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Multivariate Analysis to Evaluate Common and Tartary Buckwheat Germplasm in Sikkim

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Fifteen accessions of common buckwheat (*Fagopyrum esculentum*) and 21 of tartary buckwheat (*F. tataricum*) were studied for 15 quantitative and 21 qualitative traits to understand the nature and magnitude of genetic variability using multivariate approach. Significant variation for quantitative traits was recorded for seven traits in common buckwheat and for eleven traits in tartary buckwheat. In common buckwheat seed yield correlated positively with days to maturity while negatively associated with seed weight whereas in case of tartary type number of cymes/plant, seeds/cyme, days to flowering and days to maturity showed positive correlation with seed yield. First five and four principal components (PCs) respectively, in common and tartary type revealed majority of the variability in the accessions which further grouped the test accessions of both the species in to four clusters each. The accessions also showed considerable variation for qualitative traits.

Key Words: Buckwheat, *Fagopyrum esculentum*, *Fagopyrum tataricum*, Multivariate analysis

Introduction

The impact of climate change in the Himalayan region has driven agriculture to adapt to such farming practices or crops, which act as a buffer against stress or unfavorable weather conditions. Buckwheat is one of the important crops of the high altitudes and is grown under traditionally low input management conditions (Joshi and Rana, 1997; Tomotake *et al*., 2000; Tsuji and Ohnishi, 2001; Rana *et al*., 2011) and is now gaining worldwide importance due to its stress tolerant traits and excellent nutritional profile particularly due to rich amino acids, phenols (rutin) and antioxidant activities (Liu *et al*., 2008; Christa and Soral-Smientana, 2008; Tang *et al*., 2009; Gupta *et al*., 2011, Gupta *et al*., 2012; Rana *et al*., 2012). Buckwheat is consumed both as grain and green, and diverse populations exist in higher hilly tracts both for common (*Fagopyrum esculentum*) and tartary (*F. tataricum*) types. The cultivation of buckwheat had been decreasing at an alarming rate due to the influx of cash crops in the Himalayan region (Rana *et al*., 2000), however, in the recent years increasing awareness and the demand for health food has brought its cultivation back in many traditional growing areas of Himalayan region including Sikkim (Rana *et al*., 2012). It is now considered a cash crop and export commodity paying rich dividends to small holder farmers of hill regions. Buckwheat is not only grown on slopy dry lands but also as a major crop rotation crop between paddy and maize in Sikkim. The present area and production of buckwheat in Sikkim is 3,630 hectares and 3,490 tonnes with a productivity of 961.57 kg/ha (Anonymous, 2014).

The increasing demand for buckwheat seed has also compelled plant breeders to initiate hybridization work to enhance yield levels significantly. It is mentioned so far that improvement of buckwheat is confined to selection from farmer's populations only (Rana *et al*., 2000). It is known that yield and its associated traits are affected by the environment thereby suitability and adaptability of germplasm depends on local agro-ecology (Joshi and Rana, 1995; Rana *et al*., 2010). In order to meet the germplasm requirement of breeders, it is essential to evaluate the germplasm in the local environment of Sikkim and identify the diverse and promising germplasm lines, which could be used in crop improvement programmes at local level. The present study was therefore envisaged to assess the nature and magnitude of variation in buckwheat germplasm and identifying the useful genetic diversity using multivariate approach. Multivariate statistical algorithms has been suggested an important tool for classifying the germplasm and analyzing of genetic relationships among breeding material (Mohammadi and Prasanna, 2003).

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Materials and Methods

Thirty six buckwheat germplasm accessions comprising 15 common and 21 tartary buckwheat were procured from ICAR-National Bureau of Plant Genetic Resources, Regional Station, Shimla, Himachal Pradesh and also collected from different parts of Sikkim. The germplasm was evaluated at research farm of ICAR Research Complex for NEH Region, Sikkim centre, Tadong, Gangtok, Sikkim located at 27^{o}19'0''N and 88^{o}36'0''E at an elevation of 1320 masl. The material was grown in randomized block design with two replications during cropping season of 2012 and 2013. The data was recorded randomly on five plants based on descriptors of IPGRI (IPGRI, 1994) on 15 quantitative and 21 qualitative traits. Data on quantitative traits were analyzed for variance, correlation coefficient, Principal Component Analysis as per Pinheiro de Carvalho *et al*. (2004b). The most informative PCs were employed for clustering using Ward's hierarchical algorithm (Ward, 1963). The statistical analysis was done using SAS 9.3 software (SAS, 2012).

