GENETIC MECHANISM OF SOME PHYSIOLOGICAL TRAITS IN SPRING WHEAT AT TWO PLANT POPULATION REGIMES*

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ABSTRACT

A study was conducted in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during 2005. Graphical analysis was made for 7×7 complete diallel cross and physiological traits like flag leaf area, stomatal frequency, stomata size, epidermal cell size and leaf venation were studied. Seven wheat varieties/strains (Faisalabad-85, Punjab-96, MN-97, Uqab-2000, 6500, 6142 and 7086-1 were subjected two plant densities (high at 3 inches/7.5 cm plant spacing and low at 6 inches/15 cm plant spacing). According to results all traits were controlled by over dominance type of gene action at both population regimes. For flag leaf area, maximum dominant genes were found in genotype 6500 and Punjab-96 and maximum recessive genes were noted for genotype Faisalabad-85 at high and low population density, respectively. For stomatal frequency maximum dominant genes were noted for genotypes 6142 and 6500 and maximum recessive genes were found for Faisalabad-85 and Punjab-96 at narrow and wide interplant spacings, respectively. In case of stomatal size and epidermal cell size, maximum dominant genes were observed for genotype Punjab-96 and maximum recessive for Uqab-2000 in both plant densities. However, for leaf venation maximum recessive genes were noted for genotypes Punjab-96 and 7086-1 at high and maximum dominant genes for 7086-1 and 6142 were found at low population.

KEYWORDS: *Triticum aestivum;* genotypes; crossbreeding; plant population; agronomic characters; Pakistan.

INTRODUCTION

Wheat **(***Triticum aestivum* L. em Thell.) is the most important food crop. It meets more than 50 percent of calories and proteins of world population. Being a staple food it plays a remarkable role in meeting diversified food requirements of both urban and rural population of Pakistan. However, wheat production is not sufficient to meet needs of the country due to low per hectare yield. Among many other factors, plant density is the most important factor affecting growth (3), development and grain productivity per unit area in

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almost all crops including wheat. Yield potential is attributed to plant density (13), especially in field crops as it enables the crop to capture resources. The knowledge of inheritance of quantitative traits is important for every plant improvement programme. Diallel cross technique is commonly used to estimate inheritance and behaviour of quantitative characters. Application of different models (8, 11) in F_1 generation provides information regarding nature and magnitude of gene-action involved in inheritance of a character. Such type of information is useful for plant breeders for two reasons viz. types of genetic variations in the traits for which selection is intended and rapid evaluation of yielding capacity by identifying crosses which may produce superior genotypes.

The present study was conducted to ascertain the nature of gene-action involved in developing the complex genetic characters in wheat to further streamline wheat improvement efforts in the country.

MATERIALS AND METHODS

These studies were conducted in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during 2005. Seven wheat varieties/strains (Faisalabad-85, Punjab-96, MH-97, Uqab-2000, 6500, 6142 and 7086-1) were crossed in a diallel fashion.

F_1 material including reciprocals and parents was sown in a triplicated RCBD. The entries were assigned to the experimental unit in each block at random and each row contained 20 plants. Two experiments were sown using two plant densities [high at three inches (7.5 cm) and low at six inches (15 cm) inter plant distance) while inter row distance of 30 cm was kept uniform for both experiments. All agronomic and plant protection measures were kept normal and equal for entire experiment. At physiological maturity, ten guarded plants were randomly selected from each genotype of each replication. Data were recorded on flag leaf area (cm^2), stomatal frequency, stomata size (μ^2), epidermal cell size (μ^2) and leaf venation in following manner.

Flag leaf area: From main tiller of each selected plant, flag leaf area was measured by taking maximum length and breadth of flag leaf of mother shoot in centimetre, when plant was fully matured but was still green and turgid. Flag leaf area was then calculated by applying following formula (8) and average flag leaf area was then computed.

$$\textit{Flag leaf area} = \textit{Maximum length} \times \textit{maximum breadth} \times 0.74$$

Stomatal frequency: Stomatal frequency per unit area (at 10 microscopic field) was counted from upper surface (adaxial) of flag leaf of mother shoot of each randomly selected plant. Five strips taken from middle part of flag leaf were dipped into Carnoy's solution (acetic alcohol 100 parts and glacial acetic acid 33 parts) to arrest stomatal movement and removal of chlorophyll from the leaf tissues. After 48 hours, strips were washed with acetone and stored in alcohol for further examination. These leaf strips were peeled and examined and five samples were counted for stomatal frequency in each strip.

