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DIALLEL ANALYSIS OF SOME AGRONOMIC CHARACTERS OF RICE (*Oryza sativa* L.) PLANT UNDER TWO SPACINGS

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ABSTRACT

A 5 x 5 diallel cross experiment on rice (*Oryza sativa* L.) for genetic analysis under two spacing conditions was conducted in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. Genetic estimation for plant height, number of tillers per plant, number of grains per panicle and yield of grain per plant appeared to be additive and for number of panicles it was the case of complete dominance. No change in the gene action was noticed with the change in spacing except a little in the position of array points on the regression line.

INTRODUCTION

In addition to its importance as a food crop in Pakistan, rice is a substantial source of foreign exchange as well. Pakistan has got the monoply of growing world famous fine aromatic Basmati rice. It has fine grain and excellent cooking quality. But the varieties, for instance Bamati-370 and Basmati-Pak, producing such a good quality rice are tall and can not withstand heavy fertilization, hence, their per unit area yield is low. They are late maturing too, thus affecting the wheat crop which follows the rice crop in rotation in the rice growing tract. Keeping these facts in view the solution seems to lie in the synthesis of a short statured, well adapted genotype of Basmati possessing harmonious combination for better quality, higher yield on a unit area basis, along with response to fertilizers and a dependable genetic defence mechanism against the prevalent complex of diseases and insect pests. Genetic studies by Chang (1967), Irri (1967), Wu (1968a), Lin (1969), Hsu *et al.* (1971), Rajendran and Namboodiri (1971), Khan (1973), Khan and Khan (1982), Panwar and

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Paroda (1984) and various others have clearly indicated the pattern of inheritance of qualitative and quantitative characters in different cross combinations under different conditions. But under our conditions genetic analysis of rice plants involving different varieties under different environmental regimes is not available to the extent that it can provide a guideline to the rice breeders for the evolution of superior quality rice varieties. Therefore, it was considered worthwhile to assess and understand the genetic mechanism controlling various characters in rice plant under different environmental conditions. In the present studies different cross combinations derived from a 5 x 5 diallel experiment were sown under two spacing conditions in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, and the information thus obtained, genetically analysed and scientifically interpreted, forms the subject matter of this paper.

MATERIALS AND METHODS

Five varieties of rice (*Oryza sativa* L.) viz. BAS 370, PK 177, IR 30, IR 36, IR 1561 (first two indigenous and the others exotic) were crossed in a diallel fashion and 25 F_1 progenies including reciprocals and selfs were raised to be sown at the Experimental Fields of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, during the years 1977-79. The hybrids along with their parents were planted on 13.7.1979 in a Randomized Complete Block Design with three repeats under two spacings viz., S_1 (20 x 20 cm) and S_2 (25 x 25 cm). Ten plants in every repeat were grown. Five equally competed plants were selected and per plant data with respect to height, number of tillers, number of panicles, number of grains per panicle and grain yield were collected, tabulated and analysed by Diallel Fashion following Hayman (1954), Jinks (1954) and Whitehouse *et al.* (1958).

RESULTS AND DISCUSSION

The mean values of parents and their F_1 hybrids for various characters under different spacing conditions are presented in Table 1. The Vr/Wr graphs for the same are shown in Figures 1 to 10.

A reference to Fig. 1 for plant height under S_1 indicated that the regression line with a unit slope intercepted the Wr axis above the origin showing thereby additive type of gene action with partial dominance. From the position of the array points along the regression line it was clear that BAS 370 being the nearest to the origin possessed the maximum dominant genes for this character, whereas IR 36 the recessives being the farthest. Further, a reference to Fig. 2 for the same character under S_2 also indicated additive type of gene action with partial dominance as the regression line with a unit slope cut the Wr axis above the origin. Here the dominant position was again occupied by BAS 370 but the recessive by IR 1561 being close and away from the origin, respectively.

