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Morphological and Agronomical Characterization of Common Wheat Landraces (*Triticum aestivum* L.) Collected from Different Regions of India

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KEYWORDS

Genetic variation, Principal component analysis, Accessions, *Ex situ* conservation, Wheat (*Triticum aestivum* L.)

A B S T R A C T

The study of local germplasm and gathered knowledge about the extent of variability, the distribution and the relationship between species are a high value for the improvement and the efficient genetic diversity maintenance and utilization of plant species. The objective of this study was to assess the morphological and agronomic characteristics of original germplasm of common wheat (*Triticum aestivum* L.), maintained in *ex situ* collection in National Bureau of Plant Genetic Resources (NBPGR), New Delhi. Total of 200 accessions of wheat were planted under field condition and their agro-morphological characters such as plant shape (at tillering), leaf-flag attitude (at the beginning of heading), spike attitude (at full ripeness), spike awnedness, spike color, plant height, ear length and 1000 grain weight were recorded. Principal components (PC) analysis was carried out involving the traits i.e. plant height, ear length and 1000-grain weight. PC analysis was applied to group accessions according to similarity on the basis of three traits in two components in the factor plane. Seven accessions can be recommended as donors in the breeding selection of spring bread wheat. This approach helped in identification of top ranking wheat genotypes with high grain characters and also support efforts of conservation and utilization of landraces in winter bread wheat breeding programs.

Introduction

Genetic diversity of plants determines their potential for improved efficiency and hence their use for breeding, which eventually may result in enhanced food production (Ormoli et al. 2015). In the recent years increasingly recognize the importance of genetic resources on the prosperity of breeding selection, agriculture and ecology

(Stoyanova et al., 1998). Narrowing the range of genetic variation observed in the common wheat as a result of using of conventional breeding selection practices reducing the ability to improve productivity of crops (Hadjiivanova et al., 2010). By approaching the limits of biological productivity of wheat in the recent years has greatly increased the need of new initial material (Hailegiorgis, 2011; Graybosch and Peterson, 2010; Lanning et al., 2010). In this regard the formation of the current gene pool of wheat, its planned and targeted research has been and is a major priority in the researching activity. Genetic resources enable plant breeders to create novel plant gene combinations and select crop varieties more suited to the needs of diverse agricultural systems. A wealth of germplasm is accessible worldwide, with about 6 million accessions held in over 1400 gene banks (Hammer et al., 2003). Yet the collections are barely tapped (less than 1%) by breeders, owing to the scarcity of information on accessions other than their taxonomic status and geographical origin (Upadhyaya et al., 2006). Genome analysis tools provide access to thousands of polymorphisms, thus considerably broadening our capacity. Comprehensive evaluation of collections is a major source of information to create a database with assessment information of plant genetic diversity (Kolev, 2001; Angelova and Popova, 1998). The objective of this study was to assess the morphological and agronomic characteristics of original germplasm of common wheat (*Triticum aestivum L.)*, maintained in ex situ collection in NBPGR-India.

Materials and Methods

During the year 2010-11 and 2011-12 in the experimental field of Indian Agricultural Research Institute, New Delhi, 200 accessions of Indian wheat landraces were reproduced under field condition (Table 1). All accessions originating from India and are collected and cataloged by National Bureau of Plant Genetic Resources, New Delhi. Sowings were made in the optimal time for this area: day mean temperature 10 ^{o}C to 15 ^{o}C. Single row from each accession was raised with row spacing 20.5 cm and 1 m length. The standard variety Chinese spring was sown as a systematic check. Regular field management operations were performed during the cropping season. Observations and evaluations of morphological and agronomic traits were carried out according to international descriptors lists (Anonymous, 1984). The agronomic characters were taken after harvesting the plants. From each accession, 20 plants were collected for biometrical measurements.

Statistical analyses were performed using the statistical program SAS 9.0. PC-analysis was applied to group accessions according to similarity on the basis of three traits (plant height, ear length, 1000 grain weight) in two components in the factor plane.

