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GENETIC DIVERSITY IN WHEAT UNDER DIFFERENT CROP-ECOLOGICAL ZONES

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Abstract

Wheat germplasm comprising of 150 diverse genotypes was evaluated for four quantitative traits at five locations throughout the country viz., Islamabad, Faisalabad, Quetta, Tandojam and Peshawer. Differences among locations as well as genotypes were significant and CV was higher in grain yield as compared to other characters. High genetic variance (σ^2) was observed at all the locations that revealed the scope of selection for crop improvement. High heritibility (h^2) was estimated for days to heading and plant height, medium for days to maturity and low for grain yield. Low heritability in grain yield might be due to high additive gene effects that is influenced by environments. Elite lines were identified for further utilization in the breeding programme. Limited scope of selection was observed for days to heading and days to maturity, hence genes for these important traits should be investigated or exploited from other sources i.e., hybridization, mutation. Large scale testing of broad base gene pool needs to be built up by making extensive collection and obtaining germplasm from abroad to develop a sound breeding programme.

Introduction

Wheat is one of the most important cereal crops of the world and staple food for a major part of the world cultivated under a wide range of agro-ecological conditions. It is grown throughout the world on approximately 33% of the land under cereals. Of the total area of 51 million acres of the Punjab, the barani tract occupies 28 million acres. Pakistan often spends a lot of foreign exchange on wheat import although this crop has enough potential to attain self-sufficiency (Anon., 2000). Management methodologies permit farmers of the world to produce grain yields of 10 t/ha (Pierre *et. al.,* 1998). Genetic improvement in quantitative traits depends on effective selection. In order to utilize germplasm efficiently and effectively, it is important to investigate the extent of genetic diversity they contain. Often times, evaluation may be regarded as an end in itself, but the best evaluation is one that relates to the plant breeders need.

It is poorly understood that how and to what extent, yield stability is modified. In Argentina, Australia, Italy and the UK, the decreases in stability related to the magnitude of yield increases. However, the decrease in yield stability in Argentina and Australia was less than for Italy and the UK, particularly during the last 30 years (Brancourt & Slinkard, 1998). A thorough understanding of the environments can improve the efficiency of breeding methods. The present study was conducted to evaluate germplasm at different crop ecological zone to select superior cultivars for future use in crop improvement.

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Table 1. Means squares for days to heading, days to maturity, plant height (cm) and grain yield of 150 genotypes of bread wheat evaluated at 5 locations.

Source	df	Mean squares			
		Days to heading	Days to maturity	Plant height	Grain yield
Locations	4	67088.93**	81454.22**	21172.76**	458287188**
Genotypes	149	106.26**	59.61**	237.04**	1253959**
Error (σ^2_e)	596	12.31	10.51	24.41	613312
σ^2_p		31.10	20.33	66.94	741441.34
σ^2_g		18.79	9.82	42.53	128129.46
h^2		0.60	0.48	0.64	0.17
GA		4.53	2.62	7.17	107.01
C.V %		3.33	2.27	4.98	19.75

σ^2_p Phenotypic variance, σ^2_g Genotypic variance, σ^2_e Environmental variance
h^2 Heritability (broad sense), GA Genetic advance, CV Coefficient of variation
* and ** are significant at 5% and 1%, respectively

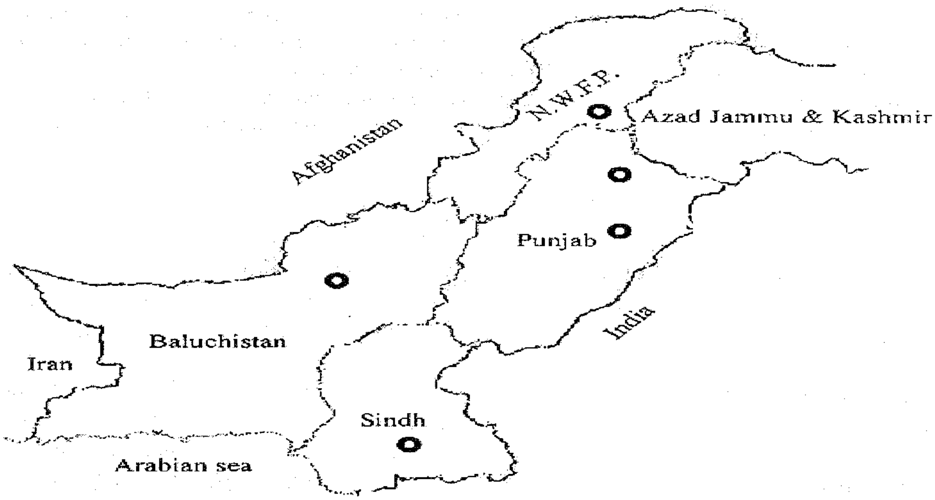

Fig. 1. Wheat germplasm evaluation sites in the country. The symbol O represents the site where experiments were conducted.

