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Full Length Research Paper

Characteristics of new breeding lines of triticale

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The objective of this study was to develop new cultivars of triticale possessing high yield and quality which would be adaptable to ecological conditions of Marmara Region. For this purpose, seven selected lines from breeding programs conducted previously and one standard cultivar were used as plant entries of the research. Yield and yield components were taken up to determine the best lines to be candidate for future varieties. Field experiments were conducted on the Research Center of Agriculture Faculty, Uludag University, Bursa, during 2004 - 2005 and 2005 - 2006 growing seasons. A randomized complete block design with three replications was chosen for experimentation. ANOVA of two-year results indicated that differences among genotypes were significant for grain number/spike, grain weight/spike and hectoliter weight. Genotype x year interaction was found to be significant for grain number/spike, grain weight/spike and grain yield. There were no significant differences among genotypes in term of their grain yield. This means that the new lines produced grain yield at par with the standard cultivar used in this experiment. Yields of the genotypes ranged between 6512 and 7133 kg ha^{-1}. As a result of correlation analysis, simple correlation coefficient analysis revealed that there had been positive and significant correlations of grain yield with the grain number/spike, grain weight/spike, plant height and hectoliter weight.

Key words: New triticale genotypes, yield, yield components.

INTRODUCTION

The determining and improving genotypes with the highest yield and quality for nourishing continually increasing world population is an important aim. The first wheat/rye cross was considered to have occurred in Scotland in 1875. Several publications outline the historical progress of triticale in the 20th century (Stoskopf, 1985; Villareal et al., 1990). The initial crosses between wheat and rye were sterile, with the first fertile crosses made in Germany in 1888. The name triticale first appeared in literature published in Germany in 1935. The first release of a commercial triticale cultivar occurred in Europe, while `Rosner' a Canadian release was the first triticale cultivar developed in North America (Stallknecht et al., 1996). Triticale (X *Triticosecale*, Wittmack) is a synthetic crop (Varughes, 1996). The word 'tiriticale' is a fusion of the latin words *Triticum* (or wheat) and *Secale* (rye).

As a common name and according to a suggestion by Lindschau and Oehler (1935) triticale was recommended for this synthetic crop. The first triticale programs in the 1964/50s were mainly devoted to the synthesis and evaluation of newly produced octoploid and also hexaploid wheat-rye hybrids. Such early studies were conducted in the USSR, Hungary, Sweden and Switzerland respecttively; Kiss and Redei, 1953; Pissarev, 1956; Ingold et al., 1968; Müntzing, 1989; Natıonal Research Councıl, 1989). However, effective programs began in 1964 by CIMMYT with spring triticale in Mexico (Müntzing, 1939; Varughese et al., 1986).

Triticale seems to be an interesting alternative to other cereals, particularly bread wheat, in environments where growing conditions are unfavorable or in low-input systems (Erekul and Köln, 2006). The primary producers of triticale are Germany, France, Poland, Australia, China and Belarus. In 2005, according to the Food and Agriculture Organization (FAO), 13.5 million tons from 3 millions ha were harvested and sown in 28 countries across the world (Anonymous, 2005). Some researchers reported that 80% of triticale was sown as winter crops and 20% of it as spring crop in the world (Bagcı, 2005). Triticale is, in general, more tolerant to environmental stresses than wheat and barley. Breeding for marginal areas (acidic or alkali soils), micro deficiencies (cooper,

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Table 1. The new lines, in the old lines (CIMMYT) and standard cultivar.

Lines and Standard cv.	Pedigree	Source
C 6	------	CIMMYT (old line)
C 9	------	CIMMYT (old line)
C 11	------	CIMMYT (old line)
Nörtingen x 2015 (17)	2015 (FAHAD9-1)	New line
Nörtingen x 2003 (12)	2003 (Juanillo 98x21295-OAP)	New line
Nörtingen x Eronga (3)	------	New line
Nörtingen x Eronga (14)	------	New line
Nörtingen (Standard)	------	Germany

zinc or magnesium) or toxicity (boron) and drought stress is the main objectives of most spring and winter-triticale breeding programs in the world (Oettler, 2005). Triticale flour can be used to replace soft wheat flour in mixtures for breads, cakes or cookies (Bagcı, 2005).

