HETEROSIS FOR CERTAIN YIELD AND QUALITY TRAITS IN WINTER TRITICALE

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Abstract

This research investigated heterosis for certain yield and quality traits in F_1 hybrids in winter triticale.The highest level of mid-parent heterosis was determined as 20.95 % for seed weight per spike. This was followed by mean mid-parent heterosis values at the rates of 18.07 % and 17.64 % for protein content and spike lenght, respectively. Negative mid- parent heterosis was determined in falling number and plant height with the mean values of – 7.09 % and – 3.93 %, respectively. When the hybrids were evaluated individually, it was determined that the traits other than protein content exhibited positive or negative heterosis, whereas for protein content, heterosis was always positive. The fact that some hybrids overrun their superior parents with respect to high-parent heterosis indicated that hybrid breeding could successfully be applied in triticale.

Key words: Heterosis, yield, quality, triticale

Tritikale'de Bazı Verim ve Kalite Özelliklerinde Heterosis

Özet

Bu araştırmada triticale F_1 melezlerinde bazı verim ve kalite özellikleri bakımından melez gücü incelenmiştir. Anaçlar ortalamasına göre, en yüksek heterosis değeri %20,95 ile başakta tane ağırlığı özelliğinde saptanmıştır. Bunu %18,07 ve %17,64 heterosis değerleri ile sırasıyla protein içeriği ve başak boyu özellikleri izlemiştir. Anaçlar ortalamasına göre negatif heterosis % -7,09 ve % - 3,93 değerleri ile düşme sayısı (falling number) ve bitki boyunda belirlenmiştir. Melezler bireysel olarak incelendiğinde; protein içeriğinde sürekli pozitif melez gücü saptanırken, diğer özelliklerde pozitif ve negatif melez gücü saptanmıştır. Bazı melezlerin üstün anaca göre melez azmanlığı göstermesi tritikale'de hibrid ıslahının başarılı bir şekilde uygulanabileceğini göstermiştir.

Anahtar Kelimeler: Heterosis, Verim, Kalite, Triticale

1. Introduction

Triticale is especially evaluated for pasture, silage and animal feeding today. It is preferred because of its high adaptability, high yield, long pasture season and tolerance to pest, diseases and stress conditions. Its grain yield is used in the feeding of poultry animals (Tritical, 2002). Moreover, it can be used in bread manufacture after being blended due to some deficiencies in its flour quality (Muntzing, 1989). A fertile wheat x rye hybrid was produced by W. Rimpau in Germany in 1888. Wheat x rye hybrids were later developed in Russia and Sweden, and more recently in the U.S.A., Canada, Mexico, Hungary and other countries (Poehlman, 1979). Triticale is generally treated as a self-pollinating crop and line breeding is practised. Hybrid breeding has been discussed for some time, but there is little information for winter triticale (Oettler et.al., 2001). Especially, very little information about heterosis for quality traits of triticale has been reported in literature. Today, hybrid breeding based on heterosis effect, in intensively used in cross-pollinating crops such as sunflower and maize whereas the same success could not be obtained so far in the use of hybrid cultivars commercially in self pollinating crops such as wheat. Although the breeding methods applied in self- pollinating crops are usually used in triticale, the heterosis effect which was determined in some researches indicate that the hybrid breeding

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could be applied successfully, as well (Pfeiffer et.al., 1998; Oettler et.al., 2001; Oettler et.al., 2003; Weiβmann and Weiβmann, 2002; Yagdı and Coplu, 2004).

This research was carried out to determine heterosis for some yield and quality traits in winter triticale.

