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EFFECT OF IRRIGATION SYSTEM ON BARLEY (*Hordeum Vulgare L.*) PRODUCTIVITY IN THE AFFECTED SALINITY REGIONS

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ABSTRACT

Two field experiments were carried out under saline water irrigation conditions at Ras Sudr Experimental Station, South Sinai, Egypt during 2008/2009 & 2009/2010 growing seasons. The main objective was aimed to study the effect of tow saline irrigation water levels i.e. 3700 ppm and 6300 ppm on barley yield and some yield attributes i.e. plant height, number of tillers/plant, number of tillers/m^2, number of leaves/plant, flag leaf area, peduncle length, spike length, biological yield and grain yield by using three different irrigation systems i.e. drip irrigation (DI), furrow irrigation (FI) and gated pipe irrigation (GPI) systems. Performed pipes which include 110 mm PVC pipes (6 bars) to convey water to the furrows in GPI irrigation system .Such pipe equipped with gated holes (25 mm) to control the water discharge. The distance between each hole is about 75 cm. Drip irrigation was performed by the distance about 40 cm between drip irrigation lines. The drip holes were about 20 cm between holes in the same line. Every irrigation system was irrigated by constant quantity of water as recommended for the region. The obtained results showed that increasing irrigation water saline level significantly decreased yield and all yield attributes studied of barley under the three irrigation systems. The high values of the growth characters and biological and grain yield were obtained by using drip irrigation system under 3700 ppm salinity followed by using gated pipe irrigation system compared with furrow irrigation system. Whereas under high saline irrigation water (6300 ppm) level the lowest values of all growth and yield and some yield attributes were obtained by using drip irrigation system compared with gated pipe irrigation and furrow irrigation systems.

Keywords: Saline Irrigation Water Levels, Irrigation Systems, Barley Productivity

INTRODUCTION

Salinity is one of the major obstacles to increasing crop productivity in Egypt. The total agriculture land of Egypt is about 7.8 million feddans which is almost entirely dependent on irrigation. In brief, 2 million feddans suffer from salinization problems. Sixty percent of the cultivated lands of the northern Delta region are salt affected, while twenty percent of the Southern Delta and Middle region and twenty five percent of the soils of the Upper Egypt region are salt affected (FAO, 2000). Salt tolerance in barley is believed to be mainly achieved through efficient compartmentalization of toxic ions besides other mechanisms conferring tissue tolerance, (Harkamal *et al*., 2006). Limited supplies of fresh water are now increasingly in demand for competing uses and creating the need to use marginal quality water, especially in agriculture. Use of saline water for irrigation has the advantages of reducing fresh water requirement for salt-tolerant crops. But, salinity affects crops depending on its degree at critical growth stages and reduces the yield. So, irrigation by saline water needs to be controlled in an appropriate level for the specific crops (Hamdy, 1995; Mojid *et al*., 2012). Salinity generally affects the growth of plants by either ion excess or by water deficits in the expanded leaves (Greenway and Munns 1980). Water uptake is restricted by salinity due to the high osmotic potential in the soil and high concentrations of specific ions that may cause physiological disorders in the plant tissues (Feigin 1985) and reduce yields (Verma and Neue 1984). However, some crops such as wheat and barley can be tolerant of saline irrigation water and selection and breeding are likely to improve the performance of these crops under highly saline regimes (Norlyn and Epstein 1982). They suggested that irrigation of barley with up to two-thirds seawater is feasible and may result in economically significant yields. This study therefore examines growth and yield of barley in irrigated pot experiments using a mixture of Caspian Sea water and well water. Field trials are described elsewhere (Dordipour 2004). The effect of saline water application on soil properties is also examined together with an assessment of overall water use and water use efficiencies in different irrigation regimes. Salinity tolerance is crucially important at reproductive stage of the plant growth (Francois and Kleiman, 1990). Salinity disturbed starch sugar balance and ultimately reduced the grain yield of barley (Gill, 1979). Salinity induces a marked reduction in spike and leaf development (Maas and Grieve, 1990), tillering capacity, spike length, number of spikelets and kernels per spike in wheat (Grieve et al., 1992; Akram *et al*., 2002). Barley in general, is known to accumulate a high level of Na^+ in the shoot tissue during salinity stress. It is widely recognized that soil salinity associated with excess NaCl adversely affects the plant growth and yield of plant by depressing the uptake of water and metabolism (Ashraf *et al*., 1998; Akhtar *et al*., 2001). Several studies (Smart *et al*., 1974; Freeman *et al.*, 1976; Peacock *et al*., 1977) have reported greater irrigation efficiencies with drip than with furrow irrigation. However, studies with other crops (Sammis, 1980) have suggested that similar irrigation efficiencies can be obtained with careful use of furrow irrigation. It is not clear whether the previous studies with grapevine exploited the maximum potential for irrigation efficiency with furrow. Present experiments were set to investigate yield and yield attributes of barley responses to water irrigation system under two different levels of irrigation salinity water at South Sinai, Egypt.

