Pak. J. Bot., 6 (2): 93—100, 1974.

ALPHA AND BETA INHERITANCE FOR YIELD AND YIELD COMPONENTS FROM A WHEAT DIALLEL CROSS.

BARKAT ALI SOOMRO
Sind Agriculture College
AND
ALI SWARWAR ABRO
Agriculture Research Institute, Tandojam, Pakistan.

Abstract

Associated alpha and beta inheritance was studied for number of spikelets per spike, 1000-kernel weight and yield per plant in a five-parent F2 diallel cross of common wheat. The results indicated that reciprocal differences for number of spikelets per spike were due to beta inheritance largely contributed by Khush-hal in maternal and Inia in paternal direction. 1000-kernel weight exhibited associated alpha inheritance only where Khush-hal was responsible for maternal and Marquis for highest paternal direction. The overall trend of alpha inheritance was in maternal direction. In case of yield per plant, alpha inheritance was absent, and therefore the reciprocal differences were ascribed to associated beta inheritance for which Inia and Chinook were the highest contributors, respectively, in maternal and paternal directions.

Introduction

Hayman's (1954a) analysis of variance of diallel tables provides general information regarding the presence of reciprocal differences. Significance of component 'c' in the analysis indicates significant reciprocal differences with respect to particular character under study. In that case, the conventional diallel analysis procedure of Hayman (1954 b & 1958), Jinks (1954 & 1956) and Mather & Jinks (1971) advocates the replacement of off-diagonal cells of the diallel table with the common mean of the relevant cross and its reciprocal, before the analysis for genetic compenents of variation is carried out.

The effect of reciprocal differences on the genetic compenents of variation has been reported by Soomro & Aksel (1974) where the complete diallel table was partitioned into two orthogonal and reciprocal subsets, one by keeping the female parent constant and male variable, and the other, by treating the male parent constant and female variable. In the present paper, the data on yield and yield components from a 5×5 wheat diallel (Soomro & Aksel 1974, and hereafter called prvious paper) has been analysed in the form of alpha and beta inheritance of Durrant (1965). Alpha inheritance may be described as the maternal or paternal effect of homozygotes or heterozygotes along their male or female arrays with respect to increase or decrease in reciprocal differences. On the other hand beta inheritance measures the deviation of reciprocal difference from the average dominance-deviation of a reciprocal hybrid. Beta may be plus or minus depicting thus maternal or paternal direction of inheritance. If it is zero, the inheritance is equilinear.

The purpose of the present investigations is to report the attribution of significant reciprocal differences towards male or female parent in a diallel table. The practical implication of such type of analysis may be reflected in the selection procedures where particular offending parent may be screened out in early stages of hybridization programme.

Materials and Methods

The parents used in the diallel table, the experimental layout and the characters studied were reported in previous paper. The reciprocal differences were tested through Hayman's (1954a) analysis of variance of diallel table (Table 2 of previous paper) where the significance of component "c" indicated significant reciprocal differences for all the characters studied. The diallel table of reciprocal differences (Table 2) obtained from Table 1, has been analysed for alpha and beta inheritance after Durrant's (1965) procedure.

Results and Discussion

The data for number of spikelets per spike, 1000-kernel weight and yield per plant in the form of 5×5 F_2 diallel table are presented in Table 1. Diallel table of reci-

TABLE 1. 5×5 complete F2 diallel talbe*

Female Parents	Male Parents (M)	(CH)	(K)	(C)	(I)	Array Total
	16.966	16.677	16.286	15.690	15.874	81.493
Marquis	36.833	37.552	38.221	37.107	38.290	188.003
(M)	26.248	22.839	27.166	22.621	25.358	124.232
	16.459	15.993	15.274	15.480	16.028	79.234
Chinook	37.641	37.406	39.375	37.364	37.835	189.621
(CH)	24.818	23.194	26.155	20.898	25.152	120.217
	15.410	15.224	14.292	15.518	14.634	75.078
Khush-hal	39.835	40.172	43.331	41.207	40.145	204.690
(K)	26.968	26.760	28.846	28.207	25.737	136.518
	15.388	14.691	13.992	14.448	15.594	74.113
Cinano	38.209	36.853	39.876	37.596	37.602	190.136
(C)	22.711	20.340	22.853	21.704	20.284	107.892
	15.785	15.672	14.188	14.784	13.869	74.298
Inia	39.077	37.793	39.280	38.135	38.329	192.614
(I)	22.628	23.445	22.371	23.280	19.995	111.719
	80.008	78.257	74.032	75.920	75.999	384.216
Array	191.595	189.776	200.083	191.409	192.201	965.064
total	123.373	116.578	127.391	116.710	116.526	600.578

