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PHENOTYPIC CHARACTERIZATION OF WHEAT LANDRACES FROM MID AND FAR WESTERN DISTRICTS OF NEPAL

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Abstract

The study was conducted to evaluate phenotypic variation in one hundred and sixty six wheat landraces from mid and far western districts of Nepal. They were sown in randomized complete block design with two replications at National Wheat Research Program in 2014/15. The observed traits were analyzed using descriptive statistics and multivariate analysis using MINITAB v. 14. The results showed a wide range of phenotypic variability in observed parameters. The results also showed that the highest value of the standard deviation from mean (Sd) was for grain yield (±290.10) followed by plant height (±7.21). Among the traits the lowest deviation from mean (Sd) was for thousand grain weight TGW (±2.68). Wheat landraces grouped in four clusters depending on similarity of the studied traits. The results in this cluster, showed that days to maturity ranged from 97 to111 days, TGW ranged from 16 to17 gm, plant height ranged from 76 to 85 cm, and grain yield ranged from 2800 to 3000 Kg ha^{-1}. Wheat landraces under study are grouped depending on specific traits useful for wheat improvement program. Results of this study can be supportive to detect wheat landraces within species with similar traits. In addition it can be useful for sampling in successive studies and parental selection in wheat breeding program.

Key words: wheat landraces, phenotypic variation, parental selection

Introduction

Globally, wheat is grown in 217 million hectares with production of 671 million tons (FAO, 2013). China ranks on the top in wheat production (120 M tons) followed by India (94 M tons) and USA (61 M tons), whereas Nepal ranks in 37^{th} position (FAO, 2013). Wheat ranks third important crop after rice and maize, in terms of area and production, in Nepal. Wheat is cultivated in 0.75 Mha and the productivity is 2496 Kg ha^{-1}(ABPSD, 2013/14). So far, National Wheat Research Program has developed and the National Seed Board has released around 40 wheat varieties (NWRP, 2013/14). Many wheat landraces and ten wild relatives of wheat is found in Nepal (Mudwari, 1999). Nepal has locally adapted wheat landraces with better quality but none has been used crop improvement program. Such trends lead to genetic erosion of the wheat genetic diversity. So, the conservation, characterization, promotion and use of these genetic resources are of importance.

Traditional wheat varieties developed through the evolution and human selection comprises wheat landraces, which are of wide adaptive nature. The population structure of wheat landraces is an evolutionary approach to survival and performance, especially under arid and semi-arid growing conditions. Morphological data has an important role in the management of genetic resources that are conserved in ex-situ gene-banks (Sanchez et al., 2000).

Many tools like, phylogenetic analysis, molecular markers are now available to study relationships among and between genotypes, however, the firsthand information on morphological characterization is needed in the description and classification of germplasm (Smith and Smith, 1989). The study of morphological variability is useful tool to ascertain accessions with anticipated features such as earliness, disease resistance, and yield. These traits are important in the present scenario of the changing climate context. Likewise, study on the morphological variability on maize inbred lines revealed wide morphological variations, which were good characters for hybrid and synthetics breeding program (Shrestha, 2014).

The meteorological information revealed that the temperature during flowering period exceeded $28^{0}C$ in both locations (Regional Agriculture Research Station, Parwanipur and National Rice Research Program, Hardinath) and still the two lines (NL 1140 and BL 3978) performed well. Hence, these two wheat lines can be used directly as well as in the crossing program to breed more heat tolerant genotypes (Puri et al., 2015).

Multivariate analysis allows the use of all information available simultaneously. It has been used to measure the genetic association among the genotypes using morphological characters. For example, wheat (Bekele, 1984) and Cross (1992). Principal component analysis (PCA) is a multivariate technique for analyzing relationships among several quantitative variables. It reduces the dimensionality of multivariate data by ignoring the relationships among parameters. Eigenvectors of the correlation matrix are the coefficients of the principal components. Thus, each principal component is a linear combination of the original variables (Mutsaers et al., 1997). Similarly, Cluster analysis allocates a set of individuals to a set of mutually exclusive groups such that individuals within groups are similar to one another, while individuals in different groups are dissimilar (Cruz et al., 1999). Richness on wheat cultivars and traditional varieties should be considered for collection, conservation and utilization of wheat gene pools for the crop improvement program (Joshi et al., 2006).

