J. Plant Production, Mansoura Univ., Vol. 5 (1): 163-173 , 2014

Performance of new promising genotypes of wheat under different nitrogen and salinity levels of irrigation water

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ABSTRACT

Plant growth and yield of wheat crop in saline soils and water may be increased by optimum fertilization management. The aim of this study was to investigate the response of new promising wheat genotypes to various nitrogen levels under various irrigation water salinity levels. To achieve this aim two experiments were conducted at the Experimental Farm of Dierab Station, Faculty of Agriculture and Food Sciences, King Saud University, Riyadh city, Kingdom Saudi Arabia during 2008/2009 and 2009/ 2010 seasons. The experiment was laid out in strip-split plot design with three replications. The vertical plots were allocated with three salinity levels of irrigation water (1000, 2000 and 4000 ppm). The horizontal plots were assigned to three nitrogen levels (100, 200 and 300 kg N/ha). While, the sub-plots were devoted to seven genotypes (KSU 101, KSU 102, KSU 104, KSU 105, KSU106 and Youkora Rojo).

The main results could be summarized as follows; the salinity levels significantly affected the yield and yield components of wheat whereas, they were significantly decreased as salinity level was increased up to 1000 ppm. The optimum nitrogen rate was 200 kg N/ha. The new released genotypes showed superiority against the commercial variety *i.e.* Youkora Rojo under normal and salinity conditions. The best released genotype was KSU102 followed by KSU 101 and KSU103.

Increasing nitrogen rate at high salinity level of irrigation water is not favorable, whereas it significantly decreased wheat grain yield and main yield components. By the way, 200 kg N/ha was the optimum under salinity conditions. The new tested wheat variety confirmed its salinity tolerance rather than common American variety.

It can be concluded that, fertilizing wheat genotype KSU102 with 200 kg N/ha could be recommend to maximizing wheat productivity under salinity conditions.

INTRODUCTION

The wheat crop is the most important strategic crops in the Saudi Arabia Kingdom, where the cultivated area is around 483861 ha produced about 2,057,471 tones (Ministry of Agriculture - Statistical Book, 1426 h and 2005).

Salinity and poor quality water are the main environmental constrains for agriculture production with some focusing on wheat production in Saudi. Patel *et al.* (2003) and Kaledhonkar and Keshari (2006) stated that the yield and yield components of wheat were significantly decreased by increasing salinity level of irrigation water.

Nitrogen is often the most important plant nutrients. Wheat is very sensitive to insufficient nitrogen and very responsive to nitrogen fertilization (David *et al.*, 2005). Many workers all over the world concluded that using nitrogen fertilizer in suitable needed rates could improve growth, yield and its components as well as quality of wheat *i.e.* Sayed *et al.* (2003), Tammam and Tawfils (2004), Allam (2005), Seadh and Badawi (2006), Ibrahim (2007), Mekhemar (2008) and Seadh *et al.* (2009).

Chosen the high yielding ability genotypes undoubtedly is very important to raise wheat productivity per unit area. It is known that using only one wheat variety in different environmental conditions such as Saudi Arabia's resulted in to low productivity. The cultivar Youkora Rojo is the dominant cultivar in Kingdom Saudi Arabia since 1982, which occupying about 90 % of the cultivated area of wheat. Youkora Rojo wheat variety is high yielding cultivar, but it is unstable due to high sensitivity to changes in the environmental factors such as salinity. As the average year find that the rate of production of wheat variety Youkora Rojo in the Kingdom's regions ranged from 3.1 tons / ha in Abha, Asir Region and to 7.1 tons / ha in the Hail region, which represents an economic waste due to poor varietal policy for each region (Ministry of Agriculture, 1422 and 2001). Recent studies conducted on the improved and selected some new genotypes Saudia Arabia Kingdom, have shown that the superiority of some strains on the trade variety of Youkora Rojo such as strains KSU 102, KSU 105 and KSU 106 which significantly exceeded it by more than 30% (Moustafa *et al.*, 1998 and Al-Doss *et al.*, 2004). Furthermore, other studies have shown the superiority of some newly produced straiNS in the growth and production under conditions of moisture and soil salinity stress (Alderfasi and Moustafa, 2001) which bodes well for the ability of these strains resistant to different environmental conditions in the Kingdom. Mohammad *et al.* (2008) and Yildirim and Bahar (2010) found great genetic variation between different wheat genotypes tested under various salinity levels regarding the yield and yield components of wheat crop.