The first, second and third reading under each column, respectively, represents number of spikelets per spike, 1000-kernel weight in grams and yield per plant in grams.

procal differences derived from Table 1 is given in Table 2. The second degree statistics in the form of variances and covariances, respectively for male and female arrays, are given in Table 3. The alpha and beta inheritance parameters thus calculated from tables 2 and 3 are presented in Table 4. In Table 4, P' represents the deviation of individual parent from their general mean, 'G' is the sum of reciprocal differences along an individual array, 'w'' stands for the difference between female and male array covariances and w' is the individual deviation of w's from their mean. 'a' denotes associated alpha inheritance while 'b' is associated beta inheritance. 'a'' and 'b'' stand for separated alpha and beta inheritance estimates for particular parents. By separated alpha and beta inheritance, it is meant that the correlated effect of 'b' on 'a' or vice versa has been removed to some extent.

TABLE 2. Diallel table of reciprocal differences.

	Marquis	Chinook	Khush-hal	Ciano	Inia
Marquis	..	0.218 —0.089 —1.979	0.876 —1.614 0.198	0.302 —1.102 —0.090	0.089 —0.787 2.730
Chinook	—0.218 0.089 1.979		0.050 —0.797 —0.605	0.789 0.511 0.558	0.356 0.042 1.707
Khush-hal	—0.876 1.614 —0.198	—0.050 0.797 0.605		1.526 1.331 5.354	0.446 0.865 3.366
Ciano	—0.302 1.120 0.090	—0.789 —0.511 —0.558	—1.526 —1.331 —5.354	..	0.810 —0.533 —2.996
Inia	—0.089 0.787 —2.730	—0.356 —0.042 —1.707	—0.446 —0.865 —3.366	—0.810 0.533 2.996	..

The parental 'b'' estimates (Table 4) for number of spikelets per spike indicated that Marquis, Chinook, Khush-hal and Ciano possessed beta inheritance in maternal while Inia in paternal direction. Khush-hall may be categorized as the maximum contributor of reciprocal differences and has greater dominance of beta inheritance in maternal direction. The whole situation is graphically expressed in Figure 1. The W♀/W♂ graph shows considerable deviations from the line of unit slope for Khush-hal and Inia in maternal and paternal directions respectively. These deviations may be attributed to either large 'random' reciprocal differences through out the diallel table or to associated beta inheritance. In the present case since rest of the parents do not significantly scatter around the line of unit slope (theoretical regression line), the chances of random reciprocal differences can be ruled out. This can also be supported from the analysis of variance

TABLE 3: Second degree statistics from 5x5 F_2 wheat diallel.

Character	Array	Vp	V♀	V♂	W♀	W♂	W♀-W♂ = w
Number of spikelets per spike	Marquis	3.4313	0.2849	0.4781	0.6282	0.8381	— 0.2099
	Chinook	0.7733	0.2228	0.5684	0.4415	0.7912	— 0.3497
	Khush-hal	0.6750	0.2801	0.1797	0.4121	0.2215	0.1906
	Ciano	0.4430	0.7385	0.2892	0.2258	0.4776	0.2518
	Inia	1.5490	0.4405	0.8466	1.0658	0.9589	0.1069
	Total	6.8716	1.9667	3.3617	2.7734	4.2873	— 0.5139
	Mean	1.3743	0.3933	0.6723	0.5546	0.8574	— 0.1028
1000-kernel weight	Marquis	3.4820	0.4238	1.3882	1.1664	2.2681	— 1.4635
	Chinook	1.6718	0.6938	1.6549	2.1424	3.2516	— 1.1092
	Khush-hal	21.4554	2.0578	3.7959	3.5325	4.9901	— 1.4576
	Ciano	1.2166	1.2992	2.8178	2.5939	4.4348	— 1.8408
	Inia	0.1369	0.4002	1.0025	0.9791	2.4813	— 1.5022
	Total	27.9627	4.8748	10.6593	10.4125	17.7859	— 7.3733
	Mean	5.5385	0.9750	2.1319	2.0825	3.5572	— 1.4746
Y eld per plant	Marquis	5.0652	4.1472	3.9500	4.7675	6.8101	— 2.0426
	Chinook	0.6455	4.2257	5.2442	3.8602	5.5488	— 1.6886
	Khush-hal	23.5089	1.5144	7.7988	3.8395	9.5102	— 5.6807
	Ciano	5.2597	1.5331	8.2120	3.6542	6.9835	— 3.3292
	Inia	16.0192	1.9291	8.4059	1.7851	8.7762	— 7.0111
	Total	50.4485	13.3433	33.6109	17.9065	37.6288	—17.7523
	Mean	10.0997	2.6687	6.7222	3.5813	7.5257	— 3.5504

Table 4. Estimates of alpha and beta inheritance parameters from 5x5 F_2 wheat diallel.

