

Evaluation of the 3rd Generation of Backcrosses and Its Parents of Two Bread Wheat (*Triticum aestivum* L.) Cultivars for Salt Tolerance

Dheya Buttrus Yousif*, Adel Salim Hadi, Samer Muhammed Ahmed

Ministry of Science and Technology, Agricultural Research Directorate, Baghdad, Iraq

Email address:

dpyousif@yahoo.com (D. P. Yousif)

*Corresponding author

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Abstract: A field experiment was conducted during the winter season of 2017-2018 at the Center of Plant Breeding and Genetics, Al-Tuwaitha Research Station (30 km south east of Baghdad) to evaluate the performance of two bread wheat genotypes at the 3rd backcross generation with their parents, cv. Furait, Barka and Iraq under saline field condition (12dSm⁻¹). The objective of this study was to evaluate the beneficial effects of different backcrosses and its parents in targeted field condition, on grain yield and its components of bread wheat. Results showed that the two generations of (Furait x Baraka) and (Furait x Iraq) were significantly exceeded their parents and gave the highest values of spikes m⁻² (207.0, 196.3), grain spike⁻¹ (37.0, 39.0), 1000 seed weight (34.3, 33.3g) and grain yield m⁻² (244.4, 242.7g), respectively. Phenotypic variation and the percentage of broad sense heritability for plant height, tillers m⁻², grains spike⁻¹, 1000 seed weight and grain yield m⁻² were the highest compared with the value of environmental variation, and emphasized the important of genotypic variation and the ability to improve the desirable quantitative traits and reflects the high percentage of heritability.

Keywords: Backcrosses and Parents, Phenotypic Variation, Heritability

1. Introduction

Plant growth and yield of bread wheat are seriously affected in salinity-prone environments, hence effective agricultural means are needed [17]. Bread wheat (*Triticum aestivum* L.) is a major food crop all over the world, but annually increasable area are suffer from saline conditions [18]. Therefore, increasing salinity tolerance for wheat is necessary due to its moderate salt tolerance with EC threshold of 6-8 dSm⁻¹ (60-80 mM NaCl) [4, 9]. According to Francois *et al.* [6], wheat yield is decreased by 3% for each increased unit of EC on field level.

Salinity has affected the area cultivated with almost all crops all over the world [7]. High salt stress causes homeostasis change in water potential and ion distribution, molecular damage, growth inhibition and even death [32]. Salt stress adversely affects plant growth by osmotic stress, toxicity and nutrient deficiency [23]. Because of wheat crop importance,

breeders are interested to develop this strategic crop for salt tolerance and associated mechanisms in candidate cultivars [27, 28, 15].

Identification of salt tolerance mechanisms led plant breeders to develop new cultivars are some of the most effective strategies for reducing salinity problems [2, 22, 24]. While the progress has not been so impressive, [3] screened many bread wheat cultivars for salt tolerance and summarized results of large international collections of wheat that have been screened by breeders in the hydroponic culture for wheat. Many Iranians were screened wheat accessions for grain yield at salinity condition in the field site in California [11] and no response for salt-tolerance. Hybridization is a useful tool for broadening the genetic variation within the crop species to estimate gene actions. [16] study on *Lycopersicum* is one of the first researches to evaluate the inheritance of salinity tolerance in a cross between *Lycopersicum esculentum* and *L.pimpinelli folium*

which found that fruit yield in the hybrid was more affected by salinity than its parents.

The objective of this study was to evaluate the beneficial effects of bread wheat backcrosses at salinity stress conditions with its parents.

2. Materials and Methods

A Field experiment was carried out during the winter season of 2017-2018 at Al-Tuwaitha Research Station (30 km southeast of Baghdad) Ministry of Science and Technology. Land prepared was practiced by plowing, disking and properly leveled and divided into plots of (2.0 × 1.5m). Two back crosses at BC3 generation for 2 wheat cultivars and its parents Furait (moderate salt tolerant), Baraka and Iraq sensitive local cultivars) for salt tolerance were planted on 15-12-2017 in the agricultural field (12 dSm⁻¹). The soil texture and its characterization showed in table 1. Nitrogen fertilizer was applied as recommended (200 N Kg ha⁻¹) during planting and tillering (45days after planting). Phosphorus fertilizer with 70 kg ha⁻¹ of P₂O₅ superphosphate (16% P₂O₅) was added at planting [12]. All backcrosses with its parents were introduced in a yield trial. Grain yield, its components and some growth traits were measured and data statistically analyzed by Randomized Complete Block Design with three replications. The phenotypic (σ^2_P), genotypic (σ^2_G) and environmental (σ^2_e) variances were estimated according to the method indicated by [29]. Data were subjected to analysis of variance and means were compared using LSD at $P \leq 0.05$ by Genstat statistical software computer (version 2013) [5]. Broad sense heritability ($H^2_{B.S}$) was estimated based on the ratio of genotypic variance to the phenotypic variance

described by [26] which indicated that the heritability less than 40% considered as low, 40-60% was medium, and more than 60% as high.

