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PHENOTYPIC DIVERSITY AND TRAIT ASSOCIATION IN BREAD WHEAT (*TRITICUM AESTIVUM* L.) LANDRACES FROM BALUCHISTAN, PAKISTAN

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Abstract

A total of 298 wheat landraces collected from Baluchistan province of Pakistan were used to estimate genetic variation for 12 quantitative characters. Substantial amount of genetic diversity was displayed for most of the characters studied. Mean values of landrace genotypes were compared with three improved cultivars. The landraces were, on average, later in days to heading, having more leaf area, and taller than the cultivars but had lower values for grain filling period, spike length, spikelets /spike, biological yield, grain yield and chlorophyll content. Days to heading correlated positively with days to physiological maturity, plant height and number of spikelets per spike but negatively with 1000-grain weight, biological yield and grain yield. The important trait grain yield was negatively correlated with all the characters in this study except 1000-grain weight and biological yield.

Introduction

Concerns are being expressed that yield plateau have been reached in major crop species including wheat. If further increases in food production per hectare are to be realized, improved management systems and cultivars, which respond to such cultural practices must be developed. The continuous supply of new germplasm material as donor of various genes of agronomic importance is an important prerequisite for further improvement of wheat cultivars (Chapman, 1985). This has been particularly evident in breeding for disease resistance (Negassa, 1986), tolerance to environmental stresses (Srivastava *et al*., 1988), adaptability (Bekele, 1983), quality characteristics (Blum *et al*., 1988) and higher yield potential (Kettata, 1987).

Duvick (1984) emphasized the need for broad-based germplasm pool as a mean of improving yield of major crops. Landraces of wheat undoubtedly, can contribute towards the development of such germplasm pools (Srivastava *et al*., 1988). A landrace is a mixture of different genotypes and evolved by natural and artificial selection under environmental conditions where they were grown. Although yield potential of these landraces is low (Ehdaie *et al*., 1988; Blum *et al*., 1989), their performance is usually stable. There is renewed interest in wheat landraces and primitive cultivars as an important source of genetic variation (Brush, 1995) mainly because of the trend toward greater uniformity that has narrowed the genetic base of modern wheat cultivars, thus increasing their vulnerability to biotic and abiotic stresses. The local germplasm is adapted to a wide range of environments and carry a large reservoir of useful genes (Williams, 1989). Jaradat (1991) reported considerable genotypic variation for developmental and yield characters among Jordanian wheat landraces. Belay *et al*., (1993) suggested that it may be possible to improve Ethiopian wheat landraces by indirect selection for increased number of tillers and kernel weight or direct selection for grain yield *perse*.

Wheat is the staple diet of the people of Pakistan. It contributes 12.1% to the value added in agriculture and 2.9% to GDP (Anon., 2001). At present, a large number of collections from Baluchistan province has been assembled in the gene bank of Plant Genetic Resources Institute (PGRI) at National Agricultural Research Centre (NARC), Islamabad. However, a thorough evaluation of these collections and a wider distribution of information on their characteristics needs to be undertaken to promote their effective utilization in breeding programs.

Due to the importance of landraces, their adaptation to stressful environment, their desirable quality characters, and lack of information about them, this study was undertaken to explore variability in landrace genotypes of wheat from different areas of Baluchistan. Analysis of genetic diversity in germplasm collections can facilitate reliable classification of accessions, and identification of subset of core accessions with possible utility for specific breeding purposes.

Materials and Methods

A set of 298 landrace genotypes of wheat collected from different parts of the province of Baluchistan were evaluated under field condition. Fig. 1 shows localities and number of wheat accessions collected. The experiment was planted in an augmented design at National Agricultural Research Centre, Islamabad. Three commercial wheat varieties viz., Chenab-97, Inqalab-91 and Margala-99 were used as check and repeated after every 20^{th} entry. A plot length was kept 4m long with row to row spacing of 25cm. Recommended agronomic practices were used to raise the crop. Observations were recorded on days to flowering, days to physiological maturity, grain filling period, plant height, spike length, number of spikelets per spike, leaf area, 1000 grain weight, chlorophyll content, biological yield, grain yield, harvest index, etc. Grain yield and biological yield was recorded from 1m area taken from the centre of the plot and used to calculate harvest index. Mean, minimum and maximum values were computed for each quantitative trait for the landrace genotypes and the improved varieties used as check. Frequency distributions for quantitative characters were calculated and presented graphically to classify the germplasm into different groups. Correlation coefficients (r) were determined between various characters.

