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A FIVE PARENTAL DIALLEL ANALYSIS OF SOME QUANTITATIVE CHARACTERS IN WHEAT (TRITICUM AESTIVUM. L)

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Graphical analysis and the analysis of the components of variance were made in a 5×5 diallel cross in wheat. Additive gene effects were more important for all the traits baring grain yield per plant. Over dominance was observed for grain yield while for all other traits i. e. plant height, tillers/plant, spikelets/spike, grains/-spike and 100 kernel weight, partial dominance was revealed. Dominant alleles were more frequent in parents for all characters except number of tillers per plant and plant height. Utilization of parental varieties for improvement of economic characters have been discussed.

INTRODUCTION

The introduction of short statured, fertilizer responsive and disease resistant varieties since 1965 has considerably increased production per unit area. In order to maintain/ensure the attained production level, and further improve it, the evolution of new genotypes by continued genetic manipulation is the need of the country. There is still a lot of genetic diversity existing in spring wheat varieties which can be further exploited to tailor new genotypes adaptable to varying agro-climatic conditions. But before such a variability is made use of, it is imperative to determine genetical parameters, especially gene action of compexly inherited traits.

The diallel analysis technique developed and advocated by Hayman(1954) and Jinks (1954) has most commonly been used in autogamous crops like wheat to ascertain the genetic mechanism controlling quantitative traits in wheat. The plant breeder equipped whth such an information can operato selection pressure right in the F1 generation. The results published by several workers on the nature of gene action in wheat have advocated that plant height, yield and some of its components are mostly conditioned by loci with additive effects

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with varying degrees of dominance. Nevertheless some workers proclaimed over dominance type of genetic mechanism operating for yield in wheat. In the present studies, two aspects of diallel analysis viz. the graphical analysis and analysis of the components of variance have been reported to determine the mode of gene effects and estimates of the degree of dominance and the proportion of dominant and recessive genes.

MATERIALS AND METHODS

A diallel set (excluding reciprocals) was made crossing 5 wheat varieties during 1979 at Wheat Research Institute, Faisalabad. The details of varieties used for the experiment are tabulated below:

S. No.	Variety	Origin	Cross
1.	SA – 42	Pakistan	C2712 – LR64
2.	SA – 75	Pakistan	(Nai – CB151xS948)MXP
3.	Blue Silver	Mexico	II – 54 – 338 – AX(Yt54 – NIOBxLR)
4.	V – 1369	Pakistan	23584 – 15 – 13 – 5xSon64
5.	V – 1413	Mexico	Nort – 7C

During 1979-80, all the 5 parents and 10 crosses were space-planted at the rate of 16 plants per rod row spaced at 30 cm apart. Within each row a distance of 15 cm was maintained between plants. Experiment was planted using randomized complete block design where each treatment was replicated four times. At maturity 10 guarded plants were measured for plant height (cm), number of tillers per plant, number of spikelets per spike, number of kernels per spike, 100 grain weight (gm).

The plot means were used for statistical analysis of various genetical parameters as given in detail by Hayman (1954) and Jinks (1954) and Vr/Wr graphs were constructed by using estimates of different variances and covariances.

RESULTS AND DISCUSSION

Graphic Analysis

The variance-covariance (Vr-Wr) graphs for different characteristics are presented in figures 1-6. The regression line with slope did not differ significantly from unity for all characters (plant height, number of spikelets per spike, number of kernels per spike, 100 kernel weight and yield per plant) except number of tillers per plant. This indicated that non allelic interactions were only operative in genes conditioning number of tillers per plant while for rest of the traits there was no evidence of presence of such effects.

Plant Height

The line of regression intercepted the Wr axis above the origin indicating partial dominance with additive gene effects. Our finding is in close agreement with that of Nanda *et al.* (1974), Paroda (1974), Khalid *et al.* (1976) and Hussain (1978). The array points for the parents SA-42, SA-75 and Blue Silver were situated farthest from the origin, hence possessed most of the recessive alleles. On the other hand, V-1369 being nearer to the origin possessed mostly the dominant genes, V-1413 had almost equal proportion of both dominant and recessive alleles. In view of the results SA-42, SA-75 and Blue Silver can be useful for developing semi-dwarf, fertilizer responsive short statured varieties.