In some regions of Turkey, up to 30% of triticale flour is used in mixture with wheat flour for bread making. In addition, in Thrace and Aegean regions of Turkey, although triticale is grown as a silage crop by farmers, it is also planted in mixture with other forage crops (Furan et al., 2005). The first studies on triticale in Turkey started with several international projects in Universities in 1940s (Demir, 1986). Some researchers reported that the yield of triticale was generally superior to wheat both in humid and dry conditions (Genc et al., 1989). On the other hand, Stacey et al. (2003) found that the most recent reports on triticale performance in pig and poultry diets confirmed that triticale was equal to or better than wheat and maize.

The purpose of this study was to determine the new lines that were suitable to Southern Marmara Region.

MATERIALS AND METHODS

In this study, four triticale lines developed by crossing method in Agriculture Faculty of Uludag University (Coplu, 2001) and three line obtained from CIMMYT were studied in terms of yield, yield components in Southern Marmara Region. Nörtingen triticale cultivar was used as standard cultivar (Table 1).

Field experiments were conducted at the Research and Applied Center of Agricultural Faculty of Uludag University in Southern Marmara Region, Turkey in 2004 - 2005 and 2005 - 2006 years. Soil is clayey and neutral in reaction. It is poor in organic matter and reach in available P and K (Ozguven and Katkat, 1997). Region has a temperate climate with on average annual rainfall of 700.0 mm and 11.5°C monthly mean temperature. Total precipitation (560.3 mm) of the first trial year was higher than the second trial year (444.8 mm).

Sowing density was 600 grain/m^2. The experiment was set up by using randomized block experimental design with three replications. The plots were fertilized with a standard dose of 45 kg P_2O_5 ha^{-1}. A total 170 kg N ha^{-1} (85 kg composite at sowing, 85 kg urea at tillering stage) was applied.

The plots (12 m^2) were harvested at maturity to obtain grain yield. Ten plants from each plot were collected randomly at harvest for grains per spike, hectoliter weight and 1000 kernel weight recorded. determining plant height, number of grains per spike, weight of

All data were subjected to analysis of variance for each character using MSTAT-C (version 2.1, Michigan State University, 1991) and MINITAB (University of Texas at Austin) Software. The significance of genotypes, genotypes x year interactions were determined at the 5 and 1% probability levels by the F-test. The F-protected least significant difference (LSD) was calculated at the 5% probability level according to Steel and Torie (1980).

RESULTS AND DISCUSSION

The results of analysis of variance (ANOVA) and mean values belonging to yield and yield components are were given in Table 2. According to ANOVA, the differences between the genotypes were statistically significant for grain numbers/spike, grain weight/spike and hectoliter weight. On the other hand, differences between the years and the Genotype x year interaction were statistically significant for grain numbers/spike, grain weight/spike and grain yield.

Two-year results of our study indicated that there were not statistically significant differences among grain yields of genotypes. This means that the lines produced grain yield as much as the standard cultivar used in this experiment. The first experimental year gave higher values for all characters because of the higher precipitation. Total precipitation of March, April and May (156.5 mm) in first year were more than that of second year (70.4 mm). According to mean of two years, grain yields ranged from 6511.2 to 7133.5 kg ha^{-1} for all genotypes. As seen from Table 2, there were insignificant variations in grain yields. It is known that variation in yield were due to annual precipitation and also, variations of precipitation in critical months. Frere et al. (1987) stated that precipitation is an important factor for grain yield, while some other researchers reported that years is an important factor for grain yield (Korkut et al., 2001).

The results for grain yields in this research were similar to the results of Guinta et al. (2004), but contrast with those of Unver et al. (1999), Atak et al. (2006), Mut et al. (2006); Yanbeyi et al. (2006) and Akgun et al. (2007). These differences may arise from different ecological conditions in which different researcher were conducted.