Results and Discussion

Morphological Characterization

The analysis of variance revealed significant differences for plant height, number of internodes, number of leaves, 1000 seed weight, days to flowering, days to maturity and seed yield in common buckwheat while tartary type differed significantly for plant height, number of branches, leaf blade length and width, 1000 seed weight, shoot diameter, petiole length, days to 50% flowering, days to maturity and seed yield. Significant differences in the buckwheat germplasm for both common and tartary buckwheat have been reported in several studies worldwide (Joshi and Paroda, 1991; Choi *et al*., 1995; Baniya *et al*., 1995 and Yan *et al*., 1992; Joshi and Rana, 1995; Senthilkumaran *et al*., 2007). The extent of variability was high in tartary type accessions, which implies wider scope of employing selection based on more number of desirable traits. Summary statistics of both the species has been shown in Table 1. Heritability estimates in case of common buckwheat were high for plant height, number of internodes, number of leaves, days to flowering, days to maturity, seed weight, seed diameter and petiole length while in tataricum type plant height, number of branches, number of leaves, leaf blade width, days to flowering, days to maturity, seed weight, seed diameter, petiole length showed high heritability. Number of cymes per plant and seeds per cyme showed low heritability in both the species, as these traits are highly influenced by the environment. Characters showing high heritability in both the species respond to selection as these are least influenced by the environment, thereby improvement in these traits can be made by employing selection on individual plants selected in both the species for respective traits.

Flowering started on 22nd day after sowing (50% flowering) in common buckwheat entries EC323730, EC125937 and EC58322 while entry EC125935 and EC58332 were earliest to attain maturity (75 days). Entry EC21874 grew tallest (90.40cm) whereas EC286396 recorded highest 1000 seed weight (33.08g). Entry PRB1 was the highest yielder (2388 kg/ha). In tartary type flowering started on 29th day after sowing in IC49669, IC108518 and Himpriya. Himpriya was earliest to attain maturity in 79 days. Maximum height attained by entry Shimla B1 (105.70 cm) whereas IC26600 recorded maximum 1000 seed weight (45.14 g). Entry IC109728 was the highest yielder (2247 kg/ha). PRB1 and VL7 were used as checks for common buckwheat whereas Himpriya and Shimla B1 for tataricum type. In case of tataricum type, accessions IC109728, IC26600, IC109729, Titey, IC15393, IC109433 and IC49671 were superior to both the checks for seed yield, however in case of common buckwheat none of the entries surpassed the checks for seed yield. Entry PRB1 and IC109728 can be recommended as high yielding varieties for buckwheat cultivation areas of Sikkim after multilocational trials.

The frequency of twenty one qualitative characters in thirty six buckwheat accessions has been shown in Table 2 which show a variable range of characters. Majority of the entries were indeterminate type with semi erect type branch shoot habit. Red stem colour predominates in twenty eight accessions. Grey, brown, black and mottled seed colour exist in different frequencies (16:8:1:11). Leaf blade shape for all the accessions were of saggitate type. Except two entries, inflorescence were of non-branched type. Triangular seed shape recorded for 15 accessions while ovate type for rest of the entries. Except four buckwheat accessions, pink margin colour of the leaf was present in all the material. Lodging resistance was recorded for majority of the accessions as a desirable character in buckwheat particularly in common type for reaping high seed yield as this species has low seed set due to genetic and climatic factors.