Tillers Per Plant

The unit slope of regression line intercepted the axis above the origin (Fig-2) indicating partial dominance.

The regression line differed significantly from the unit slope indicating presence of epistasis gene effects. However, the magnitude of additive gene effects was higher than non additive effects as revealed by component analysis. The line intercepted the Wr axis above the origin showing partial dominance. The distribution of array points revealed that Blue Silver possessed more dominant and V-1369 more recessive alleles, respectively. SA-75 had almost equal proportion of dominant and recessive alleles for the trait.

Studies made by several workers, Hsu and Walton (1969), Khalid *et al.* (1976), Shah *et al.* (1972), and Chaudhry and Azhar (1977) have shown that this trait in wheat is mostly governed by the additive gene effects, hence our findings are almost in agreement with previous workers. However, due to involvement of epistatic gene action, care should be taken while making selection in hybrid progenies.

Spikelets Per Spike

The regression co-efficient 1.15 ± 0.12 did not differ significantly from unit slope which suggested absence of non-allelic interactions (Fig-3). These

PLANT HEIGHT

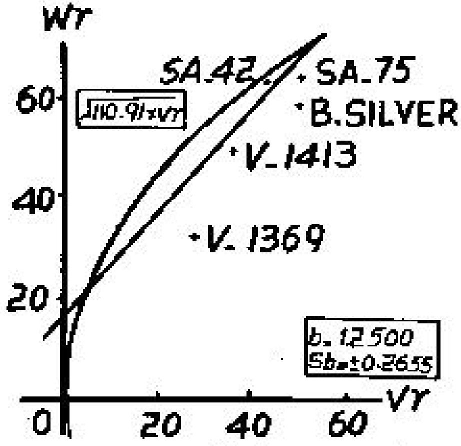

FIG. 1

TILLERS PER PLANT

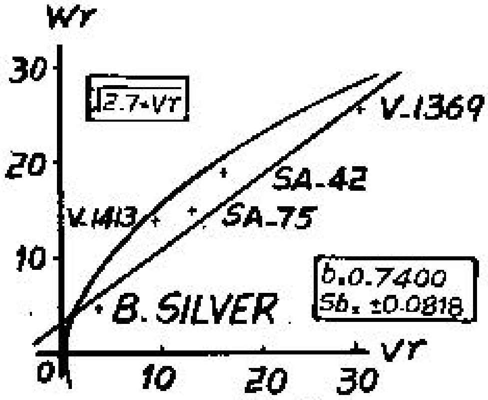

FIG. 2

SPIKELETS PER SPIKE

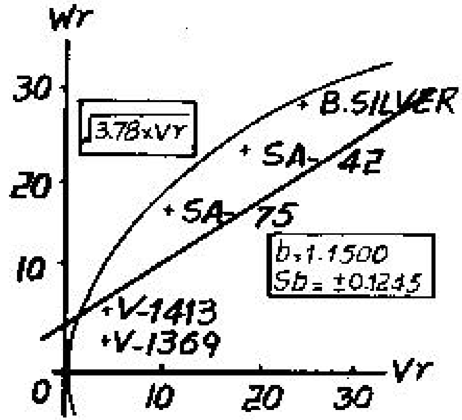

FIG. 3

GRAINS PER SPIKE

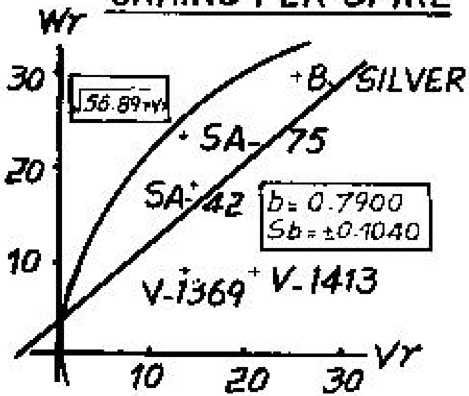

FIG. 4

100 GRAIN WEIGHT

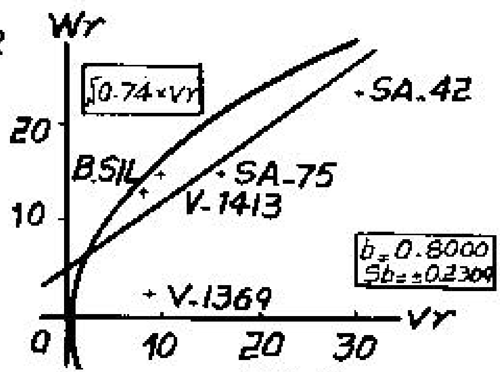

FIG. 5

YIELD PER PLANT

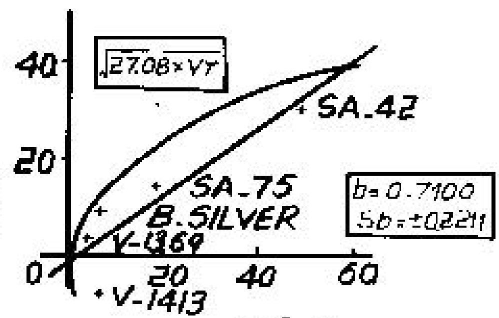

FIG. 6

findings are in agreement with other workers, Hsu and Walton (1969), Chapman and Mc Neal (1971) and Hussain (1978).

The regression line being above the origin revealed partial dominance. V-1413 and V-1369 had more dominant alleles while Blue Silver had more of the recessive allelomorphs, and SA-75 almost equal proportion of both.

Kernels Per Spike

The position of regression line on Vr-Wr graph (Fig-4) showed no evidence of non-allelic interaction with some degree of dominance. Similar gene effects have been reported by Whitehouse *et al.* (1958), Chaudhry *et al.* (1975) and Chaudhry and Azhar (1977) for this trait. The distribution of array points revealed that varieties V-1369 and V-1413 had more of the dominant alleles, Blue Silver more of the recessive alleles and SA-42 almost equal proportion of both. More environmental effects also seem to be operating. However, varieties 1369 and 1413 can be exploited for making improvement in this trait.

