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Stability parameters and performance of interregional crosses in durum wheat (*Triticum durum* Desf.) *

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Summary. Twelve durum wheat varieties originating from 3 ecologically diverse regions and their 48 inter-group crosses were evaluated for stability of performance with respect to grain yield and certain component traits. The linear component of the genotype-environment interaction was revealed for grain yield, 100-grain weight and plant height, non-linear for tiller number whereas for grains per spike both components were equally important. However, except for tiller number, the linear component appeared to be contributing to a large extent towards the prevalent interactions. NP 404, Bijaga Yellow and Giorgio VZ 331 depicted stable performance for grain yield. However, considering all the attributes, the parents NP 404, Bijaga Yellow, Anhinga 's' and Mexicali 75 and hybrids NP 401 × Mexicali 75, NP 404 × Anhinga 's', NP 412 × Mexicali 75, NP 404 × Gerardo VZ 466 and Anhinga 's' × Capeiti appeared promising. The Mexican group as a whole exhibited a more stable performance than the other two evaluated groups. Compensating shift among the component characters was evident in the case of parents as well as hybrids and stability of performance appeared to be under genetic control. Effective utilization of these two aspects through introduction in otherwise desirable varieties has been advocated.

Key words: Stability analysis – Linear and non-linear components – Transmissability – Compensating shift

Introduction

The major drawback of the durum wheat (*Triticum durum* Desf.) varieties is their instability of performance over varied situations. Therefore, stable performing varieties of durum wheat must be evolved so that they can compete with *Triticum aestivum* wheat varieties. In order to initiate the development of stable genotypes, information on various stability parameters and their mode of transmission to subsequent generations is essential. However, information on various aspects of stability is scanty in durum wheat (Kaltsikes and Larter 1970; Widner and Lebsock 1973; Gill et al. 1980; Bhullar et al. 1983). With this in view, the present investigation comprising 12 parental lines belonging to 3 ecologically different regions and their inter-group hybrids was undertaken. The objective of the investigation was to gather information on various stability parameters for grain yield and its component traits in respect of geographically diverse lines and their subsequent mode of transmission to the hybrid populations.

Materials and methods

The experimental material was comprised of 12 durum wheat varieties originating from 3 geographically diverse sources. The varieties NP 401, NP 404, NP 412 and Bijaga Yellow were from Indian sub-continent; Anhinga 's', Cocorit 's', Mexicali 75 and Crane 's' originated from the International Centre for Maize and Wheat Improvement (CIMMYT); and Capeiti, Gerardo VZ 466, Giorgio VZ 331 and Creso came from the Italian group. Sixteen hybrid combinations were produced from each of three inter-group crosses, viz. Indian × Mexican, Indian × Italian and Mexican × Italian, resulting in 48 F_1's. The 12 parents and 48 F_1's were grown in a randomized block design at 3 agroclimatically diverse sites of the Punjab Agricultural University, namely Ludhiana, Gurdaspur and Faridkot with two replications at each site. The populations were grown in single rows spaced 23 cm apart keeping interplant distance at 10 cm. Five competitive plants were selected from each row and observations were recorded on grain yield per plant, number of tillers per plant, number of grains per spike, 100-grain weight and plant height. The stability analysis was carried out following Perkins and Jinks (1968).

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Table 1. Joint regression analysis of variance for grain yield and other characters

Source	*df*	Grain yield	Tiller no.	Grains/ spike	100-grain weight	Plant height
Environments	2	2.37**	0.05	3.12	0.06	1145.27**
Genotypes	59	6.93**	3.34**	68.65**	1.11**	449.90**
Parents	11	10.85**	1.06**	54.66**	0.79*	930.07**
F_1's	47	6.19**	3.93**	71.73**	1.10**	250.98**
P vs F_1's	1	3.94	0.50**	77.55**	4.50	4516.99**
Geno. × Env.	118	0.76**	0.33**	21.43**	0.26**	127.44**
P × Env.	22	0.58**	0.15*	11.89**	0.28**	14.83**
Hetero. reg.	11	0.94**a	0.07	12.11**	0.51**aa	26.59**aa
Remainder	11	0.23	0.23**	11.68**	0.06	3.08
F_1's × Env.	94	0.30**	0.17**	10.40**	0.10**	74.23**
Hetero. reg.	47	0.39**a	0.03	15.53**aa	0.17**aa	125.22**aa
Remainder	47	0.21	0.31**	5.27**	0.04	23.25**
(P vs F_1's) Env.	2	1.74**	0.01	3.48	0.33**	111.65**
Pooled error	177	0.19	0.08	1.20	0.06	1.90