Materials and Methods

Wheat germplasm comprised of 150 diverse genotypes/varieties, developed/selected from exotic material by different breeders of various research institutes/stations. These genotypes were evaluated at five locations representing different crop ecological zones (Fig.1). Experiments were conducted in an augmented design under field conditions at five locations i.e., Islamabad (33.40 °N and 73.07 °E), Faisalabad (31.03 °N and 73.10 °E), Peshawar (34.0 °N and 72 °E), Tandojam (25.0 °N and 63.0 °E) and Quetta. Recommended cultural practices for specific ecological conditions were followed throughout the crop season. The data for days to heading and maturity were recorded on line basis and were represented by single value. Days to heading were recorded at 50% of heading, whereas days to maturity were observed when about 90% peduncles of the line plants turned yellowish. Plant height was taken as the mean of ten matured plants sampled randomly.

Samples were harvested two meter long from the center of each row for grain yield data. The harvested samples were threshed and grain yield was recorded in grams. Grain yield recorded on row basis was calculated @ Kg per hectare. Analysis of variance was employed to test significance among genotypes according to the method described by Steel & Torrie (1981) by using computer software "MSTATC".

Table 2. Identification of elite genotypes on the basis of four traits for averaged of five diversified ecological zone of the country.

Selection criteria	Range	*f*	Genotype code/cross
High yield potential	4501-5500 kg/ha.	19	V-90R34., BWL-311., WS-316., V-90R35., WS-365., F.134/CROW'S'., WS-11., CNO79* 2/PRL//CHILL., RAWAL-87., PGO/SERI., VEE//DOVE/BUC., SERI*3/ BUC., V-6., PFAU"S"/3/BB/GLL//CJ/3/ F.35-70 /Kal/BB/6/Vee#7., WL 711/BOW 'S'., BOW"S"/ CROW"S"., PSN/BOW//SERI., NR-2., URE'S'/BOW'S'
Early	Up to 100 days	10	Blue silver, RL 6043/4*NAC., B.Sil/KLT/3/ Condor'S'/ ANA75// Condor'S'/ MUS'S'., PARC-112-86/LU26S., GHK'S'// BLS/ KLT'S'., Parwaz., MERINO"S"/TLO"S"//ZEBRA32., LRG 2/LU26S*//LU26S., LU26/BOW'S'/3/CNO/HD832//HD832/BB., TRM//MAYA74'S'/MON'S
Short duration	Up to 140 days	19	Blue Silver., Parwaz., TRM//MAYA74'S'/MON'S., WL 711/BOW 'S'., BLS//F3.71/TRM., WL 711/BOW 'S'., LRG 2 / LU26S* //LU26S., F6.74/BUN//SIS/3/VEE#7., GHK'S'//BLS/KLT'S'., F3.71/TRM// VRE/VEE'S'., BWL-311., LU26/BOW'S'/3/CNO/HD832//HD832/BB., NR-6., RL 6043/4*NAC., KUFRA-T/3/CMH 74A.63015 //SERI 82 143., PAT10/ ALD'S'//PAT72300/3/PVN'S'/4/VEE#7., PARC 112/86/LU26S., PFAU"S"/3/BB/ GLL//CJ/3/ F.35-70 /Kal/ BB/6/Vee#7., NR-5
Short stature	Less than 91 cm	9	Hys/T2484-35 t-2t–1 t-CB 75-270., ND/VG9144//KAL/ BB/3/ YACO'S'/4/VEE#5'S'., WS-324., WS-298., LRG 2 / LU26S* //LU26S., CS/A.SCIRP//3*PVN'S'/3/MRL'S'/BUC'S'., BOW'S'/PRL'S'., GEN#3/ WHEATON., PAT10/ALD'S'//PAT72300/3/PVN'S'/4/VEE#7
Tall stature	111cm and above	10	NR-12., C 591., MERINO"S"/TLO"S"//ZEBRA32., V-90R34., V-90R08., V-90R02., NR-7., BUC"S"/FLK"S"//MYNA"S"/VUL"S"., NR-8., PAK 81/ WL711

