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Inheritance Pattern of Some Morphological Characters in Maize (*Zea mays* L.)

Amanullah[a]*, Shah Jehan Khan[a], Muhammad Mansoor[b] and Abdul Aziz[b]

[a]Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan

[b]Arid Zone Research Institute, Dera Ismail Khan, Pakistan

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Abstract. A 6x6 diallel cross experiment was conducted on F_1 generation of maize to explore the inheritance pattern of various morphological parameters at Agricultural Research Institute, Dera Ismail Khan, Pakistan, during 2004 and 2005. The analysis of variance indicated highly significant differences, among parental lines and their hybrids in F_1 generation *viz.*, days to maturity, plant height, ear height, leaves/plant, harvest index % and grain yield kg/ha. The Wr/Vr graph for all the characters under study, enunciated additive type of gene action with partial dominance involved in the phenotypic manifestation of the traits as regression line cuts the Wr axis above the origin. Additive type of gene action suggests that selection in early generation may be fruitful for these characters. For all characters studied the regression coefficient (b) differed significantly, from zero but not from unity, indicated the absence of non-allelic interaction, which was presented in all the characters.

Keywords: genetic analysis, inheritance pattern, analysis of variance, maize

Introduction

Maize is an important food crop after wheat and rice throughout the world and ranks third after wheat and rice in the world production of cereal crops. Being a short-duration cereal crop its importance as an industrial raw material is rapidly increasing.

Maize (*Zea mays* L.) belonging to the family Gramineae is a short duration, long day, cross-pollinated, determinate crop. Maize is grown throughout temperate and tropical regions of the world. It is the third important cereal crop of Pakistan too, after wheat and rice and is mainly the staple food of rural population. It occupies a special position in the national economy, as it is a good source of food, fodder and feed (Harris *et al.,* 2007).

The primary objective of the most maize breeding programmes is the evolution of high yielding and well adapted 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 (1954a; 1954b) and Jinks (1954) provides information on the inheritance mechanism in the early filial generations and helps the breeder to make effective selection. Kumar *et al.* (2008) provided information on genetic variance derived from 8 yields related traits. Both additive and non-additive gene actions were important for number of kernels per row and grain yield per plant. Non-additive gene actions were predominant for number of kernel rows per ear. Makumbi (2005) studied fifteen maize inbred lines crossed in a diallel for estimation of general combining ability (GCA), and specific combining ability (SCA) and heterosis. GCA effects were not significant, for grain yield. Additive genetic effects were more important for grain yield. Tabassum *et al.* (2007) conducted a trial on F_1 8 × 8 diallel for combining ability in maize. The GCA/SCA variance ratio exhibited that all the traits were under control of non-additive type of genes except plant height, which was found equally under control of additive and non-additive genes. Wardyn *et al.* (2007) studied the genetic structure of a maize population and role of dominance. The results showed that the dominance variance was larger than the additive variance for grain yield, whereas, the additive variance was larger than the dominance variance for all other traits. Srdic *et al.* (2007) reported for inheritance of maize grain yield and grain yield components. Dominant gene effects were more significant, in maize grain yield and kernels/row, while, additive gene effects were more important for kernel rows/ear and 1000-kernel weight. The kernel rows/ear was partial dominance, while, over-dominance was of greater importance for grain yield, kernels/row and

*Author for correspondence; E-mail: panyala64@yahoo.com

1000-kernel weight. Ojo *et al.* (2007) studied seven inbreds of white maize in a diallel design. Additive gene action was more important than non-additive gene action for grain yield. Miranda *et al.* (2008) studied diallel crosses of advanced generations of the popcorn hybrids and three open-pollinated popcorn varieties. Both additive and non-additive effects were important for grain yield, plant height, ear height, and husk cover. The objective of the present study was to ascertain the best cross combination for some important traits pertaining to grain yield, its components and four physiological parameters amongst six varieties of maize.