Results and Discussion

Morphological characters

During the study, accessions were characterized by following morphological characters such as plant shape (at tillering), leaf-flag attitude (at the beginning of heading), spike attitude (at full ripeness), spike color and spike awnedness. According to the plant shape investigated accessions were divided into 4 groups i.e. semi-erect, drooping, strongly declined and prostrate (Table 2). The largest numbers of accessions were with drooping plant shape (140 accessions) and strongly declined (56 accessions). Only four accessions were with semi erect plant shape (Table 2). The flag leaf attitude of 15 accessions were semi upright (15-45°), 180 accessions were horizontal (45-90º) and only 5 accessions were shown dropping flag leaf attitude. Total of 80 accessions showed white color, 47 accessions showed red and 73 accessions were brown colored spike (Table 2). The largest numbers of accessions were with awned spike (120 accessions) and 24 accessions were awnless (Table 2).

Agronomic characters

The accessions were grouped and biometrical measurements in this study included: plant height, ear length and 1000 grain weight (Table 3- 6). The results show that the ear length in the study varied from 5 to 16 cm, for this character the highest value of 15.33 cm was observed in 1 accession (*LR-134*). Accessions with tall plants (111 to130 cm) and heavy kernels (1000 grain mass from 31 to 40 g) dominated this set of accessions (Table 3-6). The highest kernel weight (100 grain weight of 52 g) was recorded in 2 accessions (LR-22 and LR-76) having the plant height in the range of 109-100 cm. The basic statistics of the main descriptive characteristics (mean, minimum and maximum, std. error of means, std. deviation, variance and coefficient of variation) of three characters are shown in Table 7.

The values of coefficient of variation (C.V. %) are from 10.91 to 23.55 %. The analysis show that the most relative variable character during the period of study is the 1000 grain weight (23.55 %), followed by ear length (15.79 %) and plant height (10.91 %). The values of these coefficients confirm that these traits are more susceptible to change under the influence of different factors (Ali et al. 2009). Relatively the least variable for the period of study indicated the plant height.

PC analysis was applied to group accessions according to similarity on the basis of three traits as Plant height, ear length and 1000 grain weight in two components in the factor plane. PC analysis reflects the importance of the largest contributor to the total variation at each axis of differentiation (Sharma, 1998). The values of the two components to each of the study parameters were calculated empirically (Table 8).

The analysis shows that the first component explains 40.22 % of the total variation and the second 33.17 %. Two factors explain total 73.39 % of the variation in the dataset. This relatively high percentage illustrated the existence of correlation of components with the studied characters. For example the characters: plant height and ear length are associated with the first component. The second component is in correlation with 1000 grain weight (Table 8). The evaluation of phenotypic variability by multivariate analysis gives the possibility to include a large number of accessions and to identify the most suitable resources for special trait (Stoilova, 2007). Distribution of evaluated accessions in the coordinate system of PC1 and PC2, presents the grouping of accessions according to similarity of traits: plant height, ear length and 1000 grain weight (Fig 1).

The accession No. LR-105 in the upper right quadrant is characterized with higher 1000 grain weight (49 g), medium plant height (116 cm) and longer ear length (13 cm). Accession No. 145 located in the lower right quadrant is with medium plant height (126 cm), longer ear length (15.33 cm) and lower kernel weight (100 grain weght18 g).

Table.1 Inventory of 200 accessions of Indian wheat (*Triticum aestivum* L) landraces used in the study

