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Impacts of Plant Population on Wheat and Barley Genotypes under Salinity Conditions

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Abstract: A study was conducted to investigate the effects of plant population on the performance of wheat and barley genotypes under salinity conditions. Three barley genotypes: Rum, Acsad 176 and Line (5) and five wheat genotypes: Jumaizeh, Bin-bashair, Cham-3, Cham-6 and Snb1s1 were grown at Central Jordan Valley during 2005 growing season. Soil and water analysis showed salinity of (4-6 dS m^{-1} at 0-60 cm depth) for soil and (1.9-2.7 dS m^{-1}) for water. The experiment was under split plot design with three replications. For wheat genotypes, results showed no significant differences with respect to grain and straw yields except for Jumaizeh for straw yield. For plant population, population (D3 = 400 plant m^{-2}) showed the highest biological (14.1 t ha^{-1}), grain (4.1 t ha^{-1}) and straw (10.3 t ha^{-1}) yields. For the interaction effects (Jumaizeh*D3) gave a significant interaction for biological (16.1t ha^{-1}), grain (4.4 t ha^{-1}) and straw (11.6 t ha^{-1}) yields. For barley genotypes, results showed no significant differences between them with respect to the three characters studied however, Rum was the highest amongst them. For the population, population (D2 = 250 plant m^{-2}) revealed the highest biological (9.9 t ha^{-1}), grain (1.6 t ha^{-1})and straw (8.3 t ha^{-1}) yields. For the interaction effects, results exhibited the significance of (Rum*D2) over other interactions for biological (12.2 t ha^{-1}), grain (2.0 t ha^{-1}) and straw (10.2 t ha^{-1}) yields. Plant populations (D3 = 400 plant m^{-2}) and (D2 = 250 plant m^{-2}) are recommended for wheat and barley, respectively when planted under saline conditions, as well as the genotypes-population interactions that revealed the highest yields.

Key words: Acssad176, bin-Bashir, biological yield, Central Jordan valley, Cham- 3 and 6, Jumaizeh, rum

INTRODUCTION

Around (62.7%) of the Jordan area is used as ranges (25.6%) of the area is used for fruit trees (860,30.5 ha) and vegetables (369, 04.2 ha) and (11.7%) of the area is not suitable for agricultural uses, using soil, land topography and climate informations (Department of Statistics, 2004). Total area planted to wheat and barley in Jordan (138193.7 ha) where, (345, 25.2 ha) planted to wheat and (1, 036, 68.5 ha) planted to barley in 2005 growing season Jordan (Department of Statistics, 2004). Saline soils with salinity greater than (12 dS m^{-1}) was around C (18,6%) of the entire land of the Jordan Valley and comprized (350,00 ha) (Authority of Jordan Valley-land classification project, 1989). Salinity tolerant wheat genotypes selected in India was about (2.5 t ha^{-1}) compared under high salinity conditions compared to (4.5 t ha^{-1}) under normal conditions (Naqvi and Tadon, 1991). Change and Sipio (1991), exposed several wheat genotypes to a salinity of (8-12 dS m^{-1}), the decrease in yield was (24-30%). Maas *et al.* (1991), found that salinity has reduced number of tillers/plant in two spring wheat cultivars and he recommended to increase planting distances under saline conditions to give opportunity of tillersto appear. Dalke *et al.* (1993) found that the seeding rate of (28 seeds/ft^2) for two wheat cultiars gave the highest seed production compared to seeding rates of (14, 42 and 56 seeds/ft^2), in a study carried out for four years. Seeding rate (120 kg ha^{-1}) exhibited the highest wheat seed production compared with the rate (90 kg ha^{-1}) (Strivastiva *et al.*, 1994). Turk and Tawaha (2002) found that seed rate of 140 kg ha^{-1} produced the highest wheat seed production, this was accompanied with low number associated of tillers/plant, number of seeds/spike and the 1000 grain weight under rain-fed conditions in Jordan. The results obtained by Lithourgidis *et al.* (2006) showed that ear numbers were increased with the increased seed rate. However, differences were not found in grain yield either. Increasing of seeding rate favored crop establishment in all tillage systems, but it did not provide any grain yield advantage.