*, ** Significant at 5% and 1%, respectively (tested against error)
a, aa Significant at 5% and 1%, respectively (tested against corresponding remainder)

Results and discussion

The joint regression analysis revealed significant differences among parents and hybrids, indicating that genetic variability existed in the materials under investigation (Table 1). Highly significant mean squares due to environments in respect to grain yield indicated sufficient differences among the measured environments. Both the parents as well as hybrids depicted interaction with the environments in respect to all evaluated characters.

The further partitioning of genotype × environment interactions into linear and non-linear functions revealed the importance of the former in the case of grain yield, grains per spike, 100-grain weight and plant height both in respect to parents as well as hybrids. Thus, in these cases the response of genotypes to varying environmental conditions could be easily attributed to differences in regression slopes, indicating an almost accurate predictability of their phenotypic performance. Similar findings have also been reported by Bhullar et al. (1983). However, in the case of tiller number the non-linear component was predominant.

A simultaneous evaluation of all the stability parameters (m_i, b_i and S^2_{di}) for different attributes indicated that NP 404 and Bijaga Yellow were stable in performance in the case of grain yield (Table 2). Crane 's' combined the highest mean performance with a low regression coefficient but had relatively high deviation mean square. Anhinga 's' and Mexicali 75 possessed high mean performance and low deviation mean squares but had significant regression coefficients, thus indicating suitability for better environments only. Giorgio VZ 331 depicted good stability but had low mean performance. From the hybrid combinations, NP 404 × Mexicali 75, NP 401 × Crane 's', NP 404 × Anhinga 's', NP 404 × Crane 's', NP 412 × Cocorit 's', NP 412 × Mexicali 75, Bijaga Yellow × Cocorit 's', NP 404 × Gerardo VZ 466, NP 404 × Creso, Anhinga 's' × Capeiti and Anhinga 's' × Giorgio VZ 331 emerged as stable performers (Table 3). It may be seen that most of these combinations involved stable performing parents.

In the case of tiller number, the parents NP 404, NP 412, Anhinga 's', Cocorit 's', Mexicali 75 and Crane 's' recorded high tiller number as well as stability of performance for this character. It is evident that hybrid combinations NP 404 × Anhinga 's', NP 404 × Mexicali 75, NP 412 × Mexicali 75, NP 412 × Crane 's', NP 404 × Capeiti, NP 412 × Capeiti, NP 412 × Giorgio VZ 331, NP 412 × Creso and Anhinga 's' × Capeiti had high tiller number and low response to environmental fluctuations.

In respect to grains per spike, Bijaga Yellow and Anhinga 's' were observed to be stable genotypes for this attribute. Mexicali 75 and Capeiti combined high mean performance and low regression coefficients with comparatively high deviation mean squares. The cross combinations NP 401 × Mexicali 75, NP 404 × Mexicali 75, Bijaga Yellow × Mexicali 75, NP 412 × Capeiti, Bijaga Yellow × Giorgio VZ 331, Bijaga Yellow × Creso, Anhinga 's' × Creso, Cocorit 's' × Giorgio VZ 331, Crane 's' × Gerardo VZ 466 and Crane 's' × Giorgio VZ 331 recorded a higher number of grains per spike along with a low response to varying conditions.

In the case of 100-grain weight, Anhinga 's' and Mexicali 75 emerged to be the most desirable parents for this trait. NP 404 revealed good stability performance but had low grain weight. NP 401, NP 412, Cocorit 's', Crane 's' and Giorgio VZ 331 indicated suitability for specific environmental conditions. The hybrid combinations NP 401 × Anhinga 's', NP 412 × Crane 's', NP 404 × Gerardo VZ 466, Bijaga Yellow × Capeiti, Bijaga Yellow × Gerardo VZ 466, Anhinga 's' × Capeiti, Mexicali 75 × Giorgio VZ 331 and Crane 's' × Giorgio VZ 331

