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GENETICS OF YIELD AND YIELD RELATED CHARACTERS IN HEXAPLOID TRITICALE

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Six hexaploid triticale strains, selected on the basis of morphological evaluation, were crossed in a diallel fashion to test their combining ability and nature of gene action involved by using Griffing technique. Significant genotypic differences were observed among these strains for all the characters. Both additive and non-additive gene action was observed. Complete dominance was expressed for spike length. Considering all the characters together, strain 6TA 204 Bronco was good general combiner for plant height, number of spikelets per spike and number of grains per spike, whereas Delfin "S" for fertility percentage and yield per plant. *Per se* performance was observed to be associated with GCA and SCA effects. Importance of these results for the improvement of triticale is discussed.

INTRODUCTION

Breeding efforts have resulted in various varieties of triticale having improved fertility and grain characters (Skovmand *et al.*, 1984). Varieties/ advanced lines with different morphological and economic characteristics are now available as breeding stock (Gupta and Priyadarshan, 1982). For further progress knowledge of breeding behaviour, particularly of combining ability and type of gene action for the various traits is necessary. Chowdhury and Singh (1978), and Shakoor *et al.* (1979) reported both additive and non-additive gene action for yield and yield components in their advanced lines, but information is rather limited on the lines in hand. The present study is an attempt to predict the performance of these lines in hybrid combinations through the diallel cross and to evalute the type of gene action involved in yield and its components in these hexaploid triticales.

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MATERIALS AND METHODS

The experimental material comprised Aba-Cheetah, 6TA 204 Bronco, T-74, Cheetah, Delfiin "S" and M_2A-IRA having superiority for various characteristics, i.e. spike length, number of spikelets per spike, number of grains per spike, 1000 grain weight, fertility percentage and protein contents, respectively, were characterized from the available breeding stock of "spring type" hexaploid triticale. These strains were crossed in a 6x6 diallel fashion. The resulting F_1's alongwith the parents were planted in a randomized complete block design with three replications at Nuclear Institute for Agriculture and Biology, Faisalabad. Each entry consisted of single row of 3 meter length with 25 cm plant to plant and 30 cm row to row distance.

At maturity, ten randomly competitive plants were selected for recording data on plant height (cm), spike length (cm), number of spikelets per spike, number of grains per spike, fertility percentage and grain yield per plant (g).

Analysis of variance was carried out on the mean values to test the significance of differences among parents/crosses. Combining ability analysis was performed following Griffing technique (1956), method 2 and model 1.

RESULTS AND DISCUSSION

Analysis of variance (Table 1) showed significant differences for all the characters under study. The variance values for general and specific combining ability were also significant for all the characters except the variance of specific combining ability for yield per plant.

The estimated SCA variance (δ^2s) was higher than estimated GCA variance (δ^2g) in the case of yield per plant, number of grains per spike and fertility percentage, indicating that non-additive gene action was important for these characters. In the case of plant height and number of spikelets per spike, additive gene action appeared to be more significant because of a low δ^2s/δ^2g ratio. Complete dominance was observed for spike length. Chowdhury and Singh (1978) have also reported non-additive gene action for grain yield and grain number per spike and additive gene action for number of spikelets per spike.

Table 1. *Analysis of variance for plant height, yield and its components in triticale*

Sources of variation	DF	Mean squares					
		Plant height	Yield per plant	Spike length	Number of spikelets per spike	Number of grains per spike	Fertility percentage
Replications	2	109 54	22.34	1.37	2.02	858.69	81.89
Parents/crosses	35	679.21**	54.87**	13.70**	34.70**	363.00**	124.12**
Error	70	42.20	30.02	0.49	1.40	63.50	39.74
General combining ability (GCA)	5	134.19**	25.64*	22.44**	70.79**	517.75**	106.47**
Specific combining ability (SCA)	15	41.25**	17.34**	2.11**	2.34**	87.47**	29.07**
$\delta^2 g$		109.62	0.14	1.84	5.81	38.49	6.22
$\delta^2 s$		27.18	7.33	1.95	1.77	66.21	25.82
$\delta^2 s/\delta^2 g$		0.25	52.35	1.05	0.30	1.72	4.15

* Significant at $P \leqslant 0.05$; ** Significant at $P \leqslant 0.01$.