In saline soils, the proper use of N fertilizer particularly, the rate in which N is applied to salt-stressed plants may influence plant-nutrient-salinity relationships (Martinez and Cerda, 1989 and Traore and Maranville, 1999). El-Gharably *et al.* (2010) stated that dry weights of shoot and root were reduced by salinity in all N treatments. Addition of N significantly increased shoot and root dry weights with significant differences between N and rates. Furthermore, under non-saline conditions, addition of NO_3–N at rates higher than N50 had a negative effect, while N100 increased shoot and root dry weights. Addition of greater than N50 increased soil salinity and reduced micronutrient uptake both of which likely limited plant growth (Ali *et al.*, 2001 and Irshad *et al.*, 2002). Under saline soil, Mahmood and Kaiser (2003) and Asghar *et al.*, (1996) found that application of 100 kg N ha' proved to be the most "suitable one. This was attributed to a significant increase in tillering, spike length. 100-grain weight and grain yield per plant. However, at the highest levels of salinity (15 dSm^{-1}) while the application of 150 Kg N/ha significantly reduced the above-mentioned traits. El-Gharably (2011) found that growth and yield of wheat crop were significantly responded to nitrogen rate to 50 g/kg under higher salinity level and increasing N beyond that level reduced the yield of wheat.

Developing proper culture practices such as crop programs fertilization occasion, will help to increase productivity in the wheat. Yecora Rojo promoted to local conditions, was significantly responded to nitrogen from 200 kg to 400 kg N/ha. With this increase in nitrogen fertilization, most farmers do not observe in the relation between level of nitrogen fertilization and the salt concentration of irrigation water as well as the soil salinity which increasing fertilizer and wheat productivity shown that by Kafafi (1984), Feigin (1985) and Ahmed *et al.* (1993).

Therefore, this investigation was established to investigate the response of some new promising genotypes of wheat irrigated by different saline water levels to various nitrogen levels under the environmental conditions of Riyadh, Kingdom Saudi Arabia.

MATERIAL AND METHODS

The field experiments were conducted at the Experimental Farm of Dierab Station, Faculty of Agriculture and Food Sciences, King Saud University, Riyadh city, Kingdom Saudi Arabia during 2008/2009 and 2009/2010 seasons to study the response of new promising wheat genotypes to various nitrogen levels under various water salinity levels.

A strip–split plot design with three replications was used in this study. The vertical plots were assigned to three salinity levels of irrigation water; A) fresh water with salinity level of 1000 ppm, B) moderate saline water with salinity level of 2000 ppm and C) high saline water with salinity level of 4000 ppm. The horizontal plots were devoted to three nitrogen levels (100, 200 and 300 kg N/ha). Meanwhile, the new tested wheat genotypes as shown in Table 1 were arranged in the sub-plots.

Table 1: The wheat genotypes used in the current experiment.

Number	Variety	Generation	Source
1	KSU101	L1199-3	Plant production department
2	KSU102	L1199-5	Plant production department
3	KSU103	L1199-6	Plant production department
4	KSU104	L1199-9	Plant production department
5	KSU105	L1199-15	Plant production department
6	KSU106	L1199-16	Plant production department
7	Youkora Rojo		America

Each experimental unit area was 2 X 3 m occupying an area of 6 m^2. The soil was sandy in texture. The experimental field was well prepared through ploughings, compaction and then divided into the experimental units with dimensions as previously mentioned. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation (after ploughing and before division) at the rate of 350 kg/ha.

