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SOME GENETIC STUDIES ON CHARACTERS INVOLVED IN DROUGHT RESISTANCE IN WHEAT.

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Five wheat varieties, i.e., LU26S, C 518, Lyp 73, Blue Silver and Sandal were used in a diallel cross analysis for the following characters; germination, coleoptile length, number of tillers per plant, number of stomata and grain yield. Both additive and non-additive genetic effects were present which indicated that the observed differences among genotypes could be incorporated into more productive varieties by suitable breeding methods.

INTRODUCTION

Wheat, the staple food of Pakistan, is grown annually on an area ranging arround 17.56 million acres; of which, about 1/3rd is rainfed, perpetually falling outside the pale of canal irrigation. The rainfall during the growing period of the crop from November to April is very low, imposing a serious soil moisture stress, especially in areas where canal irrigation is either arratic or lacking altogether. Since the crop matures under ascending temperature regimes it often ends up in reduced yields due to poor grain filling.

To get around such constraints, plant breeders prefer to provide a built in resistance in their improved commercial varieties against soil and atmospheric drought. Varieties tailor-made to economize on water use will not only do well in canal colonies, but also can lead to more prodnctivity in semiarid regions of Pakistan. Possible solutions for dry environment plant growth problems lie in identifying genetic attributes closely associated with complex phenomenon of drought resistance and their use in developing new genotypes capable of stable performance in stressful conditions obtaining in drought-stricken areas of Pakistan.

The diallel analysis developed by Hayman (1954), Jinks (1954) and Whitehouse *et al.*(1958) provides a handy technique for a quantitative analysis of

plant characters. In the present studies were so analysed the following character to ascertain the types of genetic effects controlling their phenotypic behaviour.

1. Germination.
2. Coleoptile length.
3. Number of tillers per plant.
4. Number of stomata
5. Grain yield per plant.

The available literature present substantial information on the genetic behaviour of various wheat characteristics of agronomic importance. The studies of Walton (1971), Shah and Khan (1971), Rehman *et al* (1975), Singh and Singh (1976), Srivastava *et al* (1981), Bhullar *et al* (1982), Verma *et al* (1984) on plant attributes like height, flag leaf (length and breadth) other leaves, grain yield and yield components indicated the presence of both additive and non-additive genetic effects in inheritance of these characteristics. Barring plant height and similar other characters, additive genetic effects appeared to contribute to a much greater extent to the variability exhibited by the various characters analyzed in these studies. Nonadditive effects were also present but their contribution wasrelatively small and dispensable. The present results would add further information to the relevant literature as well as give useful hints on how more effectively can this information be utilized toward a further improvement of the material in hand.

MATERIAL AND METHODS

The present studies were conducted in the Department of Plant Breeding and Genetics, Uuiversity of Agriculture, Faisalabad, during 1984-86. The material consisted of five wheat varieties, LU26S, C 518, Lyp 73 Blue Silver and Sandal which were crossed in a diallel fashion during 1984-85. The F_1 seeds obtained from these crosses were sown in the field as also in steel germination trays in the greenhouse the following year.

The F_1s, their reciprocals and the parents were spaceplanted in the field in a randomized complete block design with three replications, assigning them at random to experimental units in the single-row plots containing 15 plants per row. The row-to-row and plant-to-plant distance was 30 cm and 15 cm respectively. All necessary precautions were taken to provide a uniform environin the experiment.

Ten guarded plants were randomly picked and studied from each cross and replication. The data were recorded on the following characters.

1. Germination.
2. Coleoptile length.
3. Number of tillers per plant.
4. Number of stomata.
5. Grain yield per plant.

Germination

Counts for germination were started ten days after sowing and emergence was recorded for ten consecutive days. Per cent germination was calculated.

Coleoptile length

For coleoptile length measurements, the seeds were dibbled in rows in a 4-inch deep sand filled germination tray of 16" x 24" size. Row-to-row and plant-to-plant distance was kept at two and one inch, respectively. The seedlings were uprooted carefully on the tenth day of the planting and the coleoptile length measured in centimeters. The trays were kept moist during the germination period.