A comparative study of both the graphs revealed that the mode of gene action as well as the position of array points on the regression line was almost similar under both the spacings. This showed the stability of the genetics of this character under different environments (spacings). This type of gene action has also been reported by Khan (1973). BAS 370, the tallest parent under study possessed most of the dominant genes for height. Wu (1968a) also reported dominance for plant height in rice.

For number of tillers per plant under S_1, Fig. 3 showed that the regression line with a unit slope intercepted the Wr axis above the origin; it indicated additive type of gene action with partial dominance. From the position of the array points on the regression line IR 36 seemed to possess most dominant genes and BAS 370 the recessives. In the case of S_2, the regression line with a unit slope again showed additive type of gene action with partial dominance as it cut the covariance axis above the origin (Fig. 4). Here in this case IR 36 occupied dominant and PK 177 the recessive position.

A comparative study of both the graphs showed no change in genetic mechanism (additive) but a slight change in the position of array points with a change in spacing condition was observed. This situation suggested the stability of the gene action operating for this character over the changing environments. Mir (1959) reported that in barley the tillering was controlled

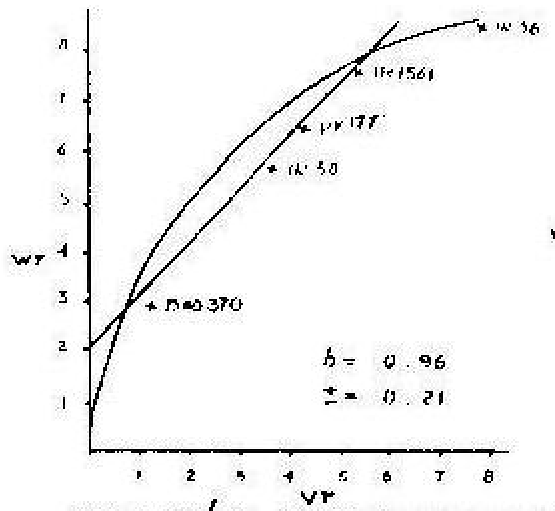

FIG. 1. VT/WT GRAPH: PLANT HEIGHT (S_1)

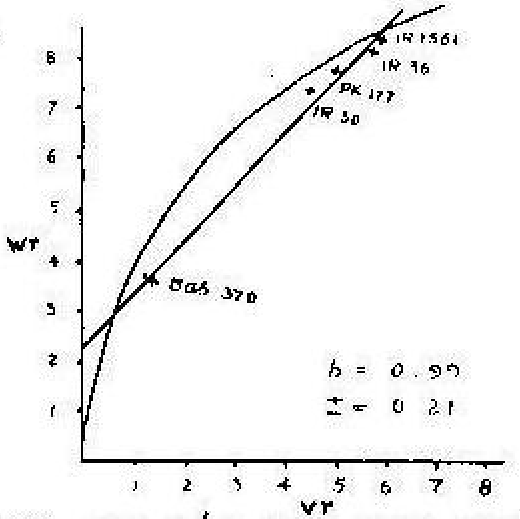

FIG. 2. VT/WT GRAPH: PLANT HEIGHT (S_2)

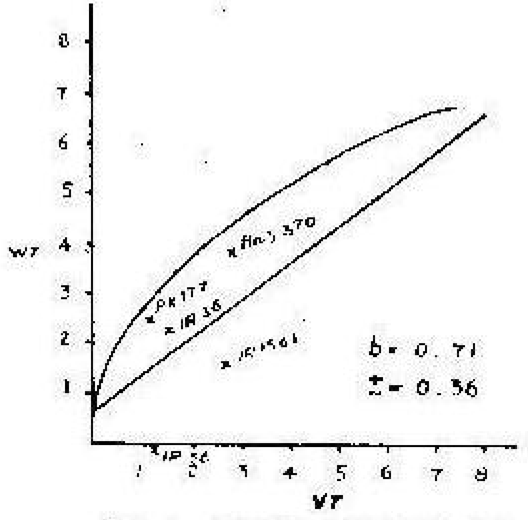

FIG. 3. GRAPH: NUMBER OF TILLERS PER PLANT (S_1)

