutes the serious shape of soil impoverishment [11]. Most studies carried out in various irrigated perimeters showed that initially unsalted soil became salted after irrigation (Bamouh and El Falah, 2002) in [12]; [13][13]. It has for principal consequence the fall of fertility [14] and the loss of many soils (Badraoui et al., 2002) in [13]

Salinity has repressive effects on the physiological characteristics of wheat [6]. But the threshold salinity of irrigation water for wheat was 7~8 dS m^{-1} that could be used after germination (Liu., 2016 and Chauhan et al., 2008) in [15]. The salinity of irrigation water between 6 to 9 dS m^{-1} has been suggested by Mass and Grattan (Skaggs, 1999) in [15], while water salinity ranging from 3 to 8 dS m^{-1} has been rated within the permissible limit and water with 4.7 dS m^{-1} in irrigation for winter wheat was not so high (Jiang, 2012; Liu, 2016) in [15].

The use of various organic matter amounts to minimize the aggressive effect of salinity constitutes one of useful means to fight against salinity, this improvement is temporary and to have a durable effect it is necessary to regularly bring the organic matter in soil according to the characteristics of the soil and the type of culture [16].

The manure is an appreciable source of organic matter whose value is evaluated by its contents in fertilizing elements and its effect like amendment of the soil. Optimal management of the manures is a pledge of the health of the soil, agricultural ecosystem, and environment; it starts as soon as the dejections are produced to finish during their spreading and their incorporation on the soil [17].

In our work, we will use three organic matter amounts “poultry manure” in combination with three levels of irrigation water salinity, to see its impact on growing wheat and finding effective doses of this poultry manure.

2. MATERIEL AND METHODS

2.1.Soil

The soil used in this trial is that of the experimental area of the agronomy department of Biskra, Algeria. It characterized by clay loam texture, alkaline, very poor in organic matter with a high content of total limestone. The other characteristics are gathered in table 1,

Table 1 Characteristics physic-chemicals of the soil

Apparent density(g/cm3) 1,4		
Electric conductivity 1/5 with 25°C (dS/m) 4,58		
pH water 8,5		
Total limestone (%) 37,96		
Organic matter (%) 0,67		
Soil solution (meq/l)	Potassium K+	0,86
	Calcium Ca++	21,20
	Magnésium Mg++	7,80
	Sodium Na+	20,97
	Sulfate SO4--	17,75
	ChloreCl-	29,08
	Bicarbonate HCO3-	1,50

2.2. Irrigation water

The irrigation water salinity is brought of a well located at M'lili (Biskra, Algeria), which electrical conductivity is 14,60 dSm^{-1} and it was diluted until the electrical conductivity 13, 9, and 5 dS m^{-1}. The table below illustrates the chemical quality of irrigation water used. The analysis of the waters show that they are characterized mainly by high salinity, alkaline pH and high richness in Na and Cl.

Table 2 Chemical quality of irrigation water

Water type	**CE (dSm^{-1})**	**pH**	**K^+ (meq/l)**	**Na^{++} (meq/l)**	**Ca^{++} (meq/l)**	**Mg^+ (meq/l)**	**Cl^- (meq/l)**	**$SO4^-$ (meq/l)**	**$HCO3^-$ (meq/l)**	**$CO3^-$ (meq/l)**
CE=13	13	8,08	1,27	84,5	26	16	93	26,6	4,75	0,3
CE=9	9	8	1,75	39,79	28	16	68	11,68	2,25	0,2
CE=5	5	8,17	0,44	2,42	3	40	32	11,61	2,5	0,2

2.3. Filling of the pots

The pots are filled with 9 kg of soil mixed well with the mineral manure and organic poultry manure. The mineral manure is made up of 3g of phosphate fertilizer SSP (superphosphate) 18% and 1g of potassium sulfate 50%. The nitrogen was brought in cover in two fractions with an amount of 1.2 g/pot in form of urea 46%.

2.4. Plant material

The durum wheat variety *Boussalem* was used as plant material. It is a tall variety of straw, showing white cobs and characterized by a strong herbaceous tillering capacity.

2.5.Experimental Protocol

The experiment comported 9 treatments and 3 repetitions; the treatments are three amounts of poultry manure and three levels of irrigation water salinity.