Results and Discussion

Overall means, minimum and maximum values for 12 quantitative characters measured on 298 landrace genotypes and three check varieties are presented in Table 1. A significant amount of variation was displayed by these landraces as compared to the improved varieties for most of the traits studied. Maximum values for yield related traits (spike length, spikelets per spike, 1000-grain weight) exceeded those of the check varieties. These results suggest that high yielding genotypes can be selected based on these traits as suggested by Ramzan *et al*., (1994).

Days to 50% flowering ranged from 106 to 139 with a mean value of 124.90 days. A bulk of the lines (68.1% of the total) flowered in between 121 and 130 days (Fig. 2). Some of the accessions in this material were earlier than the check varieties hence can be used in breeding program to develop early maturing varieties. About 4% of the accessions were late in flowering and probably represent broader ecological adaptation. The range for physiological maturity was 148 to 170 with a mean value of 157.69 days. This trait is generally difficult to measure precisely because it is highly influenced by the environment such as temperature, soil and other factors.

Table 1. Minimum, maximum and overall means for 298 landraces and three improved varieties for different agronomic traits.

	Landraces			Improved varieties					
	Min.	Max.	Mean	Inqalab 91	Chakwal 97	Margalla 99	Min.	Max.	Mean
Days to flowering	106.00	139.00	124.90 ±0.34	117.75	119.00	121.00	117.00	122.00	119.23±0.50
Days to physiological maturity	148.00	170.00	157.69 ±0.24	155.00	154.80	154.75	153.00	159.00	154.85±0.46
Grain filling period	29.00	42.00	32.72± 0.12	37.25	35.80	33.75	32.00	42.00	35.62±0.67
Plant height (cm)	86.00	167.00	133.44± 0.90	101.50	107.40	113.85	96.60	116.20	107.57±1.72
Spike length (cm)	6.20	17.33	10.17± 0.11	10.08	11.83	12.54	8.53	15.50	11.51±0.52
Number of spikelets/spike	12.67	31.00	19.72 ±0.17	17.34	22.47	21.00	17.00	25.67	20.44±0.78
Leaf area (cm^2)	4.70	27.39	13.52 ±0.28	14.40	10.43	10.70	7.82	20.54	12.04±1.13
1000-grain weight (g)	15.80	47.40	32.05 ±0.32	31.30	31.21	32.60	26.55	35.15	31.50±0.90
Biological yield (g)	200.00	1100.00	507.23 ±8.78	600.00	770.00	712.50	450.00	1000.00	700.00±52.81
Grain yield (g)	30.48	282.25	105.01 ±2.80	167.05	195.98	213.43	87.55	312.71	192.45±18.49
Harvest index	9.14	28.08	19.01 ±0.26	27.62	24.80	31.96	13.47	50.92	27.87±2.38
Chlorophyll content	25.60	96.70	57.76±0.90	62.75	64.38	60.43	27.40	81.30	62.66±3.60