In-sufficient work has been done to know-how the genetic structure of wheat landraces and the interspecific variability available in the existing agro-ecosystems, still dominate in parts of the old world. Therefore, the study was focused here on characterization of landraces, phenotypically.

Materials and Methods

Study Site and Experiment Details

One hundred and sixty six wheat landraces conserved and were planted under randomized complete block design at National Wheat Research Program, during winter season of 2014/15. Wheat landraces were sown on 19th December 2014. Each landrace was planted in 2 rows of 2 m length, and 25 cm row to row spacing, to assess their morphological variations. Geographically the station is located at 27^{0}32' North latitude and 83^{0}25' East longitude with the elevation of 104 masl. The climate is of sub-tropical type with three distinct seasons: summer, rainy and winter (NWRP, 2013/14). Fertilizer and irrigation were applied as per recommendations (Gautam et al., 2011).

Data collection and analysis

The observation was recorded for qualitative and quantitative traits. From each plot, five plants were randomly selected to collect the data, but whole plot was considered for grain and biomass yield. As, days to heading (DH), days to maturity (DM), thousand grain weight (TGW), grains per spike, plant height and grain yield. Collected data were subjected to descriptive statistics and multivariate analysis (cluster/dendrogram) was carried out using MINITAB v. 14 statistical software.

Results and Discussion

The results of the field study (Table 1) showed that mean of days to heading 74.9, days to maturity were 74.9 and 105.68, respectively. Also, mean of TGW, grains/spike, plant height and grain yields (Kg ha^{-1}) were 19.81, 25.96, 93.06 and 2158.30, respectively. Among the studied traits, the highest value of the standard deviation from mean (Sd) was for grain yield (±290.10) followed by plant height (±7.21). Among the traits the lowest deviation from mean (Sd) was for TGW (±2.68). The morphological variation is due to mainly genetic factors and also subjected to environmental factors. Tahmasebi et al. (2013) also reported significant amount of variability for different morphological traits in wheat landraces. Likewise, Sokolov and Guzhva (1997) also reported significant amount of variability for different morphological traits in other crops, like in maize inbred line populations. The information on diversity and relationships among the morphological traits will be helpful to breeders in constructing their breeding populations or lines and implementing selection strategies.

Similarly, the findings of this field study (Table 1) showed that among the tested wheat landraces in terms of the days to heading was lowest (69 days) in LGP 4, LGP 42, LGP 75, LGP 77, LGP 100 and LGP 145 and highest (89 days) in LGP 153 and LGP 166. , this long duration of wheat varieties might be due to early heat during grain filling period (Mondal et al., 2013). Wheat crop growth is highly dependent upon temperature regimes and an abrupt change in temperature; which tends to speed up the growth and vegetative stages leads the plant to shift to reproductive stage within short period of time, resulting in low yield. Under such situations, wheat varieties with shorter maturity or fast grain filling rate would be desirable (Mondal et al., 2013). Earliness in days to heading thereby, to maturity could of importance in developing wheat varieties with early maturity. Likewise, thousand grain weight (TGW) was lowest (14 gm) in LGP 31 and highest (27 gm) in LGP 45 and LGP 90. Natural and artificial selection creates diversity in wheat landraces (Belay et al., 1995). This results in the wide genetic base and can provide immense contribution to wheat improvement program (Tesemma et al., 1998).

Table 1. Mean morphological traits of 166 wheat landraces at NWRP, Bhairahawa in 2014/15

