GROWTH AND PERFORMANCE OF BROAD BEAN AS INFLUNCED BY IRRIGATION WITH SALINE WATER

نمو وأداء الباقلاء بتأثير الري بالماء المالح

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ABSTRACT

A field experiment was carried out at the fields of Kerbala government, during the growing seasons of 2008-2009 and 2009-2010. The aim of this experiment was to determine the influence of saline water on some growth characteristics and yield of three broad bean cultivars. The experiment was arranged as a split–plot with a randomized complete block design .Saline water included 4.7 and 7.8 $ds.m^{-1}$for the first season and 4.3 and 7.6 $ds.m^{-1}$for the second season. Whereas, the controls level of salinity were 1.8 and 1.7 $ds.m^{-1}$ (river water) for two seasons respectively , arranged in the main plots. Local cv , Luz De Otono cv and Zaina SGARAVATI cv arranged in the sub plots . The Results showed that Irrigation with saline water significantly reduced plant growth , chlorophyll content, yield and its components in comparison to the control .However, the yield considerably was decreased about 65.78 and 61.77% for two seasons respectively in treatment received saline water more than 4.7 $ds.m^{-1}$ in contrast to the control .The Luz De Otono cv and Zaina cv gave the highest seed yield in all treatments especially with irrigation by river water 5681 and 5406 kg/h respectively for the first season and 5942and 5673 kg/ha respectively for the second season. The highest percentage of determination coefficient with seeds yield was obtained from number of pods per plant in both seasons .According to the results it can be recommend to grow Luz De Otono cv and Zaina cv and using a number of pods per plant as a best selection indicator for high seeds yield under saline water irrigation .Also we can use saline water for irrigation with electrical conductivity not more than 4.7 $ds.m^{-1}$ with decreasing the yield not exceeded than 18.06 % .

الخلاصة :-

نفذت تجربة حقلية بأحد الحقول الزراعية لمحافظة كربلاء خلال الموسمين الزراعيين 2008- 2009 و 2009- 2010 لدراسة تأثير الري بالماء المالح في بعض صفات النمو والحاصل لثلاثة أصناف من الباقلاء . نفذت التجربة حسب ترتيب الالواح المنشقة وفق تصميم القطاعات العشوائية الكاملة .تم الري بالماء المالح 4.7 و 7.8 ديسمنز.م$^{-1}$ للموسم الاول , و4.3 و 7.6 ديسمنز.م$^{-1}$ للموسم الثاني , فضلا على معاملة المقارنة بالري بماء النهر 1.8 و 1.7 ديسمنز.م$^{-1}$ لكلا الموسمين على التوالي كعامل رئيسي وزرعت اصناف الباقلاء وهي المحلي , Luz De Otono و Zaina كعامل ثانوي . أوضحت النتائج ان الري بالماء المالح سبب انخفاضاً معنوياً في نمو النبات ،محتوى الكلوروفيل والحاصل ومكوناته بالمقارنة بمعاملة المقارنة . مع ذلك فإن الانخفاظ في الحاصل ازداد بنسبة كبيرة بلغت 65.78 و61.77% للموسمين الاول والثاني على التوالي في المعاملات المروية بماء ملوحته اكثر من 4.7 ديسمنز.م$^{-1}$ مقارنة بالري بماء النهر. حقق كل من الصنفين Luz De Otono وZaina اعلى حاصل للبذور في جميع المعاملات لا سيما عند الري بماء النهر الذي حقق 5681 و 5406 كغم/هـ على التوالي للموسم الاول و 5972 و 5942 كغم/هـ على التوالي للموسم الثاني . اعطى عدد القرنات في النبات اعلى نسبة من تغايرات الحاصل لكلا الموسمين.على ضوء النتائج المتحصل عليها يمكن ان نوصي بزراعة الصنفين Luz De Otono و Zaina واستعمال عدد القرنات في النبات كمعيار انتخابي للحاصل العالي عند الري بالماء المالح . كما يمكن استعمال ماء ري لا تتجاوز قيمة الايصالية الكهربائية له 4.7 ديسمنز.م$^{-1}$ وبخسارة في حاصل البذور لا تتجاوز 18.06% .

Introduction

Broad bean (*Vicia faba* L.) is one of the most important winter leguminous crop of high nutritive value in the world as well as in Iraq. Mature seeds of broad bean are good source of protein which is about 25.4% in dry seeds [1]. The high yield, less anti-nutritional factors, high adaptation ability to modern agriculture will make this plant more attractive for farmers; food and feed manufacture [2].