f Frequency

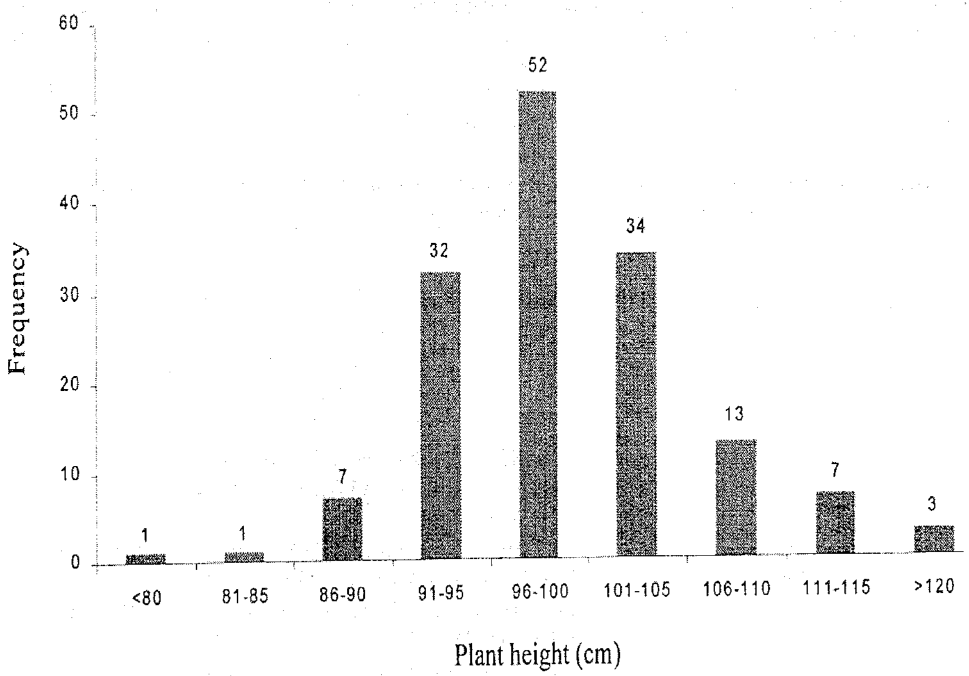

Fig. 2. Frequency distribution for plant height of 150 bread wheat genotypes.

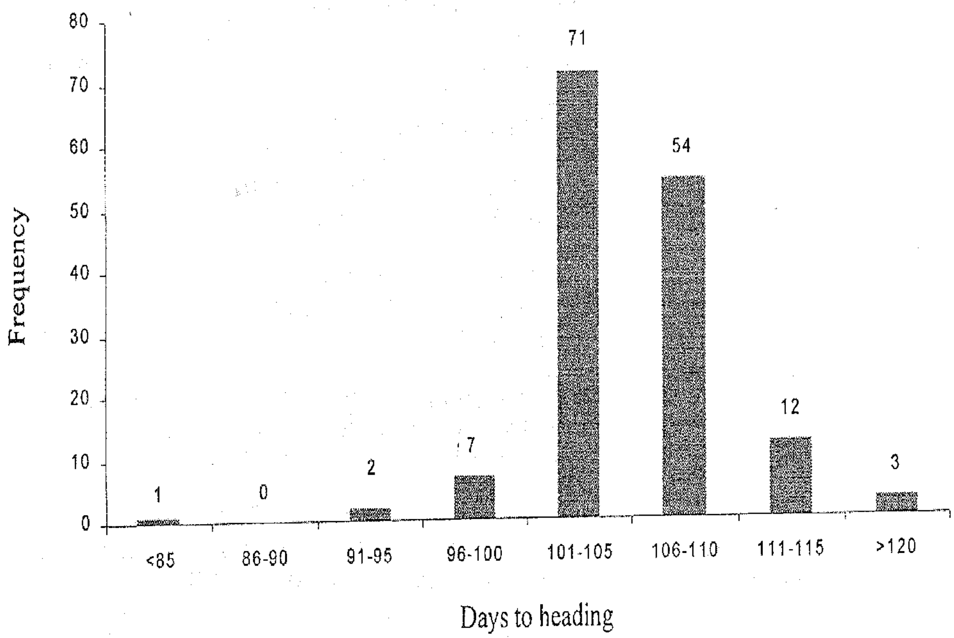

Fig. 3. Frequency distribution for days to heading of 150 bread wheat genotypes.