100 Kernel Weight

The regression line (Fig-5) is not significantly different from unity and passed above the origin indicating absence of non allelic interaction with partial dominance. Paroda (1974), Chaudhry *et al.* (1975), Chaudhry and Azhar (1977) and Hussain (1978) have also suggested similar gene effects in wheat. The scatter of array points indicated preponderance of dominant and recessive alleles in parents V-1369 and SA-42, respectively. While SA-75 and Blue Silver possessed equal proportion of dominant and recessive alleles. In view of the results, selections for higher grain weight can be made effectively by use of parental varieties V-1369 and V-1413.

Yield per plant

The regression line did not differ significantly from unity suggesting, that non additive gene effects were absent. Whitehouse *et al.* (1958), Hsu and Walton (1969), Shah *et al.* (1972), Virk and Aulakh (1975) and Hussain (1978) also reported similar results for this trait.

The regression line intercepted the Wr axis below the origin showing over dominance. The array points of parental varieties V-1413 and V-1369 showed preponderance of dominant alleles, while SA-42 of recessive alleles for this complex trait of yield. Blue Silver and SA-75 seemed to have almost equal proportion of both dominant and recessive alleles. Because yield is a complexly inherted trait, with over dominance, the selection for higher yield in early generations may be exercised with great caution.

Component Analysis

The additive (D) and dominance components (H_1) of variance were significant for all the characters, except grains/spike where variance component due to dominance was non significant. Baring grain yield/plant, the variance due to D was higher than H_1 indicating that additive gene effects were more important. Consequently in view of this and higher heritability values, selection could be operated with fair degree of success for all other characters except yield.

The values for dominance, components of variance H_2 which measures proprotion of dominance variance due to positive and negative gene effects were highly significant for all the traits except grains/spike.