Number of tillers per plant

Spike bearing tillers of each selected plant were counted and recorded at maturity.

Number of stomata

The stomatal counts per unit area were recorded on the upper surface of the second nodal leaf of the mother shoot of each plant in a treatment (genotype) The leaf strip was dipped into Carnoy's solution to arrest stomatal movement and to remove chlorophyll. The sample was then examined under the microscope in glycerine and the stomata were counted. Low power microcope field was used as unit of area for counting stomato.

Grain yield per plant

The yield per plant was calculated in each genotype by using the following formula :

$$\text{Grain yield per plant} = \frac{\text{Weight of grains per plot}}{\text{Number of plants per plot}}$$

The data in respect of germination percentage, coleoptile length, number

of tillers per plant, number of stomata, and grain yield per plant were subjected to statistical analysis. Where the differences were significant, the data were subjected to diallel analysis as described by Hayman and Jinks (1954).

RESULTS AND DISCUSSION

Germination

Analysis of variance showed that the differences among various genotypes with respect to average germination percentage were highly significant.

Graphic representation of Vr/Wr (Fig. 1) suggested that additive genetic effects with partial dominance contributed to the variability expressed for germination. Regression line deviated significantly from a unit slope, which suggested that non-allelic interaction was also involved.

The order of array points on the regression line indicated that C 518 and Sandal carried most of the dominant and recessive genes, respectively. C 518 with an array mean of 92.66 (Table 1) appeared to have relatively high general combining ability.

Table 1. 5 x 5 *diallel Average germination percentage.*

	Blue Silver	Sandal	LU26S	Lyp-73	C-518
Blue silver	95.00	76.99	78.33	84.16	85.83
Sandal	76.99	68.33	85.83	80.00	87.50
LU26S	78.33	85.83	98.33	95.00	95.83
Lyp-73	84.16	80.00	95.00	95.00	94.17
C-518	85.83	87.50	95.83	94.17	100.00
Total	420.31	398.65	453.32	448.33	463.33
Array means	84.06	79.73	90.66	89.66	92.66

Coleoptile length

A reference to Fig. 2 would reveal that regression line passed through the origin signifying full dominance for this character. As the regression line deviated significantly from a unit slope, non-allelic interaction was also present.

From the position of array points on the regression line it appeared that C 518, being closer to the origin, possessed a maximum number of dominant genes while Lyp 73, being away from the origin, had the most recessive ones. Moreover, variety C 518 with the highest array mean, (4.59), showed good general combingability (Table 2).

