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Genetic Analysis of Yield and Yield Components in Diallel Cross of Maize (*Zea mays* L.) in F_2 Generation

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Abstract. Genetic analysis was carried out for six maize cultivars and their 30 F_2 crosses under agro-climatic conditions at Agricultural Research Institute of Dera Ismail Khan, Pakistan. The analysis of variance indicated highly significant differences among parents and their F_2 progeny for all the parameters. The genetic analysis revealed that the characters *viz*; kernels/ear, kernels rows/ear, kernels/row, ear length, 1000 grain weight and grain yield have shown additive type gene action. According to regression analysis, the non-significant deviation of the regression line from unit slope indicated the absence of non-allelic interaction, which was presented in all the characters.

Keywords: genetic analysis, yield components, maize, F_2 generation

Introduction

Maize (*Zea mays* L.) belongs to the family Gramineae and is an annual, short duration, long day, cross-pollinated and determinate crop. In cereal crops maize attained third position after wheat and rice in world production. Maize is cultivated throughout temperate and tropical regions of the world.

The main objective of the maize breeding programmes is to breed high yielding and well-adapted hybrids/ cultivars. Breeding for improved varieties is a continuous process and requires primarily a thorough knowledge of the genetic mechanism governing yield and yield components. Diallel cross technique developed by Hayman (1954) and Jinks (1954) provides information on the inheritance mechanism in the early filial generations and helps the breeder to make effective selection.

Wolf *et al.* (2000) estimated additive genetic variances for F_2 generation and concluded that yield and other characters were controlled by additive genetic variance. Mufti *et al.* (2002) conducted diallel analysis of yield and yield components in maize (*Zea mays* L.). The data were recorded and the nature of gene action was investigated for kernel rows/ear, kernels/row, 100 grain weight and grain yield/plant. Vr/Wr graphs indicated that kernels/row; 100 grain weight and grain yield/plant were controlled by over-dominance type of gene action, while, kernel rows/ear was under the control of additive type of gene action. Parentoni *et al.* (2001) conducted 28 maize open pollinated varieties (OPVs) crossed in a diallel scheme. Morphological data showed a higher degree of genetic divergence among the dent germplasm than among the flint germplasm used in this study. Saleem *et al.* (2002) studied gene action for various quantitative traits in a complete diallel involving six maize populations. Variance/covariance graphs revealed that kernel rows/ear, kernels/row, 100 grain weight and grain yield/plant were controlled by over dominance type of gene action. Soengas *et al*. (2003) crossed ten open-pollinated flint maize cultivars in a diallel design without reciprocals. Crosses yielded 30% more than parental cultivars. Mid-parent heterosis values ranged from 2.5 to 64.7%. The crosses 'Gallego' × 'Basto/Enano Levantino' and Basto/Enano Levantino × 'Longfellow' showed high heterosis and the best average grain yield.

In the present studies, efforts were made to ascertain the gene action and magnitude of contribution of various quantitative characters in a 6 × 6 diallel cross experiment of F_2 maize populations to evolve new high yielding genotypes through genetic recombination to face global challenges.

Materials and Methods

The trial was conducted at Agricultural Research Institute, D.I. Khan Pakistan, during the year 2006. Trial was comprised of 6 varieties of maize *viz*; Kisan, Azam, Sarhad white, Sarhad yellow, Jalal (CCRI, Pirsabak, Nowhere, KPK varieties) and Sadaf (MMRI, Yousaf wala, Punjab variety). The F_2 population including reciprocals and parental lines were planted in a randomised complete block design with four replications.

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Each treatment consisted of four rows of five meter long with a row spacing of 75 cm and plant spacing 25 cm. Planting was done on ridges using 2-3 seeds per hill with the help of dibbler, which were later thinned to one plant per hill at four leaves stage. All other agronomic and cultural practices were kept constant for all the treatments from sowing till harvesting.

At maturity 10 plants were randomly selected in each treatment. The data were recorded on kernels/ear, kernels rows/ear, kernels/row, ear length (cm), 1000 grain weight (g) and grain yield (kg/ha) which was subjected to the statistical analysis of variance technique to establish the level of variability among F_2 population and their parental lines (Steel and Torrie, 1980).