Wheat seeds at the rate of 200 kg/ha were drilled in rows with space of 20 cm between rows. Irrigation was applied using the water kept in tanks in which the determined concentrations of salt were prepared. The nitrogen fertilizer in the form of urea (45.0 % N) was applied as formerly mentioned levels as top dressing in four equal doses before the first fourth irrigations. Magnesium sulphate was applied at the rate of 20 kg/ha in two equal doses; at 50 and 75 days after sowing. In addition, microelements were added at the rate of 3 kg/ha in two splits after 35 and 50 days from sowing. The common agricultural practices for growing wheat according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

At harvesting, ten spikes were randomly picked up from each sub-plot to determine the yield attributing characteristics; number of spikes/m^2 and 1000–grain weight (g). The sex inner rows of each sub-plots were harvested, dried, threshed and the grain and biological yield were assessed at 14 % moisture content, and converted per hectare.

All data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip split – plot design as published by Gomez and Gomez (1984) by means of "MSTAT-C" Computer software package. Least significant of difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Data in Table 2 show no significant effect to the years on 1000-grain weight and grain yield. The differences were significant for number of spikes/ m^2 and biological yield. The salinity levels of irrigation water had highly significant effects on number of spikes/m^2, 1000-grain weight grain and biological yields. However, nitrogen fertilizer levels induced significant differences only in grain yield.

Table 2: Analyses variance of the effect of water salinity levels and nitrogen fertilizer levels on wheat genotypes.

SS	D.F.	Number of spikes/m^2	1000-grain weight (g)	Grain yield (t/ha)	Biological yield (t/ha)
Years	**1**	**	**NS**	**NS**	**
Water salinity levels	2	**	**	**	**
Water salinity levels x years	2	NS	*	NS	NS
N-levels	2	NS	NS	*	NS
N-levels x years	2	*	NS	NS	*
N-levels x water salinity levels	4	NS	**	**	NS
Genotypes	6	**	**	**	*
Genotypes x years	6	**	*	**	**
Genotypes x water salinity levels	12	*	*	**	*
Genotypes x N-levels	12	**	NS	**	*
Genotypes x water salinity levels x years	12	**	NS	**	NS
Genotype x N-levels x years	12	NS	NS	NS	NS
Genotype x N-levels x water salinity levels	24	NS	NS	NS	NS
Genotype x water salinity levels x N-levels x years	48	NS	NS	NS	NS

Genotypes exhibited highly significant differences concerning number of spikes/m^2, 1000- grain weight, grain and biological yields. The interaction between genotypes and water salinity levels had a significant effect on number of spikes/ m^2 and grain yield, but the interaction effect was insignificant regarding 1000-grain weight and biological yield. The interaction between genotypes and nitrogen fertilizer levels had highly significant effect on number of spikes/ m^2 and 1000-grain weight. The triple interaction among genotypes, nitrogen fertilizer levels and years had insignificant effect on all studied characters. Also, the triple interaction among genotypes, water salinity levels and nitrogen fertilizer levels had insignificant effect on number of spikes/ m^2, 1000-grain weight, grain and biological yields. Furthermore, the interaction among years, water salinity levels, nitrogen fertilizer levels and genotypes had insignificant effects on 1000- grain weight, grain and biological yields.

Data in Table 3 revealed that no significant differences in wheat grain yield were exerted by fresh irrigation water and irrigation water of 2000 ppm with 7.04 and 6.82 t/ha, respectively. However, use of irrigation water with salinity level of 4000 ppm significantly reduced the wheat grain yield which recorded 5.88 t/ha under this high salinity level. This indicated that the wheat grain yield was reduced significantly by high salt content in irrigation water. The high salinity level of irrigation water might accumulated more salts in soil resulted high salinity levels in the soil, which suppressed the wheat growth, dry matter production, yield components leading to lower grain yield . This should be considered in irrigating wheat, and the growers and agricultural companies should assess the salinity level of irrigation water before cultivating wheat for using suitable genotype and optimum nitrogen fertilizer program particularly nitrogen fertilizer for seeking high productivity by avoid reduction in the productivity happened under saline water conduction.