Table 1. Physical and chemical properties of 0-40 cm of soil profile of Al-Tuwaitha Research Station during winter season of 2017/2018.

Properties	Values	Unites
Sand	140	gkg ⁻¹
Slit	310	gkg ⁻¹
Clay	550	gkg ⁻¹
Soil texture	slit-clay loam	-----
EC1:1	12	dSm ⁻¹
pH1:1	7.6	-----
O. M	4.2	gkg ⁻¹
Bluck density	1.27	gcm ⁻³

3. Results and Discussion

3.1. Analysis of Variance

Table 2 showed that there were significant differences ($P \leq 0.05$) among the backcrosses and their parent cultivars under investigation due to its wide genetic variation under investigation. The environmental impact of these traits and the susceptibility of the genes responsible for endurance starting its behavior for salinity tolerance effect. On the other hand, the backcrosses produced generation which superior to their parents due to the heterotic pattern caused by genetically unrelated parents. This result agreed with [21] who emphasized on the high level of genetic variation and the possibility of conducting genetic analysis of the properties and estimation of the components of phenotypic variation.

Table 2. Mean squares of the analysis of variance for bread wheat back crosses and their parents.

Source of variation	Degree of freedom	Means of variance of				
		Plant height (cm)	Spikes m ⁻²	Grains spike ⁻¹	1000 grain weight (g)	Grain yield (gm ⁻²)
Replicates	2	0.950	0.867	0.600	0.067	2.546
Back crosses and its parents	4	19.250*	225.076***	12.40***	13.433***	192.743***
Experimental error	8	0.950	4.617	1.100	1.233	5.430
Total	14					

*Significant at $P \leq 0.05$

3.2. Salinity Effect

3.2.1. Plant Height

The effect of salinity stress on plant height was shown in Table 3. Plant height was significantly affected ($P \leq 0.05$) by salinity stress. All entries grown in salinity conditions were significantly affected and were shorter than the natural condition. Results obtained were agreed with [4, 25]. The two back crosses exceeded its parents and gave plant length of 101.0 and 104.0 cm, respectively and agreed with the results found by [30].

3.2.2. Spikes m⁻²

Table 3 reveals that there were significant differences among the back crosses and its parents in the number of spike m⁻² under the salinity stress. Significant superiority for

the two back crosses than their parents and gave 207.0 and 196.3 spikes, respectively. Results agreed with [19, 20].

3.2.3. Grain Spike⁻¹

The number of the grain spike⁻¹ is an important quantitative trait as an essential grain yield component under salinity and/ or good environment. Results in table 3 indicated that there were significant differences among the backcrosses and its parents in the number of grain spikes⁻¹ exceeding of back crosses on their parents which gave 37.0 and 39.0 grain spike⁻¹, respectively. Results agreed with [10].

3.2.4. 1000 Seed Weight

Although the number of grain spike⁻¹ has predominant importance over grain weight with regard to grain yield, grain weight is well documented to be a major yield component determining final yield in Mediterranean environments [30].

Results in Table 3 showed that the two back crosses affected in 1000 grain weight and gave 34.3 g for (Furiat x baraka) and 33.3 g for (Furiat x Iraq). Results emphasized results of [1].

3.2.5. Grain Yield g Perm²

Table 3 revealed that there were significant differences

Table 3. Means of back crosses and its parents for grain yield and its component for bread wheat grown on salinity affected field (12 dSm⁻¹) during 2017/2018 of Al-Tuwaittha. Res. Center, Baghdad, Iraq.

Back crosses and its parents	Plant height (cm)	No. of spikes m ⁻²	No. of grains spike ⁻¹	1000 grains weight (g)	Grain yield (gm ⁻²)
Furait	99.2	201.7	36.7	29.0	236.3
Baraka	102.3	191.7	33.7	32.0	230.6
Iraq	103.5	184.7	35.7	30.7	225.5
Furait x Baraka	101.0	207.0	37.0	34.3	244.5
Furait x Iraq	104.0	196.3	39.0	33.3	242.7
mean	102.0	196.3	36.6	31.9	235.9
LSD P≤0.05	1.84	4.05	1.98	2.09	4.39

Table 4 showed the estimation of the broad sense heritability, phenotypic genotypic and environmental variances for all traits under investigation. Genotypic, phenotypic variability for grain yield m⁻² (82.44) and (87.87) respectively were high in comparison with the low environmental variability (5.43) which reflects and explain the increase and high value of broad sense heritability. According to [13] heritability in broad sense plays an important role in deciding the suitability and strategy for selection of a character.