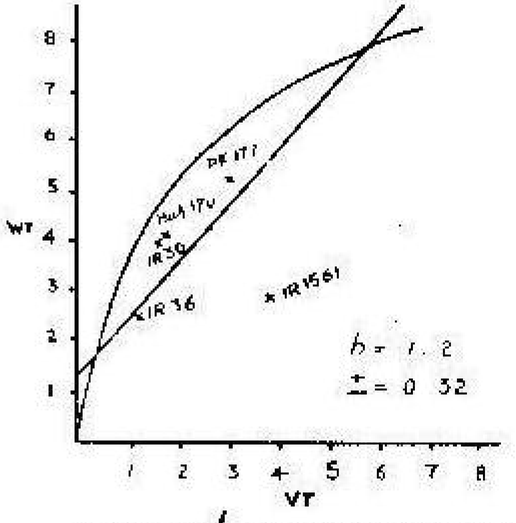

FIG. 4. VT/WT GRAPH: NUMBER OF TILLERS PER PLANT (S_2)

by many genes with cumulative effect and influenced by environments.

A perusal of Fig. 5 for number of panicles per plant under S_1 revealed complete dominance operating for this character as the regression line with a unit slope passed through the origin. The array of IR 30 contained maximum dominant genes and BAS 370 the recessives. A study of Fig. 6 for S_2 again showed the dominance of gene action as the regression line with a unit slope passed through the origin. Here the dominant position was occupied by IR 30 but the recessive position was still possessed by BAS 370.

The comparison of the two graphs indicated no change in the gene action controlling this character (dominant type), but a slight change in the order of dominance of arrays was noticed with the change in spacing condition, e. g., dominant position in case of S_1 was taken by IR 30 but under S_2 by IR 36. This type of information is available in wheat where the number of spikes per plant remained the same under three levels of spacings.

A perusal of Fig. 7 for number of grains per panicle under S_1 revealed additive type of gene action complicated by some non-allelic interaction as the regression line deviating significantly from a unit slope intercepted the Wr axis above the origin. From the position of array points on the regression line IR 36 evidently seemed to have maximum dominant genes and BAS 370 the recessives for this character. Under S_2, the gene action was still of the same type, i. e., additive with non-allelic interaction but there was a slight change in the position of array points on the regression line. Here the dominant genes were gathered by PK 177 but the recessives were still contained in BAS 370 (Fig. 8).

The comparison of both the situations suggested the consistency of the gene action (additive) over the changing spacings but a little change in the varietal position on the regression line. This situation corroborates Khan (1973), who also reported additive type of gene action controlling the number of spikelets per panicle and number of kernels per panicle in rice.

For grain yield per plant under S_1 the study of Fig. 9 indicated additive type of gene action along with non-allelic interaction as the regression line

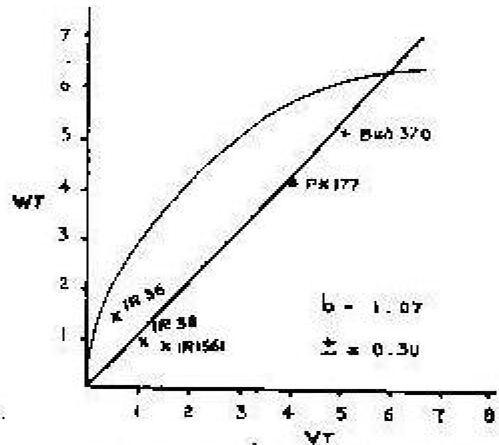

FIG. 5. VT/WT GRAPH: NUMBER OF PANICLES PER PLANT (S_1)

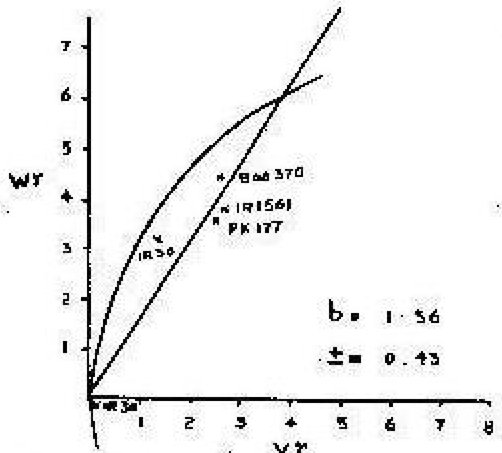

FIG. 6. VT/WT GRAPH: NUMBER OF PANICLES PER PLANT (S_2)