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The seed rates (100 and 150 kg ha^{-1}) gave the highest productive in barley cultivators in the early planting date. However, the seed rate (200 kg ha^{-1}) has raised seed production in late planting date (Conry and Hegarty, 1992). Also, the seeding rate of (130 kg ha^{-1}) has achieved the highest seed production of the barley cultivars examined (Al-Mulhim and AL-Tahir, 1991). Schillinger *et al.* (2005) found that grain yield was not affected by sowing rate for wheat, barley and oat species because increased number of heads per unit area and kernels per head consistently were compensated for reduced plant population. With precise seed placement, sowing rate of spring cereals can be reduced by 50% or more from rates commonly used. Gooding *et al.* (2002) found that, biomass and grain yields did not respond to increases in seed rate with apparent reductions in yield at very high seed rates. Plants compensated for low population densities by increased production and survival of tillers and increased grain numbers per ear. Effects of seed rate on grain specific weight and thousand grain weight were small and inconsistent. Grain protein concentration declined with increase in sowing rate. Emam and Moaicd (2000) found that plant population (250 to 400 plants m^{-2}) appeared to be the optimum population for barley where, no significant change in barley grain yield was obtained. Results obtained by Spink *et al.* (2000) showed that Grain yield was significantly affected by plant population with a mean reduction from 9.2 to 5.5 t ha^{-1} as plant number was reduced from 336 to 13 m^{-2}. There was, however, no interaction between variety and plant population in terms of yield. The experiments demonstrated scope for reducing plant populations below the current target of 250-300 plants m^{-2}; however, the degree of reduction was dependent on sowing date. reported The results indicated that plant population (300 plant m^{-2}) for barley had a significant effect on most of the measured traits and the yield determinates. Plant population (300 plants m^{-2}) for barley had a significant effect on most of the measured traits and the yield determinates under rain-fed conditions in Jordan (Turk *et al*., 2003). Patrick *et al.* (2003a) found that seeding rate and cultivars interaction occurred for both plant stand and tiller production, but the interaction resulted from a change in the magnitude of response to seeding rate adjustments for either yield component. Number of spike-bearing tillers increased from 411 to 457 plant m^{-2}. Another study showed that grain yield and test weight were increased as the seeding rate was increased. However, protein concentration and kernel weight, were unaffected (Patrick *et al.* (2003b). Scursoni and Satorre (2005) reported that increasing crop population could be an effective strategy to reduce the effect of wild oat on barley yield. Wild oat biomass was reduced by increasing barley seeding rates. Barley biomass and yield were not affected by wild oat at high crop sowing densities.

Due to the declining in good water resources, increasing of salinity in both water and soil, increasing demand on food as a result of the vast growing population and due to the availibility of wheat and barley genotypes that are salinity resistant. A study was conducted to investigate the effects of plant population on the performance of wheat and barley genotypes salinit conditions.

This research was conducted to test and evaluate the impact of plant population on productivity and quality of these genotypes under salinity conditions. Maximizing productivity will raise the farmers economical livinghood and provide substitution crops suitable for their saline land. This will be reflected positively on the national gross income of the country population.

MATERIALS AND METHODS

Varieties: Five wheat genotypes: Jumaizeh, Bin-Bashir, Cham-3, Cham-6 and Snblsl and three barley genotypes: Rum, Acsad176 and Line (5) were planted during the growing season 2004/2005.

Soil sampling for salinity analysis: Compound soil samples were taken at 0.0-30 and 30-60 cm depths salinity determination. The samples were taken/main plot (9 samples at 2 depths = total of 18 samples). Soil salinity average was (4-6.6 dS m^{-1} at a depth of 0-30 cm and 3.2-5.6 dS m^{-1} at a depth of 30-60 cm).

Water sampling for salinity analysis: Monthly water samples were taken during the growing season (total of 7 samples). Water salinity average was (1.9-2.7 dS m^{-1}).

Statistical analysis: Split plot design (SPD) with three replications was used for the experiment. Plant population was allocated to) M.P(whereas, varieties to the (SP). The planting population are indicated in Table 1. Plants were fertilized with 300 kg ha^{-1} diammonium phosphate (DAP) 18-46-0 (with seeding and 150 kg ha^{-1} urea) 46-0-0 at the tillering stage.