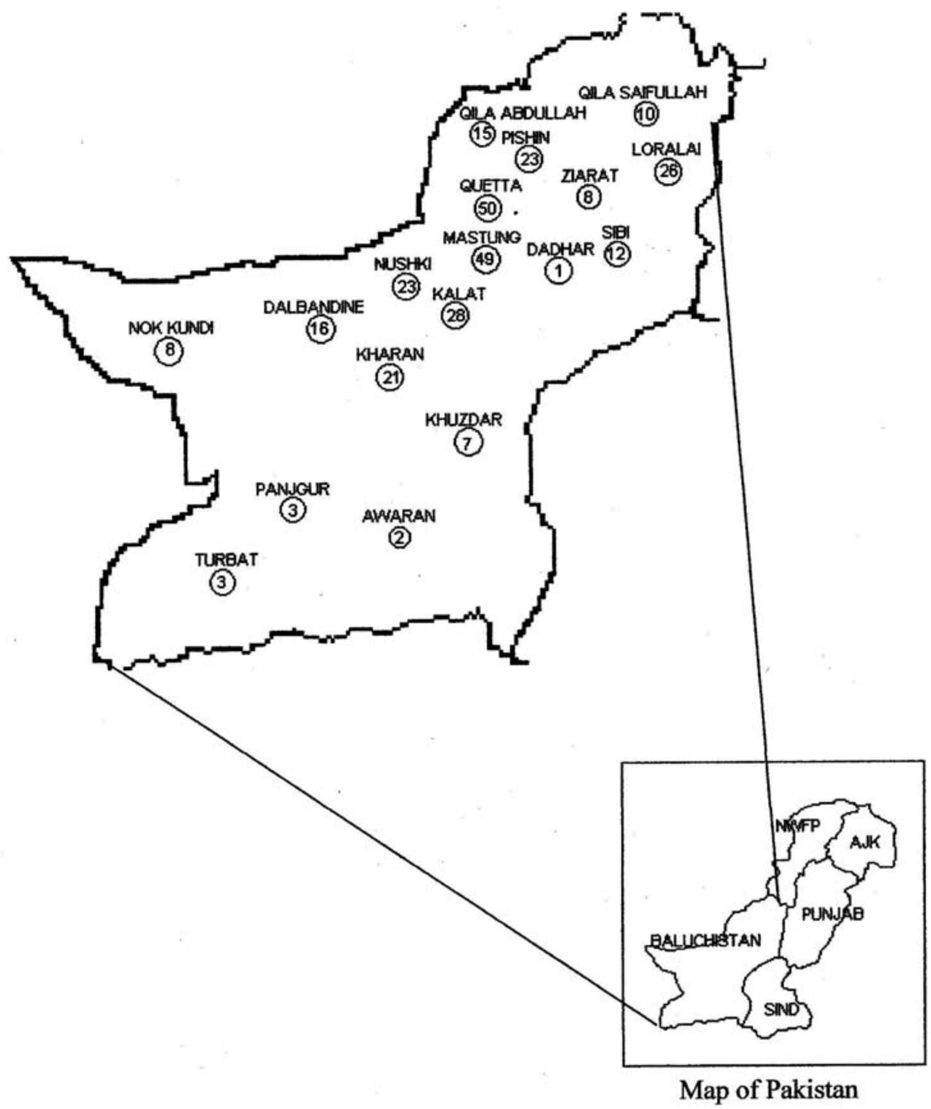
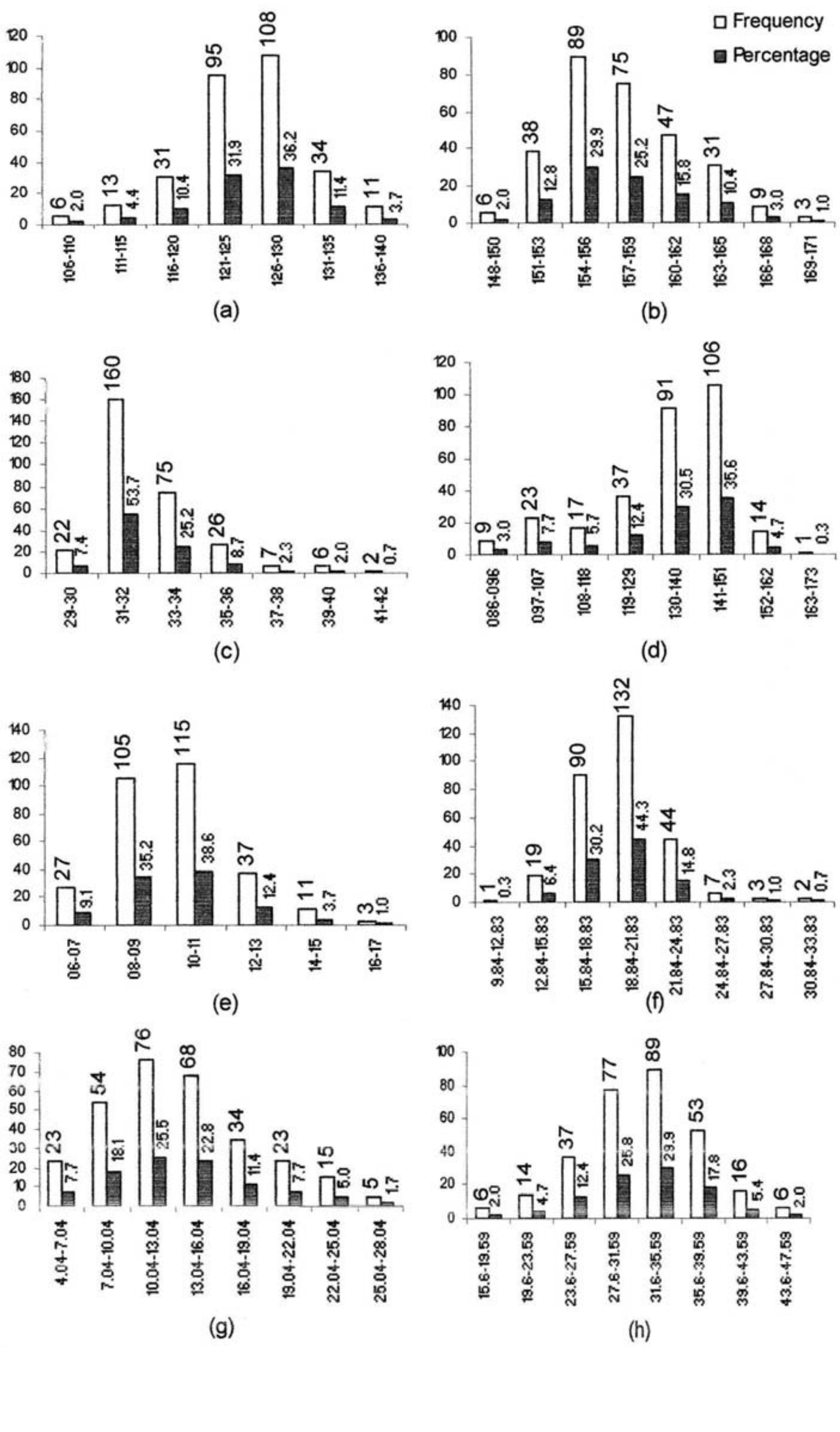