Akgun et al. (1997a) reported that spike number/m^2, grain number/spike and grain weight/spike are important

Table 2. The grain yields (kg ha^{-1}) of seven spring triticale lines and standard cultivar (2-year average).

Genotypes	Yield (kg ha^{-1})	Grain number/ spike	Grain weight/ spike (g)	Plant height (cm)	1000 kernel weight (g)	Hectoliter (kg)
C 6	6512.2	44.28	1.94	117.75	44.34	68.63
C 9	7078.9	48.58	2.26	115.35	46.34	69.68
C11	6997.7	56.68	2.58	121.98	45.32	74.20
U17	6837.7	47.95	2.14	116.27	42.66	68.47
U12	7133.5	47.02	2.21	122.57	46.77	72.50
NxE (3)	6511.2	52.08	2.47	114.60	44.59	66.63
NxE (14)	6803.3	43.40	2.01	117.68	43.98	68.63
Nörtingen (St.)	6920.1	51.27	2.32	117.10	43.40	67.57
Means	6849.3	48.91	2.24	117.91	44.68	69.54
LSD (0.05)	56.93	7.86	0.40	6.19	5.95	2.76
2004-2005	7712.1	54.19	2.42	118.88	45.04	69.88
2005-2006	5986.5	43.63	2.06	116.95	44.30	69.20
Significance of F-test of ANOVA						
Year (Y)	153.30 **	54.59 **	25.09**	1.63	0.26	3.20
Genotyp (G)	1.44	4.63 **	4.35 **	1.84	0.47	22.87**
Genotype x Year	4.34	2.77x	3.48**	0.49	0.51	0.48

*,**: Significant at P = 0.05 and 0.01, respectively.

Table 3. Correlation coefficients among six characters determined in the old lines (CIMMYT).

	Plant Height (cm)	Grain number/ spike	Grain weight/ Spike (g)	1000 kernel Weight (g)	Hectoliter weight (kg)	Grain yield (kg ha^{-1})
Plant height	-					
Grain number/ spike	0.467*	-				
Grain weight/ spike	0.457	0.915**	-			
1000 kernel weight	- 0.155	0.148	0.408	-		
Hectoliter weight	0.382	0.394	0.497*	0.213	-	
Grain yield	0.360	0.701**	0.767**	0.431	0.229	-

*,**: Significant at P = 0.05 and 0.01, respectively.

factors for grain yield. In addition, positive and significant correlations were determined between grain number/spike with grain yield (Ulger et al., 1989; Yanbeyi et al., 2006).

As seen from Tables 3 and 4, in the old lines, the correlation between grain yield and grain number/spike, grain weight/spike and plant height were positive and signifycant (respectively; r = 0.701**; r = 0.767** and r = 0.467*). But, in the new lines, the correlation between grain yield and grain number/spike, plant height and hectoliter weight were positive and significant (respectively; r = 0.575**, r = 0.408* and 0.408*). In addition, it was determined negative but insignificant correlation between grain yield and 1000 kernel weight (r = -0.030). Our results were similar to the results of Ulger et al. (1989). On the contrary, it was determined positive but insignificant correlation between grain yield and 1000 kernel weight (r = 0.431). Similar results were obtained in many previous studies (Narwal et al., 1999; Chouwdhry, 2000; Tammam et al., 2000 and Furan et al., 2005).

The differences among grain number/spike of the lines and standard cultivar were found statistically significant. Grain numbers/spike levels of the lines ranged from 43.40 to 56.68. According to mean of two years, line C_{11} gave the highest value with 56.68.

In triticale, grains number/spike is an important yield component. In this study, among the old and the new lines used in this study was determined that grain number

Table 4. Correlation coefficients among six characters determined in the new lines

	Plant height (cm)	Grain number/ spike	Grain weight/ spike (g)	1000 kernel weight (g)	Hectoliter weight (kg)	Grain yield (kg ha^{-1})
Plant height	-					
Grain number/spike	0.013	-				
Grain weight/ spike	0.089	0.625**	-			
1000 kernelweight	0.439*	-0.242	0.354	-		
Hectoliter weight	0.552**	-0.154	-0.177	0.288	-	
Grain yield	0.408*	0.575**	0.193	- 0.030	0.408	-

*,**: Significant at P = 0.05 and 0.01, respectively.

