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Genetic Variability for Seedling Traits in Wheat (*Triticum aestivum* L.) under Moisture Stress Conditions

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Abstract: The investigation was mainly restricted to morphpogical response of four wheat genotypes to water deficit conditions. The seeds of four genotypes were sown in two wooden trays at normal laboratory conditions. These genotypes were evaluated for seedling traits under four moiture regimes viz. control tap water 100, 70, 50 and 30% tap water of control. Analysis of variances revealed significant differences in most of the seedling traits, indicating the notable genetic variability among wheat genotypes at different moisture levels. Significant genetic variability and heritability existed for all seedling and emegence traits. The estimates of genetic variances were smaller than their respective phenotypic variances for all the traits evaluated. The correlation of most of the seedling traits were positive and significant with each other. Root/shoot ratio and dry root weight show significant negative correlation. Non significant correlation was also observed in emergence rate index and root/shoot ratio. The estimates of coefficient of variability (CV %) indicated that the maximum variation for root/shoot ratio, emergence rate index, fresh shoot weight, dry shoot weight and fresh shoot length.

Key words: Genetic variability, seedling, moisture stress, *Triticum aestivum* L.

Introduction

The variability among breeding material is of primary importance in the achievement of a good crop production. A near perfect crop stand can be obtained by using high quality seed that ensure high germination percentage under favorable conditions. Among seedling traits, emergence percentage has been extensively used as an indication for seedling vigour (Jafri *et al.*, 1991). Therefore high emergence percentage followed by a high seedling vigor is necessary for the attainment of good crop stand. Wheat breeders are continuously seeking the improvement in wheat yield through various ways to ensure a near perfect stand of crop, which in turn depends upon good quality seed and with good germination percentage followed by the vigorous seedling, which can escape through the hazards of the stress conditions. Wheat varieties differ inherently for their ability to with stand drought conditions. However, under field conditions, selection for seedling vigor can mask the genetic potential of seedling vigor, but controlled conditions makes such practice easy. A reliable and efficient screening techniques may facilitate isolation of drought resistance. Good performance of genotype over a range of environments will be useful in developing a stable variety regarding yield.

In the major wheat growing areas of the world, three major types of drought may be identified, late and early season drought and residual moisture. Hafid and Smith (1998) studied the impact of drought during the reproductive phase of wheat. Similarly Kameli and Loesel (1996), investigated the effect of water stress on growth of *Triticum durum* L. in relation to the sugar accumulation and water status of wheat plants. Photosynthesis rather than reserve starch might be the major source of sugar accumulated under water stress in durum wheat. Sharma and Bhargava (1996) observed the genotypic variability in wheat for total water content and excised leaf water loss under moisture stress condition. Similarly, Hussain *et al*. (1987) studied variability of the wheat genotypes to water stress. It was found that genotypes varied in grain yield under water stress condition. Long duration genotypes were observed to tolerate better water stress than short duration genotypes. Similarly Ali *et al*. (1991) observed significant genetic variability among rice genotypes in all seedling traits except fresh root length, dry root weight relative root weight. Genotypic and phenotypic ratio was significant for emergence index, dry shoot weight and root/shoot ratio. Significant genetic variance and ratio of genotypic and phenotypic variance indicated that vigor can be improved through phenotypic selection.

The research work has therefore been carried out to study genetic variability for various seedling traits of wheat (*T. aestivum* L.) genotypes under moisture stress conditions. Observations were mainly restricted to morphological responses of wheat genotypes to water deficit conditions with objective of identifying drought tolerant types suitable for cultivation and their utilization in the future breeding programs.

Materials and Methods

The experiment was conducted in the Department of Plant Breeding and Genetics, University College of Agriculture, Rawalakot, Azad Kashmir during the year 2000. The experimental material comprised four genotypes of wheat viz. Kohistan-97, Kohsar-95, 96-R08 and Inqlab-91. Four moisture regimes (treatments) viz, control tap water with normal irrigation 100% as a check, 70% tap water of the control, 50% tap water of the control and 30% tap water of the control. Seeds of four genotypes were sown in two wooden trays (3x4f)t at normal laboratory conditions. These trays were divided into four blocks each containing about 6 kg of soil. The experimental lay out system was complete randomized block design in factorial arrangements (Steel and Torrie, 1980). Each replication consists of four rows. Eight seeds of each genotypes were grown in each block per row. Different moisture levels were maintained by watering the seedlings applied to each block at saturation level. Data for various seedling traits was recorded just after the appearance of first germinating plant. After eighteen days the seedling were uprooted carefully and washed in tap water to remove sand particles and blotted dried. Data on emergence percentage (E%), emergence index (EI), emergence rate index (ERI), fresh shoot length (cm), root/shoot (R/S) ratio, fresh root length (cm), fresh shoot weight (gm), fresh root weight (gm), dry shoot weight (gm) and dry root weight (gm) were recorded. Emergence percentage was calculated according to the formula Smith and Millet (1964).