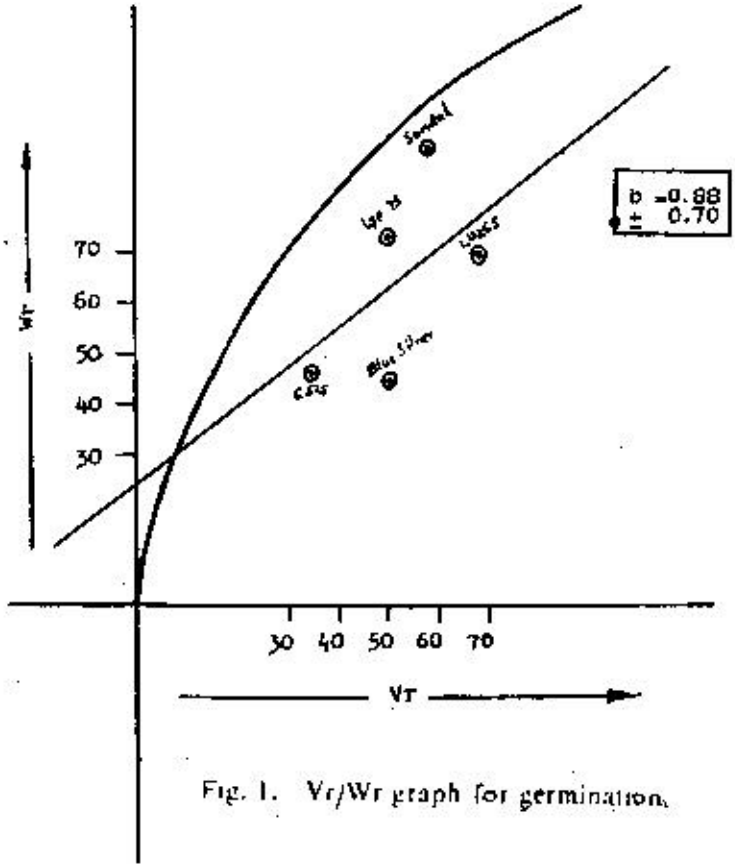

Fig. 1. Vr/Wr graph for germination.

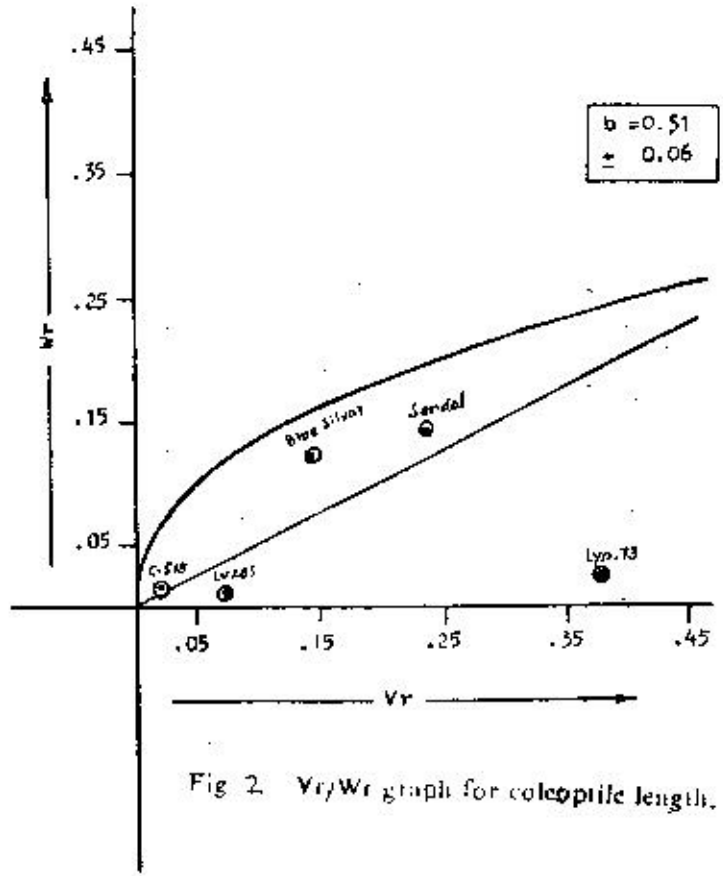

Fig 2. Vr/Wr graph for coleoptile length.

Table 2. 5 x 5 *diallel Average coleoptile length (cm)*

	Blue Silver	Sandal	LU26S	Lyp-73	C-518
Blue silver	4.30	3.76	3.75	3.78	4.57
Sandal	3.76	4.30	3.94	3.33	4.58
LU26S	3.75	3.94	4.25	3.53	3.85
Lyp-73	3.78	3.33	3.53	4.19	4.87
C-518	4.57	4.58	3.85	4.87	5.09
Total	20.16	19.91	19.32	19.70	22.96
Array means	4.03	3.98	3.86	3.94	4.59

Number of tillers per plant

Fig. 3 showed the regression line intercepted the Wr axis above the origin signifying additive type of gene action. It makes a tangent with the parabola which hints at the presence of some dominance also for this character. The regression line deviated significantly from the unit slope, which was an indication of interaction of non-allelic genes.

From the array points on the regression line, it was clear that C518, being nearer to the origin, possessed the most dominant genes, while Lyp 73, being away from the origin, had the most recessive genes. The highest array mean (18.26) showed that C518 (Table 3) was the best general combiner among the lot.