/spike were positively and significantly correlated with grain yield (respectively; r = 0.701**, r = 0.575**). Also, in many previous studies, positive and significant correlations (Ulger et al., 1989; Kumar et. al, 1998; Tammam et al., 2000; Okuyama et al., 2004; Furan et al., 2005).

The differences between the lines in terms of grain weight/spike were found significant. The grain weight/ spike of lines ranged from 1.94 to 2.58 g. The grain weight/spike was maximum in line C_{11}. Akgun et al. (1997a) reported that spike number/m^2, grain number/spike and grain weight/spike is important factor for grain yield. Our results were similar to the results of Akgun et al. (1997a) and Furan et al. (2005).

In the old lines, the correlation between grain yield and grain weight/spike was positive and significant (r = 0.767**). But, in the new lines, correlation between grain yield and grain weight/spike was positive and insignificant (r = 0.193). Our results were similar to the results of Furan et al. (2005)

In our study, there were no significant differences between plant height values of the genotypes. The plant height is very important in terms of resistance to lodging and harvest index. Many researchers reported that the plant height was more in triticale according to other cereals (Lehman et al., 1983; Yagbasanlar and Genc, 1988). On the other hand, many researchers reported that the plant height was affected from growing techniques and environment conditions (Ulger et al., 1989).

According to mean of two year, statistically, the plant height of the lines ranged from 114.60 to 122.57 cm. Both in the old lines and the new lines, the correlation between grain yield and plant height were positive and significant (r = 0.360*, r = 0.408*). Our results were similar to the results of Furan et al. (2005)

In this study, it was determined that the differences between the lines in 1000 kernel weight were insignificant. According to Table 2, 1000 kernel weight was from 42.66 to 46.77 g. As seen Table 3 and 4, in the old lines, it was found that the differences between the 1000 kernel weight with grain yield were positive and insignificant correlation (r = 0.431), but in the new lines, the correlation between 1000 kernel weight with grain yield were negative and insignificant (r = -0.030). Similar results were obtained in many previous studies (Narwal et al., 1999; Chouwdhry, 2000; Tammam et al., 2000; Furan et al. 2005).

Significant differences were found between the hectoliter weights of genotypes. The hectoliter weight of lines ranged from 66.63 to 74.20 kg. The hectoliter weight of line C_{11} was the highest (74.20 kg) followed by line U_{12}, while that of line U_3 was the lowest (66.63 kg).

As seen Table 3 and 4, in the old lines, it was found positive and insignificant correlation between grain yield and hectoliter weight (r = 0.229), but, in the new lines, it was found positive and significant correlation between grain yield and hectoliter weight (r = 0.408*). Alkus (1979) also reported positive and significant correlation between grain yield and hectoliter weight, while other researcher reported that between grain yield and hectoliter weight was found negative correlation (Furan et al., 2005).

In triticale, the hectoliter weight is low because the grains are thin and wrinkle. Ulger et al. (1989) reported that grain wrinkly had the complex genetic structure in triticale. Nevertheless, they reported almost equal value of the hectoliter weights of lines improved in last years (Genc et al., 1989). Our results were similar to the results of Genc et al. (1988).

The results presented in Table 2, show that according to mean of two years, statistically, significant differences were found among grain yields of lines and standard cultivar. Precipitations of March, April and May in the first year were more than those of second year value.

Cauderon and Bernard (1980) determined that triticale grain yield was correlated with grain number/spike and 1000 kernel weight. The economic threshold was exceeded with breeding works on triticale. Therefore, triticale has gain to be promoted as a new crop. But as a new crop, it has some problems. Especially, many researchers have reported this new crop as a feed grain. Nevertheless, some researches have reported that triticale is more resistant to negative factors compared with wheat and it has higher grain yield under unfavorable environmental conditions.