Table 4 revealed that genotypic and phenotypic variability for spike m⁻², grain spike⁻¹ and 1000 grain weight were 94.08, 78.86 and 78.37, respectively, which are considered as high in comparison with the low of environmental variability reflected in the grain yield (91.99 gm⁻²). The highest heritability values indicate that heritability may be due to higher contribution of genotypic component and thus suggested that selection could be practiced with high genetic advance [14]. This results showed clear indication of the importance of genetic improvement for raising the efficiency of back crosses and consistent with [8] when they explain the effect of gene function in the inheritance of most traits.

Results suggest that there is a high potential for inheriting the salinity characterization using the back cross method as a covariant breeding method to overcome the increasing problem of salinity in Iraq.

Table 4. Genotypic, phenotypic and environmental variations for plant height, grain yield and its components for wheat back crosses and its parents.

Characters	σ ² G	σ ² E	σ ² P	H ² B.S %
Plant height cm	6.1	0.95	7.05	86.524
No. spikes m ⁻²	73.438	4.617	78.055	94.085
No. grains spike ⁻¹	3.767	1.1	4.777	78.857
1000 grains weight (g)	4.067	1.233	5.3	76.736
Grain yield (g m ⁻²)	82.438	5.43	87.868	93.963

4. Conclusion

Although salinity stress has been well documented as an effective parameter in decreasing crop growth rate and seed productivity in soils affected salinity, developing and

among the back crosses and its parents on grain yield. The two back crosses (Furiat x baraka) and (Furiat x Iraq) significantly exceeded on its parents and gave 244.5 and 242.7 g m⁻². Results agreed with [31].

releasing new cultivars which are adaptable for salt tolerance can be a constructive program to overcome unsuitable environmental conditions. The present study indicated that it is possible to improve the salt tolerance bread wheat cultivars by conventional backcrossing programs and transferring genes which are responsible for salt tolerance from moderate tolerated genotypes or cultivars which with high grain yield and other good quality traits but sensitive to salinity. Results reflected the success in obtaining new genotypes with good grain yield and tolerate salinity in the targeted region.

References

- [1] Adat-Noori, S. A. 2005. "Assessment for salinity tolerance through intergenetic hybridization *Triticum durum* × *Aegilops speltoides*, Euphytica, 146: 149–155.
- [2] Ashraf, M. and N. A. Akram. 2009. "Improving salinity tolerance of plants through conventional breeding and genetic engineering: an analytical comparison." Biotechnology advances 27 (6): 744–752.
- [3] Colmer T.; RMunns; and T. Flowers. 2006. Improving salt tolerance of wheat and barley: future prospects. Animal Production Science 45, 1425–1443.
- [4] Genc, Y.; K. Oldach; J. Taylor and G. H. Lyons. 2016. "Uncoupling of sodium and chloride to assist breeding for salinity tolerance in crops." New Phytologist 210 (1): 145–156.
- [5] GenStat Discovery Edition 4. 2013. GenStat Procedure Library Release PL18. 2.
- [6] Flowers, T. J. 2004. Improving crop salt tolerance. Journal of Experimental Botany, Volume 55, Issue 396, 1 February 2004, Pages 307–319, <https://doi.org/10.1093/jxb/erh003>.
- [7] Francois L.; E. Maas; T. Donovan and V. Youngs. 1986. Effect of salinity on grain yield and quality, vegetative growth, and germination of semi-dwarf and durum wheat. Agronomy Journal 78, 1053–1058.
- [8] Hoffman, A. A. and P. A. Parsons. 1991. Evolutionary "Genetics and Environmental Stress. Oxford Unit Press, New York. pp. 49–57.

