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Characterization of Wheat (*Triticum aestivum* L.) Germplasm for Yield and Yield Attributing Traits

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There is a huge germplasm available in the genus *Triticum* which comprises vast number of wild relatives with different ploidy levels as well as domesticated wheat with different breeding lines from different locations all over the world. The objective of present study was to analyze the available germplasm collected from different locations within India (922 accessions) and characterize them for yield and yield attributing traits. The results yielded a wide range of variability for all the traits. On the basis of their comparison with standard checks, few accessions have been identified which can be used in breeding program for yield improvement.

Key Words: Characterization, Germplasm, Wheat, Yield

Introduction

Wheat (*Triticum aestivum* L.), being a crop of global significance, is grown in diversified environments. It is a staple food throughout the world. Growing population and industrialization has caused a gradual shrinkage in the acreage of agricultural land; this presents the enormous challenge of feeding the people using the restricted amount of land and water that is available today. Developing high yielding varieties is the top most priority of a breeder. In wheat, high yield coupled with better quality is the most desirable type for wheat growers across the country. Increasing yield is a generalized term as it accounts for improving various yield attributing characters as well as imparting resistance/tolerance against a wide range of biotic and abiotic stresses. Crop domestication practiced years ago has led to artificial selection accounting for decreased genetic variability. The challenging environment we are in, the use of genetic variability present naturally is a key to success of any breeding program, thus extensive use of genetic resources can do wonders in plant breeding research.

Yield is the foremost factor to be considered for acceptance by wheat growers. With the popularity of few high yielding varieties, the variability in farmer's field has been reduced to extreme extent. Moreover, these varieties have been developed form only six broad groups (Rao, 1988). Thus, its genetic base is already narrow which is further narrowing down. There is a need to break this trend of using less diverse wheat lines so that the genetic load can be shifted and better breeding lines can be developed by using more diverse parents. This requires collecting diverse lines from various locations, their conservation, evaluation and successful utilization in breeding programs. In this study, wheat germplasm was collected from different locations of India and its characterization is done for yield attributing traits so that useful genotypes are identified and will be used for the development of high yielding varieties.

Materials and Methods

Nine hundred twenty two wheat germplasm lines were obtained from National Bureau of Plant Genetic Resources (NBPGR), New Delhi, which belonged to different geographic locations within India, including Delhi, Haryana, Uttarakhand, Himachal Pradesh, Andhra Pradesh, Madhya Pradesh, Karnataka, Punjab and Sikkim (Fig. 1). The experiment was planned in an augmented design with four local checks *viz.,* PBW 343, Lok 1, GW 322 and Sonalika at G.B. Pant University of Agriculture and Technology (GBPUAT), Pantnagar, Uttarakhand during *rabi*, 2008-09 and 2009-10. Nine quantitative characters contributing for yield *viz.,* spikelet emergence, days to maturity, grain filling duration, plant height, spike length, spikelets/spike, grains/spike, 1000 grain weight and grain yield *per se* were recorded. All the quantitative observations on most of the characters were recorded on single plant basis except for spikelet emergence and days to maturity. Five representative plants from each plot were randomly selected and tagged for recording

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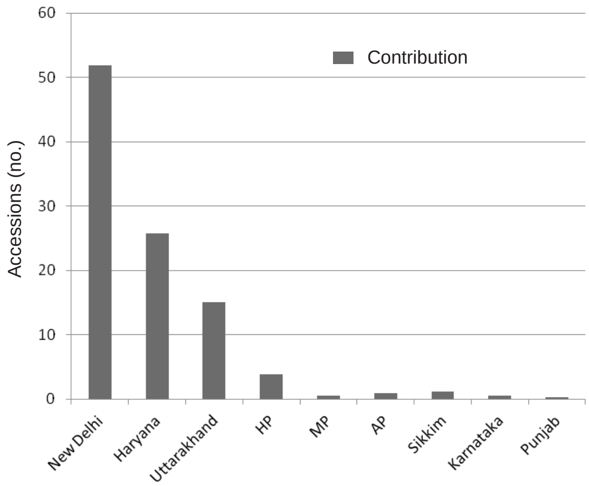

Fig. 1. Representation of accessions from different states

the observations on single plant basis. Average data from selected plants in respect of different characters were used for the statistical analyses.

Results and Discussion

The data was recorded for 922 accessions for nine quantitative traits. The analysis of variance revealed considerable inherent genetic differences among the material for all the traits under study (Table 1). The frequency distribution was found to be variable for the characters *viz.,* spikelet emergence (very early, early, medium, late, very late), days to maturity (early, medium, late), grain filling duration (long, medium, short), plant height (very tall, tall, medium, short, very short), spike length (long, medium, short), spikelets/spike (more, medium, less), grains/spike (more, medium, less), 1000-grain weight (bold, medium, small) and grain yield (very high, high, medium, low, very low) (Table 2).