Stomata size: Leaf strips taken for studying stomatal frequency were also used for measuring stomata size excluding guard cells. Size of five stomata from each strip was measured in microns using a 1.0 mm stage micrometer scaled at 0.01 mm increment and a 10 mm ocular micrometer scaled at compound microscope (Leitz Wetzler, Germany 604364) at 40 x magnification. The ocular micrometer was standardized as under:

- Stage micrometer was placed on stage of microscope and focused at 40 x magnifications.
- Ocular micrometer was placed inside the eye piece. By gently moving the mechanical stage and eye piece, scaled lens of both micrometers were made coincided.
- Number of divisions of stage micrometer and ocular micrometer which appeared clearly coincided, were recorded.
- Value of each division of ocular micrometer was then calculated as under:-

$$\frac{\textit{Division of stage micrometer}}{\textit{Division of ocular micrometer}} \times 10$$

(As each division of stage micrometer was equal to 10 micron, therefore, fraction was multiplied by 10)

- Five observations were recorded and then a mean value for a stage division of ocular micrometer was calculated, which was 3.37 microns.

Stomata size was then measured in following manner:-

- Stage micrometer was removed and a slide having a peeled leaf strip, taken for studying leaf venation was placed on the stage.

- Stomata length and breadth were measured in microns, under 40 x and these measured with the help of ocular micrometer placed inside the eye piece.

- Length and breadth of five stomata per slide were recorded in microns. The product of length and breadth of stomata was multiplied with the quotient (3.37) already calculated to estimate size in square microns (μ^2).

Epidermal cell size: Leaf strip taken for studying stomata size were also used for measuring epidermal cell size under 40 x magnification. Method was the same as for stomata size. Five cells from each slide were measured at random for length and breadth (L × B) with the help of ocular micrometer and average was calculated. Cell size was then calculated by separately multiplying the length × breadth with standardized value 3.37 of microscope and finally epidermal cell size was obtained by multiplying length × breadth of cell.

Leaf venation: Leaf strips of about 3 cm length taken for recording stomatal frequency were also used for leaf venation. Leaf venations of selected plants were counted per microscopic field of flag leaf. These peeled strips were examined below 10 x magnification to count leaf veins. Two samples were counted for leaf venation in each strip and then the average was calculated.

Analysis of variance was performed as opted by earlier workers (12) with MSTAT-C software to evaluate genetic differences among wheat genotypes. Statistical significance was assumed at 0.05 and 0.01 levels of probability and where the mean squares were significant; data were further subjected to diallel analysis technique as advocated by previous scientists (5, 7).

RESULTS AND DISCUSSION

Analysis of variance showed highly significant differences among genotypes at both high and low population densities for all physiological attributes (Table). This indicated the presence of adequate genetic variability which could be exploited in different crossing programmes.

Flag leaf area

Graphical analysis (Fig. 1) depicted that intercept of regression line is negative in both plant densities suggesting over-dominance type of gene action. Distribution of array points on regression line depicted that genotypes 6500 and 7086-1 at narrow (3 inches) planting while Punjab-96 and 7086-1 at

Table. Mean squares from analysis of variance of 7×7 diallel cross planted at high (3 inches) and low (6 inches) population densities.

SOV	d.f	Flag leaf area		Stomatal frequency	
		3 inches	6 inches	3 inches	6 inches
Rep.	2	1.39	6.46	87.33	541.20**
Gen.	48	3.94**	22.50**	76.21**	197.60**
Error	96	0.92	2.54	35.09	94.20
		Stomata size		Epidermal cell size	
Rep.	2	3 inches	6 inches	3 inches	6 inches
Gen.	48	3923.60	4009.05	2004.60	1450.30
Error	96	27768.50**	27927.61**	48432.86**	49789.5**
		1589.80	1579.10	911.99	2019.40
		Leave venation			
Rep.	2	3 inches	6 inches		
Gen.	48	0.119	0.578		
Error	96	0.445**	1.111**		
		0.113	0.582		

**Significant at 1% level.

wider (6 inches) planting possessed more dominant genes. However, the cultivar Faisalabad-85 being the farthest from origin had less number of recessive genes for flag leaf area at both densities. These results confirm the earlier findings (2, 5, 10, 11).