Materials and Methods

The research work pertaining to genetic analysis of (*Zea mays* L.) was conducted at Agricultural Research Institute, D.I.Khan, NWFP, Pakistan, under the aegis of Department of Plant Breeding and Genetics, Gomal University D.I. Khan, during 2004 and 2005. The genetic material comprised of six commercial varieties of maize *viz.*, Kisan, Azam, Sarhad white, Sarhad yellow, Jalal and Sadaf. The crossing was done in a complete diallel fashion by hand pollination, parents, 15 F_1 crosses and 15 reciprocal F_1 were evaluated in a RCB design with four replications. Each treatment comprised of 4 rows, 5 m long and kept row-to-row and plant-to-plant space of 75 and 20 cm, respectively. Planting was done on ridges using 2-3 seeds per hill with the help of dibbler. Plants were thinned to one plant per hill, when the plants reached to four leaf stage, resulting in a plant population of about 66,667 plant/ha. All other cultural practices were kept constant to all the plots from planting till harvesting. At maturity the data were recorded on ten plants from two central rows for days to maturity, plant height (cm), ear height (cm), leaves/plant, harvest index percentage and grain yield kg/ha.

Statistical analysis: The data regarding different plant characters were averaged and subjected to statistical manipulation for the analysis of variance technique to establish the level of variability among F_1 hybrids and their parental lines (lines = above mentioned six commercial varieties) Steel *et al.* (1997).

The diallel cross technique was developed by Hayman (1954a; 1954b) and Jinks (1956; 1955; and 1954). This technique is preferred when the parents are homozygous therefore, in this case Geriffen method was used for genetic analysis. All the crosses were arranged into arrays in the form of diallel tables and two statistics i.e., variance (Vr) of the family mean within an array and the covariance (Wr) of these means with the non-recurrent parental values were calculated from each diallel table.

Array nearest to the point of origin possessed most of the dominant genes, while the array that laid the farthest from the origin possessed the most recessive genes, and the intermediate position signified the presence of both dominant and recessive genes in the array. The standard error for the regression line slope was estimated as mentioned by Snedecor (1962).

Results and Discussion

The analysis of variance for days to maturity, plant height, ear height, leaves/plant, harvest index % and grain yield kg/ha have been given in Table 1. It revealed highly significant variation due to various genotypes including parents (Kisan, Azam, Sarhad white, Sarhad yellow, Jalal and Sadaf) and F_1 hybrids. Wr/Vr graphic illustrations for each trait are presented in Fig. 1-6.

The parameters studied in F_1 generation showed similar trends with regards to regression coefficient. The reg-ression analysis manifested that regression coefficient (b) differed significantly, from zero but not

Table 1. Mean squares of 36 genotypes and their F ration for six characters

Parameters	Mean square				
	Rep	Genotypes	Error	F. Ratio	C.V %
Days to maturity	6.148	45.611	3.362	13.56**	1.992054
Plant height	39.19	166.56	17.23	9.66**	2.20409
Ear height	44.82	291.53	25.52	11.42**	4.89377
Leaves/plant	1.1111	1.1286	0.6587	1.71**	5.41081
Harvest index %	4.204	16.986	2.789	6.09**	5.79245
Grain yield kg/ha	435715	1667038	230737	7.22**	8.37903

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

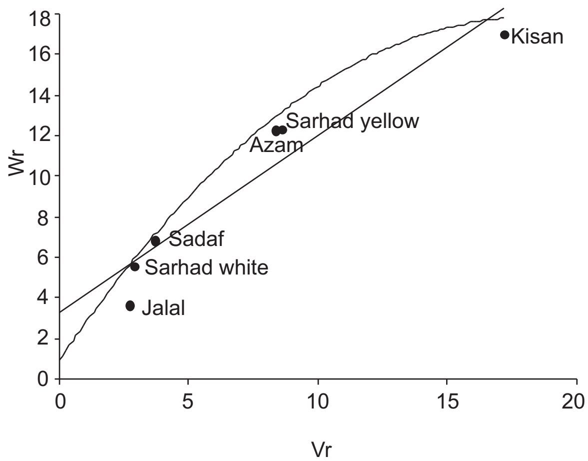

Fig. 1. Wr/Vr graph for days to maturity.

