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Diversity expressed by Wheat Germplasm under Temperate Srinagar (J & K) Conditions

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ABSTRACT
To know the expression of diversity, their extent and pattern, field evaluations of 119 indigenously collected wheat germplasm were conducted under temperate valley conditions at KD Research Farm of NBPGR, Regional Station Jammu and Kashmir, India, for two consecutive years. All together 14 traits were undertaken. To measure the diversity simple statistical tools like maximum, minimum and standard deviation were taken into account. Correlation study, principal component analysis and cluster analysis were performed. Excellent amount of diversity were expressed by the tested germplasms. Standard deviation showed highest variation in yield deciding factors, i.e., the biomass and gain yield. Correlation studies accord that no. of spikelets / spike had maximum influence with other traits of Kashmir Valley conditions. PCA bi-plot study showed less variation as compare to other traits. Cluster analysis suggested that plant height was significantly correlated with all the traits except no. of spikelets / spike. Excellent amount of diversity were expressed under temperate Kashmir valley conditions by the all the tested wheat germplasms various traits, which can be utilised as donor in the temperate wheat breeding program.

KEYWORDS
Diversity, Germplasms, Kmeans algorithm, PCA, Wheat

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INTRODUCTION

Wheat is one of the most important cereal crops, and plays a major role in agricultural produce to satisfy the global food demand. Wheat is second most important cereal crop after rice, where majority of the population fulfil their nutrition and calorie intake through cereal-based production system (Singh *et al*, 2017). By nature, wheat crop is a basically temperate crop and has potential in terms of production and productivity. Kashmir valley conditions in India come under geographically temperate zone but still very rare study were found on wheat production and potential for this region (Singh *et al*, 2021). Wheat crop by virtue of its potentiality is emerging as an important field crop under Kashmir valley conditions. It is a leading source of vegetable protein in human food with protein content of 12 to 18 percent and about 70 percent starch (Curtis *et al*, 2002). In Jammu and Kashmir wheat is cultivated nearly on 0.290 million ha with a production of 0.55 million tons with productivity 1.89 t ha^{-1}. Almost entire cultivation of wheat is concentrated in Jammu Division whereas in Kashmir Division, the cultivation is confined to some isolated pockets with total cultivation area 0.0076 million ha and production and productivity 63 thousand quintals and o.81 t ha^{-1} (Anonymous, 2017). The main reason of the low wheat area in Kashmir valley is the delay maturity of wheat due to prolonged winter- below base temperature- which coincides with transplanting period of rice.

There are several factors associated with low productivity of wheat in Kashmir valley; however, low yielding genotypes are one of them (Singh *et al*, 2021). In general, a farmer are avers to replace rice with wheat. Keeping these facts in view an experiment was designed to identify some short duration accessions of wheat which could be suitable low temperature as prevails in Kashmir valley. In this experiment the locations impact on genetic diversity and traits was regarded as a function of variety, as reported by Benadeki (1992). In hybridization programmes, the genetic distance was the process in Parental selection, as suitable parental selection was essential to increase potential yield, as reported by Islam (2004). Multivariate statistical tools like cluster analysis, principal component analysis were used for genetic diversity identification, parental selection and interactions with environmental interaction (Bhatt (1970); Carver *et al* (1987) ; Mohammadi and Prasanna (2003) ; Eivazi *et al* (2008). This field experiment was conducted with a broader objective to evaluate wheat germplasms explored and collected from India, to test its suitability in temperate condition under Kashmir valley.