MATERIALS AND SYSTEMS

Two successive field trials were conducted under saline conditions at Ras Sudr Experimental Station, Desert Research Center, South Sinai Governorate during 2008/2009 & 2009/2010 growing seasons. These experiments were conducted to study the effect of saline water irrigation levels i.e. 3700 and 6300 ppm on the productivity of Giza 126 barley variety by using three different irrigation systems i.e. surface drip irrigation (SD), furrow irrigation (FI) and gated pipe irrigation (GPI). Six treatments for each experiment were carried out i.e. combination between two salinity levels and three different irrigation systems distributed in split plot design with four replicates. The main plots were occupied by the salinity levels while irrigation systems occupied the sub-plots. Barley grains were sown at the rate of 70 kg/fed., on 20th November at both seasons. Barley grains cultivated in rows with spacing 20 cm in plots which 20m^2 (4x5m) in furrow system. Performed pipes which include 110 mm PVC pipes (6 bars) to convey water to the furrows in GPI irrigation system .Such pipe equipped with gated holes (25 mm) to control the water discharge. The distance between each hole is about 75 cm. Drip irrigation was performed by the distance about 40 cm between drip irrigation lines. The drip holes were about 20 cm between holes in the same line. Every irrigation system was irrigated by constant quantity of water as recommended for the region. The organic matter as farmyard manure (FYM) at the rate of 20 m^3/ fed., was added during soil preparation before cultivation, Nitrogen fertilizer was added in the rate of 80 kg/ fed., in three doses ate three different growing stages i.e. sowing, tillering and heading stages and potassium sulphate was added at heading stage at the rate of 24 kg K_2O/fed. Data were subjected to the proper statistical analysis of variance and the combined analysis for the results of the two seasons was applied according to Steel and Torrie (1960). The treatment means were compared by using Duncan's multiple range tests (Waller and Duncan, 1969). Physical and chemical analysis of the experimental field soil was determined as shown in Table (1). Mechanical analysis was carried out according to Jackson (1958). Chemical analysis was carried out according to Jackson,(1958) and Chapman and Pratt (1961).Water analysis was performed to determine the content of anions and cations in underground well water which was used for irrigation as shown in Table (2).

Table 1, Mechanical and chemical properties of the soil

	Physical analysis		
Texture	**Particle size distribution %**		
Class	**Clay**	**Silt**	**Sand**
Sandy loam	21.36	20.23	58.41

				Chemical analysis						
Anions (mg/L)					**Cations (mg/L)**					
$CaCO3^-$	**$SO4^-$**	**Cl^-**	**$HCO3^-$**	**$CO3^-$**	**K^+**	**Na^+**	**Mg^{++}**	**Ca^{++}**	**Ec (ppm)**	**P^h**
49.37	27.47	51.03	6.51	-	0.67	18.32	47.31	19.01	5510	7.84

Table 2, Chemical analysis of water irrigation

Water salinity level	pH	Ec ppm	Cations (mg/l) Ca $^{++}$	Mg $^{++}$	Na $^+$	K $^+$	Anions (mg/l) CO3^{--}	Hco3$^-$	Cl$^-$	SO4^{--}
3700	8.56	3700	40	75	33	0.28	-	8.0	65.51	74.01
6300	8.66	6300	38	74	35	0.29	-	8.0	65.50	74.06

RESULTS AND DISSICUTION

A. Effect of saline irrigation water levels:

Results present in table (3) showed that all parameters i.e. plant height, number of tiller pre plant, number of leaves per plant, flag leaf area, peduncle length, spike length, number of tillers/plant, and biological and grain yield were reduced by increasing salinity levels. On the other hand number of tillers/m^2 parameter did not affected significantly by increasing salinity. This finding may be due to the high regulatory efficient in barley crop exposed to salinity conditions. Akram *et al*. (2002) concluded that salinity reduced spike length, number of spikelet per spike, number of grain per spikelet, 100 grain weight and grain yield per plant. The rate of photosynthesis was significantly reduced by increased level of salinity, which is consistent with results of Francois *et al*. (1994).