Fig. 1. Map of Baluchistan province showing localities and number of wheat accessions collected.

Grain filling period is an important trait in wheat that ultimately affects the overall grain yield by increasing seed weight. It ranged from 29 to 42 days with a mean value of 32.72, which is slightly lower than our commercial varieties (35.62±0.67). A longer grain filling period is one of the important criteria for selection in our breeding programs. A significant number of lines (41%) took 31-32 days to fill the grains. Plant height ranged between 86 and 167 cm with a mean value of 133.44 cm. Compared to commercial varieties, landrace genotypes were relatively taller in size than commercial cultivars. This is a typical feature of landraces, which excel in their capacity to support panicle growth by large stem reserve mobilization. Few short statured lines were identified which can be


Frequency
Percentage
106-110
111-115
116-120
121-125
126-130
131-135
136-140
(a)
148-150
151-153
154-156
157-159
160-162
163-165
166-168
169-171
(b)
29-30
31-32
33-34
35-36
37-38
39-40
41-42
(c)
086-096
097-107
108-118
119-129
130-140
141-151
152-162
163-173
(d)
06-07
08-09
10-11
12-13
14-15
16-17
(e)
9.84-12.83
12.84-15.83
15.84-18.83
18.84-21.83
21.84-24.83
24.84-27.83
27.84-30.83
30.84-33.83
(f)
4.04-7.04
7.04-10.04
10.04-13.04
13.04-16.04
16.04-19.04
19.04-22.04
22.04-25.04
25.04-28.04
(g)
15.6-19.59
19.6-23.59
23.6-27.59
27.6-31.59
31.6-35.59
35.6-39.59
39.6-43.59
43.6-47.59
(h)