Table 3. 5 x 5 *diallel Average number of tillers per plant.*

	Blue Silver	Sandal	LU26S	Lyp-73	C-518
Blue Silver	17.13	15.47	14.07	15.14	17.71
Sandal	15.47	14.47	13.86	16.67	18.28
LU26S	14.07	13.86	15.43	14.62	17.97
Lyp-73	15.14	16.67	14.62	17.13	19.83
C-518	17.71	18.28	17.97	18.83	17.53
Total	79.52	78.75	75.95	83.39	91.32
Array means	15.90	15.75	15.19	16.68	18.26

Number of stomata

Fig. 4 revealed that the regression line cut the Wr axis below the origin,

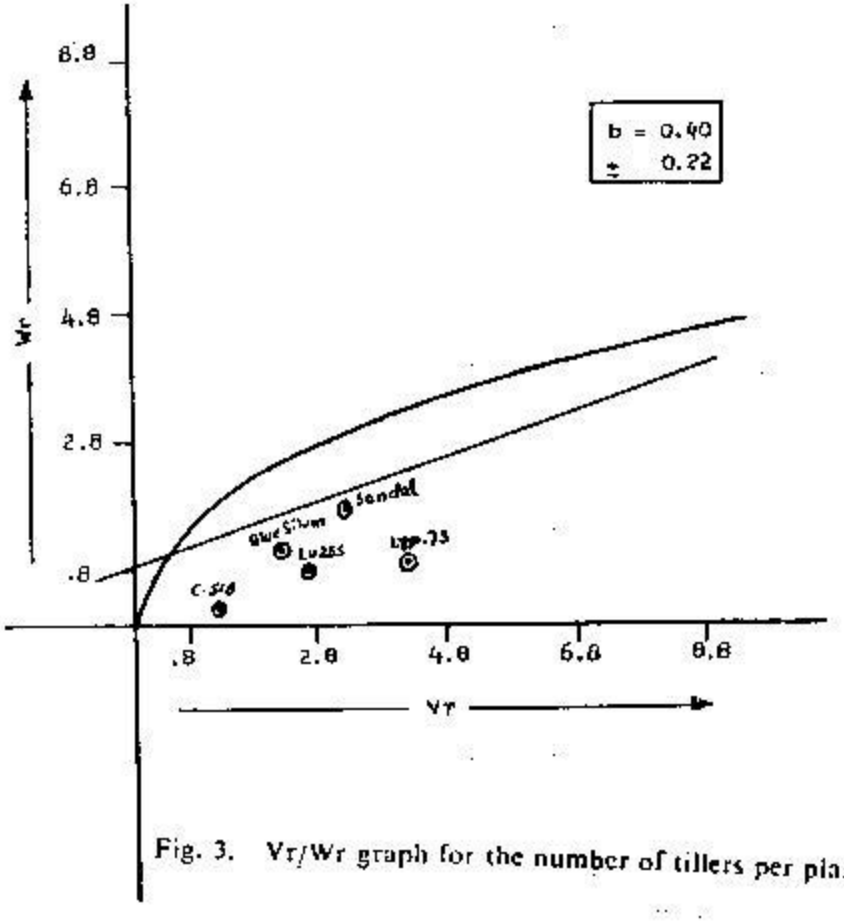

Fig. 3. Vr/Wr graph for the number of tillers per plant.