Table 1. Summary statistics of quantitative traits in common and tataricum buckwheat

Character	Species type	Mean	Std Dev	Std Error	Variance	CV	Range	Heritability	Genetic advance
Plant height (cm)	*F. esculentum*	80.13	6.89	0.25	47.49	8.61	67.00-93.40	0.714	8.991
	F. tataricum	86.90	12.15	1.87	147.66	13.98	65.20-105.70	0.742	16.537
No. of internodes	*F. esculentum*	7.25	0.99	0.18	0.99	13.73	5.20-9.60	0.820	1.571
	F. tataricum	13.08	1.09	0.16	1.19	8.36	9.60-15.00	0.486	0.893
No. of branches	*F. esculentum*	3.26	0.61	0.11	0.38	18.93	2.20-4.40	0.488	0.503
	F. tataricum	4.22	0.95	0.14	0.92	22.72	2.40-6.40	0.873	1.636
No. of leaves	*F. esculentum*	22.28	4.02	0.73	16.17	18.04	13.60-32.00	0.643	4.378
	F. tataricum	41.21	9.36	1.44	87.67	22.76	23.00-63.40	0.782	13.821
Leaf blade length (cm)	*F. esculentum*	6.37	0.45	0.08	0.20	7.16	5.54-7.24	0.019	0.013
	F. tataricum	5.33	0.49	0.07	0.24	9.19	4.54-6.52	0.590	0.502
Leaf blade width (cm)	*F. esculentum*	5.28	0.36	0.06	0.13	6.84	4.68-6.08	-0.612	-0.283
	F. tataricum	5.11	0.71	0.10	0.50	13.90	4.10-7.16	0.741	0.959
Length of cyme (cm)	*F. esculentum*	5.17	0.58	0.10	0.34	11.37	3.52-6.08	0.405	0.396
	F. tataricum	4.95	0.95	0.14	0.90	19.25	2.94-7.16	0.514	0.816
No. of cymes/plant	*F. esculentum*	25.15	5.62	1.02	31.59	22.34	19.00-46.60	-0.214	-1.607
	F. tataricum	32.02	6.58	1.01	43.34	20.55	19.80-49.20	0.298	2.985
Seeds/cyme	*F. esculentum*	12.35	2.47	0.45	6.12	20.03	6.40-18.40	0.321	1.283
	F. tataricum	15.37	3.02	0.46	9.16	19.68	10.60-25.80	0.028	0.118
Days to 50% flowering	*F. esculentum*	23.40	0.89	0.16	0.80	3.82	22.00-25.00	0.878	1.536
	F. tataricum	38.26	5.39	0.83	29.12	14.10	29.00-52.00	0.991	11.088
Days to maturity	*F. esculentum*	78.46	2.09	0.38	4.39	2.67	75.00-83.00	0.961	4.089
	F. tataricum	88.95	6.06	0.93	36.76	6.81	79.00-108.00	0.982	12.263
Seed yield (kg/ha)	*F. esculentum*	1521.11	391.16	71.41	153010.64	25.71	1005.56-2388.00	0.680	81.454
	F. tataricum	1543.52	504.28	77.81	254299.78	32.67	383.33-2247.00	0.532	83.011
1000 seed weight (gm)	*F. esculentum*	28.06	2.07	0.37	4.31	7.40	24.50-33.08	0.995	4.323
	F. tataricum	26.87	5.61	0.86	31.49	20.88	19.78-45.14	0.999	11.681
Stem diameter (mm)	*F. esculentum*	4.90	0.38	0.07	0.14	7.86	4.04-5.57	0.954	0.752
	F. tataricum	4.43	0.52	0.08	0.27	11.73	3.50-5.50	0.993	1.075
Petiole length (cm)	*F. esculentum*	4.23	1.24	0.22	1.55	29.47	2.12-7.60	0.998	2.606
	F. tataricum	3.68	1.05	0.16	1.11	28.73	2.10-6.50	0.997	2.194

Correlation Coefficient

The Pearson correlation coefficient traces out associations among the fifteen quantitative traits in study for both common and tataricum type as shown in Table 3a and 3b. Seed yield is the most economic character and is significantly positively correlated with days to maturity while negatively correlated with 1000 seed weight. Abundance of pollinators is an important parameter in securing yield of common buckwheat where the per cent seed set in flowers is genetically controlled by the raceme. Reproductive morphogenesis of common buckwheat depends on the resource availability and consequently the flower number and duration of the flowering period (Cawoy *et al*., 2009). Lines having flower open for longer duration might have better chances of pollinators visiting the flower as compared to short duration type. In tataricum type, seed yield showed significant positive correlation with number of cymes per plant, seeds per cyme, days to flowering and days to maturity. Days to flowering was significantly positively correlated with maturity duration, 1000 seed weight. Tataricum buckwheat is a self-compatible species with higher seed set. Selection can be employed on characters showing higher degree of correlation with seed yield for identification of superior tataricum buckwheat lines. Agronomic management including optimum date of sowing of buckwheat is beneficial for enhancing yield. The negative association of seed yield with test weight denotes that yield is compromised with