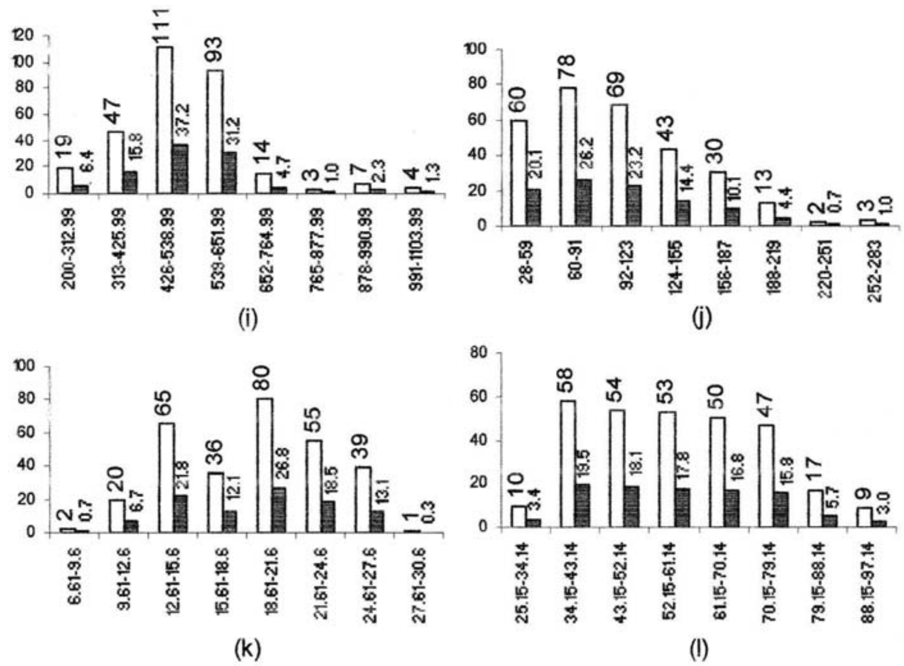


Fig. 2. Frequency distribution for (a) days to flowering, (b) days to physiological maturity, (c) grain filling period, (d) plant height, (e) spike length, (f) number of spikelets per spike, (g) leaf area, (h) thousand grain weight, (i) biological yield (j) grain yield (k) harvest index and (l) chlorophyll content.

further utilized to develop fertilizer responsive and lodging resistant wheat cultivars. Spike length is an important yield component. A wider range was observed for this trait (6.20 to 17.33) with a mean value of 10.17 cm, which is comparatively lower than the check varieties. It seems logical because all the varieties included as check were improved cultivars and have gone through a selection process before release. Number of spikelets per spike ranged from 12.67 to 31 with mean value of 19.72. Almost 45% of the lines were having spikelets of 18.84 to 21.83 (Fig. 1).

Leaf area is another important trait to be considered because of its contribution in photosynthetic activities. It ranged from 4.70 to 27.39 with a mean value of 13.52cm^2. A large leaf area development at early growth stage is thought to be a desirable character for better stand establishment, which ultimately affect the yield level. In this set of germplasm, 20 accessions (6.7%) were identified with leaf area of 22.04 to 28.04cm^2. The 1000-grain weight is one of the most important yield components. It ranged from 15.80 to 47.40 grams. The average 1000-grain weight was 32.05±0.3 grams in landrace genotypes, whereas some of the lines were having as high as 47.40g. These lines can be utilized as donor parents to improve seed weight which ultimately increase the yield level. A wider variation was observed for biological yield. To increase grain yield is the ultimate goal of all breeding programs. In this set of germplasm it ranged from 30.48 to 282.25g with a mean value of 105.00g. Some of the lines even surpassed the check varieties and could be employed to improve grain yield. Chlorophyll content ranged from 25.60 to 96.76 with a mean value of 57.70.The higher chlorophyll content is an indication ble 2. Correlation coefficients between 12 quantitative traits in landrace genotypes of wheat collected from Baluchistan, Pakistan.