Code	Genotypes	DH (Days)	MD (Days)	TGW (gm)	Grains/spike (No.)	Plant height (cm)	Grain yield (Kg ha^{-1})
1	LGP 1	73	97	23	29	76.8	1826
2	LGP 2	71	97	22	30	75.6	1909
3	LGP 3	70	97	23	22	80.0	1826
4	LGP 4	69	97	19	23	83.0	2211
5	LGP 5	72	107	18	23	91.6	2333
6	LGP 6	73	103	19	34	94.0	2211
7	LGP 7	70	101	24	33	80.8	1750
8	LGP 8	74	100	25	27	107.4	1680
9	LGP 9	80	109	24	27	113.7	1750
10	LGP 10	79	108	21	30	106.9	2000
11	LGP 11	71	100	26	26	85.4	1615
12	LGP 12	73	98	25	28	96.9	1680
13	LGP 13	74	106	18	24	86.8	2333
14	LGP 14	71	101	25	28	88.6	1680
15	LGP 15	77	100	17	24	94.6	2471
16	LGP 16	81	101	15	26	86.6	2800
17	LGP 17	80	107	18	39	84.3	2333
18	LGP 18	80	109	17	24	90.9	2471
19	LGP 19	79	101	16	26	86.6	2625
20	LGP 20	74	101	22	28	83.5	1909
21	LGP 21	78	110	15	21	85.2	2800
22	LGP 22	73	101	24	27	90.0	1750
23	LGP 23	74	101	24	32	92.6	1750
24	LGP 24	73	101	20	30	90.9	2100
25	LGP 25	74	101	23	27	92.3	1826
26	LGP 26	74	100	22	38	93.2	1909
27	LGP 27	78	110	24	19	98.1	1750
28	LGP 28	74	101	22	22	91.9	1909
29	LGP 29	73	100	19	26	91.0	2211
30	LGP 30	71	99	19	28	90.6	2211
31	LGP 31	81	109	14	23	91.7	3000
32	LGP 32	74	99	18	33	84.9	2333
33	LGP 33	71	98	20	27	83.1	2100
34	LGP 34	74	97	16	29	84.9	2625
35	LGP 35	76	98	18	34	84.8	2333
36	LGP 36	79	110	18	23	87.3	2333
37	LGP 37	71	108	23	25	89.3	1826
38	LGP 38	75	101	17	30	100.9	2471
39	LGP 39	74	100	18	25	95.7	2333
40	LGP 40	71	99	21	27	101.6	2000
41	LGP 41	73	106	21	27	99.7	2000

Code	Genotypes	DH (Days)	MD (Days)	TGW (gm)	Grains/spike (No.)	Plant Height (cm)	Grain yield (Kg ha^{-1})
42	LGP 42	69	101	23	26	101.1	1826
43	LGP 43	75	101	20	27	99.9	2100
44	LGP 44	73	99	20	34	98.8	2100
45	LGP 45	70	107	27	39	91.4	1556
46	LGP 46	70	107	20	24	90.6	2100
47	LGP 47	73	109	17	21	95.3	2471
48	LGP 48	74	110	18	30	104.6	2333
49	LGP 49	75	111	24	28	95.7	1750
50	LGP 50	73	104	22	31	94.6	1909
51	LGP 51	73	106	19	27	92.9	2211
52	LGP 52	74	109	19	23	94.9	2211
53	LGP 53	73	105	22	34	95.7	1909
54	LGP 54	74	107	22	26	95.6	1909
55	LGP 55	74	105	24	21	97.4	1750
56	LGP 56	75	110	21	22	100.0	2000
57	LGP 57	72	105	21	30	94.2	2000
58	LGP 58	72	104	19	23	97.0	2211
59	LGP 59	73	105	23	24	97.1	1826
60	LGP 60	72	105	24	28	90.9	1750
61	LGP 61	73	105	22	34	96.1	1909
62	LGP 62	71	107	20	35	87.7	2100
63	LGP 63	74	107	20	37	95.6	2100
64	LGP 64	70	106	21	31	98.1	2000
65	LGP 65	74	107	22	35	97.4	1909
66	LGP 66	75	109	20	24	104.6	2100
67	LGP 67	74	108	20	29	101.4	2100
68	LGP 68	70	107	20	35	90.0	2100
69	LGP 69	72	105	22	29	91.9	1909
70	LGP 70	72	102	20	26	92.3	2100
71	LGP 71	79	108	20	30	93.8	2100
72	LGP 72	72	107	22	31	83.6	1909
73	LGP 73	75	106	20	20	91.6	2100
74	LGP 74	78	108	19	40	91.6	2211
75	LGP 75	69	102	20	33	80.9	2100
76	LGP 76	74	108	17	38	86.7	2471
77	LGP 77	69	105	17	15	77.6	2471
78	LGP 78	73	106	16	19	83.1	2625
79	LGP 79	73	109	20	23	90.3	2100
80	LGP 80	72	107	23	21	89.1	1826
81	LGP 81	74	109	23	26	93.5	1826