Water is one of the limiting factors for agricultural development in arid and semi-arid area of the world in order to meet the growing demand of the increasing population. Recent studies have shown that saline water such as drainage water can be used to some extend to grow crops without detrimental long-term consequences to either crops or soils [3].The varietals differences in salinity tolerance that exist among crop plants can be utilized through screening programs by exploiting appropriate traits for salt tolerance . Seeds yield is frequently used in crops such as broad bean as the main criterion for salt tolerance. The use of physiological markers such as content of Na^+ , K^+ and the ratio of K^+: Na^+ are less feasible and in the view of some researchers are not promising [4]. It is believed that selection and breeding would be more successful in achieving maximum attainable tolerance, if it were based directly on the relevant agronomic and physiological mechanism or traits [5].

The main objective of this work is to study the influence of irrigation with saline water on some agronomic traits and yield of three broad bean cultivars.

Materials and Methods

A field experiment was conducted at the fields of Kerbala government, during the growing seasons of 2008-2009 and 2009-2010 to study the effect of saline water on growth and yield of three broad been cultivars. The experiment was arranged as a split–plot with a randomized complete block design of three replicates. Saline water included 4.7 $ds.m^{-1}$ (well water S1) and 7.8$ds.m^{-1}$ (drainage water S2) for the first season 2008-2009 and 4.3 $ds.m^{-1}$ (well water S1) and 7.6 $ds.m^{-1}$ (drainage water S2) for the second seasons 2009-2010 with control 1.8 and 1.7 $ds.m^{-1}$ (river water) for both seasons were located for the main plots while the broad been cultivars , Local cv , Luz De Otono A Spain cv and Zaina SGARAVATi Italian cv were located for the sub plots. Seeds were planted at 15 and 18 October for both seasons respectively in sandy clay soil (Table 1). Seeds were planted in rows 4m long, 45cm apart and in hull within rows 15cm apart. Each treatment plot contains 4 rows. Fertilizers applied to each crop according to recommended doses which were 100 kg P_2O_5/h and 60 kg N/h [6] .At pods filling stage plant height, shoots number were recorded. The plant leaf area also estimated by using discs method and chlorophyll was estimated according to [7]. At maturity 1.35m^2 was harvested for each experiment unit in order to determine seeds yield, pods length, pods per plant, seeds per pod and weight of 100 seeds. Least significant differences(LSD) was used to compare means at 5% probability and determine regression [8].

Table 1.Some of soil properties before planting

Properties	Values of first season	Values of second season
Soil pH	7.6	7.4
Soil Ec($ds.m^{-1}$)	3.1	2.8
Available N(ppm)	1	5
Available P(ppm)	10.1	11.3
Available K(ppm)	138	152.8
Na^+ (mmol/litre)	7.9	6.4
Sand%	39.0	40.1
Silt%	16.0	16.2
Clay%	45.0	43.7
Soil texture	Sandy clay	

Results and Discussion

1- Plant Growth and Chlorophyll Content.

Concerning the plant height, number of shoots per plant, leaf area, chlorophyll content and pod length (Table 2). Cultivars were significantly different; Zaina and Luz De Otono cultivars had the lowest chlorophyll and the highest plant growth traits. In contrast, Local cultivar had the highest chlorophyll content and the lowest plant growth traits in both season. The significant differences in cultivars may be due to genetic diversity of these traits among the broad been cultivars this were agree with [9 and 10] whom found the response of leguminous crops to soil and water salinity has become of increased interest in land resource management. However, such crops are known to have quite a low degree of salt tolerance, with differences also between and within species.

Results in tables (2) also indicated that increasing water salinity decreases all growth traits and chlorophyll content in both seasons. Results also indicated that no significant interaction was observed between the effect of salinity and cultivars except the number of shoots per plant and pod length which were significant interacted in both seasons . This was agree with Allen et al. [11] Who found that under saline condition, plant growth is usually reduced by reduction in the rate of leaf elongation, enlargement and the division of the cell in the leaves . Also this were agree with [12 and 13] whom found that salinity causes a rapid reduction in net photosynthesis and hence plant growth and chlorophyll content and this may be due to the high concentrations of soluble salts through the high osmotic pressures that affect plant growth by restricting the uptake of water by plant roots, high salinity can also cause nutrient imbalances.