D.F	DFM	GFP	Pl.ht	SL	NSS	LA	TGW	BY	GY	H.I
0.793**										
-0.173**	-0.037									
0.295**	0.048	-0.071								
0.101	0.297**	0.128*	-0. 003							
0.316**	0.430**	0.101	0. 058	0.580**						
-0.015	-0.018	-0.116*	-0. 055	-0.097	0.009					
-0.323**	-0.304**	-0.022	0.158**	-0.015	-0.085	0.101				
-0.285**	-0.303**	-0.055	0.146**	-0.163**	-0.167**	0.101	0.078			
-0.412**	-0.343**	0.107	-0. 036	-0.042	-0.081	-0.005	0.335**	0.662**		
0.142*	-0.024	-0.711**	0. 034	-0.263**	-0.211**	0.292**	0.059	0.088	-0.078	
0.170**	0.247**	0.181**	-0. 030	0.256**	0.279**	-0.175**	-0.080	-0.206**	-0.192	-0.35

ignificant at P=≤ 0.05 and 0.01 respectively

)ays to flowering, DFM-Days to physiological maturity, GFP, Grain filling period, Pl.ht-Plant height, SL-Spike length, NSS-Number of ts per spike, LA-Leaf area, TGW- 1000-Grain weight, BY-Biological yield, GY-Grain yield, H.I-Harvest Index, CC-Chlorophyll content.

Table 3. The selected accessions on the basis of best performance for quantitative traits.

Traits	Range	Accessions selected
Days to flowering	106-110 days	15765, 15781, 15794, 15675, 15780, 16870
Days to physiological maturity	148-150 days	15794, 15798, 15796, 15797, 15799, 15793
Grain filling period	38-39 days	15689, 15690, 15701, 15676, 15678, 15687, 15688
Plant height (cm)	86-93	15701, 15775, 15676, 15709, 15867
Spike length (cm)	16.03-17.33	15746, 16347, 15980
Number of spikelets per spike	28.00-31.00	16369, 16848, 15980, 15952, 15919
Leaf area (cm^2)	125.96-136.93	15709, 15936, 17247, 17248, 17596
1000-grain weight (g)	43.30-47.40	15798, 16848, 15695, 17302, 16346, 15794, 15775
Biological yield (g/plot)	1000-1100	15853, 15927, 16372, 16348
Grain yield (g)	258-282	15732, 16348, 16372
Harvest index	27.12-28.08	15675, 17287, 17288, 17289, 17319
Chlorophyll content	90.5-96.70	16354, 15770, 15781, 15771, 16370, 15782, 15671

of more photosynthetic rate that ultimately increase the grain yield. The variation exhibited by the 298 landraces in 12 quantitative traits indicates that selection for several of these characters might be effective. Accessions selected based on the best performance for various agronomic traits are given in Table 3. These wheat accessions could be the potential donor parents in breeding programs.

Correlation coefficients were computed among 12 quantitative traits (Table 2). Days to flowering was positively correlated with days to physiological maturity (r = 0.793), plant height (r = 0.295) and number of spikelets per spike (r = 0.316), but negatively associated with 1000-grain weight (r = -0.323), biological yield (r = -0.285), and grain yield (r=-0.412), suggesting that high temperature might have affected grain development negatively.

Plant height was positively correlated with 1000-grain weight and biological yield but had no correlation with all other traits measured. Number of spikelets per spike was negatively associated with biological yield (r = -0.167) and harvest index (r = -0.211). It is a physiological process that higher number of grains will increase competition for assimilate requirement hence the grain yield may be reduced. Spike length was positively and significantly correlated with number of spikelets/spike and chlorophyll content but negatively associated with biological yield and harvest index. The 1000-grain weight was positively and significantly associated with grain yield, while negatively correlated with days to flowering and maturity. A number of workers observed positive correlation between biological yield and grain yield (Villareal *et al.*, 1992; Jamali *et al.*, 2003.) The very important character of grain yield per plot was negatively correlated with all the characters with the exception of 1000-grain weight and biological yield. It is not known why some of the positive associations do not affect final yield in this environment.

Overall our results shows that wheat explored from Baluchistan province harbor a broad range of genetic variation. From the present study, a number of promising lines have been identified for specific traits that may have some potential value in wheat breeding programs.

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