The amounts of poultry manure are: FV30 =30 t/ha, FV60 = 60 t/ha and FV0 = 0 t/haplot without manure (control). The levels of irrigation water salinity used are: S1= 5 dS m^{-1}, S2=9 dS m^{-1} and S3=13 dS m^{-1}. The device applied is a Split plot.

3. RESULTS AND DISCUSSION

3.1.Effect of salinity and poultry manure on grain yield

The knowledge of salinity build-up in the soil is important for optimal irrigation management (Stanghellini et al. 2007) in [9]**.** However, soil salinization mostly depends on the amount of applied saline water (Meiri 1984; Shalhevet 1994) in [9].

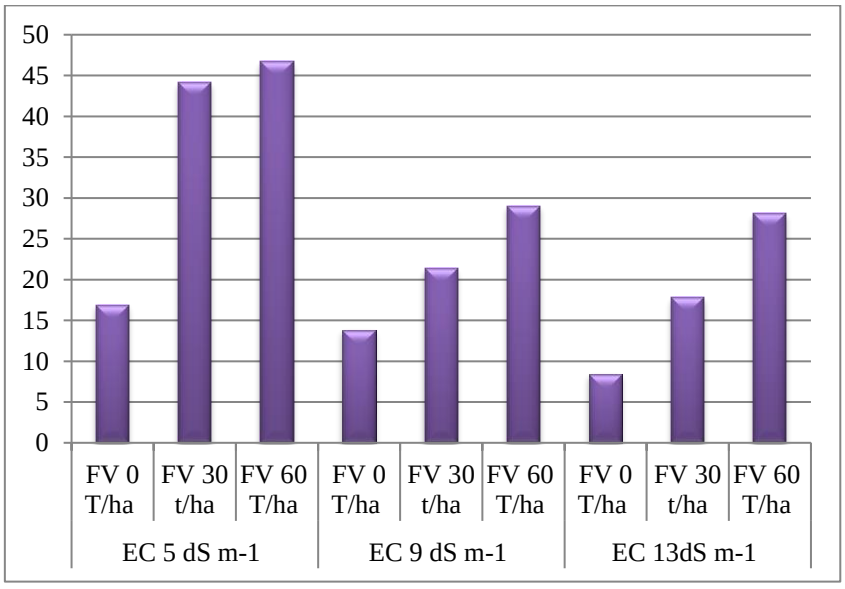

Fig. 1. Evolution of grains yield (g)

In view of the results obtained, it's so clear to us the effect of irrigation water salinity by the low yield in grains of the control treatments (FV0) ; the yield in grains obtained in pots irrigated by the water with electrical conductivity 5 dS m^{-1} is 16,9 g, and that obtained in pots irrigated by water with electrical conductivity 9 dS m^{-1} is 13,84 g, and that obtained in pots irrigated by water with electrical conductivity 13 dS m^{-1} is 8,42 g compared to the treatments that contain organic matter amounts "poultry manure" at all levels irrigation water salinity ; in the treatments

that contain organic matter amounts 30 t/ha we have: the yield in grains obtained in pots irrigated by water with electrical conductivity 5 dS m^{-1} is 44,18 g, and that obtained in pots irrigated by water with electrical conductivity 9 dS m^{-1} is 21,34 g and that obtained in pots irrigated by water with electrical conductivity 13 dSm^{-1} is 17,75 g. Also, the treatments that contain organic matter amounts 60 t/ha we have: the yield in grains obtained in pots irrigated by water with electrical conductivity 5 dS m^{-1} is 46,74 g and that obtained in pots irrigated by water with electrical conductivity 9 dS m^{-1} is 28,08 g and that obtained in pots irrigated by water with electrical conductivity 13 dS m^{-1} is 29,02g.Where there is a decrease in grain yield due to the increase in the salinity of irrigation water, more accentuated in control treatments. Previous studies reported that saline water irrigation reduced water uptake efficiency, transpiration rate, and net CO2 assimilation due to these reductions, and in turn crop growth and nutrients transport into the plant is affected (Niu, 2012; Giu_rida, 2017) in [15]. Contrary to what is happening, the grain yield increases as organic matter amounts levels increase despite the relatively high salinity of irrigation water, As for the most important result of this study, the grain yield obtained in pots irrigated by water with electrical conductivity 9dS m^{-1} and 13 dS m^{-1} with the presence of organic matter amounts is higher than that of control treatments irrigated by water with electrical conductivity 5 dSm^{-1} without organic matter. In addition, grain yields in pots irrigated by water with electrical conductivity 13 dS m^{-1} with organic matter are higher than the control treatment irrigated by water with electrical conductivity 9 dS m^{-1} without organic matter. We found that there was an increase in grains yield with the increase in the level of organic matter amounts because the pots dosed at 60 t/ha with organic matter amounts gave the highest yield in grains monitoring of pots dosed at 30 t/ha with organic matter amounts at all levels of irrigation water salinity. This reading confirms the value of organic matter amounts "poultry manure" and its effectiveness in combating the negative effects of irrigation water salinity on yield in grains. It was verified that the organic input has mitigated the negative action of irrigation water salts in the production and quality of yellow passion fruit (Dias et al., 2011; Freire et al., 2014) in [7]. In addition, we can say that the dose of 60 t/ha of organic matter amounts "poultry manure" is the best to increase the production of grains yield. An increase of 1 ton of soil organic carbon pool of degraded soils may increase crop yield by 20-40 kg/ha for wheat and similar increases for other crops, besides enhancing food security [18].