Stomatal frequency

Graphical analysis (Fig. 2) displayed that intercept of regression line is negative at both plant population densities suggesting over-dominance type of gene action. The distribution of array points on regression line showed that genotype 6142 and 6500 possessed maximum dominant genes at dense and thin plant spacings, respectively. Moreover, cultivars Faisalabad-85 and Punjab-96 being the farthest from origin had lesser number of recessive genes at compact and wider plant populations for stomatal frequency, respectively. Some earlier scientists (1, 13) also reported highly significant variation for this physiological trait.

Stomata size

Fig. 3 (a & b) also showed that regression lines intercept Wr axis below the origin indicating over-dominance type of gene action at both interplant spacings. Cultivar Punjab-96 being closer to the point of intercept had maximum dominant genes while cultivar Uqab-2000 located further had maximum recessive genes in both plant population densities.

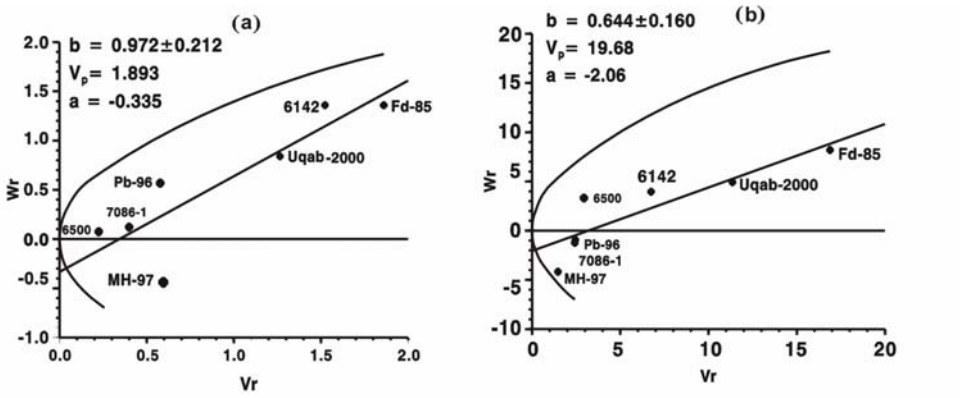

Fig .1 Wr/Vr graph for flag leaf area at 3 inches (a) and 6 inches (b) plant to plant spacing.

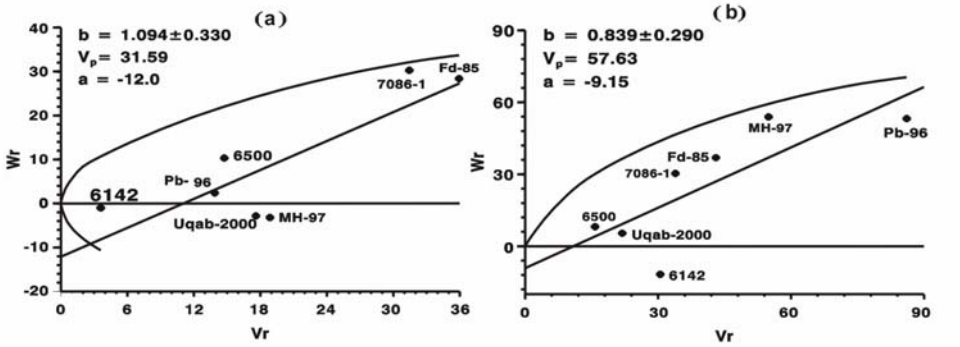

Fig. 2: Wr/Vr graph for stomatal frequency at 3 inches (a) and 6 inches (b) plant to plant spacing.

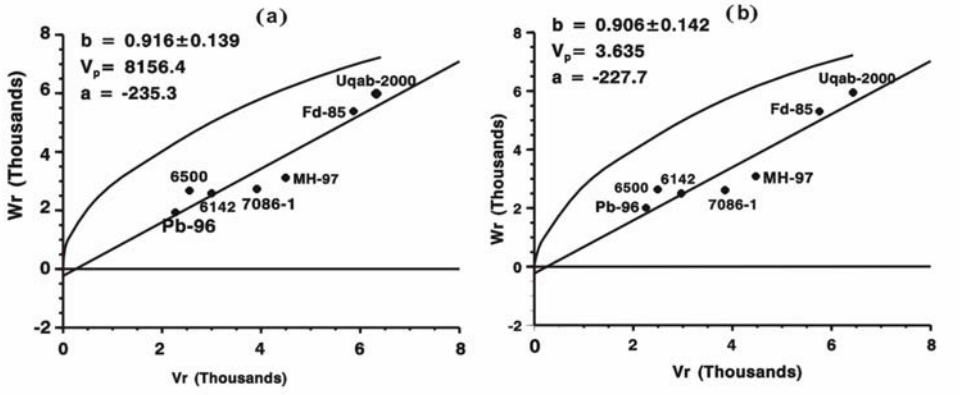

Fig. 3: Wr/Vr graph for stomata size at 3 inches (a) and 6 inches (b) plant to plant spacing.