In conclusion, Bursa ecological conditions are suitable for triticale cultivation. Taking this aim into consideration, the lines U_{12} ,C_9 and C_{11} may be proposed together with standard cultivar to be grown for higher seed yield in this experimental region, as indicated from the results of two-year experiment.

REFERENCES

Akgun I, Tosun M, Sagsoz S (1997a). A research on yield and yield components of some triticale lines and cultivars under erzurum ecological conditions. J. Agric. College. 28(1): 103-119

Akgun I, Kaya M, Altindal D (2007). Determination of yield and yield components in some triticale lines/genotypes under ısparta ecological conditions. J Fac. Agric., Akdeniz University. 20(2): 171-182.

Anonymous, (2005). http:// faostat.fao.org/faostat

Atak M, Kaya M, Ciftci CY Unver S (2006). Effect of seeding rates on yield and some yield components of Triticale (*Triticosecale Wittmack*) genotypes. J. Natural Appl. Sci. 10(1): 40-47.

Cauderon Y, Bernard M (1980). Yield improvement from crosses and genetic and cytoplasmic diversification in triticale. Hod. Rosl. Aklim. Nasien. 24 (4): 329-333.

Chowdhry MA, Ali M, Subhani GM, Khaliq I (2000). Path coefficients analysis for water use efficiency, evapo–transpiration efficiency and some yield related traits in wheat at different micro environments. Environ. Ecol. 9: 906–10.

Erekul O, Kohn W (2006). Effect of weather and soil conditions on yield components and bread-making quality of winter wheat (*Triticum aestivum* L.) and winter triticale (Triticosecale Wittm) varieties in North-East Germany, J. Agron. Crops Sci. 192: 452-464.

Frere M, Maracchi G, Migliette F, Canes C (1987). Agroclimatogical classification of the Mediterranean and Southwest Asia areas. In:Drought Tolerance in Winter Cereals. (Eds. J.P. Srivastava, E. Porceddu, E. Acevedo and S. Varma). Proc. *Intern. Workshop*. 27-31. October, Capri, Italy. pp. 3-13.

Furan AM, Demir I, Yuce S, Akcalican RR, Aykut F (2005). Research on Aegean region Triticale variety development studies and relationships among yield and quality components in the developed variety and lines. J. Fac. Agric. Akdeniz University. 18(2): 251-256.

Genç, I, Ulger AC, Yagbasanlar T, Kirtok Y, Topal N (1988). A comparative study on the yield and yield components of Triticale, Wheat and Barley in Çukurova Region. J. Fac. Agric. 3(2): 1-13.

Giunta F, Motzo R (2004). Sowing rate and cultivar affect total biomass and grain yield of spring Triticale (x*Triticosecale* Wittmack) grown in a Mediterranean-type environment. Field Crops Res. 87: 179-193.

Ingold M, Oehler E, Nogler GA (1968). Untersuchungen über Entstehung, Fertilität, Morphologie und agronomische Werteigenschaften neuer oktoploider *Triticale*- Stämme. *Zeitschrift für Pflanzenzühtung* 60: 41-88.

Kiss A, Redei G (1953). Experiments to Produce Rye-Wheat (Triticale), Acta Agr., Acad. Sci. Hung, 3(3): 257–276.

Korkut KZ, Baser I, Bilgin O (2001). Evaluation of advanced Bread Wheat (*T. aestivum L.*) lines for grain yield and some yield components. Turkey IV. Field Crops Congress. 17-21. September, Tekirdağ, 1: 99-104.

Kumar BNA, Hunshal CS (1998). Correlation and path coefficient analysis in durum wheats*(Triticum durum* Desf.) under different planting dates. Crop-Research-Hisar. 16:(3): 358-361.

Lehman WF, Ovelset CO, Jackson LF (1983). Production and Performance of Common and durum Wheats and Triticale at The Univ. of California. Imperial Valley Field Station. El Centro in 1981, 1982 and 1983, Univ. of California. Agric. Exp. Sta. Progress Report. 142, p.20.