MATERIALS AND METHODS

Total 119 accessions diverse germplasm of wheat were evaluated during winter seasons of 2001-02 and 2002-03 at K. D. Research Farm of NBPGR Regional Station Srinagar (34^0

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5'N, 74^0 8' E) located at 1605 m from mean sea level. All the wheat accessions were received from National Bureau of Plant Genetic Resources New Delhi (Table 1). The soil of experimental plots was silty clay loam, pH 7.1, available N 380 kg/ha, P_2O_5 11 kg/ha and K_2O 212 kg/ha. The organic carbon content was 0.75 percent. The treatments comprised of 30 accessions of wheat laid in augmentation design. The recommended fertilizer dose was 120:60:30 kg/ha (N: P_2O_5: K_2O) with 10 t/ha FYM were applied. FYM was applied at the time of field preparation and half dose of nitrogen and full dose of phosphorus and potassium was applied as basal while rest half nitrogen applied in two splits top dressing in 1^{st} week of March and 2^{nd} at booting stage. Sowing of wheat was done with row-to-row distances of 23 cm row distance. All the agronomic measures were adopted in raising and maintaining of healthy crop. Observation was taken from pre earmarked 1 m row length randomly at two places in each plot and converted into a unit area for statistical analysis using augmentation design. The necessary weather parameters of the location were taken from meteorological observatory of Srinagar. Weekly mean temperature was ranged between 7.81^0C to 29.41 ^{0}C (day maximum) and -5.5 ^{0}C to 13.53 ^{0}C (day minimum) during cropping period. The total season rainfall during cropping period was 636.3 mm; however, the maximum rainfall occurred only February and March, i.e., 376 mm. Total evaporation during cropping season was 461.9 mm whereas the relative humidity ranged between 65.57% to 92.43 % in morning and 43 % to 73 % in evening during cropping period. Average weekly bright sun shine hours were from 0.46 hrs to 10.63 hrs per day. The crop was grown completely in rainfed condition, as there was no irrigation facility. Data were collected for agro morphological traits, yield and yield attributes for both the years. Accordingly, pooled analysed was performed for the all the data recorded for both the years.

Table 1: Wheat germplasmevaluated at NBPGR Srinagar during (2001-02 and 2002-03) Pooled data for two years

Sr. No	Accession (IC No.)	Sr. No	Accession (IC No.)	Sr. No	Accession (IC No.)	Sr. No	Accession (IC No.)	Sr. No	Accession (IC No.)
1	82411	25	73571	49	29065	73	79520	97	78777
2	82424	26	73574	50	31616	74	79703	98	78779
3	82426	27	73575	51	35100	75	78976	99	78780
4	82435	28	73577	52	35130	76	78708	100	78787
5	82440	29	73579	53	35145	77	78111	101	78788
6	82442	30	73580	54	35152	78	78713	102	78793
7	82452	31	73884	55	35153	79	78722	103	78799
8	82453	32	73599	56	35155	80	78725	104	78810
9	82458	33	73645	57	35185	81	78726	105	78811
10	82526	34	76854	58	55716	82	78735	106	78813
11	82620	35	78700	59	57586	83	78737	107	78819
12	82796	36	78703	60	78994	84	78739	108	78821
13	82803	37	78705	61	79002	85	78741	109	78830
14	104652	38	78707	62	79007	86	78743	110	78835
15	104657	39	28532	63	79008	87	78744	111	78759
16	104698	40	28696	64	79105	88	78746	112	78878
17	63947	41	28835	65	79027	89	78748	113	78942
18	66518	42	28852	66	79031	90	78752	114	78947
19	73209	43	28871	67	79034	91	78754	115	78950
20	73214	44	28904	68	79047	92	78758	116	78956
21	73491	45	28908	69	79048	93	78765	117	78964
22	73493	46	28959	70	79050	94	78766	118	78968
23	73495	47	29023	71	79075	95	78768	119	78975
24	73498	48	29062	72	7983	96	78771		

RESULTS AND DISCUSSIONS

Results obtained after statistical analysis, were summarized in various tables and figures for the data collected, observations and recorded during filed experimentation; and analysed statistically to draw valid inference. The correlation, cluster and principal component analysis were performed on 119 wheat germplasm, reported in suitable tables. The data was normalized before analysis and correlation and cluster analysis were performed in SAS 9.3, and PCA was performed in R studio of version 3.5.0 software.

Diversity in wheat germplasm under Kashmir Valley condition

Results in Table 2 clearly vindicates that excellent amount of diversity was exhibited by the wheat germplasm with respect to all the traits recorded during filed evaluation in both the years. Highest variation was recoded in respect to biomass and wheat gain yield, as maximum standard deviation was recorded with these two yields deciding factors. The grouping of germplasms based on morphological traits similarity using cluster analysis may not include all the germplasms of same origin; there may be lack of association between morphometric traits and origin (Zubair *et al*, 2007; Ahmad *et al*, 2008; Ali *et al*, 2008).

