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ESTIMATION OF GENE ACTION AND SELECTION OF SUITABLE PARENTS FOR BREEDING HIGH YIELDING WHEAT VARIETIES

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ABSTRACT

Wheat is an important cereal crop grown for grain throughout the world. The present study was conducted to determine the type of gene action for important economic traits in wheat viz; 1000 grains weight, peduncle length, extrusion length, number of spikelets per spike, days to heading, number of grains per spike, number of tillers per plant, grain yield, plant height and spike length. A (4×4) diallel cross experiment was conducted using genotypes i.e., Chakwal 50, PBW 343, Kohistan 97 and Millet 2011 in randomized complete block design. The analysis of variance revealed that the difference among genotypes for all traits were highly significant. The graphical representation of variance (Vr) and covariance (Wr) suggested that over dominance type of gene action was involved for most of the traits. The variety Kohistan 97 appeared as the best general combiner for all traits except days to heading, peduncle length and 100 grain weight whereas; the variety Millet 2011 and PBW 343 seemed to be good general combiner for peduncle length, 1000 grain weight and number of spikeletes per spike. Epistasis was absent for all the traits. The cross PBW 343 × Kohistan 97, Chakwal 50 × Kohistan 97 and Millet 2011 × PBW 343 appeared as the best specific combiners which showed that these crosses can be used for further selection.

Key words: gene action, diallel, over dominance, additive, covariance, combining ability

INTRODUCTION

Wheat is the most important cereal crop which is grown across the globe followed by rice [1]. Wheat is the most important staple food of about 2 billion people (36% of the world population). It contributes approximately 55% of carbohydrates and 20% of food calories consumed globally [2]. It is a major source of carbohydrates for human consumption. It also provides maximum amount of vitamins, calories and proteins for humans. Bread wheat grain is used to make flour and other baking products like cookies, cornflakes and cakes. Wheat straw is used in paper and hardboard industries and a large part of wheat straw is also used as animal feed. Various uses of wheat demand enhanced wheat production. Increasing world's population also intensifies the need of increased wheat production. The objective of breeders is to enhance the genetic potential in grain yield characters of wheat but it is difficult because grain yield is a polygenic trait which is governed by many traits. Three yield

MATERIALS AND METHODS

Four wheat genotypes viz Chakwal 50, PBW 343, Kohistan 97 and Millat 2011 were crossed in complete diallel fashion during 2014-15. All F₁ plants along with four parents were sown in a randomized

components (number of grains per spike, spike length and 1000 grain weight) determine the grain yield of wheat [3]. The diallel analysis is an authentic method for estimating gene action of polygenic characters. Various studies have been done so far to investigate the inheritance of yield related characters. Farooq *et al.*, [4] studied additive type of gene action for plant height and number of tillers per plant whereas; for 1000 grain weight over dominance type of gene actions was observed. Similarly, Chowdhry *et al.*, [5] observed various yield related characters of wheat and observed additive type of gene action with partial dominance. Bakhash *et al.* [6] also observed additive gene action with partial dominance for number of tillers per plant. Keeping in view the findings of previous researchers the present study was carried out to evaluate the gene action involved in the inheritance of various plant characters and to select parents and crosses having good general and specific combining ability using diallel method.

complete block design with three replications at the experimental area of the Department of Plant Breeding and Genetics, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan during 2015-16. Plant to

plant and row to row distance was maintained 6" and 9", respectively. All the recommended agronomic practices and plant protection measures were followed throughout the season [7]. Randomly selected five plants were taken from each replication for each genotype at the time of maturity. Data were recorded for following plant traits viz. plant height, days to heading, peduncle length, extrusion length, grain

RESULTS AND DISCUSSION

Analysis of variance showed high significant ($P \leq 0.01$) differences among 16 wheat genotypes for all the investigated traits i.e., days to heading, plant height, extrusion length, peduncle length, grain yield, number of tillers per plant, spike length, spikelets per spike, 1000-kernel weight and grains per spike (Table 1)

Plant Height

Plant height showed over dominance type of gene action because regression line cut-off point was located below the origin on W_r -axis. No epistatic effects were observed for this trait because regression line did not

yield, tillers per plant, spikelets per spike, grains per spike, 1000 grain weight and spike length.

Statistical Analysis: The data collected for all the parameters was subjected to analysis of variance as suggested by Steel *et al.*, [8]. Data of those parameters showing significant differences were further analyzed using diallel cross analysis technique advocated by Jinks [9] and Hayman [10].

diverge significantly from a unit slope. The genotype PBW 343 showed maximum number of dominant genes whereas; Millet 2011 possessed maximum number of recessive genes (Figure 1). Similar results were also observed by Kashif and Khaliq, [11]. Kohistan 97 showed maximum array mean value (83.45) for plant height and this genotype was observed as the best general combiner. Cross PBW 343 and Kohistan 97 exhibited maximum mean value (83.88) for plant height than the other examined cross combination, demonstrating best specific combining ability (Table 2).