Table: 3 Effect of salinity levels on yield and some yield attributes of barley at South Sinai (average of two growing seasons 2008/2009 and 2009/2010)

Treatment	Plant Height (cm)	No. Tillers /plant	No. Leaves / plant	Flag Leave Area (cm^2)	Peduncle length (cm)	Spike length (cm)
3700 ppm	91.19 a	4.092 a	13.35 a	24.78 a	23.64 a	6.946 a
6300 ppm	65.80 b	2.164 b	8.864 a	10.36 b	16.82 b	4.216 b

Continue... Table: 3 Effect of salinity levels on yield and some yield attributes of barley at South Sinai (average of two growing seasons 2008/2009 and 2009/2010)

Treatment	No. of Tillers / m^2	Biological Yield. ton/fed	Grain Yield. ton/fed
3700 ppm	538.0 a	6.290 a	1.867 a
6300 ppm	484.8 a	4.858 b	1.360 b

B. Effect of irrigation systems:

Results obtained in Table (4) showed the differences between the three irrigation systems in the growth characters i.e. plant height, number of tillers/plant, number of leaves/plant, flag leaf area, peduncle length and spike length did not reach the significantly value at 5%. On the other hand there were significantly differences among the three different irrigation systems in number of tillers/m^2, biological yield/feddan and grain yield/feddan. Data obtained showed that drip irrigation system had the higher significantly values of number of tillers/m^2, biological yield/feddan and grain yield/feddan compared with gated pipe and furrow irrigation systems. In this respect, (Mateos *et. al*. (1991) reported that drip irrigation presumably improves the soil water regime thus leading to higher crop yields but the extent of its potential in cotton is unclear. (Daleshwar *et al* (2006), concluded that the drip system provide for opportunities to enhance the use of saline waters in water scarcity areas especially those existing at the tail end of canal commands. Drip irrigation (either daily or 3-day) created higher marketable green chile yields than the alternate row furrow irrigation. (Jinhui *et al*.1999), suggested that drip irrigation increases chile pepper yield through providing either favorable soil moisture conditions or unfavorable conditions for Phytophthora root rot incidence. Higher yields of tomato were obtained with drip irrigation in both seasons as compared to furrow irrigation. The water use efficiency (WUE) and irrigation application efficiency were determined for both irrigation systems, and it was found that the drip system showed the highest values as compared to furrow irrigation (Fekadu, 1998). These results may be due to the advantage of drip irrigation system over furrow and gated pipe irrigation systems where drip irrigation make the soil wetted constantly and this leached the salts away of the plant rot zone.

Table: 4 Effect of irrigation systems on yield and some yield attributes of barley at South Sinai (average of the two growing seasons 2008/2009 and 2009/2010)

Treatment	Plant Height (cm)	Number of tillers /plant	Number of Leaves / plant	Flag Leave Area (cm^2)	Peduncle length (cm)	Spike length (cm)
Drip Irrigation	77.65 a	2.432 b	8.250 b	15.27 a	20.40 a	5.590 a
Gated pipe Irrigation	81.99 a	3.448 a	12.83 a	16.18 a	21.06 a	5.862 a
Farrow Irrigation	75.86 a	3.505 a	12.25 a	16.76 a	19.23 a	5.290 a

Continue.. Table: 4 Effect of irrigation systems on yield and some yield attributes of barley at South Sinai (average of the two growing seasons 2008/2009 and 2009/2010)

Treatment	Number of Tillers / m^2	Biological Yield. ton/fed	Grain Yield. ton/fed
Drip Irrigation	577.0 a	5.900 a	1.727 a
Gated pipe Irrigation	514.2 ab	5.467 ab	1.600 ab
Farrow Irrigation	443.0 b	5.113 b	1.513 b