Table 2: Extent of diversity in wheat germplasms under Kashmir valley condition

Traits	Traits Code	N	Mean	Std Dev	Minimum	Maximum
Plant Height (cm)	X1	119	78.35	10.20	54.10	98.50
Days to heading	X2	119	202.46	2.47	196.00	207.00
Days to anthesis	X3	119	208.46	2.47	202.00	213.00
Days taken to maturity	X4	119	239.51	2.16	235.00	243.00
No of Ear	X5	119	158.45	70.05	32.00	373.00
Spike length (cm)	X6	119	7.78	1.19	5.30	11.20
No of Spikelets / Spike	X7	119	15.70	10.53	9.80	128.00
Grains/spike	X8	119	43.13	5.24	29.00	58.00
Test Weight (g)	X9	119	48.54	2.13	44.00	52.00
Dry Wt./ Shoot	X10	119	3.84	0.15	3.55	4.25
Grain wt./shoot	X11	119	2.08	0.18	1.51	2.61
Biomass Yield (g/plant)	X12	119	614.26	281.95	113.90	1488.00
Grain Yield (g)	X13	119	335.46	158.50	49.90	840.70
HI	X14	119	0.54	0.04	0.42	0.00

Correlation study

Correlation analysis was carried out to know the proximity of one trait to another and their association and influences on each other, as well as to ascertain the impact and importance of individual traits in the performance of different wheat germplasms at temperate conditions of Srinagar Kashmir. Correlation analysis showed that 14 wheat features are correlated with 5% significance level while non-significant ($p<0.05$) correlation were observed, marked in bold (Table 3). Perusal of results revealed that no. of spikelets / spike has maximum influence and was influenced by other trats under present study. Correlation study suggest that if only one parameter has to be taken in to account while selecting wheat germplasms for temperate Kashmir valley condition is none other than no. of spikelets / spike.

Principal Component Analysis (PCA bi-plot) of wheat traits

The PCA bi-plot of wheat traits (Figure 1) showed less variation of no. of spikelets / spike i. e. X_7, while X_1, X_5, X_6, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13} and X_{14} were highly correlated with the first principal component (Dim 1), and contributed maximum to the characteristic variations. Principal component analysis (PCA) identifies the biggest contributor to the total variations at each of the principal components. The traits with largest absolute coefficients, i.e., closer to unity influence the clustering more than the lowest absolute coefficients closer to zero (Sharma 2013; Chahal and Gosal 2002). Here in this study grouping of germplasms into different clusters was due to their relative contributions.