$$E\% = \frac{\text{Seeding emerged in 18 day DAP}}{\text{Total number of seeds planted}} \times 100$$

Emergence index (EI) is an estimate of emergence rate for wheat cultivars in each replication and was calculated according to the formula suggested by Mock and Eberhart (1972).

$$EI = \frac{\sum(\text{Plants emerged in a day})\ (\text{DAP})}{\text{Plant emerged by 18 DAP}}$$

Where : DAP = Days after planting

Emergence rate index (ERI) for each cultivar in each treatment and replication was calculated as EI ratio to germination percentage:

$$ERI = EI/E\%$$

The root shoot ratio was calculated for each genotype within the replication by dividing the dry root weight with the dried shoot weight i.e.,

$$R/S = \text{Dried root weight/Dried shoot weight}$$

Statistical analysis: The data thus obtained were subjected to analysis of variance and simple correlation coefficient were calculated between seedling traits and their significance was tested by using t-test (Steel and Torrie, 1980), genetic components of variance (Robinson *et al.*, 1951) and heritability in broad sense (Burton and Devance, 1953).

Results and Discussion

Analysis of variance was performed for all the ten seedling traits as a prerequisite for measuring genetic diversity. According to the results (Table 1) difference among the genotypes were highly significant for most of the traits, indicating notable genetic variability among wheat genotypes. However non-significant differences were also existed for emergence index, root shoot ratio, fresh root length, fresh shoot weight, dry shoot weight and dry root weight. The non significant difference among treatment means for root shoot ratio and fresh root length were also observed, while other traits have significant difference ($P<0.01$). The main effect due to different moisture levels, genotypes and their interactions were significant for all traits except emergence index, fresh shoot weight and dry shoot weight at 5 and 1% level of probability respectively.

The C.V (%) magnitudes were found maximum for root shoot ratio, emergence rate index, fresh shoot weight and dry shoot weight per plant (90.49, 67.73, 66.49 and 61.31%) respectively. However the values of C.V (%) for emergence percentage, emergence index, fresh shoot length, fresh root length, fresh root weight and dry root weight were found to be lower. These findings are similar to Medhi and Asghar (1999). In agriculture experiment, this statistic is a good index of reliability of experiment. These estimates are frequently used by the breeder to ascertain the precision of traits in an experiment. Information about the genetic properties of the given population can be drawn from the relative magnitude of the components of variance. In general, the estimated of genetic variances were smaller than their respective phenotypic variance for all the seedling traits evaluated (Table 2). Likewise, estimates of genetic variance were greater than the estimated of environmental variances for most of the traits. The estimates of variance for E%, fresh shoot length and fresh root length were found higher in seedling traits, thus indicating the presence of greater genetic variability.

Information on heritability provides the relative practicability of selection for a particular character. The estimate of broad sense heritability are useful for predicting direct and correlated responses in the evaluation of genotypes for all traits. The estimates of broad sense heritability recorded from wheat genotype at different moisture levels were significant for emergence percentage, root/shoot, fresh shoot length, fresh root length, fresh shoot weight, dry shoot weight and dry root weight. These results were in agreement with Naheem and Medhi (1993). The estimate of broad sense heritability range from 33.56 to 99.9% (for emergence rate index, emergence percentage and fresh shoot length respectively) which suggested the selection for these traits will be effective.

The information on correlation permits the feasibility of indirect selection for various parameters. Such relationships provide useful information to the plant breeder in identifying traits that have little or no importance in selection programs. Simple correlation coefficient for all seedling traits were estimated (Table 3). The simple correlation coefficients of emergence percentage showed positive and significant correlation with emergence index, fresh shoot length, fresh root length, fresh shoot weight, fresh root weight, dry shoot weight and dry root weight whereas it was negatively and non-significantly correlated with emergence rate index ($r = -0.058$) and root shoot ratio ($r = -0.0779$). These results are in agreement with Medhi and Asghar (1999). Emergence index showed positive and non-significant correlation with emergence rate index, R/S and fresh root length, while other traits were highly significantly correlated with other traits in the study. Emergence rate index was positive and significantly correlated with R/S ($r = 0.3699$) and fresh shoot length ($r = -0.2527$), whereas other traits are negative and non-significantly correlated with emergence rate index except dry root weight was positive and non significant. However R/S was negative and significant correlation with fresh shoot length, fresh root length and fresh shoot weight, while other characters are negatively and non-significant correlated. Fresh shoot length was highly correlated with fresh shoot weight, fresh root weight and dry shoot weight, whereas fresh root lenght and dry root weight was were positive and non-significant $r = 0.01219$ and $r = 0.0697$ respectively. Fresh root length was positive and significant correlation with fresh rot weight, dry root weight, dry shoot weight and dry root weight. This predict that fresh root length have an importance in the breeding program for the improvement of other traits (Jafri *et al.*, 1991). It was also shown that fresh shoot weight was positive and significantly correlated with fresh root weight and dry shoot weight, while non significantly correlated with dry root weight ($r = 0.0071$). Fresh root weight was positively and significantly correlated with dry shoot weight and dry root weight, whereas dry shoot weight is non significant negative correlation with dry root weight.