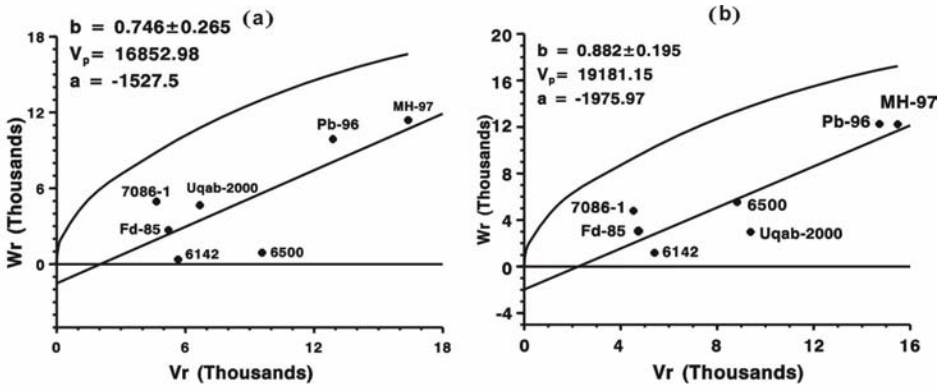

Fig. 4: Wr/Vr graph for epidermal cell size at 3 inches (a) and 6 inches (b) plant to plant spacing.

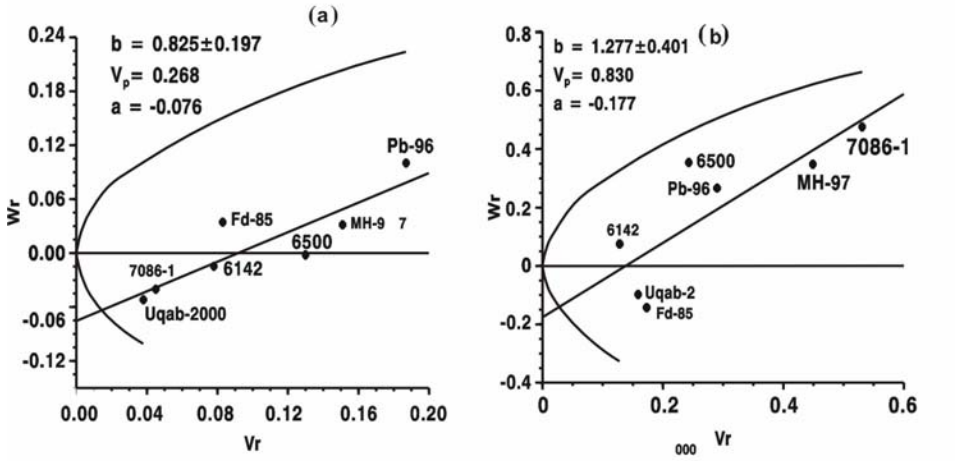

Fig. 5: Wr/Vr graph for leaf venation at 3 inches (a) and 6 inches (b) plant to plant spacing.

Epidermal cell size

The results indicated (Fig. 4a & b) that regression line intercepts Wr axis below the origin. Most of arrays gathered around regression line nearer to origin indicating to dominant genes. However, cultivar Faisalabad-85 being more nearer to origin had more dominant genes while cultivar MH-97 being farther had more recessive genes in both plant populations.

Leaf venation

The data (Fig. 5) displayed that intercept of regression line is negative in both plant densities, suggesting over-dominance type gene action. Distribution of array points on regression line depicted that genotype Uqab-2000 and 6142 possessed maximum dominant genes at three and six inches plant to plant spacings, respectively. However, genotypes Punjab-96 and 7086-1 being the farthest from origin, had more number of recessive genes at these interplant spacings, respectively. Hence, due to over-dominance type of gene action with non-allelic interaction, selection for this trait in early generation would be difficult. Ahmad (1) also observed highly significant variation for this plant attribute.

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