2. Material and Methods

In the study, 14 CIMMIYT origined lines and the cvs. Eronga-83 and Nortingen were used as parents (Table 1), and consequently 15 F1 hybrid combinations were obtained. Pedigrees of the parent genotypes are given in Table 1. F_1 hybrid seeds were produced on hand- emasculated female parents on May 2002. Hybrid seeds were sown onto 2m-long rows which were 30 cm apart together with their parents, according to randomized blocks experimental design with four replicates on 5 November during 2002/ 2003 growing period. After harvest, plant height (cm), spike length (cm), spikelet number, seed number per spike and seed weight per spike (g) were determined on 10 plants in each replicates, both in the parents and in hybrids.

Thousand kernel weight was determined on 4 x 100 seeds, while protein content, sedimentation and falling number were determined by the basis of 14% moisture to American Association of Cereal Chemists (A.A.C.C.1969). For each cross combination (P1 X P2), the hybrid performance (HYB), mid-parent value (MP) and relative heterosis (HET %) were calculated as follows : MP : (P1+P2) / 2 ;HET %=((HYB-MP)/MP)x100. Relative high-parent heterosis (HPHET%) was also obtained as heterosis relative to the higher performing or taller parent (Oettler et. al.,2003).

Table 1. The pedigree and origin of parents

PEDİGREE	ORİGİN	LİNES
BANT-2/RHINO-9//GIRAF/YOGUI-1(CTM87.1891- 5Y-0M-0RES-17M-1Y-0PAP-4Y-0B)	CIMMIYT/MEXİCO	(CMT1)*
ERIZO-7//YOGUI-1/GIRAF/3/FARAS-1(CTM88. 1805-7RES-3M-1Y-0M	CIMMIYT/MEXİCO	(CMT3)
ERIZO-11/ YOGUI-3(CTY87.99-3MI-1RES-3M-2Y-0PAP-2Y-0B	CIMMIYT/MEXİCO	(CMT4)
FAHAD-5 (CTM18931-0Y-3M-1Y-1M-2Y-2B-0Y)	CIMMIYT/MEXİCO	(CMT5)
GIRAF/YOGUI-1FARAS-1/3LAMB-4(CTM88. 1948 -3RES-1M-0Y-2M-3Y-0M)	CIMMIYT/MEXİCO	(CMT6)
ARDI-1/TOPO1419//ERIZO-9 (CTY87.852-5M-07-0M-0RES-3M-1Y-OPAP-1Y-0B)	CIMMIYT/MEXİCO	(CMT7)
SUSI-2(CITM86B.386-2Y-1M-5Y-3M-3RES-OB-2Y-OPAP)	CIMMIYT/MEXİCO	(CMT8)
LAMB-2(X65985-5M-3Y-2M-1Y-4M-1Y-1M-0Y)	CIMMIYT/MEXİCO	(CMT9)
PASSI-3-2(CTM24476-1M-0Y-0H-0Y-22B-1Y-500B-502RES-0B)	CIMMIYT/MEXİCO	(CMT10)
CAGUAN-3 (CTM86M.2281-5Y-2B-1Y-1B-2RES-0B-1Y-OPAP)	CIMMIYT/MEXİCO	(CMT11)
DAGRO/IBEX//CIVET#2 (SWTY87.246-1B-3Y-2B-5RES-0B-6Y-OPAP-1Y-0B)	CIMMIYT/MEXİCO	(CMT12)
DRIRAOUT CROU(X21295-OAP-9)	CIMMIYT/MEXİCO	(2002)
JUANNİLLO98(X 21295-OAP)	CIMMIYT/MEXİCO	(2003)
FAHAD9-1	CIMMIYT/MEXİCO	(2015)
ERONGA-83	CIMMIYT/MEXİCO	(ERG)
NORTINGEN	GERMANY	(NOR)

*:Abbreviations for this research.