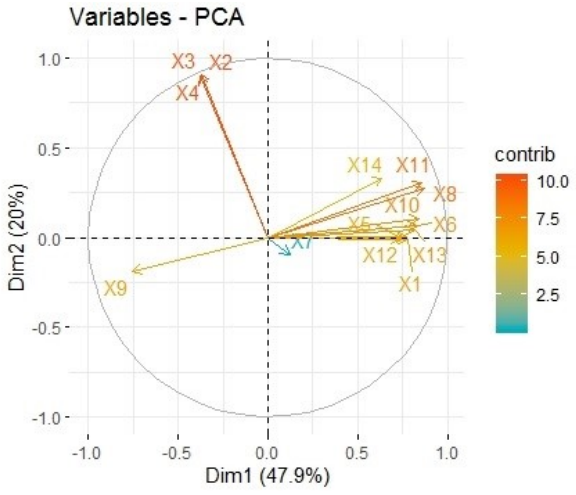

Fig. 1: PCA biplot of 14 wheat traits for 119 germplasms in Srinagar, India

Table 3: Correlation plot of 14 wheat traits of 119 germplasms

Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1	-0.23	-0.23	-0.24	0.63	0.63	**0.09**	0.54	-0.43	0.88	0.54	0.67	0.66	0.19
X2	-0.23	1	0.99	0.98	-0.19	-0.27	**-0.08**	**-0.14**	**0.17**	**-0.18**	**-0.1**	-0.19	-0.19	**-0.03**
X3	-0.23	0.99	1	0.98	-0.19	-0.27	**-0.08**	**-0.14**	**0.17**	**-0.18**	**-0.1**	-0.19	-0.19	**-0.03**
X4	-0.24	0.98	0.98	1	-0.18	-0.29	**-0.09**	**-0.15**	**0.18**	-0.2	**-0.12**	-0.19	-0.19	**-0.04**
X5	0.63	-0.19	-0.19	**-0.18**	1	0.42	**0.11**	0.41	-0.32	0.57	0.43	0.99	0.99	0.22
X6	0.63	-0.27	-0.27	-0.29	0.42	1	**0.09**	0.8	-0.72	0.74	0.77	0.46	0.51	0.56
X7	**0.09**	**-0.08**	**-0.08**	**-0.09**	**0.11**	**0.09**	1	**0.06**	**-0.09**	**0.07**	**0.04**	**0.11**	**0.1**	**0.001**
X8	0.54	**-0.14**	**-0.14**	**-0.15**	0.41	0.8	**0.06**	1	-0.89	0.71	0.97	0.45	0.53	0.85
X9	-0.43	**0.17**	**0.17**	**0.18**	-0.32	-0.72	**-0.09**	-0.89	1	-0.56	-0.76	-0.35	-0.42	-0.65
X10	0.88	**-0.18**	**-0.18**	-0.2	0.57	0.74	**0.07**	0.71	-0.56	1	0.71	0.62	0.64	0.33
X11	0.54	**-0.1**	**-0.1**	**-0.12**	0.43	0.77	**0.04**	0.97	-0.76	0.71	1	0.46	0.55	0.9
X12	0.67	-0.19	-0.19	-0.19	0.98	0.46	**0.11**	0.45	-0.35	0.62	0.46	1	0.99	0.24
X13	0.66	-0.19	-0.19	-0.19	0.99	0.51	**0.1**	0.53	-0.42	0.64	0.55	0.99	1	0.34
X14	0.19	-0.03	**-0.03**	**-0.04**	0.22	0.56	**0.001**	0.85	-0.65	0.33	0.9	0.24	0.34	1

The traits X_2, X_3 and X_4 were correlated with second principal component and contributed comparatively less. The PCA bi-plot for germplasms, presented in the Figures 2 and 1 , showed that only three types of contributions that supported the results of cluster analysis. Hence, these germplasms were categorised into three groups and X_1, X_5, X_6, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13} and X_{14} were the significant parameters that distinguished the three categories. This PCA with cluster analysis together allowed a natural type of grouping for wheat germplasms; however, different measurement techniques were also used for germplasms grouping (Bauer *et al*, 2007; Kraic *et al*, 2009) but cluster analysis with PCA showed more précised indicator of differences among the wheat germplasms than the cluster alone (Khodadadi *et al*, 2011).

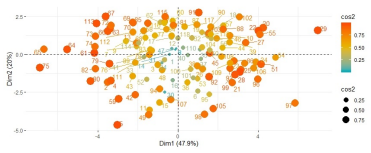

Fig. 2: PCA biplot showing the importance of 119 wheat germplasms and grouped in to three categories based on their traits in Srinagar, India

Cluster analysis

Plant height (X_1) is significantly correlated with all the traits except no. of spikelets / spike (X7). All 119 germplasms data are grouped based on their 14 characters analysed through K-means algorithm. Three clusters explain the distribution of all the germplasms (Fig. 3). These germplasms were further analysed through PCA. Three principal components explain about 82.08% variation in data sets. First principal component explains 47.9%, while second and third are 20% and 12.18% variation, respectively. Here only three principal components were taken based on their eigen values >1. Genetic diversity evaluation could be a suitable approach for selection of suitable genotype having desirable traits which could lead to improvement in wheat productivity and this will ultimately lead to an increase in food production to fulfil food and nutritional security of the ever-growing populations, especially in the Temperate valley conditions of Srinagar (Singh *et al*, 2015). Cluster analysis showed that there are three significant ($p<0.05$) distinct clusters were made for all the cultivated 119 wheat germplasms. All the wheat traits showed its significance ($p<0.05$) except X7(No of Spikelets/Spike) of wheat germplasms