S.No.	Accession number	Name	S.No.	Accession number	Name	S.No.	Accession number	Name	S.No.	Accession number	Name
1	IC - 532787	LR-1	51	IC - 532274	LR-51	101	IC - 41504	LR-101	151	IC - 532240	LR-151
2	IC - 82263	LR-2	52	IC - 532272	LR-52	102	IC - 55507	LR-102	152	IC - 532231	LR-152
3	IC - 79052	LR-3	53	IC - 532276	LR-53	103	IC - 55636	LR-103	153	IC - 532237	LR-153
4	IC - 82217	LR-4	54	IC - 532273	LR-54	104	IC - 532139	LR-104	154	IC - 532244	LR-154
5	IC - 82210	LR-5	55	IC - 532285	LR-55	105	IC - 79056	LR-105	155	IC - 532486	LR-155
6	IC - 82247	LR-6	56	IC - 532281	LR-56	106	IC - 79050	LR-106	156	IC - 532486	LR-156
7	IC - 79055	LR-7	57	IC - 532279	LR-57	107	IC - 79062	LR-107	157	IC - 532473	LR-157
8	IC - 79043	LR-8	58	IC - 78897	LR-58	108	IC - 79063	LR-108	158	IC - 532474	LR-158
9	IC - 79046	LR-9	59	IC - 532277	LR-59	109	IC - 79053	LR-109	159	IC - 532475	LR-159
10	IC - 82206	LR-10	60	IC - 532478	LR-60	110	IC - 532773	LR-110	160	IC - 534802	LR-160
11	IC - 79047	LR-11	61	IC - 532476	LR-61	111	IC - 75547	LR-111	161	IC - 534806	LR-161
12	IC - 532794	LR-12	62	IC - 532482	LR-62	112	IC - 79079	LR-112	162	IC - 534822	LR-162
13	IC - 82371	LR-13	63	IC - 532483	LR-63	113	IC - 79085	LR-113	163	IC - 534808	LR-163
14	IC - 532292	LR-14	64	IC - 534554	LR-64	114	IC - 79066	LR-114	164	IC - 534814	LR-164
15	IC - 82425	LR-15	65	IC - 534555	LR-65	115	IC - 79068	LR-115	165	IC - 534819	LR-165
16	IC - 532777	LR-16	66	IC - 534553	LR-66	116	IC - 79083	LR-116	166	IC - 534805	LR-166
17	IC - 532788	LR-17	67	IC - 534549	LR-67	117	IC - 79077	LR-117	167	IC - 534820	LR-167
18	IC - 532784	LR-18	68	IC - 534556	LR-68	118	IC - 532184	LR-118	168	IC - 534823	LR-168
19	IC - 532779	LR-19	69	IC - 532485	LR-69	119	IC - 532175	LR-119	169	IC - 82410	LR-169
20	IC - 82398	LR-20	70	IC - 82185	LR-70	120	IC - 82372	LR-120	170	IC - 532137	LR-170
21	IC - 532868	LR-21	71	IC - 82192	LR-71	121	IC - 532289	LR-121	171	IC - 78895	LR-171
22	IC - 532886	LR-22	72	IC - 82180	LR-72	122	IC - 532156	LR-122	172	IC - 532141	LR-172
23	IC - 532891	LR-23	73	IC - 82190	LR-73	123	IC - 532148	LR-123	173	IC - 532138	LR-173
24	IC - 532241	LR-24	74	IC - 532149	LR-74	124	IC - 532145	LR-124	174	IC - 532136	LR-174