Table 2. Stability performance of parents for grain yield and other characters

Parents	Grain yield			Tiller number			Grains per spike		
	m_i	b_i	S^2_{di}	m_i	b_i	S^2_{di}	m_i	b_i	S^2_{di}
NP 401	11.64	0.40*	−0.14	5.97	−3.95*	−0.06	42.63	6.32*	−0.39
NP 404	11.02	1.09	−0.14	7.03	−2.11	0.31	37.70	2.75*	−1.09
NP 412	9.58	2.76*	0.16	6.80	0.42	0.08	39.77	22.26	73.99**
Bijaga Yellow	11.37	1.24	−0.11	5.73	0.90	−0.06	49.17	3.82	−0.55
Anhinga 's'	12.57	0.04*	−0.04	6.00	1.16	−0.05	47.67	−1.13	−0.67
Cocorit 's'	12.31	2.16*	−0.03	6.42	1.53	0.37	44.03	−1.22	1.62
Mexicali 75	12.81	0.81*	−0.14	6.37	4.80	0.24	47.40	−4.15	2.87*
Crane 's'	13.48	−1.64	0.92	6.43	−0.27	−0.05	45.68	−0.11	7.31**
Capeiti	11.44	−0.35*	−0.15	5.37	−0.10	−0.01	47.93	0.52	1.24
Gerardo VZ 466	7.73	2.17	0.29	5.90	1.16	−0.05	42.88	6.29	3.99*
Giorgio VZ 331	9.73	0.98	0.26	5.20	7.96	0.66	43.65	−18.29	25.09**
Creso	7.95	2.35*	−0.15	5.23	0.58	0.38	35.58	4.35	0.78

Parents	100-grain weight			Plant height		
	m_i	b_i	S^2_{di}	m_i	b_i	S^2_{di}
NP 401	5.89	0.32*	−0.05	113.43	−2.02	20.33**
NP 404	5.25	1.12	−0.02	114.50	3.10*	6.36**
NP 412	5.69	−1.46*	−0.05	103.80	−0.15*	−1.81
Bijaga Yellow	4.56	−0.13*	−0.05	99.28	1.68	1.11
Anhinga 's'	5.57	−0.12	0.04	99.57	2.09*	−0.76
Cocorit 's'	5.45	1.89*	−0.04	75.78	−0.15*	−1.60
Mexicali 75	5.52	−0.96	0.01	75.32	−0.20*	−1.92
Crane 's'	5.55	−2.69*	0.09	78.75	1.96*	−1.83
Capeiti	5.15	−1.47*	−0.04	116.58	−0.68*	−1.73
Gerardo VZ 466	4.39	5.68*	−0.01	74.87	1.27	1.53
Giorgio VZ 331	5.76	4.51*	0.09	115.65	1.94*	−1.64
Creso	4.53	5.42*	−0.05	78.92	3.15*	0.04

*, ** Significant at 5% and 1%, respectively

showed higher 100-grain weight as well as low response to environmental variations. Most of the hybrids depicting stable performance in respect to the above mentioned traits usually involved these desirable parents in one form or the other.

Considering grain yield and its components, NP 404, Bijaga Yellow, Anhinga 's', Cocorit 's', Mexicali 75 and Crane 's' emerged desirable. It is clear that while all of the Mexican group revealed a good degree of stability, none of the varieties of the Italian group showed a reasonable level of stability behaviour. This could be attributed to the fact that from among these three groups of varieties, the Mexican group was subjected to a wide range of diverse environmental conditions, whereas the other groups of varieties remained somewhat localized. Similarly, from among the hybrid combinations, NP 401 × Mexicali 75, NP 404 × Anhinga 's', NP 404 × Mexicali 75, NP 412 × Mexicali 75, NP 412 × Crane 's', NP 404 × Gerardo VZ 466, NP 412 × Capeiti, Anhinga 's' × Capeiti and Crane 's' × Giorgio VZ 331 seemed to be more desirable.

It is evident from the stability of performance for these traits that from among the parents, NP 404 depicted stable performance for grain yield and tiller number, while Bijaga Yellow did so for grain yield and grains per spike. On the contrary, Anhinga 's', Cocorit 's', Mexicali 75 and Crane 's', having exhibited buffering ability for at least one of the component attributes, were relatively less stable for the main character grain yield itself. It could, therefore, be inferred that stability of the final character depends upon the plasticity in the component characters. Similar findings have been reported earlier by Bains and Gupta (1974) and Talukdar (1980). Similarly, the hybrid combinations NP 401 × Crane 's', NP 404 × Crane 's', NP 412 × Cocorit 's', Bijaga Yellow × Cocorit 's', NP 404 × Creso and Anhinga 's' × Giorgio VZ 331 showed stable performance for grain yield but could not perform so in the case of component characters. In contrast to this, many other combinations, while depicting low response to environmental fluctuations in the case of component characters, were poor in terms of stability performance for grain yield. It is, therefore, indicative that