82	LGP 82	74	109	21	30	91.1	2000

Code	Genotypes	DH (Days)	MD (Days)	TGW (gm)	Grains/spike (No.)	Plant height (cm)	Grain yield (Kg ha^{-1})
83	LGP 83	74	109	23	35	93.2	1826
84	LGP 84	75	107	20	29	87.1	2100
85	LGP 85	74	109	19	27	90.9	2211
86	LGP 86	76	109	23	33	96.4	1826
87	LGP 87	75	110	20	30	99.9	2100
88	LGP 88	74	110	20	40	105.2	2100
89	LGP 89	74	110	25	24	103.3	1680
90	LGP 90	74	109	27	32	87.1	1556
91	LGP 91	72	109	21	24	90.3	2000
92	LGP 92	73	109	21	24	98.4	2000
93	LGP 93	76	108	23	26	91.4	1826
94	LGP 94	74	106	15	33	75.5	2800
95	LGP 95	78	109	25	24	97.8	1680
96	LGP 96	73	105	20	21	90.9	2100
97	LGP 97	75	107	17	28	89.6	2471
98	LGP 98	81	107	19	21	95.9	2211
99	LGP 99	72	106	17	26	85.6	2471
100	LGP 100	69	102	23	24	94.9	1826
101	LGP 101	73	102	17	24	86.6	2471
102	LGP 102	71	107	18	24	94.6	2333
103	LGP 103	78	108	20	23	98.1	2100
104	LGP 104	76	108	18	29	101.9	2333
105	LGP 105	73	107	20	28	98.8	2100
106	LGP 106	71	104	19	30	88.2	2211
107	LGP 107	75	108	15	27	99.6	2800
108	LGP 108	73	104	17	19	91.8	2471
109	LGP 109	75	109	20	27	91.6	2100
110	LGP 110	79	103	17	27	100.0	2471
111	LGP 111	73	102	16	26	89.1	2625
112	LGP 112	72	102	17	27	96.5	2471
113	LGP 113	75	107	16	19	97.3	2625
114	LGP 114	78	109	17	32	91.6	2471
115	LGP 115	75	107	17	27	91.4	2471
116	LGP 116	71	102	19	26	100.0	2211
117	LGP 117	74	105	20	33	98.0	2100
118	LGP 118	71	102	20	22	89.6	2100
119	LGP 119	75	105	18	24	96.5	2333
120	LGP 120	76	104	17	26	92.3	2471
121	LGP 121	78	110	17	21	99.3	2471
122	LGP 122	78	108	17	15	90.9	2471
123	LGP 123	77	110	19	16	94.2	2211

124	LGP 124	76	108	19	26	89.6	2211

Code	Genotypes	DH (Days)	MD (Days)	TGW (gm)	Grains/spike (No.)	Plant height (cm)	Grain yield (Kg ha^{-1})
125	LGP 125	77	105	20	22	96.4	2100
126	LGP 126	81	110	20	20	97.5	2100
127	LGP 127	75	110	23	21	81.9	1826
128	LGP 128	78	111	21	14	91.1	2000
129	LGP 129	83	111	17	20	90.0	2471
130	LGP 130	79	109	20	36	95.4	2100
131	LGP 131	75	106	17	26	91.3	2471
132	LGP 132	77	106	17	24	95.0	2471
133	LGP 133	77	104	19	24	92.2	2211
134	LGP 134	78	109	17	22	100.9	2471
135	LGP 135	75	102	15	26	95.9	2800
136	LGP 136	76	104	19	22	94.8	2211
137	LGP 137	77	108	20	24	94.8	2100
138	LGP 138	75	107	20	23	102.1	2100
139	LGP 139	77	107	20	25	104.1	2100
140	LGP 140	78	106	22	25	102.4	1909
141	LGP 141	82	109	23	15	109.6	1826
142	LGP 142	82	110	24	18	115.8	1750
143	LGP 143	76	109	20	29	96.4	2100
144	LGP 144	70	102	20	40	102.2	2100
145	LGP 145	69	104	20	29	99.3	2100
146	LGP 146	83	108	18	25	101.5	2333
147	LGP 147	80	109	22	20	91.4	1909
148	LGP 148	74	108	19	29	91.6	2211
149	LGP 149	74	109	17	23	101.5	2471
150	LGP 150	78	107	20	29	105.9	2100
151	LGP 151	76	106	20	31	94.2	2100
152	LGP 152	77	107	20	19	100.0	2100
153	LGP 153	85	110	17	21	105.0	2471
154	LGP 154	77	111	18	24	89.5	2333
155	LGP 155	78	111	18	14	82.6	2333
156	LGP 156	76	109	21	18	82.4	2000
157	LGP 157	78	107	17	17	88.1	2471
158	LGP 158	77	107	17	22	91.4	2471
159	LGP 159	75	106	19	21	93.5	2211
160	LGP 160	74	105	19	20	92.3	2211
161	LGP 161	83	109	16	21	87.1	2625
162	LGP 162	83	108	17	15	92.3	2471
163	LGP 163	80	109	16	11	82.9	2625
164	LGP 164	75	107	17	24	76.3	2471
165	LGP 165	74	102	18	22	78.3	2333
166	LGP 166	85	111	18	17	81.9	2333
Mean		74.90	105.68	19.81	25.96	93.06	2158.30
SE of Mean		0.26	0.29	0.21	0.46	0.56	22.50
Sd		±3.39	±3.70	±2.68	±5.98	±7.21	±290.10
CV (%)		4.52	3.50	13.53	13.03	7.75	13.44
Range		16	14	13	40	40.31	1444.40