25	IC - 532238	LR-25	75	IC - 82393	LR-75	125	IC - 532155	LR-125	175	IC - 532134	LR-175
26	IC - 532242	LR-26	76	IC - 532153	LR-76	126	IC - 532790	LR-126	176	IC - 532140	LR-176
27	IC - 532880	LR-27	77	IC - 82381	LR-77	127	IC - 532147	LR-127	177	IC - 532142	LR-177
28	IC - 532232	LR-28	78	IC - 532146	LR-78	128	IC - 532151	LR-128	178	IC - 78891	LR-178
29	IC - 534883	LR-29	79	IC - 532150	LR-79	129	IC - 82377	LR-129	179	IC - 532143	LR-179
30	IC - 532284	LR-30	80	IC - 79065	LR-80	130	IC - 534480	LR-130	180	IC - 532239	LR-180
31	IC -532297	LR-31	81	IC - 79090	LR-81	131	IC - 534524	LR-131	181	IC - 532872	LR-181
32	IC - 532298	LR-32	82	IC - 532492	LR-82	132	IC - 534481	LR-132	182	IC - 532811	LR-182
33	IC - 532309	LR-33	83	IC - 79067	LR-83	133	IC - 534543	LR-133	183	IC - 532935	LR-183
34	IC - 532318	LR-34	84	IC - 79080	LR-84	134	IC - 534534	LR-134	184	IC - 532805	LR-184
35	IC - 532310	LR-35	85	IC - 532497	LR-85	135	IC - 82187	LR-135	185	IC - 532807	LR-185
36	IC - 532286	LR-36	86	IC - 532495	LR-86	136	IC - 82198	LR-136	186	IC - 532923	LR-186
37	IC - 532267	LR-37	87	IC - 532487	LR-87	137	IC - 82193	LR-137	187	IC - 532910	LR-187
38	IC - 532271	LR-38	88	IC - 532490	LR-88	138	IC - 82189	LR-138	188	IC - 532930	LR-188
39	IC - 532697	LR-39	89	IC - 532489	LR-89	139	IC - 82200	LR-139	189	IC - 532934	LR-189
40	IC - 532290	LR-40	90	IC - 532089	LR-90	140	IC - 532258	LR-140	190	IC - 82303	LR-190
41	IC - 534886	LR-41	91	IC - 78899	LR-91	141	IC - 532699	LR-141	191	IC - 532698	LR-191
42	IC - 212142	LR-42	92	IC - 532095	LR-92	142	IC - 82440	LR-142	192	IC - 53502	LR-192
43	IC - 212145	LR-43	93	IC - 78877	LR-93	143	IC - 532261	LR-143	193	IC - 82338	LR-193
44	IC - 534885	LR-44	94	IC - 532094	LR-94	144	IC - 532262	LR-144	194	IC - 82286	LR-194
45	IC - 532144	LR-45	95	IC - 532096	LR-95	145	IC - 532265	LR-145	195	IC -82285	LR-195
46	IC - 212185	LR-46	96	IC - 532098	LR-96	146	IC - 532263	LR-146	196	IC - 82335	LR-196
47	IC - 534884	LR-47	97	IC - 532093	LR-97	147	IC - 532264	LR-147	197	IC -82432	LR-197
48	IC - 532097	LR-48	98	IC - 532090	LR-98	148	IC - 532268	LR-148	198	IC - 82385	LR-198
49	IC - 532092	LR-49	99	IC - 532091	LR-99	149	IC - 532259	LR-149	199	IC - 82426 A	LR-199
50	IC - 534887	LR-50	100	IC - 41597	LR-100	150	IC - 532243	LR-150	200	IC-79070	LR-200

Table.2 Summary of morphological characters of 200 accessions of Indian wheat landraces (*Triticum aestivum* L.)

Group	Semi-erect (25-45°)	drooping (46-55°)	strongly declinated (56-70°)	prostrate (>70°)
Total number of accessions	4	140	56	0
Leaf-flag-attitude				
Group	semi-upright (15-45°)	horizontal (46-90°)	drooping (91-135°)	very drooping (>135°)
Total number of accessions	15	180	5	0
Spike-attitude				
Group	white	red	brown	
Total number of accessions	80	47	73	
Spike-color				
Groups	absent	awnless <21mm	awned	
Total number of accessions for Spike-awnedness	56	24	120	

Table.3 Classification of 200 accessions of Indian wheat landraces according to their plant height