Lindschau M, Oehler E (1935). Untersuchungen am konstant intermedia ren additiven Rimpau'schen Weizen-Roggenbastard. Der Zu¨chter 7: 228–233.

Müntzing A (1939). Studies on the properties and the ways of production of rye-wheat amhidiploids. Hereditas 25: 387–430.

Müntzing A (1989). Triticale results and problems. Advances in Plant Breeding. Supplement to Journal of Plant Breeding. Verlag Paul Parey. Berlin und Hamburg. p.103.

Mut Z, Albayrak S, Tongel Ö (2006). Determination of grain yield and some traits of Triticale (*xTtriticosecale Wittmack*) lines. J. Agric. Sci. 12 (1): 56-64.

Narwal NK, Verma PK, Narwal MS (1999). Genetic variability, correlation and path-coefficient analysis in bread wheat in two climatic zones of Haryana. Agricultural-Science- Digest-Karnal. 19 (2): 73-76.

National Research Council (1989). Triticale. A Promising Addition to the World's Cereal Grains. Washington, DC:National Academy Press.

Oettler G (2005). The fortune of a botanical curiosity – Triticale : past, present and future. J. Agric. Sci. 143: 329-346.

Okuyama LA, Federizzi LC, Neto JFB (2004). Correlation and path analysis of yield and its components and plant traits in wheat. *Cienc.* Rural vol. 34 no.6 Santa Maria November/December.

Ozguven CN, Katkat AV (1997). Determination of the fertility levels of the soil in the experimental farm of Agricultural Faculty, Uludağ University. J. Agric. Fac. Uludağ University. 13: 43-54.

Pissarev VE (1956). Die Amphidiploiden ''Sommerweizen x Sommerroggen''. Zeitschrift fue Pflanzenzüchtung 35: 27–50.

Stacey P, O'Kiely P, Rice B, Hacket R, O'Mara FP (2003). Changes in yield and composition of barley, wheat and triticale grains with advancing maturity. Proceedings Agricultural Research Forum, Tullamore, March.

Stallknecht GF, Gilbertson KM, Ranney JE (1996). Alternative wheat cereals as food grains: Einkorn, emmer, spelt, kamut, and triticale. p. 156-170. In: J. Janick (ed.),
Progress in new crops. ASHS Press, Alexandria, VA. pp. 156-170

Steel R, Torie J (1980). Principles and proceedures of statistics. McGraw-Hill, New York, 144 pp.

Stoskopf NC (1985). Cereal Grain Crops. Reston Publishing Company, Inc., Reston, Virginia. Chp. 22: 444-458.

Tammam AM, Ali-SA. El-Sayed EAM (2000). Phenotypic, genotypic correlations and path coefficient analysis in some bread wheat crosses. Assist-J. Agric. Sci. 31(3): 73-85.

Ulger AC, Yagbasanlar T, Genc I (1989). A study on the important agronomical characteristics of the high-yielding lines of Triticale selected in the Çukurova ecological conditions. Turk. J. Agric. For. 13(3): 1342-1362.

Unver S (1999). Investigation of yield and yield components on some Triticale lines. J. Field Crops Centeral Research Institute. 8 (1-2): 82-92.

Varughese G, Sari EE, Abdalla OS (1986). Two decades of triticale breeding and research at CIMMYT. *In proceeding of International Triticale Symposium.* Australian Institute of Agricultural Science, Sydney, Australia: Occasional Publication. 24: 148-169

Varughese G (1996). Triticale: Present status and challenges ahead. In: H. Guedes-Pinto *et al.* Triticale*:* Today and Tomorrow, Kluwer Academic, Deventer, The Nedherlands, pp. 13-20.

Villareal RL, Varughese G, Abdalla OS (1990). Advances in spring triticale breeding. in: Janick J(ed.), Plantbreeding reviews,Vol.8. Portland, Oregon: Timber Press, Inc, pp. 43-90

Yanbeyi S, Sezer İ (2006). A research on yield and yield component of some Triticale lines in Samsun ecological conditions. J. Fac. Agric. OMU, 21(1): 33-39