- [9] Hillel, D. 2000. "Salinity management for sustainable irrigation: integrating science, environment, and economics. World Bank library Publications 315-327.
- [10] Houshmand, S.; A. Zrzani; and S. A. M Mir mohammadi-Maibody. 2014. "Effects of salinity and drought stress on grain quality of durum wheat. Commun". Soil Sci. Plant Analysis. 45: 297-308.
- [11] Jafari-Shabestari, J.; H.; Corke; C. O. Qualset. 1995. Field evaluation of tolerance to salinity stress in Iranian hexaploid wheat landrace accessions. Genetic Resources and Crop Evolution 42, 147-156.
- [12] Jadoaa, K. A. and M. S. Hammed. 2013. Fertilizer of wheat crop. National Program for Wheat Development. Ministry of Agriculture. Paper 2, pp12.
- [13] Kumar, A.; M. Mazzanti; M. Mistrik.; M. Kosar.; G. V. Beznoussenko; A. A. Mrionov.; M. Garre.; D. Parazzol; G. V. Beznoussenko; A. A. Mironov; M. Garre; D. Parazzoli; G. V. Shivashankar; G. Scita; J. Bartek.; and M. Foinai. 2014. "ATR mediates a checkpoint at the nuclear envelope in response to mechanical stress". Cell 158 (3): 633-46.
- [14] Larik A. S.; H. M. I.; Hafiz; and A. M. Khushk. 1989. Estimation of genetic parameters in wheat populations derived from inter cultivar hybridization. Pakphyton, 1: 51-56.
- [15] López-Aguilar, R.; A. Orduño-Cruz; A. Lucero-Arce; B. Murillo-Amador; and E. Troyo-Diéguez. 2003. Response to salinity of three grain legumes for potential cultivation in arid areas. Soil Science and Plant Nutrition 49, 329-336.
- [16] Lyon, C. B. 1941. Responses of two species of tomatoes and the F1 generation to sodium sulphate in the nutrient medium. Botanical Gazette, 107-122.
- [17] ICARDA. 2012. Statistics Division. Available online at <http://www.iraq-icarda.org>.
- [18] Maid, L. Q.; E. F. Zhou; N. X. Huo; R. H. Zhou; G. Y. Wang; and J. Z. Jia 2007. Genetic analysis of salt tolerance in a recombinant inbred population of wheat (*Triticum aestivum* L.). Euphytica, 153: 109-117.
- [19] Maas, E. V.; and C. M. Grieve. 1990. Spike and leaf development of salt-stressed wheat. Crop Sci. 30: 1309-1313.
- [20] Mass, E. V.; S. M. Lesch; L. Francos; and C. M. EandGrieve. 1994. Tiller development in salt-stressed wheat. Crop Sci. 34: 1594-1603.
- [21] Marzooghian, A., M. Moghaddam; M. Toorchi; and M. Shakiba, R. 2014. "Investigation of genetic structure and gene action in bread wheat affected by salt stress". International Journal of Biosciences 5: 173-181.
- [22] Munns, R.; R. A. James; and A. Läuchli. 2006. "Approaches to increasing the salt tolerance of wheat and other cereals." Journal of experimental botany 57 (5): 1025-1043.
- [23] Munns, R.; and M. Gilliam. 2015. "Salinity tolerance of crops- what is the cost?." New Phytologist 208 (3): 668-673.
- [24] Munns, R.; and M. Tester. 2008. "Mechanisms of salinity tolerance." Annu. Rev. Plant Biol. 59: 651-681.
- [25] Niaz, A. K.; I. Rajpar; S. A. Kalhoro; A. Ali; S. Raza; M. Ahmed; F. A. Kalhoro; M. Ramzan; and F. Wahid. 2016. "Effect of salts stress on the growth and yield of Wheat (*Triticum aestivum* L.)". American Journal of Plant Sciences. 7, 2257-2271.
- [26] Nyquist, W. E. 1991. "Estimation of heritability and prediction of selection response in plant-populations". Crist Rev. Plant Sci. 10: 235-322.
- [27] Sreenivasulu, N.; B. Grimm; U., Wobus; W. Weschke. 2000. Differential response of antioxidant compounds to salinity stress in salt-tolerant and salt-sensitive seedlings of foxtail millet (*Setaria italica*). Physiologia Plantarum. 109, 435-442.
- [28] Snedecor, G. W. G. W. Cochran. 1989. "Statistical Methods", 8th ed., Iowa State University Press, USA.
- [29] Suiyun, C.; G. Suiyun; Q. Taiyong; X. Fengnin; J. Ya; and C. Huimin. 2004. "Introgression of salt-tolerance from somatic backcrosses between common wheat and *Thinopy rimponticum*". Plant Sci. 167: 773-779.
- [30] Timonova, E.; L. Irena; M. S. Röder; and E. Salina. 2013. Marker-assisted development and characterization of a set of *Triticum aestivum* lines carrying different introgressions from the *T. timopheevii* genome. Mol. Breed. 31: 123-136.
- [31] Turki, N.; M. Harrabi; and K. Okuno. 2012. "Effect of salinity on grain yield and quality of wheat and genetic relationships among durum and common wheat". J. Arid Land Stud. 22 (1): 311-314.
- [32] Zhu, J. K. 2001. "Plant salt tolerance". Trends in Plant Science 6, 66-71.