The accessions were classified state-wise on the basis of the passport data available. Thus, there were nine geographic groups representing nine different states of India. Out of these groups the maximum contribution was from New Delhi (479) followed by Haryana (238) and Uttarakhand (139), whereas lowest contribution was from Punjab (3). Overall, the geographical distribution of the entire collection showed a disparity in the collection from different locations (states) (Fig. 1). However, this represented a wide distribution of wheat growing areas over the country. Same results in earlier studies were also obtained in chickpea germplasm collection that some parts of the geographic distributions were under represented (Upadhyaya *et al.,* 2001). The unequal representation of the accessions from different states may be the result of using well established improved varieties instead of landraces according to farmer's need. The poor representation of some states could also be attributed to the difficulties in collection from the fields, the political situations in the prospected areas or the socio-economic conditions of the farmers (Bhattarcharjee *et al.,* 2007)

Characterization of all the accessions was done on the basis of the frequency distribution of all the nine

Table 1. Analysis of variance for different characters

Source of variation	Degree of Freedom	Mean squares									
		Spikelet emergence	Days to maturity	Grain filling duration	Plant height	Spike length	Spikelets/ spike	Grains/ /spike	100-grain weight	Total grain weight	Grain yield
Block (b)	5	3.366**	1.175**	1.141**	10.072**	0.112**	0.075**	7.219**	0.018**	6.136**	27.068**
Check (c)	3	62.832	0.819**	53.819	61.509	1.863	28.880	230.210	0.009	64.270**	508.059
Error (e)	15	3.233	1.086	4.253	10.425	0.075	0.532	4.284	0.021	4.007	30.288

** significant at 1% level of probability
* significant at 5% level of probability

Table 2. Frequency distribution of different characters

Characters	Frequency distribution
Spikelet emergence (days)	Very early <70 (40), Early 70-80 (322), medium 81-90 (462), late 91-100 (49), Very late >100 (49)
Days to maturity (days)	Early <110(165), medium 110-130 (737), late >130 (20)
Grain filling duration (days)	Short <30(140), medium 30-40(586), long >40(196)
Plant height (cm)	Very tall >110cm(44), tall 89-110cm (309), intermediate 80-89cm (89), short 70-79cm (367), Very short <70cm (22)
Spike length (cm)	Short <10cm(46), medium 30-40cm(827), long >20cm (53)
Spikelets/spike (no.)	More >25 (7), medium 15-25(592), less <15 (323)
Grains/spike (no.)	Less <50 (684), medium 50-80 (231), more >80 (7)
1000 grains weight (g)	Small <20g(63), medium 20-40g (672), bold >40g(187)
Grain yield (g)	V high >700g (13), high 500-700g (166), medium 300-499g (200), low 100-299g (312), v low <100g (231)

characters (Table 2). For all the characters most of the accessions were found to fall under medium category except plant height, grains/spike and grain yield. The frequency distribution was studied and was found to be maximum for spikelet emergence (68-115 d), plant height (68-122 cm) and grain yield (20-800 g). Rest of the six characters were divided into three categories each for days to maturity (early, medium and late), grain filling duration (short, medium, long), spikelet length (short, medium, long), spikelets/spike (more, medium, less), grains/spike (more, medium, less) and 1000-grain weight, with values ranging from 108 to 142 for days to maturity, 10-66 for grain filling duration, 5.5 to 28.5 for spikelet length, 8.8 to 43.2 for spikelets/spike, 6 to 155 for grains/spike and 10.56 to 70 for 1000 grain weight (Tables 2 and 3). Pal *et al.* (2007) evaluated 150 wheat germplasm and selected few potential accessions and suggested their utilization in wheat improvement program. Range of frequency distribution was an indicator of coefficient of variation which was highest for grain yield (30.78) followed by grains/spike (27.57), spikelets/spike (25.00) and 1000-grain weight (23.11) (Table 3). This indicates that the data points for these characters are spread out over a large range of values. Spike length possessed lowest coefficient of variation (4.37) followed by spikelet emergence (9.56) indicating that they are very close to the mean. Coefficient of variation was used as an estimate to select superior genotypes from chickpea minicore collection by Parameshwarappa *et al.* (2012). The mean for grain yield (260.65) was found to be significantly superior over checks (105.93) which points towards the assumption that the accessions studied possesses good combinations of genes for better yield. As the diversity for yield was high it is obvious that there are few genotypes which have the high yield potential. Thus, these superior accessions were found out by calculating the differences in the means of checks and genotypes. This was further validated by subtracting the checks mean LSD so that the differences found were significant. Thus, 580 out of 922 accessions were significantly superior over check for grain yield, although most of these accessions are late maturing. Amulaka *et al.* (2013) characterized wheat germplasm for Russian wheat aphid and stem rust. Bux *et al.* (2012) also characterized 200 wheat germplasm for stripe rust. Upon correlating all the characters with grain yield, it was also found that maturity was positively correlated with grain yield with a correlation coefficient of 0.384 (Table 4). However, farmers are interested in varieties which have early maturity but there is compensation of yield too. Other characters were also classified on the basis of their performance over standard checks. This way the best performing accessions were selected for different trait. The superior accessions are presented in Table 5. Thus, based on preference, the accessions can be used in breeding program whether to breed for enhanced yield or for shortening of maturity without sacrificing yield.