Table 2. Plant growth characteristics and chlorophyll content of broad bean cultivars under effect of saline water in the first and second seasons.

Traits / Cultivar		Plant height (cm)		No. of shoots per plant		Plant leaf area (cm^2)		Chlorophyll mg/g fresh weight		Pod length (cm)	
		First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Local cultivar		54.80	66.70	3.91	4.04	2403	2852	2.46	2.63	10.88	10.69
Luz De Otona		60.60	80.30	4.41	5.52	2943	3602	2.03	2.21	14.66	14.66
Zaina		61.40	80.30	4.61	5.47	2920	3505	1.61	1.90	14.26	14.46
LSD		1.95	5.69	0.27	0.53	218.40	195	0.20	0.16	0.88	0.71
Salinity											
Control		65.1	85.80	5.35	5.84	3147	3653	2.43	2.67	15.17	15.39
S1		58.3	83.10	4.54	5.65	2793	3395	2.02	2.24	14.86	14.66
S2		53.3	58.40	3.03	3.63	2325	2911	1.65	1.90	9.77	9.76
LSD		2.10	6.50	0.40	0.97	150.8	220	0.42	0.24	0.66	1.56
Interaction											
Local cultivar	Control	58.00	72.70	4.30	4.33	2583	3019	2.70	2.80	11.63	12.07
	S1	55.80	71.90	3.93	4.30	2477	2972	2.56	2.76	12.13	11.37
	S2	50.40	55.50	3.50	3.50	2148	2566	2.13	2.33	8.87	8.63
Luz De Otona	Control	69.60	91.80	6.06	6.57	3440	3890	2.56	2.70	16.97	16.97
	S1	57.20	85.80	4.40	6.13	2973	3679	1.83	2.10	16.10	16.33
	S2	54.90	63.20	2.76	3.87	2417	3238	1.70	1.83	10.90	10.67
Zaina	Control	67.5	92.80	5.70	6.63	3419	4052	2.03	2.53	16.90	17.13
	S1	61.9	91.60	5.30	6.23	2930	3534	1.66	1.86	16.33	16.27
	S2	54.7	56.40	2.83	3.53	2410	2928	1.13	1.53	9.53	9.97
LSD		N.S	N.S	0.55	1.08	N.S	N.S	N.S	N.S	1.32	1.63

2- Yield and Its Components:

Analysis of variance in table (3) indicated that cultivars showed highly significant differences in yield and its components. Local cultivar had the lowest yield and its components in contrast to the other two cultivars.

Results in table (3) revealed that irrigation with saline water significantly affected the yield and its components. Increasing irrigation water salinity from 1.8 (control) to 4.7 and 7.8 for the first season and from 1.7 (control) to 4.3 and 7.6 for the second season significantly decreased the number of pods per plant a bout 9.92 and 42.88% respectively for the first season and a bout 9.20 and 39.66% respectively in the second season . The decrease in the seeds per pod approximate 8.99 and 19.37% for the first season and a bout 4.96 and 45.27% respectively for the second season. Decreasing in the 100 seeds Wight approximate 1.40 and 3.37% respectively for the first season and 2.46 and 5.47% respectively for the second season. This was reflected in decreasing yield almost 18.06 and 65.78% respectively for the first season and almost 15.10 and 61.77% respectively for the second season. This was due to the effects of salinity on water stress and water use [14] and this was due to the osmotic effect, that means that salts increase the energy with which water is held in the soil , in other words the soil must be kept water to supply the same amount of plant water availability as would be present without the salt . Plants then must increase the energy suspended to obtain

water from the soil, the plant must use energy to get water that would otherwise be used for growth, flowering and pods set [15 and 16].
The analysis of regression in table (4) showed that yield variations under control and saline water are mainly due to pods per plant because the highest percentage of determination coefficient was obtained from number of pods per plant which were 93, 89, and 50% for 1.8, 4.7 and 7.8 $ds.m^{-1}$ respectively and the increase one pod per plant cause increasing in seeds yield about 511.69, 395.93 and 223.87 kg/ha respectively for the first season.
In the second season however the determination coefficient was 91, 90 and 79% for 1.7, 4.3 and 7.6 $ds.m^{-1}$ respectively which means increasing one pod per plant could cause increasing in seeds yield about 351.22, 367.73 and 127.50 kg/ha respectively.
The results suggest that the cultivars Luz De Otono and Zaina could tolerate irrigation with saline water and can be considered and directed to the production of salt tolerance lines of broad bean plants or the development of salt crop genotypes by selection using pods per plant.