SE: Standard error; Sd: Standard deviation; CV: Coefficient of variation

Cluster analysis

The clustering pattern of the wheat landraces (Figure 1), revealed that the wheat landraces showed considerable genetic diversity among themselves by forming 4 distinct clusters at 80% similarity level based on the phenotypic characters. Similar results were reported by Sonmezoglu et al., 2012. The number of wheat landraces in a cluster ranged from 44 in cluster I to 6 in cluster IV (Figure 1). Cluster I had 44 wheat landraces with early maturity (97-111 days).Wheat landraces with averaged TGW (19.81±2.68) ranging from 16-21gm were grouped into cluster II. Besides this, lower plant height (93.06±7.21) ranging from 76-105 cm was grouped in cluster III. Wheat landraces with highest grain yield (2158.30±290.10) ranging from 2800-3000 (Kg. ha^{-1}) were grouped in to Cluster IV.

The greater the difference between parents in individual components of yield, the greater the progeny variance. Crossing accessions belonging to different cluster could maximize opportunities for transgressive segregation. Because there is a higher probability that unrelated genotypes would contribute unique desirable alleles at different loci (Beer et al., 1993). Therefore the grouping of landraces by multivariate method in the present study would be of practical value to wheat breeders.

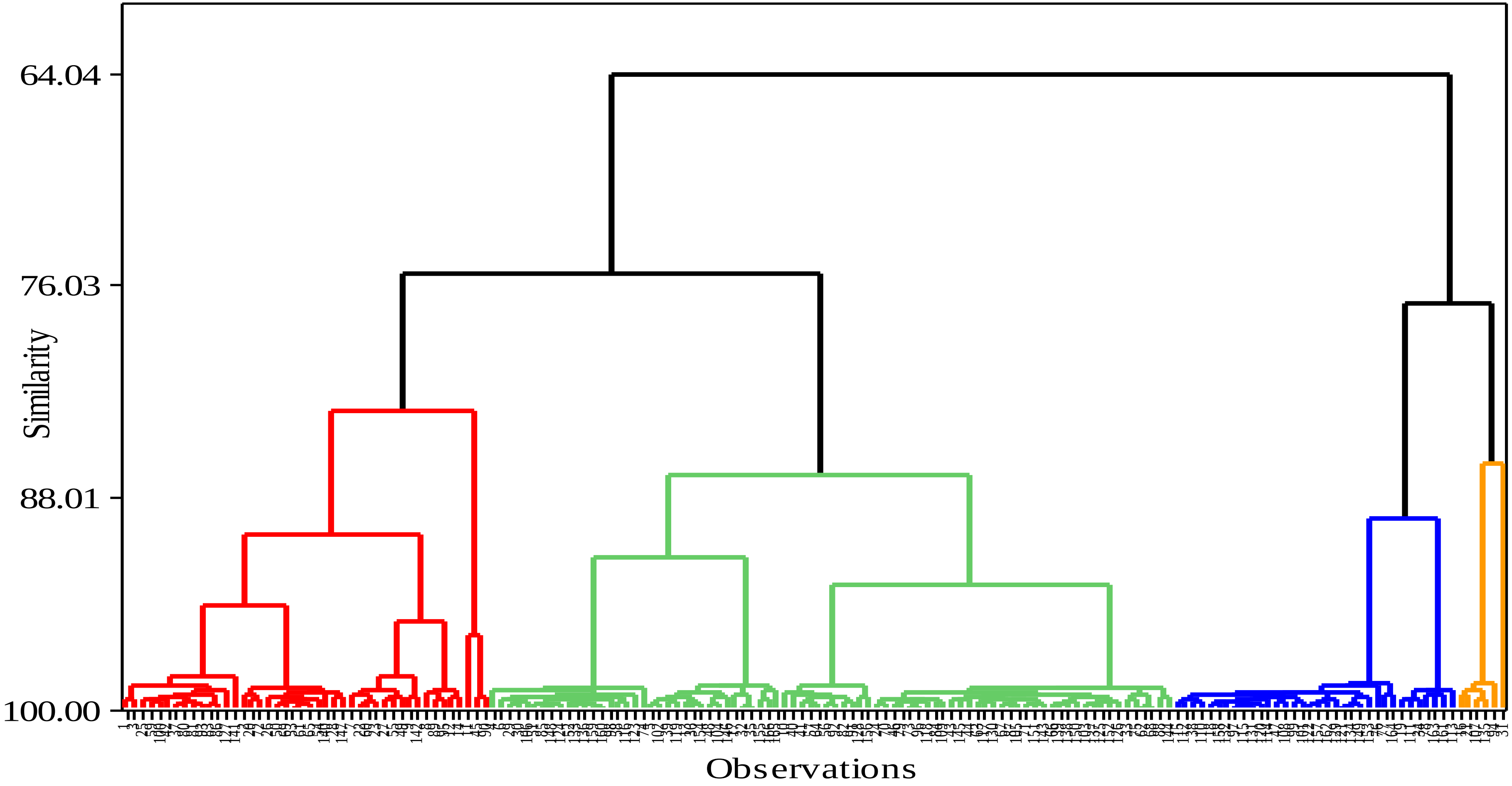

Figure 1. Cluster dendrogram showing the relationship among 166 wheat landraces based on phenotypic characters (Similarity level=80%) at NWRP, Bhairahawa, 2014/15.

Table 3. Clustering of wheat landraces (N=166) into four clusters based on phenotypic characterization at 80% similarity level, at NWRP, 2014/15

Cluster I(N=44) Days to maturity	Cluster II(N=82) TGW(gm)	Cluster III(N=34) Plant height (cm)	Cluster IV(N=6) Grain yield ($Kg.ha^{-1}$)