Table 1: Plant densities used in the experiment

Varieties	(P1) plant m^{-2}	(P2) plant m^{-2}	(P3) plant m^{-2}
Wheat	300	350	400
Barley	200	250	300

RESULTS AND DISCUSSION

Table 2 showed the different characters studied. For the biological yield, Jumaizeh (14.1 t ha^{-1}) significant difference to Snblsl and insignificant difference to the rest of genotypes. However, Cham-3 showed insignificant difference to Snblsl. concerning seed yield genotypes showed no significant difference among themselves, however, Cham-6 and Jumaizeh were the highest amongst them and produced (3.8 and 3.7 t ha^{-1}), respectively. For the straw yield, Jumaizeh (14.4 t ha^{-1}) significant difference to Snblsl and insignificant difference to the rest of genotypes. For the number of spikes/plant, has Snblsl (7.7 t ha^{-1}), exceeded Cham- 6 with a significant difference and with insignificant differences to the rest of genotypes, which in turn did not differ significantly with Cham- 6. For the number of spikelets/spike Jumaizeh (20.4) exhibited a significant difference to the rest of the genotypes, which in turn did not differ significantly among themselves. For the plant height, Snblsl and Cham- 6 (97.1 and 95.1 cm) the tallest genotypes with a significant difference to Cham-3 and in significant difference to the rest of the genotypes. For the biological yield, plant population (D3 = 400 plants m^{-2}) (14.4 t ha^{-1}) revealed a significant difference the rest of densities followed by (D2 = 350 plants m^{-2}) (12.9 t ha^{-1}). concerning seed yield plant population (D3 = 400 plants m^{-2}) (4.1 t ha^{-1}) showed a significant difference to (D1 = 300 plants m^{-2}) (3.2 t ha^{-1}) and with insignificant difference to (D2 = 350 plants m^{-2}) (3.5 t ha^{-1}), The same trend was obtained with respect to hay yield where (D3 = 400plants m^{-2}) (10.3 t ha^{-1}) showed a significant difference (Table 3). This is consistent with the results obtained by Turk and Tawaha (2000), Patrick *et al.* (2003a, b) Emam and Moaicd (2000), Dalke *et al.* (1993), Strivastiva *et al.* (1994) and Scursoni and Satorre (2005) that the yield increases with the increase in plant population and differ with the results obtained by Schillinger *et al.* (2005) and Gooding *et al.* (2002) in terms that no yield increase by increasing seeding rates. Concerning number of spikes/plant densities did not differ significantly amongst themselves. For the number spikelets/spike plant population (D1 = 300plants m^{-2}) (18.8) exceeded significantly plant population (D3 = 400 plants m^{-2}) and with insignificant difference with (D2 = 350 plants m^{-2}). For plant height, plant population (D2 = 350 plants m^{-2}) showed significant difference to the rest of densities.

For the biological yield the interaction (Jumaizeh*D3) exceeds significantly the rest of the genotypes except the interactions (Jumaizeh*D2) (Bin Bashir and Cham- 3 and 6 *D 3) and (Cham-6 *D2) with insignificant differences. Concerning seed yield, the interactions (Jumaizeh * D3) and (Cham- 6 *D3) (4.4 t ha^{-1} for each) out yielded the interactions (Bin-bashir, Cham- 3 * D2) and (Cham- 6 *D1) with a significant differences and the rest of the intersections with a non-significant differences, (Table 4) For hay yield interaction (Jumaizeh *D3) (11.6 t ha^{-1}) exceeded (Jumaizeh and Cham- 6 *D 1) and (Snblsl *D3) with a significant differences and with insignificant differences with the rest of the intersections. For the number of tillers/plant the interaction (Snblsl *D3) (8 spikes/plant)exceeded (Jumaizeh, Bin-Bashir * D1 and 3)

Table 2: Biological, straw and seed yields (t h^{-1}), no of spike/plant, No of spikelet/spike and plant height (cm) of salinity tolerant wheat varieties planted in the middle Jordan valley during 2004/2005

Varieties	Biological yield (t ha^{-1})	Seed production (t ha^{-1})	Straw production (t ha^{-1})	No. of spike/ plant	No. of spikelet /spike	Plant height (cm)
Jumaizeh	14.1a*	3.7a	10.4a	7.1ab	20.4a	94.3ab
Bin-bashir	13.6a	3.5a	10.1ab	7.6ab	17.1b	93.3ab
Cham 3	12.6ab	3.4a	9.3a	7.1ab	18.2b	89.9b
Cham 6	13.1a	3.8a	9.1a	7.1b	17.3b	95.1a
Snb1s1	11.2b	3.6a	8.2b	7.7a	18.1b	97.1a
LSD (0.05)	1.801	1.248	1.952	0.6226	1.77	4.532
CV%	13.3	24.0	15.8	7.1	0.5	1.9

Numbers with the same letter(s) have no significant differences at 5% level

Table 3: Effect of plant population on biological, straw and seedyields (t h^{-1}), No of spike/plant, no of spikelet/spike and plant height (cm) of salinity tolerant wheat genotypes planted in themiddle Jordan valley during 2004/2005