Table 3: Averages of number spikes/m^2, 1000- grain weight, grain and biological yields as affected water salinity levels as average of both years of study.

Water salinity levels	Number of spikes/m^2	1000-grain weight (g)	Grain yield (t/ha)	Biological yield (t/ha)
Fresh water	626.03a	37.13a	7.04a	26.26a
(2000 ppm)	568.67b	35.51b	6.82a	24.43b
(4000 ppm)	512.12c	28.90c	5.88b	22.22c
L S D at 0.05	27.91	1.51	0.83	1.39

Significant differences were recorded in the biological yield, number of spikes/ m^2 and 1000- grain weight by using different levels of salinity in water of irrigation. The biological yield was reduced from 26.26 to 24.43 t /ha under fresher water and 2000 ppm, respectively. Also, number of spikes /m^2 was reduced from 626.03 to 568.67 under using irrigation water with salinity levels of fresh and 2000 ppm, respectively. The same trend was found regarding 1000 – grain weight that was reduced from 37.13 to 35.51 and 28.9 g for fresh water, 2000 and 4000 ppm, respectively.

In conclusion, all yield attributes were reduced by using high level of salinity in irrigation water. Similar results were reported by Patel *et al.* (2003), Kaledhonkar and Keshari (2006), Mohammad *et al.* (2008) and Yildirim **and** Bahar (2010).

Data in Table 4 show that the effect of nitrogen fertilizer levels on grain yield and yield attributes as average of both years of study.

The grain yield insignificantly increased from 6.42 to 6.97 t/ha when the nitrogen fertilization rates increased from 100 kg to 200 kg N/ha, respectively. The grain yield was significant reduced to 6.34 t/ ha at 300 kg N /ha. This yield reduction could be attributed to high level of fertilization under high salinity level as was indicated by previous studies (Asghar *et al.*, 1996 and El-Gharably, 2011). The rest of yield attributes did not affect by the tested nitrogen levels in both seasons. Thereby, the recommended nitrogen under saline water is 100 kg N/ha. Thus, high nitrogen level is not recommended under higher salinity level in soil or irrigation water. The current findings are in a good conformity with those reported by Ahmed *et al.* (1993).

Table 4: Averages of number spikes/m^2, 1000- grain weight, grain and biological yields as affected nitrogen fertilizer levels as average of both years of study.

Nitrogen fertilizer levels (kg N/ha)	Number of spikes/m^2	1000-grain weight (g)	Grain yield (t/ha)	Biological yield (t/ha)
100	568.10a	34.19a	6.42 ab	24.27a
200	575.08a	34.22a	6.97a	24.85a
300	571.27a	33.15a	6.34 b	24.07a
L S D at 0.05	NS	NS	0.57	0.99

Table 5: Averages of number spikes/m^2, 1000- grain weight, grain and biological yields as affected by some wheat genotypes as average of both years of study.

Genotypes	Number of spikes/m^2	1000-grain weight (g)	Grain yield (t/ha)	Biological yield (t/ha)
KSU101	689.26a	26.84d	6.77bc	31.24a
KSU102	575.56bc	38.25a	7.52a	26.54b
KSU103	569.63bc	35.49b	7.08bc	24.17cd
KSU104	562.59bc	35.00b	6.76bc	25.06bc
KSU105	590.00b	35.29b	6.83bc	25.51bc
KSU106	543.33c	33.39c	6.36c	22.68d
Youkora Rojo	470.00d	32.71c	4.71d	15.61h
L S D at 0.05	39.35	1.34	0.58	1.62