Table 3.Yield and its components of broad bean cultivars under effect of saline water in the first and second seasons.

Traits / Cultivar		No. of Pods per plant		No. of seeds per pods		Wight of 100 seeds (g)		Seeds yield (Kg/ha)	
		First season	Second season	First season	Second season	First season	Second season	First season	Second season
Local cultivar		7.15	8.13	3.86	3.96	89.00	93.00	1803	2057
Luz De Otona		12.00	15.75	5.34	5.67	97.44	100.11	3977	4230
Zaina		11.74	15.11	5.83	5.77	96.00	97.67	3830	4098
LSD		0.44	0.85	0.30	0.36	0.70	0.72	398.10	156.2
Salinity									
Control		12.50	15.53	5.67	5.84	95.67	99.56	4446	4693
S1		11.26	14.10	5.16	5.55	94.33	97.11	3643	3899
S2		7.14	9.37	4.16	4.02	92.44	94.11	1521	1794
LSD		0.63	1.19	0.29	0.38	0.79	1.40	703.9	441.70
Interaction									
Local cultivar	Control	8.13	9.53	4.26	4.43	90.00	95.00	2252	2463
	S1	8.03	9.03	4.03	4.00	90.00	94.00	2127	2393
	S2	5.30	5.83	3.30	3.46	87.00	90.00	1031	1315
Luz De Otona	Control	14.86	18.60	6.53	6.63	99.67	103.00	5681	5942
	S1	13.06	17.10	5.33	6.23	97.33	100.00	4479	4712
	S2	8.10	11.57	4.16	4.16	95.33	96.67	1770	2037
Zaina	Control	14.52	18.47	6.23	6.46	97.33	100.00	5406	5673
	S1	12.70	16.17	6.13	6.43	95.67	97.33	4323	4590
	S2	8.02	10.70	5.03	4.43	95.00	95.67	1762	2031
LSD		0.78	1.49	0.47	0.58	1.24	1.51	787.10	440.1

Table 4. Simple regression equations and determination coefficients between studied characteristics with seeds yield in two levels of saline water with control.

	First season	Second season
	control	control
Characteristics	Simple regression equations and determination coefficient (R^2)	Simple regression equations and determination coefficient (R^2)
Plant height	$\hat{Y}$= -23084.17 + 454.12 *X R^2= 0.50	$\hat{Y}$= -9325.22 + 163.46 *X R^2= 0.95
No. of branches per plant	$\hat{Y}$= -5999.36 + 1950.41 *X R^2= 0.92	$\hat{Y}$= -2001.11 + 1145.30 *X R^2= 0.74
Plant leaf area (cm^2)	$\hat{Y}$= -4710.13 + 2.91 *X R^2= 0.76	$\hat{Y}$= -6648.00 + 3.10 *X R^2= 0.83
Chlorophyll content	$\hat{Y}$= 10607.47 + -2532.03 *X R^2= 0.31	$\hat{Y}$= 19239.19 + -5432.36 *X R^2= 0.30
Pod length	$\hat{Y}$= -4038.85 + 559.45 *X R^2= 0.85	$\hat{Y}$= -4594.77 + 600.58 *X R^2= 0.85
Pods No./plant	$\hat{Y}$= -1858.92 + 511.69 *X R^2= 0.93	$\hat{Y}$= -763.07 + 351.22 *X R^2= 0.91
Seeds No./pod	$\hat{Y}$= -3637.09 + 1423.67 *X R^2= 0.86	$\hat{Y}$= -4219.80 + 1524.92 *X R^2= 0.90
Wight of 100 seeds	$\hat{Y}$= -30503.37 + 365.33 *X R^2= 0.90	$\hat{Y}$= -34175.54 + 390.42 *X R^2= 0.79
	S1	S1
Characteristics	Simple regression equations and determination coefficient (R^2)	Simple regression equations and determination coefficient (R^2)
Plant height	$\hat{Y}$= 12970.73 + -173.16 *X R^2= 0.26	$\hat{Y}$= 7325.99 + -58.73 *X R^2= 0.09
No. of branches per plant	$\hat{Y}$= -1646.65 + 1164.00 *X R^2= 0.41	$\hat{Y}$= 4123.74 + -298.84 *X R^2= 0.03
Plant leaf area (cm^2)	$\hat{Y}$= -8043.55 + 4.18 *X R^2= 0.56	$\hat{Y}$= 7330 + 1.38 *X R^2= 0.12
Chlorophyll content	$\hat{Y}$= 7633.80 + -1973.44 *X R^2= 0.61	$\hat{Y}$= 4149.75 + -241.14 *X R^2= 0.78
Pod length	$\hat{Y}$= -4185.09 + 526.95 *X R^2= 0.59	$\hat{Y}$= 4034.88 + -107.81 *X R^2= 0.02
Pods No./plant	$\hat{Y}$= -949.73 + 395.93 *X R^2= 0.89	$\hat{Y}$= 1788.82 + 367.73 *X R^2= 0.90
Seeds No./pod	$\hat{Y}$= -1942.95 + 1081.16 *X R^2= 0.76	$\hat{Y}$= 3776.50 + -39.85 *X R^2= 0.74
Wight of 100 seeds	$\hat{Y}$= -28003.31 + 335.47 *X R^2= 0.88	$\hat{Y}$= -259.41 + 39.74 *X R^2= 0.79
	S2	S2
Characteristics	Simple regression equations and determination coefficient (R^2)	Simple regression equations and determination coefficient (R^2)
Plant height	$\hat{Y}$= 9827.40 +- 169.86*X R^2= 0.45	$\hat{Y}$= 640.42 + 19.76 *X R^2= 0.12
No. of branches per plant	$\hat{Y}$= 3086.24 +-515.97 *X R^2= 0.18	$\hat{Y}$= 1601.62 + 53.00 *X R^2= 0.00
Plant leaf area (cm^2)	$\hat{Y}$= -1955.08 + 1.50 *X	$\hat{Y}$= -33.25 + 0.63 *X