Table 2. Frequency of qualitative characters for common and tartary buckwheat accessions

Descriptors	Features	Frequency ratio
Cotyledon/seedling leaf colour	3green, 5 pink, 7 red	36:0:0
Growth and branch shoot habit	3semi-erect, 5 semi-erect longer, 7erect longer, 9 erect longer	36:0:0:0
Degree of determination	1 indeterminate, 5 intermediate, 9 determinate	33:0:3
Plant branching	1 very weak, 3 weak, 5 intermediate, 7 strong, 9 very strong	0:23:12:1:0
Stem colour	3 green, 5 pink, 7 red	0:8:28
Lodging suscept.	1 very resistant, 5 intermediate, 9 very susceptible	31:5:0
Leaf colour	3 green, 5 pink, 7 red	36:0:0
Leaf margin colour	3 green, 5 pink, 7 red	4:32:0
Leaf vein colour	3 green, 5 pink, 7 red	27:9:0
Petiole colour	3 green, 5 pink, 7 red	17:10:9
Leaf blade shape	1 ovate, 2 hastate, 3 sagittate, 4 cordate,	0:0:36:0
Compactness of inflorescence	3 cyme loose, 5 cyme semi compact, 7 cyme compact	20:13:3
Branched inflorescence	0 Yes, 1 No	2:34
Colour of inflorescence stalk	3 green, 5 pink, 7 red	2:34:0
Flower colour	1 white, 3 greenish yellow, 7 pink, 9 red	7:21:8:0
Flower abortion	3 low, 5 intermediate, 7 high	22:11:3
Seed colour	3 grey, 5 brown, 7 black, 9 mottled	16:8:1:11
Seed shape	1 triangular, 2 ovate, 3 conoidal	15:21:0
Seed surface	1 smooth, 2 irregular/wrinkled, 3 other	15:21:0
Seed quality	3 poor, 5 intermediate, 7 good	0:7:29
Threshability	3 difficult, 5 intermediate, 7 easy	9:9:18

Table 3a. Correlation matrix of quantitative traits in common buckwheat

Character	PH	NI	NOB	NOL	LBL	LBW	LOC	NOCP	SW	SD	PL	SC	DF	DM	YP
PH		**0.72**	0.28	0.29	**0.51**	**0.59**	0.39	-0.04	-0.13	0.10	-0.09	-0.00	0.16	0.26	0.04
NI			0.38	**0.47**	0.23	0.32	0.11	0.10	**-0.36**	0.15	0.09	-0.03	0.35	0.33	0.27
NOB				**0.57**	0.09	0.08	-0.13	0.29	0.07	-0.06	0.13	-0.20	0.09	0.23	0.11
NOL					0.00	0.07	-0.04	**0.45**	-0.06	-0.03	0.26	**-0.36**	**0.43**	0.38	0.16
LBL						**0.73**	**0.53**	-0.18	-0.00	0.02	0.07	0.13	0.19	0.22	0.12
LBW							**0.71**	-0.19	-0.11	0.11	-0.14	0.11	0.09	0.33	0.11
LOC								-0.17	0.07	**0.46**	0.00	**0.36**	-0.07	0.33	0.18
NOCP									0.19	0.09	-0.04	**-0.36**	0.35	**0.13**	-0.02
SW										0.02	-0.08	0.07	**-0.36**	-0.20	**-0.54**
SD											0.34	0.11	-0.16	0.19	0.25
PL												-0.20	0.24	0.05	0.27
SC													-0.08	0.07	-0.02
DF														0.43	0.28
DM															0.32

Bold figures means significant at 5% level of significance

*PH: plant height; NI: no. of internodes; NOB: no. of branches; NOL: no. of leaves; LBL: leaf blade length; LBW: leaf blade width; LOC: length of cyme; NOCP: no. of cymes per plant; SW: seed weight; SD: need diameter; PL: petiole length; SC: seeds per cyme; DF: days to 50% flowering; DM: days to maturity; YP: seed yield per plant

employing selection for higher seed weight in both the species. Selection of lines with small to medium sized achenes alongwith flowering for longer duration may enhance seed yield.