Data in Table 5 indicated that the new promising strains significantly performed better than those obtained by the American variety Youkora Rojo which occupies 90 % of wheat cultivate area in Saudi Arabia. Interestingly, data in Table 5 showed the Superiority of the new strains of KSU102 and KSU 103 over all other strains with productivity of 7.52 and 7.08 t/ha, respectively. This encourages recommending the cultivation of the new elite strains under The Kingdom of Saudi Arabia condition replacing to the common American variety in the Kingdom. Previous studies (Al- Dos et al, 2004) proved the superiority of the new genotypes and it was approved by the General Organization of Silos because of its excellent technological characteristics. The genotypes, KSU101, KSU102 were superior in their biological yield (31.24 & 26.54 t /ha), respectively, and were superior for the number of spikes; 689.26 and 575.56 /m^2. Also, the genotype KSU102 was superior in 1000- grain weight with 32.84 g followed by KSU 103 with 35.49 g as compared by the commercial cultivar, Youkora Rojo with 32.71. Great genetic variations among various genotypes under saline conditions were reported by Al-Doss *et al.* (2004), Mohammad *et al.* (2008) and Yildirim and Bahar (2010).

Data in Table 6 showed the obtained grain yield t/ha as affected by the interaction between tested wheat genotypes and salinity levels of irrigation water.

Table 6: Averages of grain yield as affected the interaction between water salinity levels and wheat genotypes as average of both years of study.

Genotypes \ Salinity of irrigation water	Irrigated with fresh water	Irrigated with 2000 ppm	Irrigated with 4000 ppm
KSU101	7.30	7.15	5.87
KSU102	7.72	8.23	6.62
KSU103	6.61	8.23	6.68
KSU104	7.16	6.9	6.18
KSU105	7.70	6.71	6.08
KSU106	6.95	6.62	5.51
Youkora Roj	5.89	4.13	4.13
L S D at 0.05	0.99		

The new developed strains significantly performed better under various salinity levels of irrigation water as compared to the American variety. In case of using fresh water all genotypes surpassed the American one with yields of 7.30, 7,72,7.16 and 7.70 t/ha for KSU101,KSu102, KSU104 and KSU105, respectively, as compared with 5.89 t/ha for the American variety, The differences proved to be significant. The same trend was found in case of 2000 ppm and 4000 ppm salinity levels. From going discussion, it could be recommended that the new genotypes cloud be used even under saline conditions either soil or water Al-Doss *et al.* (2004), Mohammad *et al.* (2008) and Yildirim and Bahar(2010) came to similar results.

Data in Table 7 present the obtained wheat yield as influenced by the interaction between salinity levels of irrigation water and nitrogen rates. As previously mentioned the higher nitrogen level is not recommended under higher salinity level which led to significant yield reduction and that was fact with all tested genotypes. This yield reduction due to higher nitrogen level under higher salinity level agree with the finding of Kafaki (1984), Feigin (1985), Ahmed *et al.* (1993), Mahmood and Kaiser (2003) and El-Gharably *et al.* (2010).

Table 7: Averages of grain yield as affected the interaction between salinity of irrigation water nitrogen fertilizer levels as average of both years of study.

N-levels (kg/ha)	Salinity of irrigation water		
	Fresh water	2000 ppm	4000 ppm
100	7.60	.046	5.60
200	7.35	7.55	6.00
300	6.17	6.86	6.00
L S D at 0.05	0.98		

Data in Table 8 show the variable response of wheat genotypes to different levels of nitrogen fertilizer. At 100 kg N/ ha the genotypes, KSU102 gave the highest values of grain yield (7.86 t/ha), while, the genotype, Youkora Rojo gave the lowest value of grain yield (4.62 t /ha). At 200 kg N /ha, the most yielder genotypes was KSU 104 (8.32 t/ha) followed by KSU 103(7.69 t/ha) and KSU 102 (7.67 t/ha), while the least yielder one was Youkora Rojo (4.70 t/ha). At 300 kg N/ha, the yield was generally decreased for all tested genotypes. However, KSU102 genotype was the most established one , as it yielded 7.04 t/ha, followed by KSU105 with productivity of 7.02 t/ha . Also, The Youkora Rojo American genotype exhibited the lowest yield (4.83 t/ha). Similar results were reported by Mohammad *et al.* (2008) and Yildirim and Bahar (2010).