Varieties	Biological yield (t ha^{-1})	Seed production (t ha^{-1})	Straw production (t ha^{-1})	No. of spike/ plant	No. of spikelet /spike	Plant height (cm)
(P1) 300 plant m^{-2}	11.4c*	3.2b	8.6b	7.3a	18.8a	93.5b
(P2) 350 plant m^{-2}	12.9b	3.5ab	9.30ab	7.2a	18.2ab	95.3a
(P3) 400 plant m^{-2}	14.4a	4.1a	10.3a	7.3a	17.7b	93.1b
LSD (0.05)	1.307	0.6395	1.132	0.3936	0.6906	1.334

*Numbers with the same letter(s) have no significant differences at 5% level

(Cham- 3 *D 2) and (Cham- 6 *D 1, D 2 and D 3) with significant differences and with insignificant differences with the rest of the intersections. For the trait number of spikelets/spike, the interactions (Jumaizeh *D 2 and D 3) (20.7 Spikelet/Spike) exceeded the interaction (Jumaizeh *D 1) and with a significant difference and with a non-significant differences with the rest of interactions. For plant height the interaction (Snblsl*D 3) (98.0 cm)was the tallest, a non-significant differences compared to (Snblsl *D 1, D 2) and (Jumaizeh, Cham-6 *D 2) and with the rest of the intersections with a significant differences achieved. These results come in consistent with the results obtained by Patrick *et al.* (2003a,b) which revealed that interaction of seeding rates and genotypes of wheat have had a clear and significant effect on the number spikes and tillers which increased by increasing of the plant population so were for the production seed weight and test weight. Concerning barley genotypes (Table 5), in all traits studied results showed no significant differences among barley genotypes. However, Rum out yielded other cultivars with respect to biological, seed and hay and number of spikes/plant. With respect to the effects of the plant population (Table 6), for the biological and hay yields the population (D2 = 250 plants m^{-2}) (11.1 and 9.4 t ha^{-1} for the two traits, respectively) exceeded the rest of the densities with a significant differences. These results have endorsed what had obtained by Al-Mulhim and AL-Tahir (1991), Conry and Hegarty, (1992), Spink *et al.* (2000), Emam and Moaicd, (2000), Lithourgidis *et al.*(2006) and Scursoni and Satorre (2005) in that yield increased with increasing plant population. However, these results come in contrast with results obtained by Schillinger *et al.* (2005) and Gooding *et al.* (2002) which revealed no increase in yield with increasing plant population. In relation to seed yield the three different densities did not show significant differences among each others, however (D2 = 250 plants m^{-2}) (1.7 t ha^{-1}) was the highest amongst them. For the traits: number of tillers/plant, number spikelets/spike and plant height no significant differences were noted between the different densities. Concerning the interactions of barley genotypes with plant population (Table 7). For the biological yield, the interaction (Rum *D 2) (12.2 t ha^{-1}) out yielded interactions (Acsad 176 and Line (5) *D 2) with a insignificant differences and with a significant differences with the rest interactions. With respect to seed yield, no significant differences were detected between the different interactions, noting that the interaction (Rum*D2) is the highest amongst them. For hay yield, the interaction

Table 4: Effect of genotypes-population interaction on biological, straw and seed yields (t h^{-1}), No of spike/plant, No. of spikelet/spike and plant height (cm) of salinity tolerant wheat genotypes planted in the middle Jordan valley during 2004/2005

Varieties	Population	Biological yield (t ha^{-1})	Seed production (t ha^{-1})	Straw production (t ha^{-1})	No. of spike/ plant	No. of spikelet /spike	Plant height (cm)
Jumaizeh	P1	11.50ef*	3.3ab	8.2d	7.0bc	20.0ab	94.1b-d
	P2	14.8a-c	3.5ab	11.3ab	7.3a-c	20.7a	96.0a-c
	P3	16.1a	4.4a	11.6a	7.0bc	20.7a	92.7d
Bin-bashir	P1	12.4c-f	3.3bd	9.1bd	7.7ab	18.3cd	93.3cd
	P2	12.8b-f	3.3ad	9.8ad	7.7ab	17.0de	94.3b-d
	P3	15.5ab	4.2ab	11.3ab	7.3ab	16.0e	92.3d
Cham 3	P1	12.6c-f	3.3ab	9.3ad	7.3a-c	18.7bc	89.3bef
	P2	11.3ef	3.0ab	8.3cd	6.7a-c	18.0cd	92.0de
	P3	14.1a-e	3.9ab	10.2ad	7.3c	18.0cd	88.0f
Cham 6	P1	10.8f	3.0b	7.8d	7.0c	18.7bc	94.3b-d
	P2	14.1a-e	4.4a	8.8bd	7.0a-c	18.3c-e	96.7ab
	P3	14.7a-d	4.0ab	10.7a-c	7.0bc	16.0e	94.3bd
Sb1s1	P1	10.0f	3.1ab	8.5cd	7.7ab	18.3cd	96.3ab
	P2	11.8d-f	3.6ab	8.2cd	7.3a-c	18.0cd	97.0ab
	P3	11.8d-f	4.1ab	7.7d	8.0 a	18.0cd	98.0a
LSD (0.05)		2.922	1.430	2.532	0.8801	1.544	2.983