Joshi (2005) reported negative correlation of flowering days with days to maturity in tartaricum type. Rana and Sharma (2000) reported direct positive effects of days to maturity, leaf length and width, 100 seed weight, seeds per cyme and negative direct effects of number of branches, plant height, flowers per cyme, number of leaves, days to flowering and number of internodes on seed yield. Joshi and Okuna (2010) reported positive and significant association of grain yield with number of primary branches, number

Table 3b. Correlation matrix of quantitative traits in tataricum buckwheat

Character	PH	NI	NOB	NOL	LBL	LBW	LOC	NOCP	SW	SD	PL	SC	DF	DM	YP
PH		**0.32**	-0.15	-0.22	0.19	0.16	0.25	0.12	**-0.52**	0.07	0.08	**0.39**	0.06	0.07	0.21
NI			**0.41**	-0.23	-0.08	-0.20	-0.22	**0.42**	-0.29	-0.01	**-0.40**	0.10	0.20	0.00	0.11
NOB				0.02	-0.18	-0.26	-0.41	**0.53**	**0.36**	0.15	-0.10	0.03	**0.61**	**0.41**	0.08
NOL					0.22	0.29	0.29	-0.13	0.13	0.02	**-0.32**	0.19	-0.05	-0.02	0.17
LBL						**0.91**	**0.48**	-0.06	-0.05	-0.00	0.06	0.16	-0.21	-0.16	0.00
LBW							**0.60**	-0.17	-0.15	-0.11	0.09	0.13	-0.28	-0.26	-0.03
LOC								-0.23	-0.19	0.00	-0.08	0.20	-0.22	-0.28	0.12
NOCP									0.08	0.09	-0.10	0.10	**0.47**	**0.37**	**0.38**
SW										**0.44**	0.25	-0.25	**0.45**	**0.36**	0.11
SD											-0.04	0.13	**0.42**	**0.33**	0.23
PL												-0.08	0.09	0.14	-0.04
SC													0.17	0.29	**0.33**
DF														**0.81**	**0.51**
DM															0.32

Bold figures means significant at 5% level of significance

*PH: plant height; NI: no. of internodes; NOB: no. of branches; NOL: no. of leaves; LBL: leaf blade length; LBW: leaf blade width; LOC: length of cyme; NOCP: no. of cymes per plant; SW: seed weight; SD: seed diameter; PL: petiole length; SC: seeds per cyme; DF: days to 50% flowering; DM: days to maturity; YP: seed yield per plant

Table 4(a). Mean values of clusters in common buckwheat accessions

Character	Cluster I	Cluster II	Cluster III	Cluster IV
Plant height (cm)	84.26	79.92	83.10	72.10
No. of internodes	7.98	7.00	8.00	6.30
Number of branches	3.32	3.27	4.20	2.83
No. of leaves	23.18	22.28	28.10	18.87
Leaf blade length (cm)	6.70	6.19	6.21	6.24
Leaf blade width (cm)	5.51	5.27	5.15	4.98
Length of cyme (cm)	5.52	5.29	3.83	4.81
No. of cymes/plant	23.66	27.28	29.30	22.00
Seeds/cyme	13.16	12.30	8.80	12.30
Days to 50% flowering	23.80	23.25	24.00	22.83
Days to maturity	80.20	78.50	78.00	75.67
1000 seed weight (g)	26.67	29.35	26.36	28.41
Shoot diameter (mm)	5.00	5.02	4.06	4.79
Petiole length (cm)	4.32	4.11	3.10	4.70
Seed yield (kg/ha)	320.30	240.67	259.00	267.50