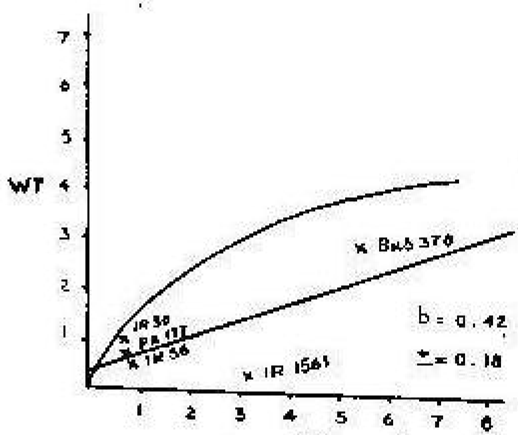

FIG. 7. VT/WT GRAPH: NUMBER OF GRAINS PER PANICLE (S_1)

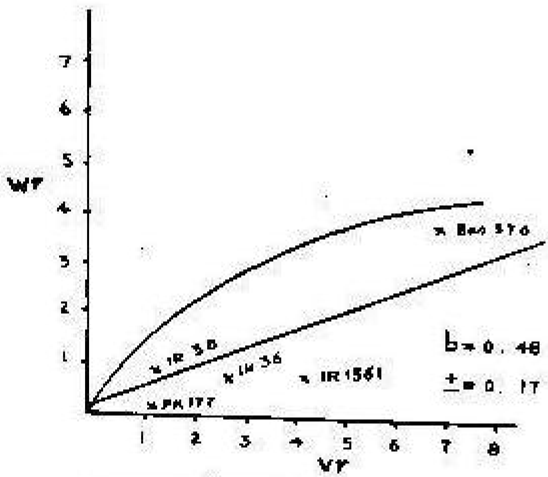

FIG. 8 VT/WT GRAPH: NUMBER OF GRAINS PER PANICLE (S_2)

Table 1. *Mean values of parents and F_1 hybrids under S_1 and S_2*

Genotype	Plant height		No. of tillers		No. of panicles		No. of grains		Grain Yield	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
BAS 370	170.0	177.4	19.0	19.8	15.7	17.3	123.9	115.7	38.4	42.7
PK 177	122.0	119.1	16.6	18.7	11.7	16.8	117.5	148.8	52.6	61.2
IR 1561	95.0	94.7	28.4	42.9	20.7	33.1	61.5	101.0	48.3	66.8
IR 30	100.0	102.1	18.3	28.7	14.1	20.7	116.1	129.58	45.1	58.8
IR 36	86.0	95.6	25.8	36.0	18.7	24.5	61.6	91.60	36.8	45.7
BAS 370 x PK 177	160.0	165.1	16.1	23.9	12.6	19.8	144.9	145.0	55.8	64.3
BAS 370 x IR 1561	147.5	152.3	26.1	31.7	21.1	26.7	63.6	54.6	30.0	41.4
BAS 370 x IR 30	144.0	152.2	20.2	27.6	16.3	22.8	125.8	123.6	44.7	58.6
BAS 370 x IR 36	156.0	152.8	23.2	26.5	17.5	23.2	84.9	75.7	41.0	51.6
PK 177 x IR 1561	115.0	113.4	21.4	30.3	19.2	24.4	130.9	129.7	56.4	69.5
PK 177 x IR 30	110.5	114.3	17.7	22.9	15.1	22.3	135.4	129.4	49.2	63.8
PK 177 x IR 36	116.0	112.7	20.6	33.1	16.0	25.6	114.2	112.9	49.5	61.3
IR 1561 x IR 30	100.0	100.1	21.3	36.6	16.9	27.8	107.3	105.1	51.6	59.7
IR 1561 x IR 36	90.0	92.0	19.8	30.4	18.2	24.4	100.5	105.1	41.6	56.7
IR 30 x IR 36	98.4	105.4	24.3	34.1	18.2	24.37	104.1	112.2	43.9	64.8