Table 2. *Estimates of general combining ability effects for plant height, yield and its components in triticale*

Triticale strains	General combining ability effects					
	Plant height	Spike length	Number of spikelets per spike	Number of grains per spike	Fertility percentage	Yield per plant
6TA 204 Bronco	15 284	1.391	3.679	11.798	0.159	−0.024
T-74	−9.196	−1.937	−3.188	−2.894	1.742	−1.207
Cheetah	−2.937	−0.307	−1.318	1.648	1.877	−0.995
Delfin "S"	7.744	0.401	1.201	1.951	2.973	2.779
Aba-Cheetah	2.165	1.510	0.938	−1 657	−1.623	0.145
M_1A-IRA	−13.062	−1.059	−1.312	−7.534	−5.128	−0.697
$SE(g_i-g_j)$	1.531	0.166	0.278	1.878	1.485	1.291

Chowdhury and Singh (1978) suggested that any of the selection criteria, i. e. GCA effects for array means can be used to select the best parent. In the present study, GCA effects have been used to select the best progenitors. General combining ability effects for various characters are presented in Table 2.

Table 3. *Crosses showing best means on the basis of per se performance and SCA effects*

Characters	*Per se* performance	SCA effects
Yield per plant	T-74 — Delfin "S"	T-74 —Delfin "S"
	Delfin "S" — Aba-cheetah	Delfin "S" —Aba-cheetah
	T-74 — Cheetah	Cheetah —M_2A-IRA
	6TA 204 Bronco — Cheetah	6TA 204 Bronco —Cheetah
	6TA 204 Bronco — Delfin "S"	6TA 204 Bronco —Cheetah
Fertility percentage	Cheetah — Delfin "S"	Cheetah —Delfin "S"
	Cheetah — 6TA 204 Bronco	6TA 204 Bronco —Aba-cheetah
	T-74 — Delfin "S"	6TA 204 Bronco —Cheetah
Spike length	6TA 204 Bronco — Aba-cheetah	6TA 204 Bronco—Aba-cheetah
	Delfin "S" — Aba-cheetah	Delfin "S"—Aba-cheetah
	6TA 204 Bronco — Cheetah	6TA 204 Bronco—T-74
	6TA 204 Bronco — T-74	Aba-cheetah—M_2A-IRA
	Aba-cheetah — M_2A-IRA	6TA 204 Bronco—Cheetah
Number of spikelets per spike	6TA 204 Bronco — Aba-cheetah	6TA 204 Bronco—T-74
	6TA 204 Bronco — T-74	Cheetah—Aba-cheetah
	6TA 204 Bronco — Aba-cheetah	Cheetah—Delfin "S"
	6AT 204 Bronco — Delfin "S"	6TA 204 Bronco—Aba-cheetah
Number of grains per spike	6AT 204 Bronco — Delfin "S"	6TA 204 Bronco—Delfin "S"
	Cheetah — 6TA 204 Bronco	T-74—M_2A-IRA
	6TA 204 Bronco — Aba-cheetah	6TA 204 Bronco—Aba-cheetah
	6TA 204 Bronco — Cheetah	T-74—Aba-cheetah
	6TA 204 Bronco — T-74	Cheetah—Delfin "S"
Plant height	6TA 204 Bronco — Aba-cheetah	Cheetah—M_2A-IRA
	6TA 204 Bronco — Delfin "S"	6TA 204 Bronco—T-74
	Cheetah — 6TA 204 Bronco	T-74—Cheetah
	6TA 204 Bronco — Cheetah	6TA 204 Bronco—Delfin "S"
	6TA 204 Bronco — T-74	6TA 204 Bronco—Cheetah

6TA 204 Bronco proved to be the best general combiner for plant height, number of spikelets per spike and number of grains per spike, whereas Delfin "S" was for fertility percentage and yield per plant. Aba-Cheetah showed good general combining effect for spike length. M_2A-IRA was the poorest general combiner for almost all the traits. In general, lines showing superiority for traits based on their morphological evaluation proved to be the best general combiners as estimated by diallel technique.

Per se performance and SCA effects were used to study the performance of lines in their specific combinations. The crosses showing best performance on the basis of *per se* performance and SCA effects are listed in Table 3. Crosses were not found common for all the characters studied. Lines showing good general combining ability for the characters were also involved in the specific cross combinations for that character as well. The best general combiner for grain yield was also high combiner for some of the other yield contributing traits. Thus combining ability for yield seemed to be influenced by combining ability for its components. At least, one high general combining parent was involved in the best combinations especially for yield, fertility percentage, spike length and number of spikelets/spike.

The present study suggests that simple selection would be effective for the improvement of characters usually controlled by additive gene action.

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