1, 3, 25, 59, 100, 42, 37, 80, 81, 93, 83, 86, 127, 141, 2, 20, 72, 26, 50, 69, 53, 61, 65, 54, 140, 28, 147, 7, 22, 60, 23, 27, 55, 49, 9, 142, 8, 89, 95, 12, 14, 11, 45, 90	4, 6, 29, 30, 106, 51, 85, 148, 124, 52, 133, 136, 159, 160, 98, 58, 116, 123, 74, 5, 102, 39, 119, 13, 36, 154, 48, 104, 146, 17, 32, 35, 155, 166, 165, 10, 40, 41, 57, 64, 56, 92, 82, 91, 128, 156, 24, 70, 46, 79, 73, 96, 118, 84, 109, 43, 145, 44, 63, 117, 130, 67, 87, 105, 71, 151, 143, 66, 139, 138, 150, 103, 137, 125, 152, 126, 33, 75, 62, 68, 88, 144	15, 112, 38, 110, 18, 158, 132, 97, 115, 131, 120, 114, 47, 108, 99, 101, 122, 157, 162, 129, 121, 134, 149, 153, 76, 77, 164, 19, 111, 34, 78, 163, 161, 113	16, 21, 107, 135, 94, 31

Conclusion

The morphological variability exists among the tested landraces are the sources for wheat breeding aspects. The varietal development from landraces is a practical strategy to improve the performance of crop in the farmers' field. The results showed that mean days to heading of the landraces were 74.9, mean days to maturity were 105.68. Similarly, mean TGW, grains/spike, plant height and grain yield (Kg ha^{-1}) were 19.81, 25.96, 93.06 and 2158.30, respectively. Among the studied traits, the highest deviation from mean (Sd) was for grain yield (±290.10) followed by plant height (±7.21). Among the traits the lowest deviation from mean (Sd) was for TGW (±2.68). Clustering these accessions can be helpful to identify accessions with similar traits which can be useful for sampling in subsequent studies and parental selection in breeding program. Therefore the grouping of accessions by multivariate method in the present study would be of practical value to wheat breeders. Earliness in wheat landraces grouped in cluster I can be used to cope with the terminal heat stress issues in the terrain region of Nepal. Likewise, breeding for lower plant height, higher grain yield can also be met by using the genetic resources as identified in the study.

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