Table 4(b). Mean values of clusters in tataricum buckwheat accessions

Character	Cluster I	Cluster II	Cluster III	Cluster IV
Plant height (cm)	99.20	72.20	86.72	85.13
No. of internodes	13.33	11.10	12.18	13.57
Number of branches	3.63	5.50	3.24	4.68
No. of leaves	42.70	53.40	46.22	37.75
Leaf blade length (cm)	5.66	5.05	5.53	5.20
Leaf blade width (cm)	5.61	4.61	5.57	4.85
Length of cyme (cm)	5.61	4.51	5.60	4.56
No. of cymes/plant	30.53	32.60	25.10	35.23
Seeds/cyme	18.17	16.20	14.90	14.80
Days to 50% flowering	40.67	52.00	30.70	39.67
Days to maturity	91.83	107.00	82.60	89.38
1000 seed weight (g)	22.14	45.14	24.58	27.49
Shoot diameter (mm)	4.78	5.28	4.16	4.40
Petiole length (cm)	3.23	5.45	3.91	3.55
Seed yield (kg/ha)	334.00	365.50	207.60	285.75

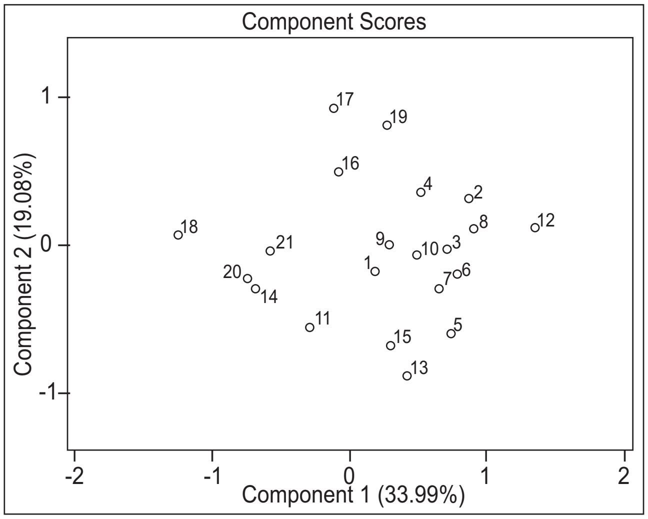

Fig. 1(a). Scatter plot of the principal component scores of esculentum buckwheat entries

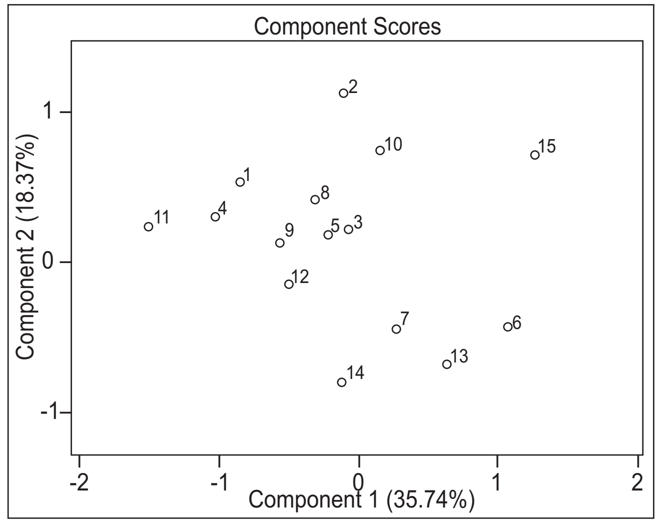

Fig. 1(b). Scatter plot of the principal component scores of tataricum buckwheat entries

of leaves, plant height, number of clusters and cyme, days to flowering, number of filled and unfilled grains, grain width and weight in 192 tartary accessions. Li *et al*., 2012 reported association of late flowering with tall plant height and higher yields in tartary buckwheat in F_3 population.