The different parameters studied in the present investigation could

Table 1: Mean squares from analysis of variance of seedling traits in Wheat (*Triticum aestivum* L.) genotypes

		Traits									
SOV	df	E%	EI	ERI	R/S	FSL	FRL	FSW	FRW	DSW	DRW
Genotypes(G)	3	325.25**	0.23NS	0.017**	0.310NS	10477.85**	3.79NS	0.0025NS	0.0172**	0.000037NS	0.000014NS
Treatment (T)	3	14240.45**	4.64**	0.063**	0.972NS	10247.52**	90.008NS	0.086**	0.0160**	0.0006**	0.00035**
GXE	9	0.42*	0.27NS	0.0111*	6.69**	0.130**	6.877NS	0.0047NS	0.0170**	0.000003NS	0.0010**
Error	32	0.118	0.59	0.003	1.449	0.036	117.668	0.0085	0.0026	0.00006	0.000015

*** significant at $P<0.05$; ** significant at $p<0.01$ NS non-significant**

Where, E% = Emergence percentage, EI = Emergence index, ERI = Emergence rate index, R/S = Root shoot ratio, FSL = Fresh shoot length, FRL = Fresh root length, FSW = Fresh shoot weight, FRW = Fresh root weight, DSW = Dry shoot weight and DRW = Dry root weight

Table 2: Means (x) variance, coefficient of variation (CV%) genotypic variance ($\delta^2 g$), phenotypic variance ($\delta^2 p$) and broad sense heritability (h^2_{BS}) of seedling traits in four wheat genotypes at different moisture regimes

Traits	E%	EI	ERI	R/S	FSL	FRL	FSW	FRW	DSW	DRW
Means (x)	76.97	1.773	0.0406	0.6029	15.7344	10.0461	0.1152	0.0336	0.0137	0.0076
Variance	12.46	0.4569	0.0016	0.2977	6.4187	21.599	0.058	0.0001	7.1031	1.1137
CV%	45.86	38.12	67.73	90.49	50.91	35.13	66.49	41.36	61.31	43.42
$\delta^2 g$	108.467	0.1215	4.8195	0.3797	3492.609	37.9589	1.9748	4.8610	3.3743	3.5946
$\delta^2 p$	108.506	0.3197	14.3638	0.8629	3492.621	77.1815	4.8090	13.6036	5.51	8.8891
h^2_{BS}	0.999	0.3800	0.3356	0.4400	0.999	0.4918	0.4106	0.3573	0.6123	0.4040

Table 3: Simple correlation coefficients between seedling traits among four wheat genotypes

Traits	EI	ERI	R/S	FSL	FRL	FSW	FRW	DSW	DRW
E%	0.8146**	-0.058NS	-0.0779NS	0.7087**	0.6357**	0.6222**	0.5318**	0.4926**	0.2573*
EI	-	0.058NS	0.0868NS	0.6889**	0.118NS	0.5873**	0.6496**	0.4959**	0.3045*
ERI		-	0.3699*	-0.2527*	-0.0223NS	-0.0233NS	-0.308NS	-0.1596NS	0.1289NS
R/S			-	-0.388*	-0.8673**	-0.4359**	-0.0125NS	-0.1551NS	-0.124NS
FSL				-	0.01219NS	0.9587**	0.5736**	0.5540**	0.0697NS
FRL					-	0.5656**	0.8027**	0.4273**	0.5020**
FSW						-	0.5337**	0.5746**	0.0071NS
FRW							-	0.2321*	0.4891**
DSW								-	-0.148NS

*, ** = Significant at 0.05 and 0.01 probability levels, respectively; N.S= non-significant

be proved useful for screening wheat genotypes at seedling traits. High positive correlation (r= 0.9587) between fresh shoot length and fresh shoot weight and between E % and EI (r= 0.8146) and (r=0.8027) between fresh root length and fresh root weight was recorded which suggested that the selection for these traits will be effective in breeding program. While the estimates of broad sense heritability of genotypes at different moisture regimes were significant for most of the seedling traits like E%, R/S ratio fresh shoot length fresh shoot weight and dry root weight which suggested that selection for these traits will also be effective in future breeding program of wheat under rainfed areas.

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