Fig. 1: Plant Height (cm)

Days to Heading

Additive genetic effects with partial dominance type of gene action was observed for days to heading because regression line cut-off point for this character was located above the origin on the W_r -axis. Similar type of gene action was also observed by Subhani and Chowdary, [12] and Nazeer *et al.*, [13]. The genotype Millet 2011 showed higher number of dominant genes being nearest to the origin while PBW 343

exhibited minimum recessive genes being furthest from origin (Figure 2). The genotype Chakwal 50 showed maximum array mean value (94.46) for days to heading and this genotype was observed as the best general combiner among all parents. Cross between Chakwal 50 and PBW 343 showed highest value (94.83) for days to heading displayed best specific combining ability (Table 2).

Fig. 2 Days to Heading

Extrusion length

The regression line cut-off point for extrusion length was located below the origin on the W_r -axis, indicating that this character was governed by over dominance form of genetic effect. Non-allelic interaction was not present in this character because regression line did not diverge significantly from a unit slope. The distribution of array points on regression line showed that genotypes PBW 343 and Kohistan 97 possessed maximum number of dominant genes because PBW 343 was nearest to the origin and genotype Chakwal

50 showed maximum number recessive genes because it was farthest from the origin for this character (Figure 3).

The variety Kohistan 97 showed maximum array mean value (14.41) for extrusion length than other genotypes and this genotype was observed as the best general combiner and Cross PBW 343 and Kohistan 97 exhibited maximum mean value (15.25) for extrusion length than the other examined cross combinations, demonstrating best specific combining ability effects (Table 2).

Fig .3 Extrusion Length (cm)

Peduncle Length

The regression line cut-off point for peduncle length was located above the origin on the W_r -axis, indicating that this character was governed by additive form of genetic effects. Habib and Khan [14] also

showed such results for peduncle length. Maximum recessive genes for this trait were accounted by PBW 343 whereas; Millet 2011 possessed maximum genes (Figure 4). The variety Millet 2011 showed maximum array mean value (34.80) for peduncle

length and appeared as the best general combiner. Cross PBW 343 and Millet 2011 exhibited maximum mean value (34.72) for this trait demonstrating best specific combining ability effect (Table 2).

Number of Tillers per plant

The regression line cut-off point for tillers per plant was located below the origin on the V_r -axis, indicating that this character was

governed by over dominance. The results are according to the results Kashif and Khaliq (11) but outcome of Inamullah *et al.* (15) and Gurmani *et al.* (16) vary from these results. Moreover, the absence of inter-allelic interactions for character was confirmed by non-significant deviation of regression line from unit slope.

Fig.4: Peduncle Length (cm)

Fig.5: Number of tillers per plant

Array point's distribution on regression line showed that Chakwal 50 displayed higher number of dominant genes being nearest to the origin while PBW 343 showed minimum recessive genes being furthest from the origin (Figure 5). Kohistan 97 showed maximum array mean value (14.00) for tillers per plant than other genotypes and this genotype was observed as the best general combiner. Cross Chakwal 50 and Kohistan 97 exhibited maximum mean value

(13.83) for this trait than the other examined cross combinations, demonstrating better specific combining ability (Table 2).

Number of Grain per Spike

The trait number of grains per spike was governed by over dominance type of gene action. Inter-allelic interaction was found absent for this trait. Millat 2011 and Chakwal 50 possessed maximum number of dominant and recessive genes for this trait, respectively (Figure 6).

Fig.6 Grain per Spike

The variety Millet 2011 showed maximum array mean value (37.79) for number of grains per spike and appeared as the best general combiner and greater specific combining ability effect was represented by cross PBW 343 and Kohistan 97 having higher value (40.17) for this character (Table 2).

Spiklelets per Spike

The regression line cut-off point for number of spiklelets per spike was located above the origin on the W_r -axis, indicating that this character was governed by additive form of genetic effect. The results are according to results of Kashif and Khaliq, [11], Ali *et al.*, [17] and Nazeer *et al.*, [13]. Variety Millet

2011 showed maximum number of dominant genes because PBW 343 was nearest to the origin and Chakwal 50 the maximum recessive genes because it was found far from the origin (Figure 7). The variety PBW 343 showed maximum array mean value (12.46) for number of spikelets per spike than other genotypes and this

genotype was observed as the best general combiner and cross between Millet 2011 and PBW 343 showed maximum mean value (12.67) for this trait than the other examined cross combinations, demonstrating best specific combining ability (Table 2).

Fig.7 number of Spikelet

1000- Grain weight

This trait showed over dominance type of gene action. It was also observed that chakwal 50 possessed maximum number of dominant genes whereas; Millat 2011 maximum recessive genes (Figure 8). The variety PBW 343 possessed maximum array mean value (41.28) for 1000 grain weight and this genotype was observed as the best general combiner and cross Millet 2011 and

Kohistan 97 and cross Kohistan 97 and Chakwal 50 possessed the maximum value (43.22) showing the best specific combining ability (Table 2). Similar results were also observed by Gurmani *et al.*, [16] and Kashif and Khaliq, [11].

Fig 8 1000 grain wt.