Table 3. Stability performance of F_1's for grain yield and other characters

Cross	Grain yield			Tiller no.			Grains per spike		
	m_i	b_i	S^2_{di}	m_i	b_i	S^2_{di}	m_i	b_i	S^2_{di}
NP 401 × Anhinga 's'	13.68	1.40*	−0.15	4.60	−9.53*	−0.06	42.87	1.62*	−1.00
NP 401 × Cocorit 's'	9.39	1.68	−0.11	5.43	6.47	0.31	46.57	−7.24*	−0.28
NP 401 × Mexicali 75	12.17	3.16	0.01	5.60	1.76	−0.04	46.33	0.49	0.72
NP 401 × Crane 's'	13.67	2.52	0.08	5.87	2.11	−0.06	51.33	−5.06*	1.03
NP 404 × Anhinga 's'	13.03	0.76	−0.15	8.53	−4.24	0.25	43.57	−2.76	0.23
NP 404 × Cocorit 's'	14.45	−3.14*	−0.08	7.50	−5.53	0.53	40.77	5.05*	−0.23
NP 404 × Mexicali 75	11.68	0.06	−0.06	7.28	2.47	−0.01	48.07	0.18	0.79
NP 404 × Crane 's'	14.35	−2.39	0.30	7.53	−12.82	1.43	51.77	−4.97	1.71
NP 412 × Anhinga 's'	10.55	−3.45	0.61	6.10	−3.41	0.01	36.23	0.04	−0.86
NP 412 × Cocorit 's'	13.73	1.38	0.13	9.10	−9.18	7.63**	41.27	−0.32	−0.93
NP 412 × Mexicali 75	13.35	1.51	−0.03	7.37	−4.35	−0.05	37.33	9.38*	2.55
NP 412 × Crane 's'	13.14	−0.35*	−0.15	6.60	−1.76	−0.03	42.47	6.90	10.15**
B. Yellow × Anhinga 's'	9.60	−0.52*	−0.14	5.61	−4.12	−0.05	39.22	4.06	−0.13
B. Yellow × Cocorit 's'	12.49	−3.33	0.79	6.22	−5.53	0.05	39.32	16.59*	8.34**
B. Yellow × Mexicali 75	11.40	3.07*	−0.15	5.62	4.12	0.08	46.27	−0.57	−0.86
B. Yellow × Crane 's'	11.08	−0.97*	−0.14	5.13	7.76	0.08	49.03	−6.98	5.79**
NP 401 × Capeiti	10.75	−2.62	0.36	4.40	8.24	0.02	44.17	16.17*	1.48
NP 401 × Gerardo VZ 466	9.53	−0.43	−0.11	5.78	−5.76	0.19	45.75	−1.91*	−1.07
NP 401 × Giorgio VZ 331	9.98	−5.17*	−0.15	4.43	4.35	−0.05	43.67	10.93*	3.51*
NP 401 × Creso	10.96	2.73	0.31	5.43	4.35	−0.05	45.57	−14.20	24.47**
NP 404 × Capeiti	10.22	1.79*	−0.15	7.20	1.76	−0.04	40.57	9.70*	3.13*
NP 404 × Gerardo VZ 466	12.54	3.98	0.18	5.70	6.82	0.23	41.83	−12.53	27.20**
NP 404 × Giorgio VZ 331	10.63	1.36	0.41	6.15	2.82	0.03	36.60	7.53	4.88*