Table 3. Mean, range and coefficient of variation for different characters in 922 wheat accessions

Characters	Mean	Range	Coefficient of variation
Spikelet emergence (days)	82.67	68-115	9.56
Days to maturity (days)	117.58	108-142	17.09
Grain filling duration (days)	34.91	10-66	16.38
Plant height (cm)	86.13	68-122	15.31
Spike length (cm)	16.09	5.5-28.5	4.37
Spikelets per spike (no.)	15.81	8.8-43.2	25.00
Grains per spike (no.)	40.59	6-155	27.57
1000-grain weight (g)	32.57	10.56-70	23.11
Grain yield (g)	260.65	20-800	30.78

Table 4. Correlation of grain yield with other traits

Characters	Correlation coefficient with grain yield
Days to heading	0.126
Days to maturity	0.384
Grain filling duration	0.118
Plant height	0.063
Spike length	0.030
Spikelets per spike	0.245
Grains per spike	0.142
1000-grain weight	0.040
Grain yield	1.000

Table 5. Promising accessions of wheat germplasm for different characters

Characters	Promising accessions
Spikelet emergence	IC535220, IC535223, IC535239, IC535541, IC535260, IC262042, IC535199, IC535226, IC535450, IC535228, IC535232, IC535452, IC535386, IC535505, IC535453, IC535488, IC26740, IC290074, IC535460, IC290023, IC290035, IC535236, IC535234, IC535377, IC25614, IC290073
Days to maturity	IC279439, IC535218, IC535445, IC535529, IC26734, IC535447, IC535532, IC290069, IC290080, IC290317, IC535523, IC47014, IC535527, IC535525, IC535528, IC535537, IC313148, IC260967, IC260970

Characters	Promising accessions
Grain filling duration	IC31774, IC290231, IC290023, IC290035, IC535220, IC535260, IC535199, IC535543, IC535239, IC535541, IC535228, IC535452, IC535386, IC535505, IC535453, IC535488, IC535460, IC255632, IC535236, IC535223, IC535226, IC535293, IC535234, IC25614, IC26728
Plant height	IC290271, IC535382, IC535400, IC535561, IC290304, IC535383, IC535358, IC290272, IC535381, IC535357, IC535217, IC31774, IC290046, IC535368, IC290247, IC535468, IC535414, IC535242, IC266884, IC535576, IC290324, IC535365, IC535331, IC535555, IC535360
Spike length	IC535374, IC535376, IC535525, IC535520, IC535198, IC47016, IC47011, IC290245, IC279336, IC535371, IC535383, IC535288, IC535305, IC, 35372, IC535202, IC290093, IC535438, IC535449, IC535516, IC313157, IC290265, IC290250, IC290227
Spikelets per spike	IC535415, IC260871, IC535543, IC535374, IC535368, IC535376, IC260941, IC41877, IC315871, IC535372, IC535576, IC36900, IC535303, IC316093, IC535297, IC535425, IC535492, IC535515, IC535575, IC28566, IC535554, IC535484, IC290305, IC316085, IC31529, IC310127, IC60939, IC290057
Grains per spike	IC535374, IC535372I, C260871I, C260870, IC535317, IC535376, IC535479, IC31614, IC266977, IC535338, IC535326, IC535268, IC535368, IC535474, IC41877, IC535521, IC535554, IC535266, IC535509, IC290026, IC535311, IC31615, IC535407, IC535269, IC535402, IC535365, IC535472
1000 grain weight	IC535438, IC535425, IC313152, IC535349, IC535396, IC535348, IC290260, IC290211, IC535404, IC535411, IC535397, IC290240, IC535344, IC535395, IC535299, IC535307, IC535483, IC535401, IC535449, IC535413, IC535507, IC535506, IC535476, IC535549
Grain yield	IC535552, IC535197, IC535239, IC535303, IC535309, IC535538, IC535546, IC535547, IC535569, IC535338, IC535220, IC535263, IC535274, IC535201, IC535259, IC53528, IC535296, IC535299, IC53532, IC535323, IC535324, IC535330, IC535335, IC535337, IC535436, IC535438, IC535496, IC535501, IC535549, IC535211, IC535286, IC535317, IC535401

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