Table 8: Averages of grain yield as affected the interaction between nitrogen fertilizer levels and wheat genotypes as average of both years of study.

Genotypes	N-levels (kg/ha)		
	100	200	300
KSU101	6.91	7.06	6.35
KSU102	7.86	7.67	7.04
KSU103	6.71	7.69	6.85
KSU104	5.99	8.32	5.97
KSU105	6.45	7.02	7.02
KSU106	6.38	6.35	6.35
Youkora Rojo	4.62	4.7	4.83
L S D at 0.05	0.99		

Conclusions and Recommendations

Nitrogen fertilizer at the rate of 200 kg N/ha proved to be the optimum rate for higher wheat yield under tested salinity levels. All new genotypes significantly surpassed the common American genotype Youkora Rojo under all tested levels of nitrogen and salinity. The new genotype of KSU102 was superior to other new released genotypes and Youkora Rojo American genotype by around 37 % even under high salinity level of 1000 ppm.

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سلوك سلالات جديدة من القمح تحت مستويات مختلفة من النيتروجين والملوحة

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**** قسم بحوث المحاصيل الحقلية – شعبة البحوث الزراعية المركز القومي للبحوث – الجيزة - مصر**

من أهداف برامج تربية القمح في المملكة العربية السعودية تطوير أصناف قمح عالية الإنتاج لظروف بيئية محددة، ومن هذه الظروف الإجهاد الملحي في كل من مياه الري والتربة الذي يلعب دور أساسي في الحد من الإنتاجية.

أجريت الدراسة خلال موسمي الزراعة ٢٠٠٨/٢٠٠٩ م و ٢٠٠٩/٢٠١٠في محطة الأبحاث والتجارب الزراعية – التابعة لكلية علوم الأغذية والزراعة – جامعة الملك سعود بالرياض. أستخدم تصميم الشرائح المتعامدة المنشقة في ثلاث مكررات حيث وضعت مستويات الملوحة (١٠٠٠ ،٢٠٠٠ و٤٠٠٠ جزء في المليون) في الشرائح الأفقية بينما وضعت مستويات التسميد النيتروجيني (١٠٠,٢٠٠ و ٣٠٠ كجم نيتروجين /هكتار في الشرائح الرأسية. ووزعت سلالات القمح المنتخبة من برنامج تربية القمح – قسم الإنتاج النباتي – كلية علوم الأغذية والزراعة – جامعة الملك سعود وهي ,KSU101, KSU102, KSU103 KSU104, KSU105, KSU106 بالإضافة الى صنف القمح المنزرع بالمملكة يو كوراروجو في القطع الشقية.

أوضحت النتائج التأثير المعنوي لمعاملات التسميد النيتروجيني والملوحة على المحصول ومكوناته. كما أظهرت النتائج تفوق السلالات الجديدة المنتخبة KSU 103 وKSU102 (٦.٦٨و ٦.٦٢ طن للهكتار) على صنف القمح المنزرع بالمملكة يوكوراروجو (٤.١٣ طن للهكتار)عند مستوى ملوحة ٤٠٠٠جزء في المليون.

أفضل معدل نتروجين هو ٢٠٠ كجم / هكتار. وزيادة معدلات النتروجين تحت ظروف الملوحة العالي غير مفضلة حيث ادت لي نقص المحصول و المكونات الرئيسية للمحصول.

من النتائج المتحصل عليها من الدراسة الحالية يمكن التوصية بإدخال السلالات الجديدة مستقبلا في المناطق التي تعاني من ارتفاع تركيز الأملاح في مياه الري. ويمكن التوصية بزراعة السلالة KSU102 تحت ظروف الملوحة العالية مع التسميد النيتروجيني بمعدل ٢٠٠ كجم نيتروجين/هكتار.

قام بتحكيم البحث

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