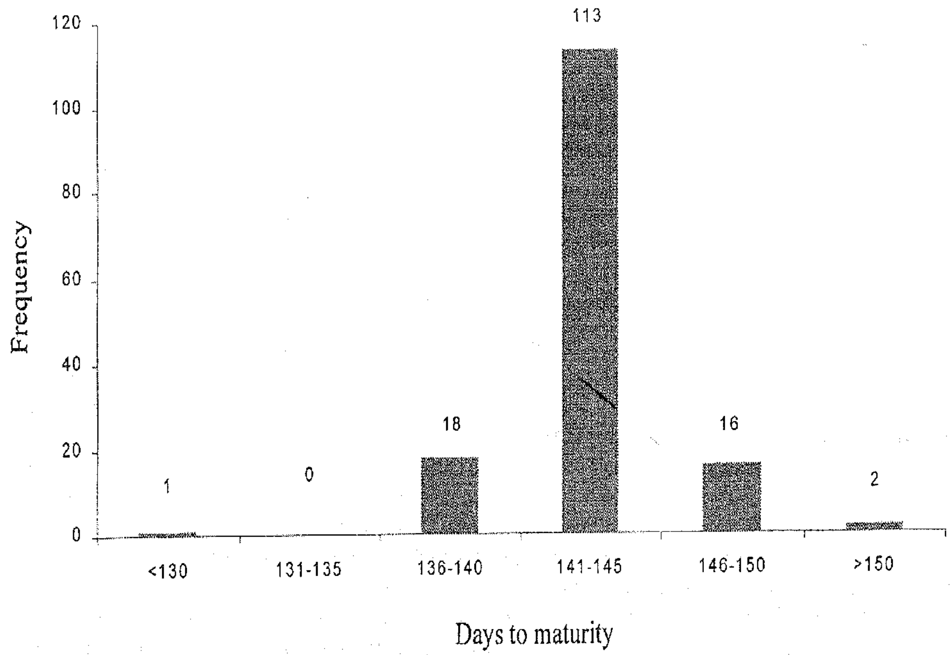

Fig. 4. Frequency distribution for day to maturity of 150 bread wheat genotypes.

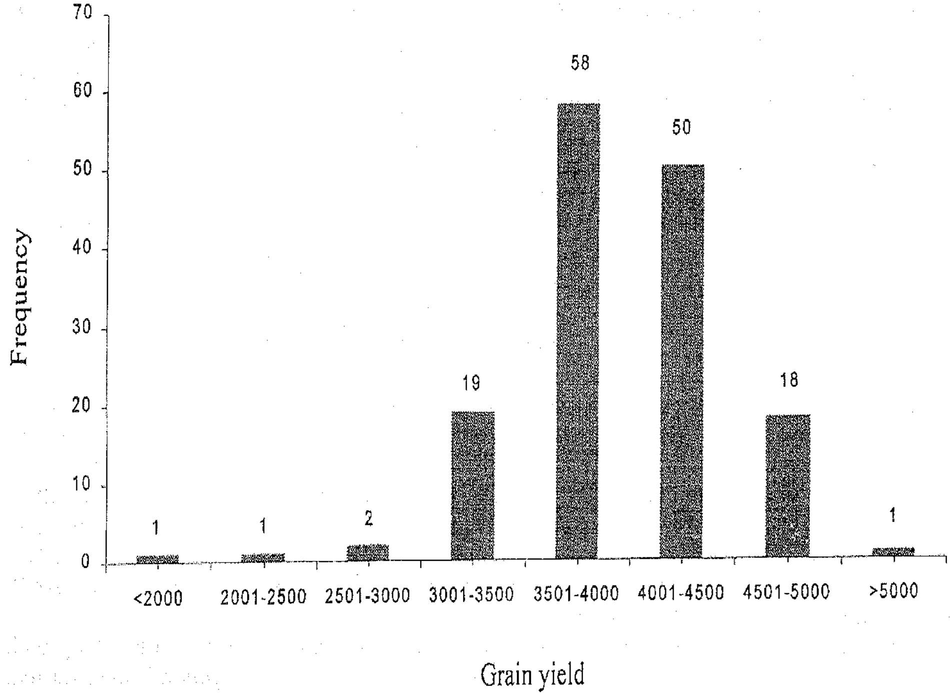

Fig. 5. Frequency distribution for grain yield Kg/ha. of 150 bread wheat genotypes.