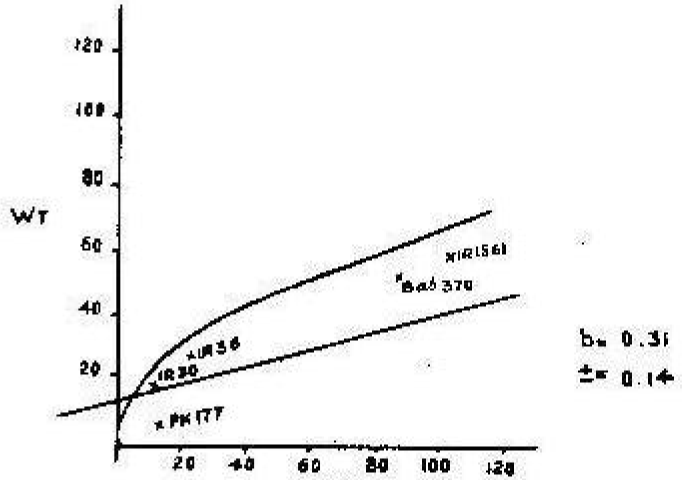

FIG. 9. VT/WT GRAPH: GRAIN YIELD PER PLANT (S_1)

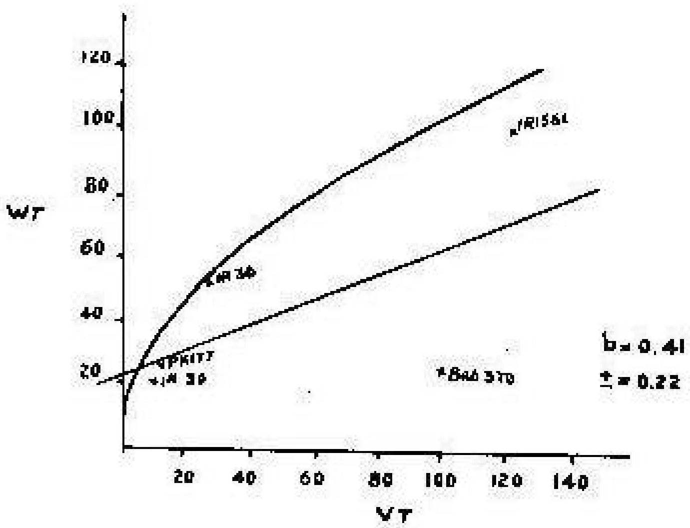

FIG. 10. VT/WT GRAPH: GRAIN YIELD PER PLANT (S_2)

deviating significantly from a unit slope intercepted the covariance axis above the origin. From the position of array points on the regression line, PK 177 appeared to have maximum dominant and IR 1561 the recessive genes. In case of S_2 (Fig. 10), the regression line again deviated significantly from a unit slope and intercepted the Wr axis above the origin signifying additive type of gene action complicated wth non-allelic interactions. Here IR 30 had most dominant genes while IR 1561 still the recessives.

The comparison of the two graphs suggested consistency of the gene action over the two environments, but little alteration in the order of dominance of the arrays on the regression line was noticed. Shah (1969) while working on wheat observed no pronounced change in the genetic mechanism controlling grain yield and other characters by a change in the planting density.

From the foregoing results and discussion there appeared to be no change in the genetic mechanism controlling different characters when the plants were subjected to different spacing conditions namely 20 x 20 and 25 x 25 cm, but a slight change in the dominance order of the array points was observed. This situation indicated the consistency in the genetic behaviour of the rice plant for the characters studied under the said environments. Such information could be of vital importance in the rice breeding programme to synthesize a superior genotype well adapted to various cropping conditions.

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