Results and Discussion

The results for the analysis of variance are presented in Table 1 and Wr/Vr graphic illustration for each trait is presented in Fig. 1-4. The analysis of variance for all the characters revealed highly significant variation, among genotypes including parents and F_2 hybrids. All above characters are discussed as follows.

Kernels/ear. A reference to Wr/Vr graph plotted in Fig. 1 for F_2 kernels/ear, indicated that the regression line intercepted the Wr axis above the origin and denoted additive type of gene action with partial dominance controlling the inheritance pattern of this trait. From the position of array points on regression line it was found that Sarhad yellow, Jalal and Kisan possessed maximum dominant genes by virtue of their nearest position to origin. Cultivars Azam, Sarhad white and Sadaf being away from the origin had the recessive genes.

These findings are in accordance the findings of other workers like Derera *et al.* (2008); Jumbo and Carena (2008); Frascaroli *et al.* (2007), who reported additive type of gene action in manifestation of kernel/ear. However, Kumar *et al.* (2008) observed non additive type of gene action, which may be due to different genetic background of the cultivars used in different environmental condition.

Table 1. Mean squares and F ratios at 35 & 105 D.F for analysis of variance for different yields and other traits of maize (*Zea mays* L.) in F_2 generation during 2006

Parameters	Genotypes	F ratio	C.V%
Kernels/ear	521.900	1.63NS	4.667
Kernel rows/ear	4.250	3.47**	7.741
Kernels/row	7.936	1.32NS	8.500
Ear length	3.464	5.15**	5.914
1000 grain weight	419.300	1.82	5.676
Grain yield (kg/ha)	659346	4.27	7.930

** = significant at $P \leq 0.01$.

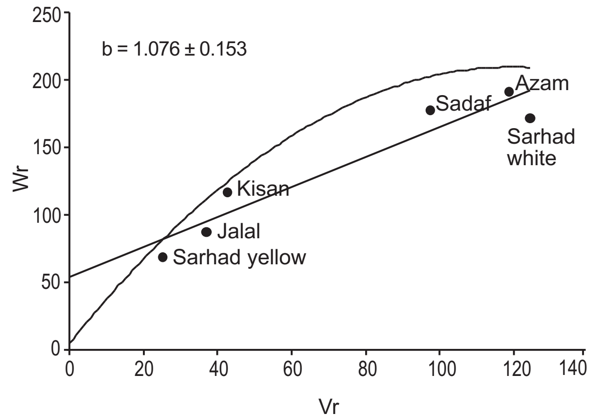

Fig. 1. Wr/Vr graph for kernels/ear.

Kernel rows/ear. The Wr/Vr graph plotted in Fig. 2 for F_2 kernel row/ear, indicated additive type of gene action with partial dominance controlling the inheritance pattern of this trait as the regression line intercepted the Wr axis above the origin. From the position of array points on regression line it was observed that Sadaf, Jalal, Kisan and Sarhad white seemed to have maximum dominant genes and being nearer to the origin, while the cultivars Sarhad yellow and Azam, being away from the origin due to the recessive genes for kernel rows/ear.

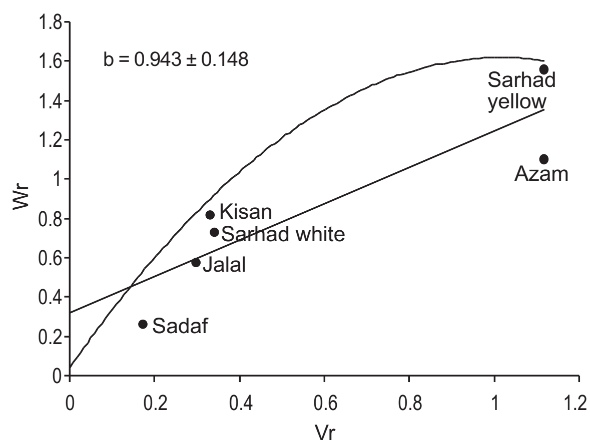

Fig. 2. Wr/Vr graph for kernels raw/ear.