Results and Discussion

Significant differences were observed for the traits at different locations under study (Table 1). Differences among genotypes were highly significant and coefficient of variability (CV) was higher in grain yield (19.75 %) as compared to plant height (4.98 %), days to heading (3.33 %), and days to maturity (2.27 %), respectively. The optimum values of CV revealed consistency of the experiments at five locations; hence the results obtained could be of wider acceptance. High heritability (broad sense) were observed for days to heading and plant height, whereas low to moderate heritability was observed for grain yield and days to maturity. Low heritibilities for grain yield might be due to high variation in experimental conditions. On the basis of performance, best genotypes were selected. The selected cultivars are suggested to be tested under replicated trials to find best ones (Table 2). The landraces of tetraploid wheat from two provinces (Shewa and Tigray) of Ethiopia were found to be distinctly different (Pecetti *et al.,* 1996). This divergence was attributed to the differences in environmental conditions between them. Wide differentiation among landraces within each province was also present. Brancourt (1999) used crop diagnosis, which was helpful to characterize the environments and also to select environmental variables. Such an approach succeeded in providing an agronomic explanation of genotype environment interaction and in defining the responses or parameters for each genotype and each environment.

Plant height ranged from 80 cm to 116 cm. The maximum number of genotypes (52) were in the range of 96 to 100 cm followed by 34 genotypes in the range of 101 to 105 cm and 32 were in the range of 91 to 95 cm (Fig. 2). Two genotypes (Hys/T2484-35 t-2 t–1 t-CB 75-270 and ND/VG9144//KAL/BB/3/YACO'S'/4/VEE#5'S') were less than 85cm in height. Three genotypes (NR-12, C 591 and MERINO"S"/TLO"S"//ZEBRA32) were of tall stature. These selected genotypes are suggested to be used in crossing programme for improving plant architecture. Maximum number of genotype (71) headed from 101 to 105 days followed by 54 genotypes in 106 to 110 days. Only one genotype, Blue silver headed less than 85 days (Fig. 3), whereas, three genotype (C 591, V-3 and Hys/T2484-35 t-2 t–1 t-CB 75-270) were late headed. For maturity, frequency distribution in graphic form ranged from 126 to 158 days. The maximum number of genotypes 113 matured in 141 to 145 days (Fig. 4). Grain yield ranged from 1910 to 5207 Kg ha^{-1}. Maximum (58) genotypes produced 3501 to 3500 Kg ha^{-1}, followed by 50 genotypes in the range of 4001 to 4500- Kg ha^{-1} (Fig. 5). One genotype, Hys/T2484-35 t-2 t–1 t-CB 75-270 produced very low yield and this was followed NR 14. Ninteen genotypes produced high yield above 4500 Kg ha^{-1} (Table 2).

In this study, wheat genotypes were obtained from different sources, evaluated under five diverse environments that revealed high genotypic variance and carefull selection gave rise to some promising genotypes as presented in Table 2. These selected genotypes are suggested to be tested under a wide range of environment in replicated trials to find out the best one. Tesemma *et al.*, (1998) have also described, testing of locations with different climatic and edaphic conditions, necessary for assessment of stability. Badhe *et al.*, (1998) studied 21 varieties of wheat along with four checks, at six locations for grain yield, 1000-grain weight and days to 50% heading.

The important yield traits, plant height, and grain yield exhibited high range along with high genetic variation on an average basis of five locations which, in general revealed that selection for these traits could be effective for crop improvement. For days to heading and days to maturity, low genetic variability seemed to limit the scope of selection in the present germplasm. Large scale testing of broad base gene pool needs to be built up by making extensive local collection and obtaining germplasm from abroad to develop a sound breeding programme (Ghafoor, 2001). Germplasm evaluation is the first step in plant breeding programme and it is commonly based on a simultaneous examination of a large number of populations for several characters both agronomic and physiological interest (Pezzotti *et al.* 1994).

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