	R^2= 0.15	R^2= 0.31
Chlorophyll content	$\hat{Y}$= 2542.49 + -616.93 *X R^2= 0.27	$\hat{Y}$= 3067.89 + -670.38 *X R^2= 0.44
Pod length	$\hat{Y}$= -2081.92 + 368.91*X R^2= 0.41	$\hat{Y}$= 6.96 + 183.20 *X R^2= 0.28
Pods No./plant	$\hat{Y}$= -65.89 + 223.87 *X R^2= 0.50	$\hat{Y}$= 599.97 + 127.50 *X R^2= 0.79
Seeds No./pod	$\hat{Y}$= 153.21 + 328.30 *X R^2= 0.21	$\hat{Y}$= 125.85 + 414.78 *X R^2= 0.43
Wight of 100 seeds	$\hat{Y}$= -5905.60 + 80.34 *X R^2= 0.37	$\hat{Y}$= -7370.93 + 97.39 *X R^2= 0.64

3-Soil Electrical Conductivity After Harvesting

Result of final soil salinity at harvest in relation to salinity of water treatments is presented in table (5).Result showed that salt build up in the soil increased significantly with increasing water salinity levels .Increasing irrigation water salinity from 1.8(control) to 4.7 and7.8 $ds.m^{-1}$ for the first season and from 1.7(control) to 4.3 and 7.6 $ds.m^{-1}$ for the second season significantly increases soil electrical conductivity at harvest about 70.37 and 137.97% respectively for the first season and about 65.32 and 123.65 % respectively for the second season .

Result indicated that poor quality of irrigation water increased soil salinity .Salinity become a problem when enough salts accumulated in the root zone which badly affect plant growth (tables 2 and 5).This agree with Abdelhamid et al. [17] whom found that irrigation with saline water causes salt accumulated in the root zone and refracted on decreases plant growth. To prevent salt accumulation within soil root zone leaching requirement should practiced [18].According to the results it can be recommend to study the amount of leaching requirement in anther experiment to prevent salt accumulation in the root zone.

Table (5) PH and Ec of soil after irrigation with saline water at harvest

	Treat for first season				Treat for second season			
	$ds.m^{-1}$				$ds.m^{-1}$			
properties	Control	S1	S2	LSD	Control	S1	S2	LSD
PH	7.8	8.0	8.5	0.26	7.4	7.8	8.4	0.69
Ec($ds.m^{-1}$)	3.95	6.73	9.40	0.13	3.72	6.15	8.32	0.23

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