The findings of kernel rows/ear are similar to the results reported by earlier workers like Alam *et al.* (2008) and Aydin *et al.* (2007), who reported additive type of gene action in manifestation of kernel rows/ear. However, Kumar *et al.* (2008) observed non-additive type of gene action, which may be due to different genetic backgrounds of the cultivars used in different environmental conditions.

Kernels/row. The Wr/Vr graph plotted in Fig. 3 for F_2 kernels/row, indicated additive type of gene action with partial dominance controlling the inheritance pattern of this trait as the regression line intercepted the Wr axis above the origin. From the position of array points on regression line it was observed that Sadaf and Sarhad white seemed to have maximum dominant genes being nearer to the origin, while the cultivars Sarhad yellow, Azam, Kisan and Jalal being away from the origin had the recessive genes. The kernels/row, showing additive gene affects in F_2 generation is encouraging because the over dominance causing extra ordinary increase in kernels/row is also not desirable.

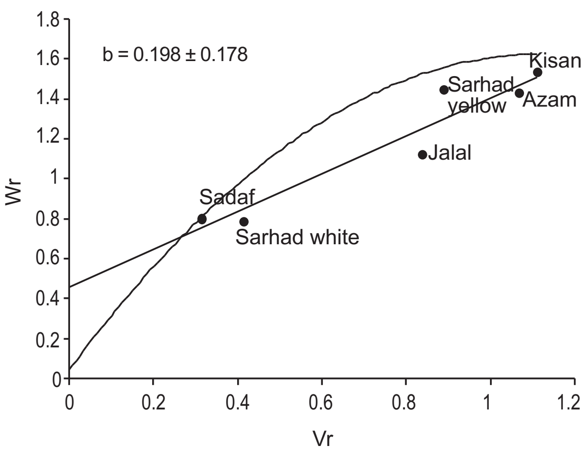

Fig. 3. Wr/Vr graph for kernels/row.

Kernels/row is a quantitative character and these findings are in concordance with the conclusion of workers like Zdunic *et al.* (2008) and Aydin *et al.* (2007), who reported additive type of gene action in manifestation of kernels/row. However, Kumar *et al.* (2008) and Tabassum *et al.* (2007) observed non additive type of gene action, which may be due to different genetic backgrounds of the cultivars used in different environmental conditions.

Ear length. The Wr/Vr graph plotted in Fig. 4, F_2 ear length, indicated additive type of gene action as the regression line intercepted the Wr axis above the origin. The position of parental cultivars on the regression line showed that Azam had the maximum dominant genes due to their proximity to the origin, the distal position of Sarhad white and Sarhad yellow indicated maximum recessive genes. The ear length, showing additive gene affects in F_2 generation, revealed stability of additive variance.

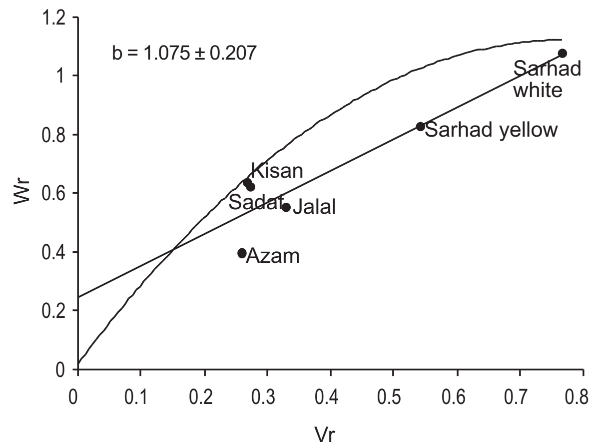

Fig. 4. Wr/Vr graph for ear length.

These findings are similar to the results reported by Alam *et al.* (2008) and Aydin *et al.* (2007), who reported additive type of gene action in manifestation of ear length. However, Tabassum *et al.* (2007) observed non-additive type of gene action, which may be due to different genetic backgrounds of the cultivars used in different environmental conditions.