Class, cm	Frequency	Accessions
<70	0	-
70-80	2	LR-5 & LR-12
81-90	7	LR-4, LR-14, LR-64, LR-71, LR-136, LR-138 & LR-139
91-100	10	LR-8, LR-10, LR-84, LR-109, LR-114, LR-118, LR-137, LR-152, LR-154 & LR-164
101-110	20	LR -6, LR -9, LR -20, LR -21, LR-26, LR-29, LR-52, LR-54, LR-72, LR-74, LR-76, LR-78, LR-85, LR-103, LR-107, LR-131, LR-135, LR-162, LR-170 & LR-198
111-120	62	LR-7, LR-11, LR-12, LR-13, LR-17, LR-19, LR-22, LR-25, LR-28, LR-32, LR-36, LR-37, LR-41, LR-43, LR-56, LR-57, LR-58, LR-60, LR-61, LR-62, LR-63, LR-67, LR-81, LR-82, LR-94, LR-102, LR-104, LR-105, LR-106, LR-110, LR-111, LR-113, LR-116, LR-119, LR-121, LR-122, LR-124, LR-128, LR-129,LR-130,LR-132,LR-133,LR-134,LR-140, LR-141,LR-143,LR-150, LR-151, LR-163, LR-165, LR-166, LR-168, LR-176, LR-182, LR-183, LR-185, LR-186, LR-188, LR-193, LR-194, LR-199 & LR-200
121-130	75	LR-1, LR-2, LR-3, LR-15, LR-16, LR-18, L -24, LR-27, LR-30, LR-31, LR-33, LR-34, LR-35, LR-38, LR-39, LR-44, LR-45, LR-46, LR-47, LR-49, LR-51, LR-53, LR-55, LR-59, LR-65, LR-66, LR-68, LR-69, LR-70, LR-73, LR-75, LR-79, LR-83, LR-87, LR-89, LR-92, LR-93, LR-95, LR-96, LR-97, LR-98, LR-99, LR-100, LR-101, LR-115, LR-120, LR-125, LR-126, LR-142, LR-144, LR-145, LR-146, LR-147, LR-149, LR-153, LR-156, LR-157, LR-159, LR-160, LR-161, LR-167, LR-169, LR-172, LR-173, LR-175 & LR-177, LR-180, LR-181, LR-184, LR-189, LR-190, LR-191, LR-192, LR-196 & LR-197
131-140	19	LR-23, LR-40, LR-42, LR-48, LR-50, LR-77, LR-80, LR-86, LR-88, LR-90, LR-91, LR-108, LR-117, LR-123, LR-127, LR-158, LR-174, LR-179 & LR-187
141-150	5	LR-148, LR-155, LR-171, LR-174, LR-178 & LR-195
>150	0	-

Table.4 Classification of 200 accessions of Indian wheat landraces according to their ear length

Class, cm	Frequency	Accessions
< 5	0	-
5-9	51	LR-1, LR-3, LR-6, LR-10, LR-12, LR-13, LR-14, LR-16, LR-17, LR-19, LR-20, LR-21, LR-22, LR-25,LR-26,LR-29,LR-31,LR-32,LR-36,LR-41, LR-49, LR-54, LR-61, LR-64, LR-66, LR-71, LR-76, LR-78, LR-86, LR-102, LR-103, LR-111, LR-112, LR-119, LR-121, LR-22, LR-32,LR-140, LR-154, LR-163, LR-165, LR-166, LR-169, LR-172, LR-177, LR-184,LR-185, LR-188, LR-192, LR-193 & LR-200
10-14	132	LR-2, LR-4, LR-5,LR-7, LR-8, LR-9, LR-11, LR-15, LR-18, LR-23,LR-24, LR-27, LR-28, LR-30, LR-33, LR-34, LR-35, LR-37, LR-38, LR-39, LR-42, LR-43, LR-44, LR-45, LR-46, LR-47, LR-48, LR-50, LR-5, LR-52, LR-57, LR-58, LR-59, LR-60, LR-62, LR-63, LR-65, LR-68,LR-69,LR-72,LR-73, LR-74,LR-75,LR-77,LR-79,LR-80,LR-81,LR-82,LR-83, LR-84,LR-85, LR-87,LR-88,LR-89,LR-90,LR-91,LR-92,LR-93,LR-95,LR-96,LR-97, LR-8,LR-99,LR-100,LR-101,LR-104,LR-105,LR-106,LR-107,LR-108, LR-109, LR-110, LR-113, LR-114, LR-115, LR-116, LR-117, LR-118, LR-120, LR-123, LR-124, LR-125, LR-126, LR-128, LR-129, LR-130, LR-131, LR-135, LR-136, LR-139, LR-141, LR-142, LR-143, LR-146, LR-148, LR-149, LR-150, LR-151, LR-152, LR-153, LR-155, LR-156, LR-157, LR-158, LR-159, LR-160, LR-162, LR-164, LR-167, LR-168, LR-170, LR-171, LR-173, LR-174, LR-175, LR-176, LR-178, LR-179, LR-180, LR-182, LR-183, LR-186, LR-187, LR-189, LR-190, LR-191, LR-194, LR-195, LR-196, LR-197, LR-198 & LR-199
15-19	3	LR-134, LR-137 & LR-145
>19	0	-