C. Effect of interaction:

Results in Table (5) showed that there were significant differences in all studied parameters among the interaction between the two salinity levels and the three irrigation systems. Where the high significant values in plant height, peduncle length, spike length, number of tillers/m^2 and biological yield/feddan were produced by the using drip irrigation system under 3700 ppm salinity level compared with the other treatments. Whereas, there was no significant differences between drip irrigation and gated pipe irrigation systems in flag leaf area and grain yield/feddan under salinity level 3700 ppm. Meantime, using gated pipe irrigation system produced the high values of number of tillers/plant, number of leaves/plant compared with drip irrigation system under the low level of salinity. The lowest significant values of plant height, peduncle length, number of leaves/plant and biological yield characters were obtained by using gated pipe irrigation system under 6300 ppm salinity level. The lowest values of all growth and biological and grain yield were recorded by using drip irrigation system under the high salinity level, this may be due to the non effect of the drip irrigation system in bushing salts deeply in the leaching salt requirements presses compared with gated pipe and furrow irrigation systems. Results clearly showed that there were no significantly differences in grain yield among the gated pipe and furrow irrigation systems under the high salinity level. In this respect, Royo *et.al*, (2000) demonstrated that the drip-injection irrigation system is a reliable system for estimating the salinity response functions of barley. They added that the grain yields obtained in the control (EC e = 4 dS m^{-1}) and intermediate (EC e = 9 dS m^{-1}) soil salinity were highly correlated ($r = 0.81, P < 0.01$), indicating that the highest-yielding cultivars under nonsaline conditions were also most productive under intermediate saline conditions. However they reported that yields at high soil salinity (EC e = 17 dS m^{-1}) were not correlated with the control yields. Hansona *et. al*. (1997) compared furrow, surface drip, and subsurface drip irrigation methods on a farm in the Salinas Valley of California. They reported that, applied water of the drip methods ranged between 43 and 74% of that of the furrow method. Spatial variability of plant mass along transects in each plot showed different patterns of variability between the furrow and the drip transects. They added that less variability in plant mass and yield occurred for the drip plots than for the furrow plot. Daleshwar *et. al.* (2006) evaluated the response of cotton (*Gossypium hirsutum* L.) to applied irrigation water (IW, 0.8, 1.0, 1.2 and 1.4 times the evapotranspiration, ET) with drip and furrow irrigation method in soil salinity (EC_e, surface 0.6 m). They found that the growth and yield performance of cotton irrigated through furrows, even though with good quality canal water (EC_w 0.25 dS m^{-1}), was poor when compared with drip irrigation with marginally saline water (EC_w 2.2 dS m^{-1}). They concluded that the drip system provide for opportunities to enhance the use of saline waters in water scarcity areas especially those existing at the tail end of canal commands.

Table: 5 Effect of the interaction between salinity levels and irrigation systems on yield and some yield attributes of barley under at South Sinai (average of the two growing seasons 2008/2009and 2009/2010)

	Treatments	Plant Height (cm)	Number of tillers /plant	Number of leaves / plant	Flag Leave Area (cm2)	Peduncle length (cm)	Spike length (cm)
Salinity 3700 ppm	Drip Irri.	٩٨.٢٠ a	٣.٣٠٠b	١٠.٥٠ab	٢٢.٢٥ a	٢٦.٢٣ a	٧.٨٦٧ a
	Gated Pipe Irrigation	٨٨.٧٨ ab	٤.٦٦٣a	١٥.٧٧a	٢٢.٢٤ a	٢٣.٦٧ ab	٧.٣٣٣ ab
	Farrow Irri.	٨٦.٦٠ab	٤.٣١٣a	٦.٠٠٠b	٢٠.٨٥ a	٢١.٠٢ bc	٥.٦٣٧bc
Salinity 6300 ppm	Drip Irri.	٥٧.٠٩ b	١.٥٦٣ d	٩.٨٩٠ab	٨.٢٩٣ b	١٤.٥٦ d	٣.٣١٣d
	Gated Pipe Irri.	٧٥.٢٠ ab	٢.٢٣٣cd	١٠.٧٠ab	١٠.١٢ b	١٨.٤٥ cd	٤.٣٩٠cd
	Farrow Irri.	٦٥.١١ b	٢.٦٩٧ bc	١٠.٥٠ab	١٢.٦٧b	١٧.٤٥ cd	٤.٩٤٣cd

Continue.. Table: 5 Effect of the interaction between salinity levels and irrigation systems on yield and some yield attributes of barley under at South Sinai (average of the two growing seasons 2008/2009 and 2009/2010)