CONCLUSION

Based upon foregone discussion, as per the results obtained in this field evaluation of wheat germplasm, it can be concluded that excellent diversity was expressed by the all 119 accessions for one or other yield and yield attributing traits. Crop improvement worker engaged in the wheat improvement can select this germplasm as giver parent for their upcoming breeding program.

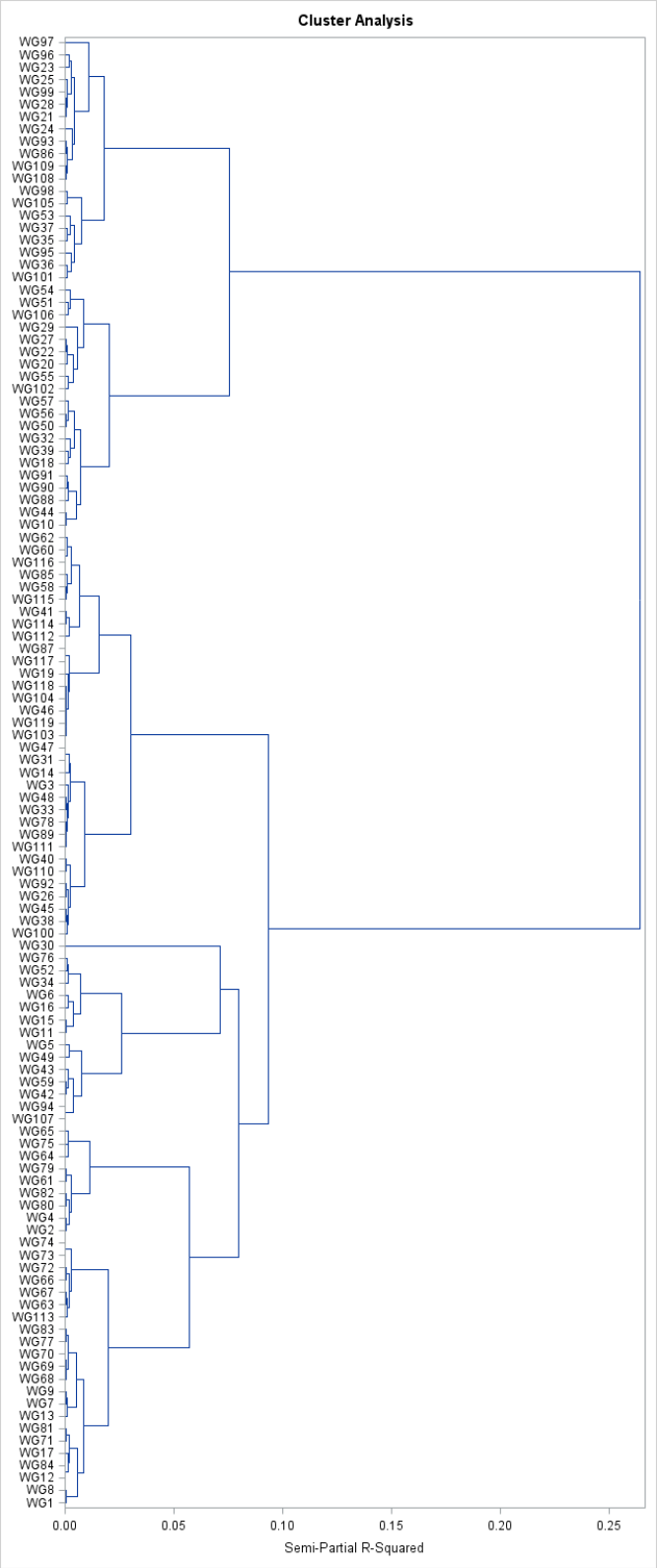

Fig. 3: Cluster analysis of wheat germplasms

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