Table.5 Classification of 200 accessions of Indian wheat landraces according to their 1000 grain weight

Class, g	Frequency	Accessions
< 10	0	-
10-20	18	LR-38, LR-101, LR-109, LR-142, LR-143, LR-144, LR-145, LR-146, LR-154, LR-182, LR-183, LR-184, LR-185, LR-186, LR-188, LR-190, LR-197 & LR-199
21-30	71	LR-129, LR-132, LR-133, LR-136, LR-138, LR-140, LR-141, LR-147, LR-148, LR-149, LR-150, LR-52, LR-155, LR-161, LR-163, LR-164, LR-170, LR-173, LR-174, LR-176, LR-177, LR-192 & LR-200
31-40	93	LR-1, LR-3, LR-4, LR-6, LR-7, LR-11, LR-13, LR-15, LR-21, LR-24, LR-25,LR-27, LR-28, LR-29, LR-30, LR-33, LR-35, LR-36, LR-37, LR-44, LR-48, LR-49, LR-51, LR-52, LR-54, LR-55, LR-56, LR-57, LR-58, LR-60, LR-62, LR-63, LR-67, LR-68, LR-69, LR-71, LR-72, LR-73, LR-74, LR-75, LR-77, LR-80, LR-81, LR-82, LR-84, LR-86, LR-87, LR-89, LR-90, LR-91, LR-94, LR-95, LR-96, LR-110, LR-113, LR-115, LR-116, LR-122, LR-123, LR-127, LR-128, LR-131, LR-134, LR-135, LR-137, LR-139, LR-151, LR-153, LR-156, LR-157, LR-158, LR-160, LR-162, LR-165, LR-166, LR-167, LR-168, LR-169, LR-171, LR-172, LR-175, LR-178, LR-179, LR-180, LR-181, LR-187, LR-189, LR-191, LR-193, LR-194, LR-195, LR-196 & LR-198
41-50	16	LR-9, LR-18, LR-19, LR-23, LR-50, LR-53, LR-59, LR-78, LR-85, LR-105, LR-111, LR-112, LR-114, LR-121, LR-130 & LR-159
51-60	2	LR-22 & LR-76
>60	0	-

Table.6 Biometrical descriptors of 200 accessions of Indian wheat (*Triticum aestivum* L) landraces

Plant height, cm		Ear length, cm		100 grain weight, g	
cm	**Total number of accessions**	**cm**	**Total number of accessions**	**g**	**Total number of accessions**
<70	0	< 5	0	< 10	0
70-80	2	5-9	51	10-20	18
81-90	7	10-14	132	21-30	71
91-100	10	15-19	3	31-40	93
101-110	20	>19	0	41-50	16
111-120	62			51-60	2
121-130	75			>60	0
131-140	19				
141-150	5				
>150	0				