*Numbers with the same letter(s) have no significant differences at 5% level

Table 5: Biological, straw and seed yields (t h^{-1}), No. of spike/plant, No. of spikelet/spike and plant height (cm) of salinity tolerant barley genotypes planted in the middle Jordan valley during 2004/2005

Varieties	Biological yield (t ha^{-1})	Seed production (t ha^{-1})	Straw production (t ha^{-1})	No. of spike/ plant	No. of spikelet /spike	Plant height (cm)
Rum	9.9a*	1.6a	8.3a	6.3a	17.8a	54.0a
Acsad 176	9.5a	1.6a	7.9a	5.9a	19.8b	51.1a
Line (5)	9.5a	1.5a	8.0a	5.9a	19.2a	53.6a
LDS (0.05)	1.959	0.386	1.831	0.7961	1.182	3.753
CV%	14.7	24.9	14.5	6.0	6.1	7.8

* Numbers with the same letters have no significant differences at 5% level

Table 6: Effect of plant population on biological, straw and seed yields (t h^{-1}), No. of spike/plant, No. of spikelet/spike and plant height (cm) of salinity tolerant barley genotypes planted in the middle Jordan valley during 2004/2005

Variety	Biological yield (t ha^{-1})	Seed production (t ha^{-1})	Straw production (t ha^{-1})	No of spike/ plant	No of spikelet /spike	Plant height (cm)
(P1) 200 plant m^{-2}	8.8b*	1.5a	7.3b	6.0a	19.0a	75.2a
(P2) 250 plant m^{-2}	11.1a	1.7a	9.4a	6.2a	18.6a	54.0a
(P3) 300 plant m^{-2}	9.0b	1.5a	7.6b	5.9a	19.2a	52.1a
LDS (0.05)	1.457	0.3951	1.206	0.3703	1.186	4.230

Numbers with the same letter(s) have no significant differences at 5% level

Table 7: Effect of genotypes-population interaction on biological, straw and seed yields (t h^{-1}), No. of spike/plant, No. of spikelet/spike and plant height (cm) of salinity tolerant barley genotypes planted in the middle Jordan valley during 2004/2005

Variety	Population	Biological yield (t ha^{-1})	Seed production (t ha^{-1})	Straw production (t ha^{-1})	No. of spike/ plant	No. of spikelet /spike	Plant height (cm)
Rum	P1	8.9b*	1.4a	7.5bc	6.7a	18.3ab	54.0a
	P2	12.2a	2.0a	10.3a	6.3ab	16.7b	55.0a
	P3	8.6b	1.4a	7.2c	5.3d	18.3a	53.0a
Acsad 176	P1	8.7b	1.6a	7.2c	5.3d	19.7a	51.0a
	P2	10.1ab	1.6a	8.5a-c	6.3ab	19.3a	52.0a
	P3	9.6b	1.7a	7.9bc	6.0bc	20.3a	50.3a
Line (5)	P1	8.7b	1.5a	2.7c	6.0bc	19.0a	52.7a
	P2	10.9ab	1.6a	3.9ab	6.0bc	19.7a	55.0a
	P3	8.9b	1.3a	6.7bc	5.7cd	19.0a	53.0a
LSD (0.05)		2.523	0.6844	2.089	0.6414	2.054	7.327

*Numbers with the same letter(s) have no significant differences at 5% level

(Rum*D2) (10.3 t ha^{-1}) exceeded the interaction (Line (5) *D2) with a non-significant difference and with a significant difference with the rest of interactions. For number of spikes/plant, the interaction (Rum *D1) (6.7 Spike/plant) exceeded the interaction z (Rum D2) and (Acsad 176 *D 2) with a non-significant difference and with a significant difference with the rest of interactions. Concerning number of spikelets/Spike, the interaction Acsad-176-*D3) (18.3 Spikelet/Spike) has exceeded (Rum *D 2) with a significant difference and the rest of the intersections with a non-significant differences. For plant height, results exhibited no significant differences between the different interactions.