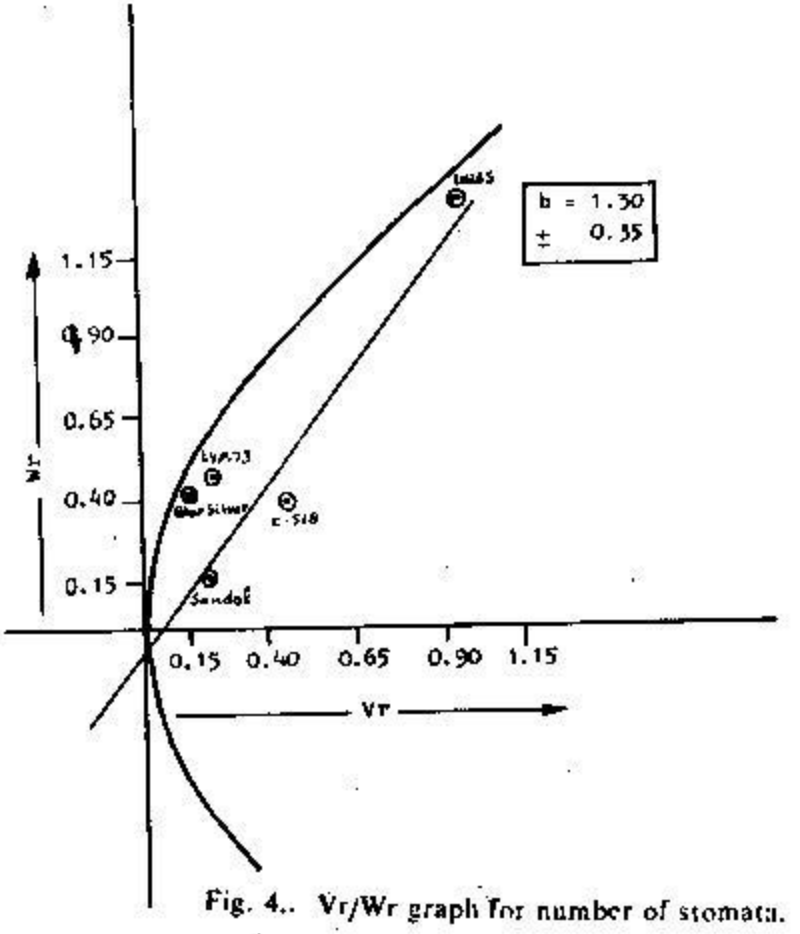

Fig. 4.. Vr/Wr graph for number of stomata.

which signified the overdominance type of gene action. The regression line deviated significantly from the unit slope, indicating the presence of non-allelic interaction for the expression of this character.

Location of varieties on the regression line showd that Sandal contained the maximum dominant genes while LU26S had the most recessive genes.

Table 4 also revealed that LU26S had the highest array mean of 6.47 indicating a better general combining ability.

Table 4. 5 x 5 *diallel Average number of stomata*

	Blue Silver	Sandal	LU26S	Lyp-73	C-518
Blue Silver	6.63	6.38	6.52	5.97	5.67
Sandal	6.38	5.47	6.50	6.77	6.27
LU26S	6.52	6.50	8,20	5.70	5.47
Lyp-73	5.97	6.77	5.70	5.33	5.60
C-518	5.67	6.27	5.47	5.60	4.20
Total	31.17	31.39	32.39	29.37	27.21
Array means	6.23	6.27	6.47	5.87	5.44

Yield per plant

A perusal of Fig. 5 would indicate that the regression line cut the Wr axis on the negative side, showing over-dominance type of gene action. The regression line deviated significantly from the unit slope which meant the presence of epistatic effects also.

Distribution of array points on the regression line (Fig. 5) suggested that variety Blue Silver had the maximum dominant genes and variety C 518 the least of them.

Again a perusal of Table 5 would indicate that variety Lyp 73 with its array mean of 50.76 gm was the best general combiner for yield.

The results of this study indicated that the inheritance of the plant characters under reference was conditioned by both additive and nonadditive genetic effects. The presence of additive genetic effects could be exploited for further improvement of these populations. Of the test entries, C 518 and LU26S appeared to be good general combiners and could be further used in crosses with advantage.