According to the results of variance analysis (Annex 1,2), we mark an effect very highly significant, the best treatments are FV60 and FV30 especially in the pots irrigated by the waters of electrical conductivity 5 dS m^{-1} which are integrated into the same homogeneous group. It also results that the *Boussalam* variety tolerates salinity due to the presence of poultry manure.

The tolerance of crops to salinity and management of practices such as irrigation and fertilization is essential to identify beneficial strategies (Pinheiro et al., 2013) in [5].

3.2.Effect of salinity and poultry manure on weight of 1000 grains

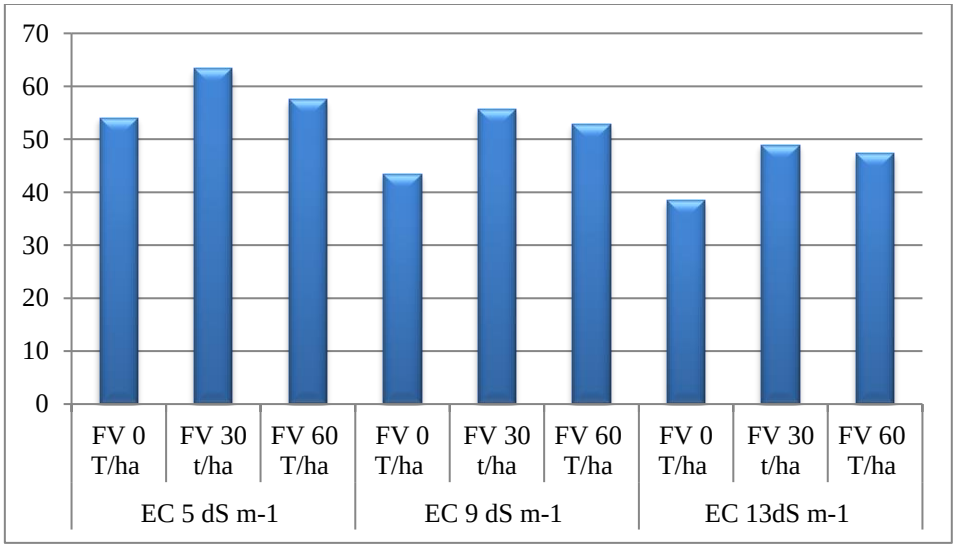

Fig.2. Evolution of weight of 1000 grains (g)

The weight of 1000 grains decrease inversely with the increase in irrigation water salinity for the control treatments (FV0), which confirms the negative effect of irrigation water salinity on this parameter. A soil with continued high salinity values above crop thresholds can create considerable osmotic impacts, which reduces crop water uptake and renders the soil unfit for crop production [9]. However, we note that the positive effect of organic matter amounts "poultry manure" by increasing in the weight of 1000 grains of the pots which contain 30 t/ha and 60 t/ha of this organic matter compared to each control treatments, with a decrease in the weight of 1000 grains with the increase in the levels of irrigation water salinity. We note that the increase in levels of organic matter from 30 t/ha to 60 t/ha is not accompanied by an increase in the weight of 1000 grains in pots irrigated by water with electrical conductivity 5 dS m^{-1} and 9 dS m^{-1},with a slight increase in pots irrigated by water with electrical conductivity 13 dS m^{-1}. We also record that the pots irrigated by water with electrical conductivity 9 dS m^{-1} and dosed with 30 t/ha of the organic matter reached a higher weight of 1000 grains than the control treatment irrigated by water with electrical conductivity 5 dS m^{-1}. The best means of maintaining soil fertility, productivity, and salt tolerance could be through periodic addition of organic manures such as cattle, sheep, poultry manures and composts [19]. Chicken manure is rich in mineral elements, essential nutrients N, P, and K, and other nutrients that can improve soil physical, and chemical properties (Celik et al 2010) in [20]. Organic matter is an important