3. Results and Discussion

Relative mid-parent heterosis values determined according to hybrid combinations with respect to the eight traits examined in research are given in Table 2 and relative high parent heterosis values, in table 3. The highest level of mid-parent heterosis was determined as 20.95 % for seed weight per spike, being average of 15 hybrids. This trait was followed by mid-parent heterosis rates of 18.07%, 17.64%, 12.30% and 5.48% for protein content, spike lenght, seed number per spike and thousand kernel weight, respectively. Pfeiffer *et al.* (1998),Oettler *et al.*(2001, 2003) determined mid-parent heterosis for kernels/spike, and thousand kernel weight in triticale. Negative mid-parent heterosis was determined in falling number and plant height with the mean values of -7.09% and – 3.93%, respectively. Oettler *et.al.*(2003) reported that a serious drawback to farmer's acceptance of hybrid triticale could be the significantly lower falling number and consequently higher ά- amylase activity of hybrids compared with their mid-parent value. The mid-parent heterosis results which were at rather high rates (-6.00% - -53.60%) individually in the hybrids in our study are similar to the results of this study. However, it is interesting to note that although the lowest (-53.60%) mid-parent heterosis was determined for falling number, the highest mid-parent heterosis (65.40%) found in the study was also determined for this trait. Mid-parent heterosis values determined in hybrids exhibit great differences, in relation to combinations. This situation indicates the effect of the selection of parents that will produce the hybrids on the hybrid performance.

The highest positive heterosis for plant height was obtained from CMT1/NOR hybrid with 3.72%, and the lowest negative heterosis from CMT10/2003 hybrid with -13.36%. The highest heterosis for seed number per spike was determined in CMT4/2015 hybrid with 40.15%. Positive heterosis for seed weight per spike was obtained from CMT9/ERG hybrid with a value as high as 59.02%. Positive mid-parent heterosis for thousand kernel weight was obtained from 10 hybrid combinations and negative mid-parent heterosis from 5 hybrid combinations. The highest value for this trait was determined in CMT6/2015 hybrid with 29.65%. Contrarily to the other traits, positive mid-parent heterosis was determined in all hybrids, with respect to protein content. The highest value for this trait was obtained from CMT10/2003 hybrid with 45.80%. As to the sedimentation and falling number, negative or positive mid-parent heterosis results were obtained depending on concentrations. The highest and positive heterosis results were obtained from CMT11/2002 with 32.90% for sedimentation and from CMT12/2002 hybrid with 65.40% for falling number. On the other hand, the negative mid-parent heterosis obtained from CMT3/NOR hybrid at -53.60% level for falling number was the lowest value determined in the research.

The highest values of high parent heterosis, as the mean of all hybrids examined in the study were determined in seed weight per spike and protein content with 12.77% and 12.05%, respectively. Other than these two traits, mean high-parent heterosis results of hybrids were positive for spike length and seed number

Table 2.Relative mid-parent heterosis for yield and quality components of triticale F_1 hybrids

Hybrids	PH*	SL	SNPS	SWPS	TKW	PRO	SDS	FN
CMT1/ERG	1.85	-0.86	27.71	46.85	21.64	18.60**	-23.00**	-27.40**
CMT1/NOR	3.72	-16.60*	13.28	27.52	9.11	41.70**	-14.60	-22.70**
CMT1/2015	- 2.96*	0.98	23.37	20.21	-1.46	4.60**	-18.60**	-31.90**
CMT3/ERG	- 2.29	13.38	-6.05	-16.73	-22.70	29.90**	-0.64	-21.90**
CMT3/NOR	- 3.71	32.89**	33.41	26.53*	3.79	33.00**	11.50	-53.60**
CMT4/2015	- 9.26**	31.55**	40.15**	43.72*	- 3.22	3.20**	-8.80	-22.50**
CMT5/2002	- 0.93	12.5**	-10.21	-8.20	8.88	17.80**	-15.30**	-16,50**
CMT6/2015	-7.63	17.47**	9.58	25.85	29.45**	2.00	9.90	42,80**
CMT7/NOR	- 9.29**	29.02**	18.28	-4.35	0.66	19.90**	3.29	-31.90**
CMT8/ERG	- 4.29	22.05	7.93	1.62	-10.07	12.80**	-13.30**	12.10**
CMT9/ERG	1.66	18.79**	9.32**	59.02**	25.05**	21.80**	-3.20	5.30**
CMT10/2003	- 13.36	22.01**	-1.75	-5.24	- 17.58**	45.80**	-7.10	-6.00**
CMT11/2002	1.67	27.13**	10.68	24.90	19.90	0.29	32.90**	-26.30**
CMT12/2002	- 4.95*	25.28**	7.49	37.06	-2.96**	7.10**	17.50*	65.40**
CMT12/2003	- 9.17	29.00**	1.26	35.11	21.71**	12.60**	-12.60*	28.70**
Average	-3.93	17.64	12.30	20.95	5.48	18.07	-2.80	-7.09