Treatments		Number of Tillers / m2	Biological Yield ton/fed	Grain Yield ton/fed
Irrigation water salinity level 3700 ppm	Drip Irri.	٧١٨.٠ a	٦.٩٧٣ a	٢.٠٦٧ a
	Gated Pipe Irri.	٤٨٥.٠b	٥.٨١٣ b	١.٨٩٣ a
	Farrow Irri.	٤١١.٠ b	٥.٦٠٠ bc	١.٦٤٠ b
Irrigation water salinity level 6300 ppm	Drip Irri.	٤٣٦.٠ b	٤.٨٢٧ cd	١.٣٠٧ d
	Gated Pipe Irri.	٥٤٣.٣ b	٥.١٢٠ bcd	١.٣٨٧ c
	Farrow Irri.	٤٧٥.٠ b	٤.٦٢٧ d	١.٣٨٧ c

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تأثير نظم الري علي انتاجية محصول الشعير بالمناطق المتاثرة بالملوحة

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اجريت هذه الدراسة بمحطة بحوث راس سدر والتابعة لمركز بحوث الصحراء في جنوب سيناء خلال موسمي ٢٠٠٨/ ٢٠٠٩ و ٢٠٠٩ / ٢٠١٠ لدراسة تاثير استخدام ثلاث انظمة للري علي محصول الشعير ومكوناته تحت ظروف ملوحة مياه الري ٣٦٠٠ جزء/ مليون و ٦٧٠٠ جزء في المليون بمنطقة راس سدر بجنوب سيناء زقد اظهرت النتائج المتحصل عليها ما يلى :

١- اظهرت النتائج ان استخدام مستوى مرتفع من ملوحة مياه الري قدرها ٦٧٠٠ جزء في المليون الي نقص معنوي في الصفات المورفولوجية ومحصول الشعيرمقارنة باستخدام الري بمستوى ملوحة قدرها ٣٦٠٠ جزء في المليون

٢- توضحت النتائج عدم تاثر الصفات المورفولوجية معنويا مثل ارتفاع النبات وعدد الافرع/نبات وعدد الاوراق/نبات ومساحة ورقة العلم وطول حامل السنبلة وطول السنبلة بنظم الري الثلاثة المستخدمة، بينما اوضحت النتائج المتحصل عليها تفوق الري بالتنقيط تفوقا معنويا في كل من عدد الافرع/م٢ والمحصول البيولوجي ومحصول الحبوب للفدان يليه الري المبوب مقارنة باستخدام نظام الري بالغمر

٣- اشارت النتائج الي ان التفاعل الثنائي بين مستوي ملوحة مياه الري ونظم الري وجود اختلافات معنوية في جميع الصفات المورفولوجية والمحصول وبعض مكوناته. حيث حقق استخدام نظام الري بالتنقيط تفوقا معنويا في كل من ارتفاع النبات ومساحة ورقة العلم وطول حامل السنبلة وطول السنبلة وعدد الافرع/م٢ والمحصول البيولوجي ومحصول الحبوب للفدان مقارنة بنظام الري المبوب والري بالغمر تحت ظروف الري بالمستوي المنخفض من ملوحة مياه الري (٣٧٠٠ جزء في المليون). بينما تحت ظروف الري بمستوي ملوحة مرتفع (٦٣٠٠ جزء في المليون) اعطي نظام الري بالتنقيط اقل القيم للصفات المورفولوجية السابقة

٤- اظهرت النتائج تفوق نظام الري المبوب يليه نظام الري بالغمر تفوقا معنويا في كل من كل الصفات المورفولوجية التي تم دراستها وفي عدد الافرع/م٢ والمحصول البيولوجي ومحصول الحبوب للفدان تحت ظروف ظروف الري بمستوي ملوحة مرتفع (٦٣٠٠ جزء/مليون) مقارنة بالري بالتنقيط وقد يرجع ذلك الي عدم قدرة الري نظام الري بالتنقيط علي غسيل الاملاح مقارنة بالري المبوب او الري بالغمر

٥- وتوصي هذه الدراسة بالتوسع في زراعة محصول الشعير بالمناطق المتاثرة بالملوحة واستخدام نظم الري الحديثة مثل الري بالتنقيط الذي يحافظ علي استمرارية رطوبة التربة وازاحة الاملاح عن منطقة انتشار الجذور خاصة تحت الظروف الملحية المتوسطة. اما تحت الظروف الري بمياه مرتفعة في نسبة الملوحة يقضل استخدام نظام الري المبوب عن الري بالغمر للحد من الاستهلاك المائي وتجنب تراكم كميات كبيرة من الاملاح بالتربة الناتج عن الاستخدام المفرط في نظام الري بالغمر.