component of organic fertilizers, and organic acids contained in organic matter can acidify nutrients improving their effectiveness (Tripathi et al., 2014) in [20].

We conclude that the organic matter contributed to the high weight of 1000 grains despite watered by saltwater, this confirmed by the effect very highly significant according to the analysis of variance (Annex 3, 4), but we can say that a dose of 30 t/ha of the organic matter is the optimal dose to increase the weight of 1000 grains although it does not present a significant difference with the dose of 60 t/ha.

3.3.Effect of salinity and poultry manure on straw yield

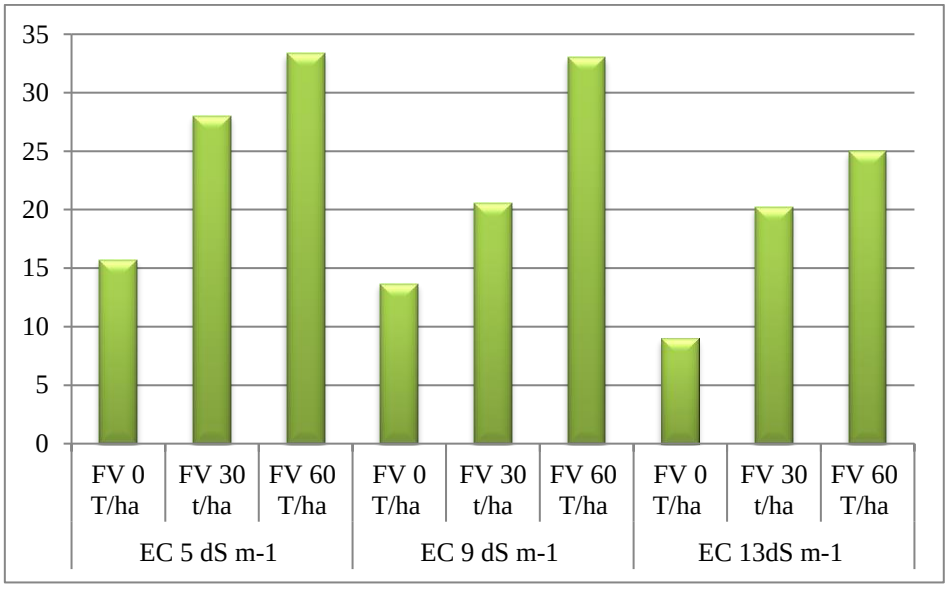

Fig.3. Evolution of straw yield(g)

The salinity of irrigation water significantly affected the straw yield, since it decreased with the increase in the salinity of irrigation water in the control treatments, where we obtained:

15,67 g in the control treatments pots irrigated by water with electrical conductivity 5dS m^{-1} and 13.63 g in the pots irrigated by water with electrical conductivity 9 dS m^{-1} and 9 g in the pots irrigated by water with electrical conductivity 13 dS m^{-1}. Plant growth is compromised by salinity at all stages of development, but sensitivity varies widely at different stages (Caravajal et al., 1998; Akramet al., 2002; Akinci et al., 2004) in [2]. Salt-affected plants exhibit stunted growth and have darker leaf color [6]. Indeed, salt enrichment is inversely proportional to chlorophyll accumulation, reducing the plant's ability to increase the number of leaves (Abousalim et al., 2002) in [21]; [22].

Also, the yield in straw increased after adding the organic matter amounts "poultry manure" in the pots doses by 30 t/ha and 60 t/ha, but 60 t/ha gave the highest straw yield. The organic

manures improve the water holding capacity of the soil; improve the soil structure, the soil aeration, and a positive influence on the growth.[19]; [20]; (Mwangi, 2010) in [23]; [10]. Pontes (1991) in [5], working with manure application in the production of papaya seedlings, observed that manure addition in soil composition led to beneficial effects for plant growth and root phytomass; and [24] on onion revealed also that organic manure enhanced the availability of certain elements and their supply to the plant during the growth period.