1000 grain weight. It is evident from Wr/Vr graph plotted in Fig. 5 that additive type of gene action with partial dominance controlled the inheritance of 1000 grain weight in F_2 as the regression line intercepted the Wr axis above the origin. From the position of array points on regression line it was obvious that only Kisan possessed maximum dominant genes due to maximum and their close position to the origin. The cultivars Sarhad yellow and Azam being away from the origin depicted recessive genes.

These findings are in concordance with the conclusion of workers like Welcker (2005), Aydin *et al.* (2007) and Alam *et al.* (2008), who reported additive type of gene action in manifestation of 1000 grain weight. However,

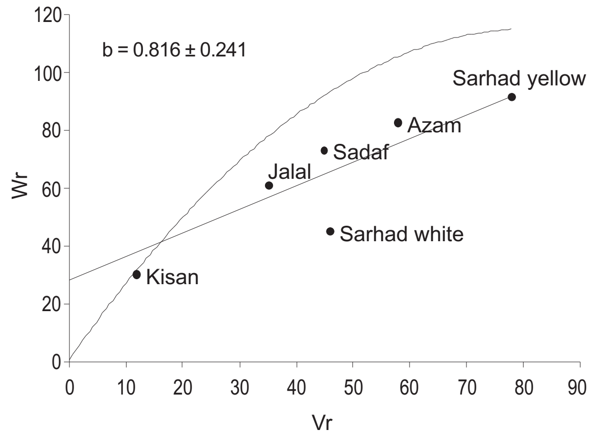

Fig. 5. Wr/Vr graph for 1000 grain weight.

Devi *et al.* (2007) and Tabassum *et al*. (2007) observed non-additive type of gene action, which may be due to deviation from environmental conditions and genetic material used.

Grain yield kg/ha. The relationship of Wr/Vr graph plotted in Fig. 6 for F_2 grain yield (kg/ha), indicated additive type of gene action with partial dominance controlling the inheritance pattern of this trait as the regression line intercepted the Wr axis above the origin. The position of array points on regression line showed that Sarhad white, Azam and Sarhad yellow possessed maximum dominant genes and their close proximity to the origin. The cultivars Sadaf and Kisan, being away from the origin had recessive genes.

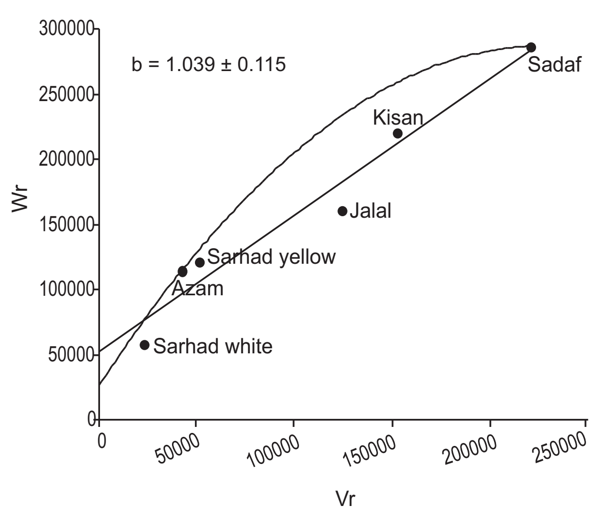

Fig. 6. Wr/Vr graph for 1000 grain yield (kg/ha).

Grain yield (kg/ha) is a quantitative character and these findings are in concordance with the conclusion of workers like Velásquez *et al.* (2008), Miranda *et al.* (2008) and Zdunic *et al.* (2008), who reported additive type of gene action in manifestation of grain yield (kg/ha). However, Ojo *et al.* (2007) and Tabassum *et al.* (2007) observed non additive type of gene action, which may be due to different genetic background of the cultivars used in different environmental conditions.

Conclusion

All the parameters were under the control of additive type of gene action in F_2 generation which proved that the selection in early generations would be more effective than late generation for all the characters under study.

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