NP 404 × Creso	12.19	−4.28	−0.06	6.73	9.53	0.19	46.73	−6.54*	1.53
NP 412 × Capeiti	10.58	2.69	−0.06	6.57	3.88	−0.03	50.50	−4.15	1.22
NP 412 × Gerardo VZ 466	9.30	5.88*	−0.05	4.75	3.29	−0.05	37.00	−11.72	11.42**
NP 412 × Giorgio VZ 331	13.62	−3.96*	−0.10	6.70	−1.76	−0.04	41.37	8.91	7.66**
NP 412 × Creso	10.59	−0.16*	−0.14	8.52	−4.12	−0.05	36.53	9.84	5.76**
B. Yellow × Capeiti	10.51	2.49	−0.13	6.10	15.06	0.61	44.03	−1.65*	−1.03
B. Yellow × Gerardo VZ 466	12.20	10.51	1.21	4.93	6.47	0.31	47.60	−2.41*	−1.11
B. Yellow × Giorgio VZ 331	11.89	4.87	−0.02	5.68	4.12	−0.05	51.77	−1.79	−0.37
B. Yellow × Creso	11.03	5.58*	−0.14	5.63	2.00	−0.05	49.37	1.35	−0.67
Anhinga 's' × Capaiti	12.37	−1.33	0.01	6.43	−0.82	0.03	45.40	−3.39	2.41
Anhinga 's' × Gerardo VZ 466	10.60	1.98	−0.06	3.93	−5.18*	−0.06	49.77	−18.81	46.32**
Anhinga 's' × Giorgio VZ 331	12.20	2.98	0.15	4.60	2.12	0.20	44.03	−9.71	5.59**
Anhinga 's' × Creso	11.32	4.09	0.01	4.43	6.00	0.00	48.17	−5.23	1.04
Cocorit 's' × Capeiti	10.76	3.53	0.15	6.47	2.59	0.12	51.70	7.12*	−0.27
Cocorit 's' × Gerardo VZ 466	10.32	1.38	−0.11	5.00	6.47	−0.04	43.37	6.46	4.46*
Cocorit 's' × Giorgio VZ 331	11.42	12.09*	0.30	4.90	3.41	0.01	49.00	−0.55	−0.80
Cocorit 's' × Creso	10.30	7.28*	−0.02	4.87	10.35	0.06	44.60	10.77*	3.50*
Mexicali 75 × Capeiti	9.33	4.76*	−0.10	6.27	−2.24	0.10	42.17	1.63*	−1.10
Mexicali 75 × Gerardo VZ 466	9.78	−1.01	−0.08	4.50	3.06	−0.05	52.17	11.91*	4.22*
Mexicali 75 × Giorgio VZ 331	10.18	−4.47*	0.00	5.63	1.29	−0.01	52.00	7.59*	0.67
Mexicali 75 × Creso	9.93	−0.04	−0.10	5.33	−0.82	0.03	43.60	−1.76*	−1.09
Crane 's' × Capeiti	10.09	−0.79	0.08	5.77	−1.29	−0.01	47.07	14.54	16.71*
Crane 's' × Gerardo VZ 466	10.47	−4.40	0.33	5.87	−4.71	0.17	56.60	2.92	−0.71
Crane 's' × Giorgio VZ 331	11.39	−6.43*	0.00	5.43	−5.17*	−0.06	52.17	−3.01	0.40
Crane 's' × Creso	9.60	3.24*	−0.14	5.23	7.76	0.08	47.60	2.65	−0.17