- In treatments with electrical conductivity 5 dS m^{-1}, the straw yield increased from 15,67 g in control treatments to 28,03 g in treatments containing 30 t/ha of poultry manure and then to 33,33 g in treatments containing 60t/ha of poultry manure.
- In treatments with electrical conductivity 9 dS m^{-1}, the straw yield increased from 13,63 g in control treatments to 20,53 g in treatments containing 30 t/ha poultry manure and then to 33 g in treatments containing 60 t/ha of poultry manure.
- In treatments with electrical conductivity 13 dS m^{-1}, the straw yield increased from 9 g in control treatments to 20,16 g in treatments containing 30 t/ha of poultry manure and then to 24,97 g in treatments containing 60 t/ha of poultry manure.

From the above, there is noticeable effectiveness in combating the irrigation water salinity with organic matter amounts “poultry manure”, while the most effective dose is 60 t/ha. According to the analysis of variance (Annex 5, 6), there is a significant difference between the yields of this dose in the treatments irrigated by irrigation water 5dS m^{-1} and 9dSm^{-1} which shows the positive effect of organic matter in saline conditions.

In the present study, there was a significant positive effect of the increase in the levels of poultry manure in the soil on the studied parameters of plant.

4. CONCLUSION

This study came to confirm the damage caused by irrigation water salinity on the wheat plant, through the low level of output in the studied parameters (grains yield, straw yield and weight of 1000 grains). It also confirmed that the combination of organic matter with irrigation water salinity has led to a reduction in this damage and to improve the parameters studied thanks to the positive effect of organic matter on the plant in a salty environment.

we can say that a dose of 60 t/ha of poultry manure is the best to increase the production of grains yield and straw yield, but the dose of 30 t/ha of the poultry manure is the optimal dose to increase the weight of 1000 grains.

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Annex 1:

Results of variance analysis of salinity effect in the presence of poultry manure on grain yield.

Source	DDL	Sum of squares	Square Average	F	Pr > F
Template	8	4191,114	523,889	6,578	0,000
Error	18	1433,671	79,648		
Adjusted Total	26	5624,785			

Annex 2 :

Modalité	Estimated average	Groupes	
S1F2	46,738	A	
S1F1	44,182	A	
S2F2	29,024	A	B
S3F2	28,076	A	B
S2F1	21,342	A	B
S3F1	17,753		B
S1F0	16,896		B
S2F0	13,840		B
S3F0	8,418		B

Annex 3 :

Results of variance analysis of salinity effect in the presence of poultry manure on weight of 1000 grains (g)

Source	DDL	Sum of squares	Square Average	F	Pr > F
Template	8	2661,585	147,866	12,027	0,001
Error	18	98,357	12,295		
Adjusted Total	26	2759,943			

Annex 4 :

Modality	Estimated average	Groups				
S1F1	64,340	A				
S1F1	62,440	A				
S1F0	58,260	A	B			
S1F2	57,513	A	B			
S2F1	55,713	A	B			
S2F2	54,520	A	B	C		
S2F2	54,360	A	B	C		
S1F0	51,850	A	B	C		
S2F2	49,700	A	B	C		
S3F1	48,930	A	B	C		
S1F1	47,880	A	B	C		
S3F2	47,760	A	B	C		
S3F2	46,820	A	B	C		
S2F0	45,490	A	B	C		
S3F0	43,820	A	B	C		
S2F0	39,300		B	C	D	
S3F0	35,630			C	D	
S3F2	26,440				D	E
S3F1	22,320					E

Annex 5 :

Results of variance analysis of salinity effect in the presence of poultry manure on straw yield (g).

Source	DDL	Sum of squares	Square Average	F	Pr > F
Template	8	1737,776	217,222	10,279	< 0.0001
Error	18	380,387	21,133		
Adjusted Total	26	2118,163			

Annex 6 :

Modality	Estimated average	Groups			
S2F2	33,333	A			
S1F2	33,000	A			
S1F1	28,033	A	B		
S3F2	24,967	A	B	C	
S2F1	20,533		B	C	
S3F1	20,167		B	C	
S1F0	15,667			C	D
S2F0	13,633			C	D
S3F0	9,000				D

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