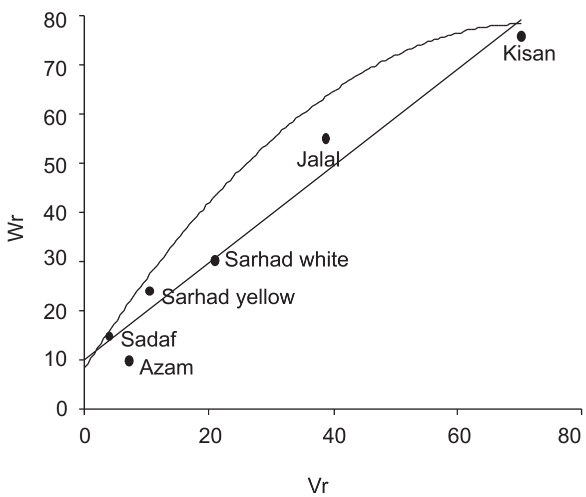

Fig. 2. Wr/Vr graph for plant height.

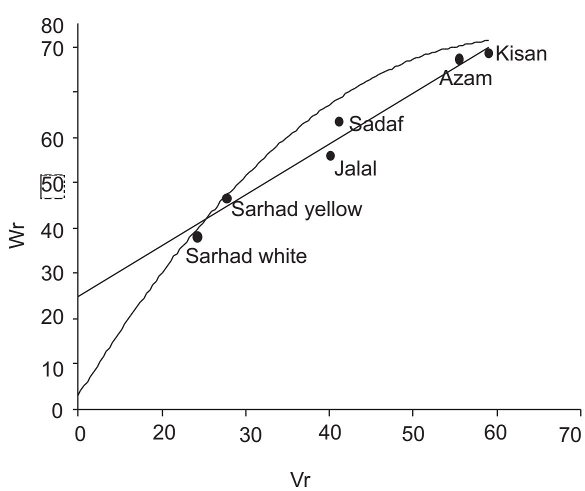

Fig. 3. Wr/Vr graph for ear height.

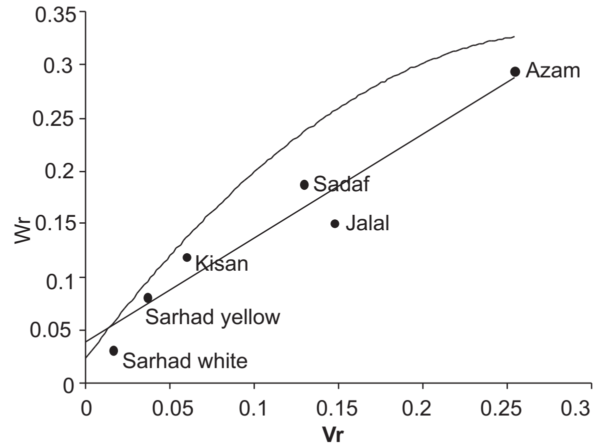

Fig. 4. Wr/Vr graph for leaves/plant.

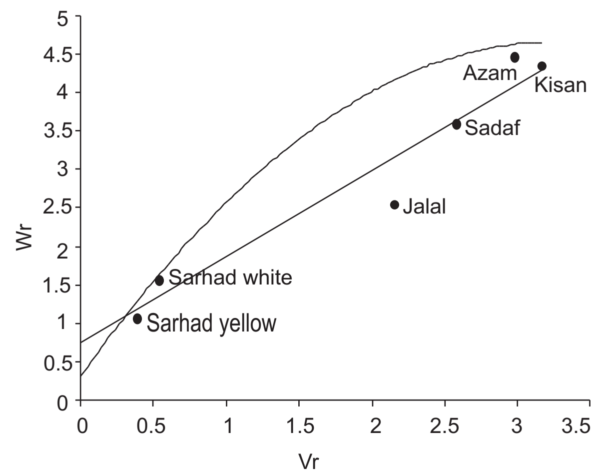

Fig. 5. Wr/Vr graph for harvest index %.