*Abbreviations: PH :Plant Height , SL : Spike Length , SNPS :Seed Number Per Spike, SWPS: Seed Weight Per Spike TKW : Thousand Kernel Weight, PRO :Protein Content, SDS :Sedimentation , FN :Falling Number

Table 3.Relative high parent heterosis for yield and quality components of triticale F_1 hybrids

Hybrids	PH	SL	SNPS	SWPS	TKW	PRO	SDS	FN
CMT1/ERG	-3.48*	-17.10	-15.85	28.62	15.16	8.67**	-30.93**	-28.57**
CMT1/NOR	0.49	-26.32*	5.72	11.21	0.69	29.20**	-24.75**	-27.96**
CMT1/2015	-6.99*	-12.30**	11.21	18.96	-1.91	2.16**	-27.84**	-37.89**
CMT3/ERG	-3.98	8.64	-9.40	-25.27	-24.11	23.64**	-3.65	-24.99**
CMT3/NOR	-4.26	30.95**	27.51	18.47	0.50	25.83**	6.11	-58.60**
CMT4/2015	-11.74**	28.02**	30.99**	42.19*	-9.60	-3.92**	-18.75**	-30.07**
CMT5/2002	-4.08	7.83**	-15.28	-12.64	3.92	14.38**	-26.59**	-33.53**
CMT6/2015	-9.52	6.63**	1.29	17.38	26.47**	0.00	4.00	22.70**
CMT7/NOR	-9.31**	22.70**	15.88	-8.92	- 8.02*	4.54**	1.28	-39.25**
CMT8/ERG	-5.54	12.97	-0.32	-9.09	-12.67	3.59**	-21.88**	11.39**
CMT9/ERG	1.78	18.45**	28.07**	43.17**	13.75**	17.59**	-3.85	3.63**
CMT10/2003	-18.91	20.43**	-4.72	-8.33	-22.02**	45.16**	-7.69	-8.26**
CMT11/2002	-1.20	25.09**	0.06	15.61	11.15	-6.05**	21.68**	-29.99**
CMT12/2002	-8.06*	24.81**	5.82	31.97	-11.71**	5.96**	13.49*	47.71**
CMT12/2003	-9.94	27.32**	-0.79	28.26	11.35	10.04**	-14.30*	19.30**
Average	-6.32	11.88	5.35	12.77	-0.47	12.05	-8.91	-14.29

*Abbreviations: PH :Plant Height , SL : Spike Length , SNPS :Seed Number Per Spike, SWPS: Seed Weight Per Spike TKW : Thousand Kernel Weight, PRO :Protein Content, SDS :Sedimentation , FN :Falling Number

per spike, as well. Mean high-parent heterosis value for the other five traits was found to be negative. The highest positive value determined in the study was obtained from CMT12/2002 hybrid in falling number with 47.71% high parent heterosis, whereas the lowest high parent heterosis was determined again in falling number, with -58.60% from CMT3/NOR hybrid. The highest high parent heterosis for seed number per spike was determined in CMT9/ERG hybrid with 43.17%, as in mid-parent heterosis.

The fact that these hybrids overrun their superior parents with respect to high-parent heterosis indicates that hybrid breeding can successfully be applied in triticale.

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