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GENETIC ANALYSIS FOR YIELD AND YIELD COMPONENTS IN HEXAPLOID TRITICALE

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Six true breeding triticale strains selected on the basis of their wide differences in some of the morphological traits were crossed in all possible combinations to obtain F_1 hybrid seed. Significant genotypic differences were obtained in the parents and their hybrid combinations for plant height, number of spikelets per spike, number of grains per spike, fertility percentage and yield per plant. NIAB–T 158 exhibited good general combining ability for number of grains per spike, fertility percentage and yield per plant, on the other hand, NIAB–T 103 for plant height and number of spikelets per spike. Non additive type of gene action was more predominant as compared to additive gene action for all the traits and its implication in triticale breeding programme has been discussed. In a breeding programme involving NIAB–T 158 and NIAB–T 103, may produce desirable segregates for yield and yield components.

INTRODUCTION

In the past a large part of breeding efforts was focussed on the improvement of fertility and grain characters in the hexaploid triticale in various national and international triticale improvement programmes. With the development of fertile hexaploid triticale and improvement in test weight (Zillinsky, 1973) the triticale breeders have in recent years started investigating various genetic and breeding aspects of this new cereal (Chowdhury and Singh, 1978). In a well planned breeding programme, combining ability analysis is frequently used for testing the performance of advanced lines/varieties in hybrid combinations for obtaining information on yield and yield components and other characters of economic importance. The present study was initiated with a view to investigating the general and specific combining ability and evaluating the type of gene action involved in some hexaploid triticale strains for yield and its components.

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MATERIALS AND METHODS

Six strains of triticale i.e. NIAB–T 77, NIAB–T 103, NIAB–T 157, NIAB–T 158, NIAB–T 159 and NIAB–T 163 were selected primarily due to their wide differences in various morphological characteristics. All possible single crosses were made among these lines and 15 F_1's alongwith the six parents were sown during 1977-78 at Nuclear Institute for Agriculture and Biology, Faisalabad. The experiment was laid out in a randomized complete block design with three replications with a 2 m row length, spaced 22 cm apart, keeping 15 cm distance among plants Observations on ten competitive plants from each plot, were recorded for plant height, number of spikelets per spike, number of grains per spike, fertility percentage and yield per plant.

Analysis of variance was carried out to test the significance of differences among the genotypes. Combining ability analysis was performed according to the procedure proposed by Griffing (1956) using method 2, model I. Mean values for the five characteristics obtained in the parents and single crosses, were used for running various analyses including estimates of general and specific combining ability.

RESULTS AND DISCUSSION

Analysis of variance showed highly significant genotypic differences for all the characters under study (Table 1). Mean squares due to general as well as specific combining ability were highly significant for plant height, number of spikelets per spike, number of grains per spike, fertility percentage, and yield per plant, showing that total variability for each trait was associated with both general and specific combining ability.

The estimates of general combining ability effects were calculated for all the characters under study (Table 2). Information obtained on general combining ability indicated that some of the strains may contribute significantly towards higher yield through individual yield components. Highest positive effect for plant height and number of spikelets per spike was shown by NIAB–T 103 whereas NIAB–T 158 showed the greatest positive effects for number of grains per spike, fertility percentage and yield per plant. Hence cross combinations involving NIAB–T 158 and NIAB–T 103, may be expected to produce recombinants possessing desirable attributes contributing towards better fertility and consequently, high yield.

Table 1. *Analysis of variance for plant height, number of spikelets per spike, number of grains per spike, fertility percentage, and yield per plant in a 6 x 6 diallel set of triticale.*

Source of variation	D.F.	Mean Square				
		Plant height (cm)	Number of spikelets per spike	Number of grains per spike	Fertility percentage	Yield per plant (gm)
Replication	2	1.3080	0.1556	0.8857	0.2667	0.6526
Crosses/parents	20	4145.8622**	68.4832**	1321.0419**	1839.4571**	627.0127**
Error	252	11.8048	1.3459	4.5222	1.6302	0.7617
General combining ability	5	602.2918**	7.6948**	99.1967**	75.1166**	9.2644**
Specific combining ability	15	167.7536**	3.5165**	84.3458**	138.4598**	52.6416**
Error	252	0.7870	0.0877	0.3015	0.1087	0.0508

Table 2. *Estimates of general combining ability effects for plant height, number of spikelets per spike, number of grains per spike, fertility percentage and yield per plant in a 6 x 6 diallel set of triticale.*

Triticale strains	General combining ability effects				
	Plant height (cm)	Number of spikelets per spike	Number of grains per spike	Fertility percentage	Yield per plant (gm)
NIAB–T 77	– 5.6517	– 0.6275	– 4.7496	2.1983	0.0796
NIAB–T 103	17.1133	1.4538	1.3592	– 3.3346	0.6621
NIAB–T 157	– 5.5192	– 1.2438	– 1.7083	0.5267	– 0.1567
NIAB–T 158	– 3.4029	0.1988	4.8329	5.4404	1.6671
NIAB–T 159	– 3.0529	– 0.4788	2.2421	0.4992	1.0717
NIAB–T 163	0.5133	0.6975	2.5079	– 0.9333	– 1.1804
$SE(g_i–g_j)$	0.4436	0.1480	0.2746	0.1649	0.1127

Estimates of specific combining ability effects are presented in Table 3. The greatest positive and negative effects for plant height were observed in the cross combinations NIAB–T 157 x NIAB–T 103 and NIAB–T 157 x NIAB–T 158 respectively. The largest estimate of specific combining ability effect for number of spikelets per spike, and number of grains per spike was observed in the cross NIAB–T 158 x NIAB–T 163, however, negative effect was more pronounced in the other two cross combinations NIAB–T 77 x NIAB–T 103 and NIAB–T 157 x NIAB–T 159 for each trait respectively. The cross NIAB–T 157 x NIAB–T 163 exhibited more fertility in hybrid combination due to highest specific combining ability for fertility percentage. Based on the highest specific combining ability for yield per plant it may be expected that the cross combination NIAB–T 159 x NIAB–T 103 may produce desirable recombinants with high yield potential.