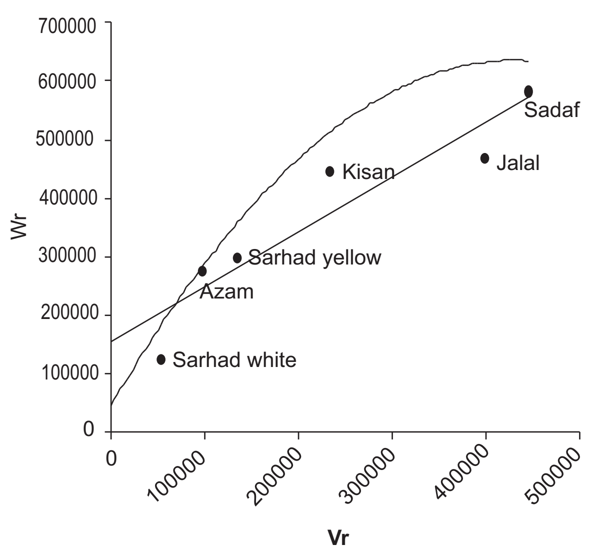

Fig. 6. Wr/Vr graph for grain yield kg/ha.

from unity, which fulfills the assumption of the Hayman-Jinks additive-dominance model. The results are in line with the findings reported earlier. It is also worth mentioning here that Wr+Vr were significant, for days to maturity, plant height and grain yield kg/ha, while, Wr-Vr were non-significant, for all the parameters under study. The significance of Wr+Vr represents the presence of dominance, while, that of Wr-Vr reveals the adequacy of additive-dominance model. The "t" tests were also non-significant, confirming the adequacy of model with no non-allelic interaction (epistasis) and indicate that genes were independent in their action for random combinations.

The Wr/Vr graph plotted in Fig.1-6 for all the characters under study, enunciated additive type of gene action with partial dominance involved in the phenotypic manifestation of the traits because the regression line cuts the Wr axis above the origin. However, from the position of array points on regression line it was revealed that Sarhad white having the closest position to the origin in ear height, leaves per plant and grain yield, having maximum value and maximum number of dominant genes (Fig. 3, Fig. 4 and Fig. 6), while cultivars Kisan due to its distal position from origin, having lowest value and maximum number of recessive genes (Fig. 1, Fig.2, Fig. 3 and Fig. 5). For days to maturity (Fig.1), cultivar Jalal, Sarhad white and Sadaf having maximum value and possess maximum number of dominant genes, for plant height (Fig. 2) cultivar Azam and Sadaf having maximum value and posses maximum number of dominant genes, while, cultivar Kisan due to its distal position from origin, having lowest value and maximum number of recessive genes (Fig.1 and Fig. 2). For harvest index % Sarhad yellow having the closest position to the origin having maximum value and maximum number of dominant genes (Fig. 5). Additive type of gene action suggests that selection in early generation may be fruitful for these characters. The results are in agreement with the findings of Saleem *et al.* (2002), who found the presence of additive type of gene action responsible of these traits. However, the results are in contradiction to Kumar *et al*. (2008) and Mufti *et al*. (2002), which may be due to different genetic materials used for experimentation and different environmental conditions.

Conclusion

It is obvious from the present study that if practiced with care it can in general, go a long way in developing promising synthetics and hybrids of maize. All the studied characters were under the control of additive type of gene action, which reveals that selection in early generations may be more effective.

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