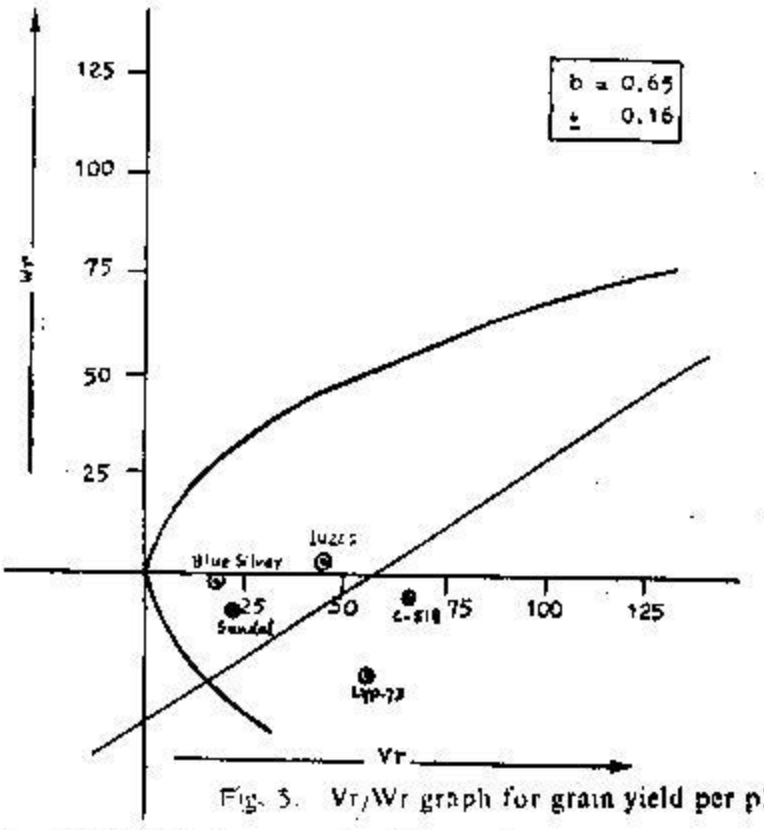

Fig. 3. Vr/Wr graph for grain yield per plant.

Table 5. 5 x 5 *diallel Average grain yield per plant.*

	Blue Silver	Sandal	LU26S	Lyp-73	C-518
Blue Silver	47.97	44.25	34.59	46.19	40.50
Sandal	44.25	54.57	42.13	44.72	51.89
LU26S	34.59	42.13	56.53	41.57	48.48
Lyp-73	46.19	44.72	42.57	57.30	63.02
C-518	40.50	51.89	48.48	63.02	37.77
Total	213.50	237.56	224.30	253.80	241.66
Array means	42.70	47.51	44.86	50.76	48.33

REFERENCES

Bhullar, G.S., Ranvir Singh and K. S. Gill. 1982. Genetic architecture of grain yield and certain other traits in durum wheat. Crop. Improvement, 4 (1): 54-59.

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

Jinks, J. L. 1954. The analysis of continuous variation in diallel crosses of *Nicotina rustica* varieties. Genetics, 39 : 767-786.

Rehman, C. A., K. P. Sinolinding and M. A. Khan. 1975. Diallel analysis of yield and component of yield in wheat under irrigated and moisture stress Pak. J. Agric. Sci., 7 (1-2) : 1-16.

Shah, S. D. and M. A. Khan. 1971. Genetic analysis of yield and its components in wheat. Pak. J. Agric. Sci., VIII (3-4) : 69-61.

Singh, S. and R. B. Singh. 1976. Triplet Test Cross analysis in two wheat crosses Heredity, 37 (2) : 173-177.

Srivastava, R. B., O. P. Luthra, D. Singh and K. C. Goyal, 1981. Genetic architecture of yield, harvest index and related traits in wheat. Cereal Res. Communication, 9 (1) : 31-37. (Pl. Br. Abst., 52 (2) : 1076; 1982).

Verma, P. K., O. P. Luthra, R. S. Paroda and G. D. Sharma. 1984. Genetics of yield and its component chaeacters in durum wheat. Cereal Research Communication, 12 (3/4) : 179-185. (Pl. Br. Abst., 55 (5) : 3217; 1985).

Walton, P. D. 1971. The genetics of yield in spring wheat (*Triticum aestivum* L.) Can. J. Genet. Cytol., 13 (1) : 110-114.

Whitehouse, R. N. H., J. B. Thompson and M. A. N. Ribeiro. 1958. Studies on the breeding of self pollinated cereals. II. The use of diallel cross analysis in yield prediction. Euphytica, 7 : 147-169.