Table 3. *Estimates of specific combining ability effects for plant height, number of spikelets per spike, number of grains per spike, fertility percentage and yield per plant in a 6 × 6 diallel set of triticale.*

Crosses	Specific combining ability effects				
	Plant height (cm)	Number of spikelets per spike	Number of grains per spike	Fertility percentage	Yield per plant
NIAB-T 157 × NIAB-T 158	−15.1670	− 1.5264	− 8.4456	− 8.8024	− 0.4767
NIAB-T 157 × NIAB-T 159	8.1170	− 1.1889	−13.5106	−14.6611	− 4.2879
NIAB-T 157 × NIAB-T 77	4.3518	2.6298	−10.6631	0.0364	7.3308
NIAB-T 157 × NIAB-T 103	20.5168	− 0.9214	8.9382	8.5026	2.2638
NIAB-T 157 × NIAB-T 163	− 0.2832	− 0.4252	2.0094	9.9014	4.7508
NIAB-T 158 × NIAB-T 159	1.0968	− 1.4914	− 8.8518	18.1149	− 1.5183
NIAB-T 158 × NIAB-T 77	− 6.9645	0.2573	6.8043	− 6.2174	0.5871
NIAB-T 158 × NIAB-T 103	15.8705	1.0361	0.4869	0.9889	7.2446
NIAB-T 158 × NIAB-T 163	−10.8695	3.2623	12.6682	0.2824	7.2071
NIAB-T 159 × NIAB-T 77	7.2855	0.6648	7.0007	4.8639	− 3.5352
NIAB-T 159 × NIAB-T 103	11.9205	2.5136	− 4.4381	14.7399	7.8133
NIAB-T 159 × NIAB-T 163	4.5805	2.4698	5.0732	− 3.4011	5.7158
NIAB-T 77 × NIAB-T 103	6.9793	− 1.9377	8.5994	− 4.9024	10.0621
NIAB-T 77 × NIAB-T 163	−10.8807	− 0.9814	2.8507	9.0964	2.1846
NIAB-T 103 × NIAB-T 163	8.6843	0.4073	− 1.5281	0.3626	− 5.9879
SE ($S_{ij}-S_{ik}$)	1.1736	0.8918	0.7264	0.4361	0.2982
SE ($S_{ij}-S_{kl}$)	1.0865	0.3628	0.6725	0.4039	0.2760

Table 4. *Components of variance for general and specific combining ability effects for plant height, number of grains per spike, fertility percentage and yield per plant in a 6 × 6 diallel set of triticale.*

Variance component	Plant height (cm)		Number of spikelets per spike		Number of grains per spike		Fertility percentage		Yield per plant (gm)	
	Component estimate	%age	Component estimate	%age	Component estimate	%age	Component estimate	%age	Component estimate	%age
$1/5\Sigma g_i^2$	75.1881	30.95	0.9509	21.29	12.3619	12.78	9.3760	6.34	1.1517	2.14
$1/15\Sigma\Sigma s_{ij}^2$	166.9666	68.73	3.4288	76.75	84.0443	86.91	138.3511	93.59	52.5908	97.77
σ^2	0.7870	0.32	0.0877	1.96	0.3015	0.31	0.1087	0.07	0.0508	0.09

Estimates of variance components for general and specific combining ability are given in Table 4. The contribution of various components in the total variance provides information on the significance of additive and non additive effects of genes involved for the expression of various traits. Additive gene action is desirable particularly in the self pollinated crops where exploitation of hybrid vigour is not generally commercially feasible while non additive gene action is important in the crops where hybrid vigour can be commercially exploited (Singh and Chaudhary, 1979).

The estimated specific combining ability variance was higher than the estimated general combining ability variance in case of plant height, number of spikelets per spike, number of grains per spike, fertility percentage and yield per plant indicating that these characters were predominantly controlled by non additive gene action in these hexaploid triticale strains. In hexaploid triticale hybrids Chowdhury and Singh (1978) also reported non additive gene action for number of grains per spike, 100-grain weight and grain yield. Non additive gene action seemed to be relatively more pronounced for all the characters in the present study.

The estimates of general and specific combining ability effects provide basis for selecting the parents for use in future breeding programme. Present investigations indicated that NIAB–T 158 and NIAB–T 103 may prove good parents in a triticale breeding programme, aiming at evolution of fertile, high yielding lines. However, the additive type of gene action observed for plant height, number of spikelets per spike, number of grains per spike, fertility percentage and yield per plant, warrants a careful planning and consequently the selection procedure to be adopted in the segregating generations to obtain the desired objectives.

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