Principal Component Analysis (PCA)

The PCA simplified the complex data by transforming the number of correlated variables in to small number of most informative variables. The PCA figured out variables that account for maximum variability in both the buckwheat species. Eigen value of the correlation matrix in common buckwheat showed first five principal components (PCs) had eigen value greater than 1 and cumulatively account for 75% of the variability. The eigenvectors having high value of PC1 are number of internodes (0.39), plant height (0.36), days to maturity (0.32) and number of leaves (0.34), in PC2 are length of cyme (0.49), seeds per cyme (0.38), in PC3 1000 seed weight (0.53) and number of cymes per plant, in PC4 are shoot diameter (0.60) and petiole length (0.47) while in PC5 are days to flowering (0.55) seeds per cyme (0.54). In tataricum type eigen value of the correlation matrix showed first 4 principal components had eigen value greater than 1 and cumulatively account for 72% of the variability. The eigenvectors having high value of PC1 are number of cymes per plant (0.39) and days to flowering (0.38), in PC2 are seeds per cyme (0.55) and plant height (0.41), in PC3 are 1000 seed weight (0.51) and number of leaves (0.31) and in PC4 are petiole length (0.63) and plant height (0.37). Scatter plot of the principal components for both the species has been shown in Figure 1a and 1b. Senthilkumaran *et al*. (2008) reported first three components as most informative accounting for 59.97% and 74.36% variance in common and tataricum type buckwheat respectively. This variability provides useful information to the workers regarding most variable characters in buckwheat on which selection for buckwheat improvement can be employed.

Cluster Analysis

The first five PCs in common type and four PCs in tataricum type were used for clustering. In the former, the first five PCs divided 15 accessions in to 4 clusters. Mean value of clusters in common and tataricum buckwheat has been shown in table 4a and 4b. Cluster I consisted of five entries namely PRB1, VL7, Meethey, EC218784 and EC218742, cluster II consist of six entries EC286936, EC272442, IC188701, EC125937, EC216631, EC18864, cluster III was solitary with entry IC202226, cluster IV consists of EC323730, EC58332, EC125935. In tataricum type, Cluster I comprised of Titey, IC109433 and IC109549, cluster II comprised of IC108518, Himpriya, IC49669, Shimla B1, IC24301, cluster III was solitary with entry IC26600, cluster IV with IC49671, IC36805, IC108510, IC243184, IC202268, IC109728, IC107998, IC15393, IC107994, IC109729, IC109619 and IC108514. Wards minimum variance dendrogram of both the species has been shown in figure 2a and 2b. The grouping of clusters clearly segregate the entries according to their metric traits. Further crop improvement work in buckwheat accessions should be carried out selecting entries inter-clusters for obtaining desirable segregates. Analysis of genetic diversity in germplasm collections aids in classification of genotypes and identification of core collection with possible utility for breeding goals (Mohammadi and Prasanna, 2003). Debnath *et al*. (2008) reported division of 21 local buckwheat germplasm in to 5 clusters using 15 quantitaive characters. Senthilkumaran *et al*. (2008) classified 30 common buckwheat in to 4 clusters and 16 tataricum in to three distinct clusters based on 14 quantitative characters. Cepkova *et al*., 2009 clustered 77 common buckwheat in to 5 major clusters and 15 tartary in to 6 clusters collections of Czech genebank collection.

Buckwheat is an underutilized crop where the varietal development work is mainly hindered by the incompatible nature of common buckwheat and availability of very few literature on its genetic improvement. However, better crop production through agronomic practices have been reported for yield improvement. In short run, selection strategies may prove to be beneficial in both the species but realizing its potential as a climate resilient crop, improvement in yield particularly in common buckwheat is needed which is only possible through breeding strategies that overcome reproductive barriers for enhancing seed yield. Breeding methodology to overcome self-incompatibility has been reported by Mukasa (2011). Alternate breeding methodology for common buckwheat (*F. esculentum* Moench) involving the use of self-incompatibility (S^h) gene derived from *F. homotropicum* Ohnishi have been reported by Mukasa *et al*. (2010). The agricultural system has been witnessing effects of climate change thereby it is prerogative to explore potential crops like buckwheat. Conserving the genetic resources alongwith catalouging and documentation after evaluation at multi locations will figure out the best adaptable lines in different locations. The *in-situ* and *ex-situ* conservation strategies needs to be strengthened and specific adaptations from diversity rich areas and their conservation on-farm is important especially in marginal and low-input areas of Himalayan region.

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