Character	Array	P'	G	(n-1)w	(n-1)w'	a	b	a'	b'
	Marquis	+1.8524	+1.485	—0.8396	—0.4285	+0.297	—0.2497	—0.0337	—0.0624
	Chinook	+0.8794	+0.977	—1.3988	—0.9877	+0.195	—0.1287	—0.0380	—0.1437
Number of spikelets	Khush-hall	—0.8216	+1.046	+0.7624	+1.1735	+0.209	+0.5595	+0.0250	—0.4113
per spike	Ciano	—0.6656	—1.807	—0.0072	—0.5961	—0.361	—1.7644	—0.0436	—0.0867
	Inia	—1.2446	—1.701	+0.4276	+0.8387	—0.340	+0.8043	+0.0241	+0.1221
	Total	0.0	0.0	—2.0556	0.0	0.0	—0.7790	0.0	0.0
	$\bar{b}$	—	—	—	—	+0.1514	—0.1558	—0.0256	
	Marquis	—1.8660	—3.592	—5.8540	+0.0446	—0.718	—0.3305	—0.1547	+0.0016
	Chinook	—1.2930	—0.155	—4.4368	+1.4618	—0.031	+0.0292	—0.0082	+0.0523
1000-kernel weight	Khush-hal	+4.6320	+4.607	—5.8304	+0.0682	+0.921	—0.1464	+0.1992	+0.0024
	Ciano	—1.1030	—1.273	—7.3632	—1.4646	—0.255	+0.1670	—0.0412	—0.0524
	Inia	—0.3700	+0.413	—6.0088	—0.1102	+0.083	—0.0518	+0.0181	+0.0039
	Total	0.0	0.0	—29.4932	0.0	0.0	—0.3324	0.0	0.0
	$\bar{b}$	—	—	—	—	+0.1265	—0.0665	+0.1609	
	Marquis	+2.2506	+0.859	—8.1704	+7.6314	+0.172	+0.2369	—0.0075	+0.1513
	Chinook	—0.8034	+3.639	—6.7544	+9.0474	+0.728	+0.3995	—0.0113	+0.1793
Yield per plant	Khush-hal	+4.4886	+9.127	—22.7228	—6.9210	+1.825	—0.6078	—0.6114	—0.1732
	Ciano	—2.2934	—8.818	—13.3168	+2.4850	—1.764	—0.1231	+0.2568	+0.0493
	Inia	—4.0024	—4.807	—28.0444	—12.2426	—0.961	—0.3673	+0.4205	—0.2427
	Total	0.0	0.0	—79.0088	0.0	0.0	—0.4618	0.0	0.0
	$\bar{b}$	—	—	—	—	+0.3927	—0.0924	—0.0974—	

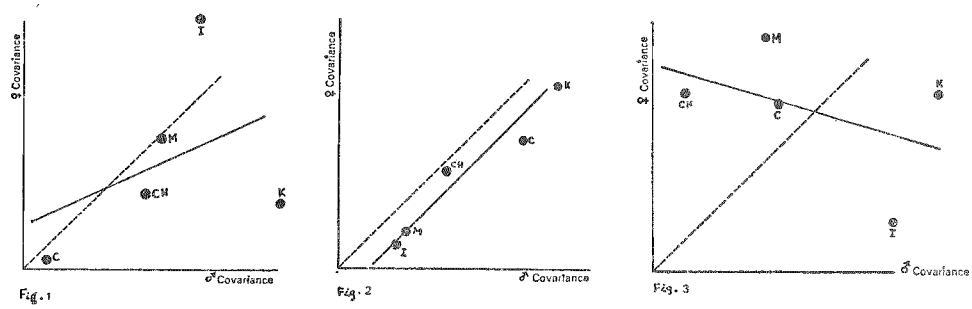
TABLE 5. Analysis of variance of alpha and beta inheritance estimates.