Grain Yield per Plant

The regression line cut-off point for grain yield per plant was located above the origin on the W_r -axis, indicating that this character was governed by additive form of genetic effect (Figure 9). Similar type of gene action

was also observed by Farooq et al., (4) Inamullah *et al.*, (15). The variety Kohistan 97 appeared as the best general combiner and cross Millet 2011 and Chakwal 50 showed highest specific combining ability for this trait (Table 2).

Fig 9 grain yield per plant

Spike Length

Spike length showed over dominance type of gene action because regression line cut-off point for this trait was located below the origin on the W_r -axis. Chakwal 50 possessed maximum number of dominant genes for this traits whereas; Kohistan 97 possessed maximum recessive genes (Figure

10). Best general combiner for this trait was Kohistan 97 whereas; the cross Millet 2011 and Kohistan 97 exhibited maximum mean value (12.62) for this trait among all investigated crosses, demonstrating best specific combining ability (Table 2).

Fig. 10: for Spike length

Table 1: Mean squares values of studied traits in 4x4 diallel cross of *Triticum aestivum* L

SOV	D.F	PH	DTH	EXT	PED	T/P	GY/P	S/S	G/S	TGW	SL
Replications	2	2.09	0.39	1.20	0.67	1.18	3.11	0.14	2.08	0.06	0.46
Genotypes	15	233.04**	5.37**	20.15**	23.57**	5.59**	18.20**	6.46**	50.27**	27.97**	4.06**
Error	30	1.47	0.30	1.22	1.25	0.89	1.58	0.87	0.84	0.31	0.31

SOV=source of Variance d.f= Degree of freedom, PH= Plant Height, DTH=Days to Heading, EXT=Extrusion Length, PED= Peduncle Length, T/P=Number of tillers/plant, GY/P=Grain Yield/plant, S/S =Number of Spikelets/spike, G/S=Number of grain/spike, TGW=1000-grains weight, SL= Spike Length

Table 2. Diallel cross (4 × 4) for morphological traits in wheat

Traits	Genotypes	PBW 343	Kohistan 97	Chakwal 50	Millet 2011
Plant height	PBW 343	82.07	83.88	71.68	78.25
	Kohistan 97	83.88	91.63	75.43	82.83
	Chakwal 50	71.68	75.43	83.37	76.63
	Millet 2011	78.25	82.83	76.63	91.43
		78.97	83.45	76.78	82.29
Days to heading	PBW 343	90.33	92.67	94.83	92.67
	Kohistan 97	92.67	93.00	94.33	92.83
	Chakwal 50	94.83	94.33	94.33	94.33
	Millet 2011	92.67	92.83	94.33	92.33
		92.63	93.21	94.46	93.04
Days to maturity	PBW 343	126.00	129.83	128.00	126.33
	Kohistan 97	129.83	129.33	129.33	128.50
	Chakwal 50	128.00	129.33	128.67	129.33
	Millet 2011	126.33	128.50	129.33	125.33
		127.54	129.25	128.83	127.38
Peduncle length	PBW 343	28.70	29.02	31.65	34.72
	Kohistan 97	29.02	30.17	31.87	34.60
	Chakwal 50	31.65	31.87	33.70	34.10
	Millet 2011	34.72	34.60	34.10	35.80
		31.02	31.41	32.83	34.80
Grain yield/plant	PBW 343	16.95	20.51	17.42	19.85
	Kohistan 97	20.51	21.76	22.04	20.67
	Chakwal 50	17.42	22.04	23.12	21.68
	Millet 2011	19.85	20.67	21.68	20.43
		18.68	21.25	21.07	20.66

		PBW 343	Kohistan 97	Chakwal 50	Millet 2011
Number of spikelets/spike	PBW 343	12.67	12.00	12.50	12.67
	Kohistan 97	11.00	10.00	10.50	11.33
	Chakwal 50	12.50	10.50	13.33	12.33
	Millet 2011	12.67	11.33	12.33	12.00
		12.46	10.96	12.17	12.08
		PBW 343	Kohistan 97	Chakwal 50	Millet 2011
Number of grain/spike	PBW 343	39.67	40.17	32.17	38.83
	Kohistan 97	40.17	37.33	31.50	37.33
	Chakwal 50	32.17	31.50	41.33	32.33
	Millet 2011	38.83	37.33	32.33	42.67
		37.71	36.58	34.33	37.79
		PBW 343	Kohistan 97	Chakwal 50	Millet 2011
1000 grains weight	PBW 343	40.03	41.64	40.98	42.46
	Kohistan 97	41.64	36.86	43.22	43.22
	Chakwal 50	40.98	43.22	42.32	41.84
	Millet 2011	42.46	43.22	41.84	33.72
		41.28	41.23	42.09	40.31
		PBW 343	Kohistan 97	Chakwal 50	Millet 2011
Spike length	PBW 343	10.77	11.98	10.70	12.53
	Kohistan 97	11.98	9.00	12.40	12.62
	Chakwal 50	10.70	12.40	11.87	11.63
	Millet 2011	12.53	12.62	11.63	10.73
		12.53	12.62	11.65	11.88

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