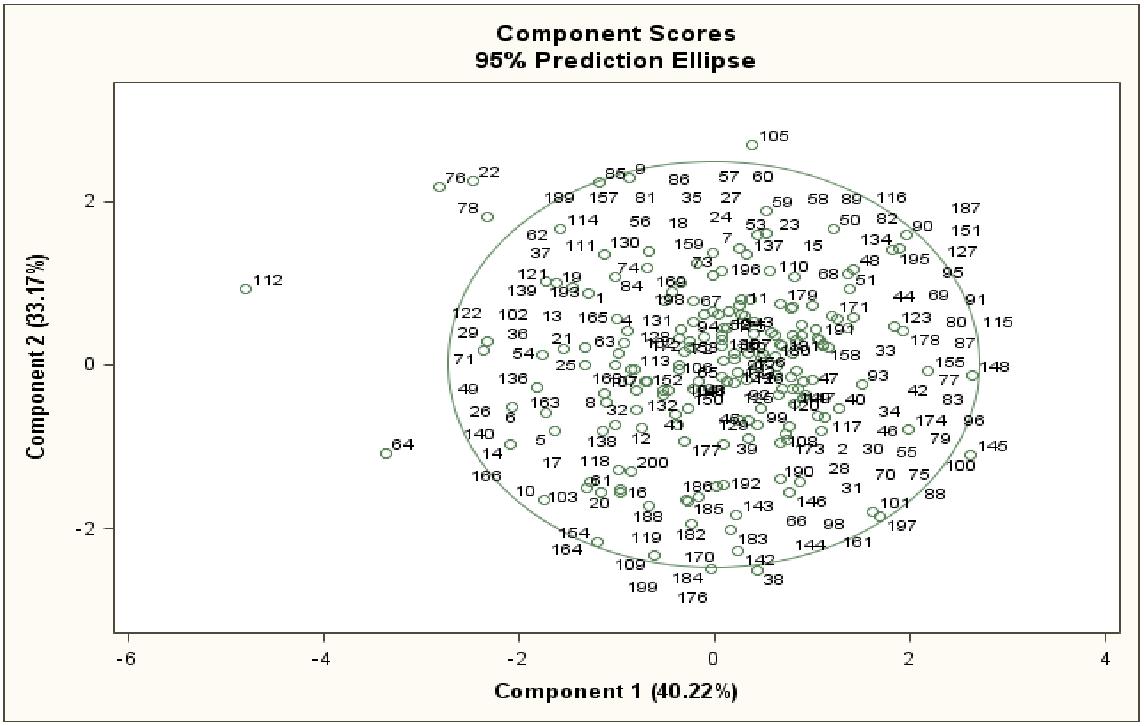
Table.7 The basic statistics of the main descriptive characteristics in accessions of Indian wheat (*Triticum aestivum* L) landraces

Parameters	Plant height, cm	Spike length, cm	1000 grain weight, g
Mean	118.58	10.70	31.10
Std. Error of Mean	0.92	0.12	0.52
Std. Deviation	12.94	1.69	7.31
Variance	167.49	2.84	53.42
Minimum	74	5.67	12.8
Maximum	142.67	16	51.6
Coefficient of variations, %	10.91	15.79	23.55

Table.8 Weighted factors (PC1 and PC2) of descriptive characteristics on the rotated matrix with two factors

Characters	PC1	PC2
Plant height, cm	0.702	0.054
Ear length, cm	0.688	0.206
1000 grain mass, g	-0.184	0.977

Fig.1 Distribution of evaluated accessions within the factor plane



The accessions presented with the conditional numbers 1-200 of the graph correspond to the description in Table 1

The accession LR-64 in the left lower quadrant is with the shorter plant height (88 cm), shorter ear length (6.33 cm) and medium 1000 grain weight (28 g), and The accessions no. 22, 76, 78 and 112 are located in the upper left quadrant, among them LR-22 and LR-76 have highest kernel weight (1000 grain weight 52 g) followed by LR-112 (1000 grain weight 44g) characterized with shortest plant height (74 cm) and shortest ear length (5.67 cm) and LR-78 (1000 grain weight 32 g). These accessions represent a certain interest to hybridization by different traits and can be recommended as donors in the breeding selection of spring bread wheat.

Conclusion

The present research provided information on genotype characteristics studied and its grouping. The most relative variable character during the period of study is the 1000 grain weight (23.55 %), followed by ear length (15.79 %). Relatively the least variable for the period of study indicated the Plant height (10.91 %). PC analysis was applied to group accessions according to similarity on the basis of three traits in two components in the factor plane. Accessions LR-22, LR-76, LR-78 (all 3 with heavy 1000 grain weight, 52 g), LR 112 (characterized with shortest plant height, 74 cm; and higher 1000 grain weight, 44 g), LR-105(with higher 1000 grain weight, 49 g), LR-145 (the highest ear length, 15.33 cm), and LR-64 (with shorter plant height, 88cm) can be recommended as donors in the breeding selection of spring bread wheat. PC analyses information of investigated accessions is useful for exploitation of the genetic resource available in the accessions studied.

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