The estimates of F were only significant for number of tillers per plant. The negative values in case of plant height and number of tillers/plant suggested excess of recessive alleles. While in other traits positive F value revealed excess of dominant alleles.

The variance of $(H_1/D)^{0.5}$ which estimates degree of dominance, suggested that it was partial for plant height, tillers/plant, spikelets/spike and grains/spike and complete for 100 grain weight while over dominance for grain yield/plant. The degree of dominance revealed by graphic analysis is similar except in case of 100 grain weight. This consistency can be explained on the grounds that the estimates obtained through the formula $(H_1/D)^{0.5}$ at the best give an approximate value of the degree of dominance in real sense (Sharma and Ahmed, 1979).

The ratio $(4DH_1)^{0.5} + F/(4DH_1)^{0.5} - F$ which gives the relative estimate of dominant and recessive alleles in the parents was lesser than unity in plant height and tillers/plant indicating the excess of recessive alleles in the parents. The estimate was higher than unity in all other traits, suggesting high proportion of dominant alleles in the populations.

Table 1. *Estimates of genetic component of variance for different characters*

Components	Plant height	Tillers/Plant	Spikelets/Spike	Grains/Spike	100 Grain weight	Grain yield/Plan
D	102.97 ± 4.03**	2.34 ± 0.22**	3.63 ± 0.19**	54.76 ± 7.21**	0.72 ± 0.11**	24.48 ± 6.71**
H_1	44.75 ± 10.89**	2.2 ± 0.59**	1.35 ± 0.51**	26.75 ± 19.48	0.73 ± 0.29**	47.92 ± 18.17**
H_2	36.12 ± 9.88**	2.0 ± 0.54**	1.38 ± 0.46**	19.22 ± 17.67	0.88 ± 0.27**	38.48 ± 16.44*
F	-10.67 ± 10.08	$-1.23 \pm .42$*	0.66 ± 0.47	30.06 ± 18.02	0.06 ± 0.12	9.36 ± 16.77
h_2	21.21 ± 6.67**	1.03 ± 0.36**	1.26 ± 0.32**	13.56 ± 11.92	0.59 ± 0.18	31.3 ± 11.09**
$(H_1/D)^{0.5}$	0.656	0.969	0.609	0.698	1.007	1.39
$(H_2/4H_1)$	0.204	0.227	0.255	1.179	0.301	0.201
$[(4DH_1)^{0.5}+F]$ / $[(4DH_1)^{0.5}-F]$	0.854	0.574	1.795	2.293	2.55	3.185
h_2/H_2	0.587	0.515	0.913	0.706	0.67	0.813
H_1-H_2	8.23	0.2	−0.03	7.53	−0.15	9.44
Heritability (%)	83	53	75	85	51	53

$H_2/4H_1$ estimate which is a measure of symmetry of allelic distribution suggested that there were unequal frequencies of dominant and recessive alleles at all loci for height, grains/spike and yield while for all other traits the positive and negative heterozygotes were almost in equal proportion. The difference of $H_1 - H_2$ supported the asymmetry of positive and negative genes in parents, as the estimate of $H_1 - H_2$ were far from zero. From amongst yield components, the highest heritability was shown for grains/spike (85%) and was followed by plant height (83%) and spikelets/spike (75%). This estimate was modest for tillers per plant, 100 grain weight and yield per plant. Low to medium heritability for yield and high for components of yield had been reported by Fonseca and Patterson (1968) and Lebsock and Arnoldo (1969).

In light of the available information with regard to type of gene action and presence of allelomorphs in different parents meaningful hybridization programms can be outlined for improving economic traits. For example, the plant height is controlled by recessive genes and by exploiting parents like SA-42, SA-75 and Blue Silver semidwarf fertilizer responsive varieties can be developed. Both the analysis of variance and graphic analysis has in general indicated diversification in parents for all the traits. Crosses between these parents can be used for recovering heterotic effects for yield and some of its components like grains/spike and 100 kernel weight. Some combinations may yield potential hybrids which may produce higher frequency of desirable plants in segregating generations. However, in view of the over dominance gene action shown in case of yield, care should be taken in selection.

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