Character	Source of variation	D.F.	S.S.	M.S.
Number of spikelets per spike	(*a*) Alpha inheritance			
	Alpha ('c')	4	1.0413	0.2603
	Residual ('d')	6	1.3834	0.2306
	(*b*) Beta inheritance			
	Beta	5	2.3174	0.4635**
	Residual	5	0.1073	0.0215
	(*c*) Alpha + Beta	7	1.3029	0.7861
	a'	3	0.0142	0.0047
	b'	3	0.5985	0.1995
	$\overline{b}$	1	0.0450	0.0450
	Residual	3	1.1218	0.3739
	Total	10	2.4247	..
1000-kernel weight	(*a*) Alpha inheritance			
	Alpha ('c')	4	3.5942	0.8986*
	Residual	6	0.7587	0.1265
	(*b*) Beta inheritance			
	Beta	5	3.5314	0.7062
	Residual	5	0.8215	0.1643
	(*c*) Alpha + Beta	7	3.6699	0.5243
	a'	3	0.1644	0.0548
	b'	3	0.0969	0.0323
	$\overline{b}$	1	3.1975	3.1975*
	Residual	3	0.6830	0.2277
	Total	10	4.3529	.
Yield per plant	(*a*) Alpha inheritance			
	Alpha ('c')	4	19.8147	4.9537
	Residual	6	12.1749	2.0291
	(*b*) Beta inheritance			
	Beta	5	29.1401	5.8280*
	Residual	5	2.8495	0.5699
	(*c*) Alpha + Beta	7	23.2246	3.3178
	a'	3	1.5421	0.5140
	b'	3	5.7684	1.9228
	$\overline{b}$	1	4.7886	4.7886
	Residual	3	8.7650	2.9217
	Total	10	31.9896	.

Each component has been tested against its own residual mean-squares.
*Significant at 5% level.
**Significant at 1% level

of beta inheritance (b of Table 5). Since b is nonsignificant, therefore there is no evidence of any overall trend in maternal or paternal direction. Table 5 also shows that the mean squares for alpha inheritance (component 'c' of Hayman) are not significantly greater than residual alpha mean squares (component 'd' of Hayman) and therefore it may be assumed that alpha inheritance for number of spikelets per spike is absent. Respective parental 'a' values from Table 4 support this conclusion.

With respect to 1000-kernel weight, individual parental b' values may be seen from Table 4. They have been tested to be non-significant (Table 5) which is also supported by female covariance/male covariance graph (Figure 2). Moreover, estimates of 'b' also stand non-significant (Table 4 and 5) and therefore beta inheritance is absent. The mean squares for alpha inheritance (Table 5) were significant, indicating increased or decreased contributions of parental effects in reciprocal differences towards maternal or paternal direction. Khush-hal and Marquis exhibited highest maternal and paternal alpha inheritance respectively. Chinook and Inia indicated nonsignificant contribution while Ciano contributed paternal alpha inhertance, next to Marquis. The overall value of 'b' for alpha inheritance ($\bar{b} = 0.1265$) is significant and in maternal direction.



(Fig.1), Female covariance (W♀)/male covariance (W♂) graph for number of spikelets per spike (Fig. 2) 1000-kernel weight and (Fig. 3) yield per plant from five-parent F2 wheat diallel cross.

As far as yield per plant is concerned, the beta inheritance was highly significant (Table 5). Inia exhibited highest beta inheritance (b' $= -0.2427$) in maternal and Chinook (b' $= +0.1793$) in paternal direction, respectively. Marquis and Ciano followed Chinook in their ranking orders. Khush-hall ranked next highest to Inia in maternal beta inheritance. This situation is reflected by female covariance/male covaraince graph (Figure 3) where Kush-hal and Inia fall below the expected beta regression line of unit slope. Marquis, Chinook and Ciano occupy raised positions above the theoretical regression line and amongst them, Chinook, possessed maximum deviation from it and therefore was classified as the highest contributor of paternal beta inheritance. The overall beta inheritance value ($\bar{b} = 0.0974$) was very small and nonsignificant (Table 5) and hence the general trend of beta inheritance may be assumed to be equilinear. The alpha inheritance for yield was nonsignificant (Table 5) and therefore the reciprocal differences for this character can only be attributed to associated beta inhertiance.

References

Durrant, A. 1965. Analysis of reciprocal differences in diallel crosses. Heredity, **20**: 573-607.

Hayman, B. I. 1954a. Analysis of variances of diallel tables. Biometrics, **10**: 235-244.

Hayman, B. I. 1954b. Theory and analysis of diallel cresses I. Genetics, **39**: 789-809.

Hayman, B. I. 1958. Theory and analysis of diallel crosses II. Genetics, 43: 63-85.

Jinks, J. L. 1954. The analysis of continuous variation in diallel cross of *Nicotiana rustica* varieties. Genetics, **39**: 767-788.

Jinks, J. L. 1956. The F2 and backcross generations from a set of diallel crosses. Heredity, **10**: 1-30.

Mather, K. and J.L. Jinks. 1971. Biometrical genetics. Second edition. Chapman and Hall Ltd., London. pp. 382.

Soomro, B. A. and R. Aksel. 1974. The eflect of reciprocal differencess on the genetic components of variation in a five-parent diallel cross of common wheat (*Triticum aestivum* L.). Pak. Jour. Bot., 6 : 1-14.