CONCLUSIONS

From this investigation, it is concluded that the population (D3 = 400 plants m^{-2}) for the wheat genotypes is the most superior for the traits studied. Therefore, it is recommended to adopt plant population and the genotypes-population interactions that showed significant results for wheat production under salinity conditions. Whereas, population (D2 = 250 plants m^{-2}) for the barley genotypes and the genotypes-population interactions is recommended to be adopted for barley production under salinity conditions.

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REFERENCES

Al-Mulhim, F.N. and O.A. AL-Tahir, 1991. Response of irrigated Barley to Nitrogen fertilization and seeding rates at Al-Hassa, Saudi Arabia. RACHIS-ICARDA - Barley and Wheat-Newsletter, 10: 13-15.

Authority of Jordan Valley-land Classification Project, 1989.

Change, M.H. and Q.A. Sipio, 1991. Salt tolerance of two wheat varieties. J. Drainage-and-land-Reclamation, 3: 36-39.

Conry, M.J. and A. Hegarty, 1992. Effect of sowing date and seed rate on the grain yield and protein content of Winter Barley. J. Agric. Sci., 118: 279-287.

Dalke, B.J., E.S. Oplinger, J.M. Goska and M.J. Mantinka, 1993. Influence of planting date and seeding rate on winter wheat, grain yield components. J. Prod. Agric., 6: 408-414.

Department of Statistics, Year Book, 2004.

Emam, Y. and G.R. Moaicd, 2000. Effect of planting population and chlormequat chloride on morphological and physiological characteristics of winter barley (*Hordeum Vulgare* L.) cultivar's valfajr J. Agric. Sci. Tech. Jast., 2: 2-7.

Gooding, M.J., A. Pinyosinwat and R.H. Ellis, 2002. Responses of wheat grain yield and quality to seed rate. J. Agric. Sci., 138: 317-331.

Lithourgidis, A.S. K.V. Dhima., C.A. Damalas I.B. Vasilakoglou and I.G. Eleftherohorinos, 2006. Tillage effects on wheat emergence and yield at varying seeding rates and on labor and fuel consumption. Crop. Sci., 46: 1187-1192.

Patrick, M.C., D. H. Richard and W.P. Woodrow, 2003a. Tillage and seeding rate effects on eatcultivars. II. Yield components. Crop Sci., 43: 210-218.

Patrick, M.C., D.H. Richard and W.P. Woodrow, 2003b. Tillage and seeding rate effects on wheat cultivars. Crop. Sci., 43: 202-209.

Maas, E.V. S.M. Lesch, L.E. Francois and C.M. Grieve, 1994. Tiller development in salt stressed Wheat Crop. Sci., 34: 1594-1603.

Naqvi, S.M. and J.P. Tandon, 1991. Wheat varieties for salt-affected lands. Indian-Farming, 4: 11-14.

Schillinger, W.F., 2005. Tillage method and sowing rate relations for dry land spring wheat, barley and oat. Crop. Sci., 45: 36-2643.

Scursoni, J.A. and E.H. Satorre, 2005. Barley (*Hordeum vulgare*) and wild oat (*Avena fatua*) competition is affected by crop and weed population. Weed Technol. SSN., 19: 790-795.

Spink, J.H.T. Semere, D.L. Spares, J.M. Whaley, M.J. Foulkes, R.W. Clare and A. Rosemaund, 2000. Effect of sowing date on the optimum plant population of winter wheat. Ann. Applied Biol., 137: 179-1 88.

Strivastiva, V.K. R.L. Rajput and N.K. Sinha, 1994. Effects of seed rate, fertility levels and weeding on the yield of wheat. Agric-Digest-Karnal., 14: 5-7.

Turk, M.A. and A.M. Tawaha, 2002. Effect of sowing rates and weed control methods on winter wheat under mediterranean environment. Pak. J. Agron., 1: 25-27.

Turk, M.A. A.M. Tawaha, H. Taifour, A. Al-Ghzawi, I.W. Musallam, G.A. Maghaireh and Y.I. Al-Omari, 2003. Two row barley response to plant population, date of seeding, rate and application of phosphorus in absence of moisture stress. Asian J. Plant Sci., 2: 180-183.