phenomenon of compensating shift among the component characters was also operative in the heterozygous populations.

There is sufficient evidence at present that mean performance and ability to perform consistently over varying situations are two independently genetically controlled characters (Bucio-Alanis et al. 1969; Bains 1976). In the present study, the majority of hybrid combinations showing stability of performance involved one or even both the high performing parents for the corresponding attribute. In light of the evidence that ability to perform uniformly over a number of sites is under genetic control, it may be feasible to incorporate stability behaviour in otherwise desirable lines. Additionally, the buffering ability of component traits could effectively be utilized by suitable breeding procedures for production of high-yielding stable genotypes.

Table 3. (Continued)

Cross	100-grain weight			Plant height		
	m_i	b_i	S^2_{di}	m_i	b_i	S^2_{di}
NP 401 × Anhinga 's'	6.36	4.02	−0.02	111.85	0.71	2.46*
NP 401 × Cocorit 's'	5.27	3.30	−0.03	107.37	2.11*	1.01
NP 401 × Mexicali 75	5.78	3.82	0.00	111.88	0.86	−0.53
NP 401 × Crane 's'	5.76	4.46	0.01	107.22	1.53	55.61**
NP 404 × Anhinga 's'	4.47	2.02*	−0.05	116.62	0.56	14.34*
NP 404 × Cocorit 's'	5.79	8.92*	−0.04	112.45	−1.07*	24.14**
NP 404 × Mexicali 75	5.17	2.47*	−0.05	117.63	−0.91*	29.42**
NP 404 × Crane 's'	5.35	7.00*	−0.04	106.85	−0.58*	22.30**
NP 412 × Anhinga 's'	5.57	3.13	0.04	113.83	1.17*	−1.79
NP 412 × Cocorit 's'	5.41	−5.31*	−0.05	114.53	0.90	12.48**
NP 412 × Mexicali 75	6.10	4.69*	−0.02	117.82	0.56	34.21**
NP 412 × Crane 's'	5.98	0.96	−0.04	106.67	−0.02	13.23**
B. Yellow × Anhinga 's'	5.29	0.74	−0.05	114.37	0.86	−1.20
B. Yellow × Cocorit 's'	5.67	0.90	−0.02	105.07	0.41*	1.34
B. Yellow × Mexicali 75	5.92	2.90*	−0.05	115.28	−0.69*	19.42**
B. Yellow × Crane 's'	5.65	1.75*	−0.05	106.92	−0.20	19.22**
NP 401 × Capeiti	5.62	8.43*	−0.03	125.72	1.23	0.11
NP 401 × Gerardo VZ 466	5.95	2.38*	−0.05	117.07	2.59	30.26**
NP 401 × Giorgio VZ 331	5.71	1.45	−0.03	120.03	2.65*	24.75**
NP 401 × Creso	6.80	−2.20*	−0.05	112.57	0.33	11.80**
NP 404 × Capeiti	4.20	−9.08	0.37	115.53	0.75*	−1.42
NP 404 × Gerardo VZ 466	6.18	0.30	−0.02	113.80	2.07*	3.21*
NP 404 × Giorgio VZ 331	6.31	−3.22*	−0.05	122.62	2.69*	11.16**
NP 404 × Creso	5.99	7.05*	−0.05	111.02	1.92*	1.87
NP 412 × Capeiti	4.56	−1.70*	−0.05	110.35	1.49	1.27
NP 412 × Gerardo VZ 466	6.55	−2.32*	−0.04	102.38	3.48*	37.59**
NP 412 × Giorgio VZ 331	6.98	3.59*	−0.05	119.57	2.33*	9.06**
NP 412 × Creso	5.19	−4.00	−0.05	104.58	4.03*	64.55**
B. Yellow × Capeiti	5.83	0.32	−0.04	113.85	2.38	31.85**
B. Yellow × Gerardo VZ 466	6.18	−4.00	−0.05	101.82	2.92*	13.31**
B. Yellow × Giorgio VZ 331	6.33	−0.22*	−0.05	112.12	0.47	6.91**
B. Yellow × Creso	5.75	−1.54*	−0.05	107.73	3.93*	58.11**
Anhinga 's' × Capeiti	6.33	4.76	−0.02	113.03	2.69*	11.44**
Anhinga 's' × Gerardo VZ 466	5.64	3.94*	−0.03	100.65	3.73*	44.97**
Anhinga 's' × Giorgio VZ 331	6.23	−4.52*	−0.04	104.05	1.85	17.70**
Anhinga 's' × Creso	6.24	2.47*	−0.05	94.08	3.67*	71.82**
Cocorit 's' × Capeiti	5.07	0.05*	−0.05	111.83	0.03*	9.18**
Cocorit 's' × Gerardo VZ 466	5.36	−0.54*	−0.05	95.63	−1.55*	62.87**
Cocorit 's' × Giorgio VZ 331	5.96	−2.06*	−0.05	104.89	0.37*	−0.24
Cocorit 's' × Creso	5.30	−0.95*	−0.05	91.22	−2.25*	77.48**
Mexicali 75 × Capeiti	4.69	0.84	−0.05	104.30	0.47*	0.62
Mexicali 75 × Gerardo VZ 466	5.79	−5.03*	−0.05	88.33	−1.13*	7.07**
Mexicali 75 × Giorgio VZ 331	6.35	1.90	−0.05	109.41	1.78	14.96**
Mexicali 75 × Creso	4.95	0.05*	−0.05	89.86	−0.31*	7.53**
Crane 's' × Capeiti	4.96	2.09	−0.05	105.69	−0.33*	11.34**
Crane 's' × Gerardo VZ 466	4.83	1.86*	−0.05	89.25	−2.24*	74.97**
Crane 's' × Giorgio VZ 331	5.76	2.35	−0.03	98.92	2.10*	−0.26
Crane 's' × Creso	5.03	−0.38*	−0.05	88.75	−1.23	71.20**

*, ** Significant at 5% and 1%, respectively

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