Proceeding of
2nd International
Conference on
Horticulture
Godavari, Lalitpur
3-4 April 2023

TECHNICAL PAPER

Agro Morphological Diversity of Locally Adaptability French Bean in Sankhuwasabha District of Nepal

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Abstract

French bean has been a nutritiously and economically important legume crop and has a diversity ranging from Terai to High Hills of Nepal. Diversity studies should be done for crop improvement and for their genetic conservation for breeding purpose to adapt them in concurrent climate change. This paper focused on studying the agro morphological diversity of the French bean landraces available in Sankhuwasabha district. Eleven landraces were collected and tested during the month of March to July 2022. The experiment was carried out in randomized complete block design and replicated three times. The size of the plot was maintained 4.6m^2 with spacing of 75cm×30cm and data was recorded on 15 quantitative and 8 qualitative characteristics. The result revealed that significant differences were observed among the genotypes for all quantitative traits and qualitative characteristics except stem diameter. The variation on germination % (98.67-82.67), plant height (210.8-22.5cm), number of pods/plant (82-90), pod weight/plot (68.2-17.64 gm) and 100 seed weight (40.47-13.6gm) were observed. The tested landraces took 38-41 days for flowering and first picking matured at 63-78 days and consequently 1-4 harvesting was done. The three major principle components were formed with Eigen value >1 with cumulative diversity of 78.1%. The result showed great variation in pod weight among the genotypes. Genotypes were clustered in and three groups on all quantitative traits showed a similarity level of 26.95-72.8%. Among the tested landraces, Rato bhatte and soste simi showed prominent quantitative characters in terms of pod number, plant height and test weight. This study is useful for promoting the landraces and uses their genetic traits for further improvement in the breeding purpose of French bean.

Keywords: Landraces, diversity, characters, French bean, traits

Introduction

French bean (*Phaseolus vulgaris* L.) has been a nutritiously and economically important legume crop. It is widely grown for human consumption in the world (Singh, 1999). It possesses anti-diabetic properties, making it a good supplement to any diet (Singh & Singh 1992) and a cheap source of nitrogen to soil (Shrestha et al., 2008). It is one of the popular vegetables of Nepal having a high potential to grow throughout the year either in mono cropping or multiple cropping systems. The purpose of growing French bean is green pod, dried pulses, fodder and green manure. The diversity of French bean has been ranging from Terai to High Hills region of Nepal (Neupane et al., 2008). Bean plays a key role in food security in the hill and mountain region of Nepal. Diversity among the beans with distinct characteristics was most abundant in hills and mountains in Nepal (KC et al., 2016). Farmers in hills and mountains have been cultivating a variety of landraces for years (Neupane & Vaidya, 2002) though landraces are in the threatened condition in recent days. The production of French bean in Nepal is 26,927 metric tons in a total area of 3,136 hactor (MOALD, 2019/20).

Nepal is rich in a diversity of cereals, grains, legumes, vegetables, fruits and other crops (poudel et al., 2016). Cultivation of various genotypes with specific traits in particular niches has been practiced for years. The diversity of such genotypes is being decreased continually from their natural habitats. Decreasing diversity leads to genetic erosion (Joshi et al; 2008) which is a major threat to sustainability (Chang 1985). The trend of growing local genotypes is replaced by modern hybrid cultivars. Agricultural plant genetic resources are most important for food

and nutrition security (Joshi, 2019). Genotype is a major component of any agricultural production which serves as the foundation for other technologies (Goutam et al., 2001). Breeding of desired plant genotypes depends upon the existence of genetic variability among the population (Singh et al., 2005). Diversity assessment among the local genotypes is widely important to cope with stress in the changing global environment. Knowledge of genetic diversity is a prerequisite for the breeding programs. Characterization of germplasm provides information on the basis of traits that would be helpful for breeding purposes (kaduwal et al., 2019). Characterization of plant resource diversity is valuable for the conservation and utilization of resources and crop improvement programs. The Study aims to evaluate the performance of adaptability and variability of local genotypes based on their morphological characters. This study is significant for promoting the landraces and uses their genetic traits for further improvement in the breeding purpose of French bean.

Materials and methods

The experiment was carried out in Khandbari municipality 08, Sankhuwasabha district. The research site lies in 27°22'N and 87°13'E coordinates with an elevation of 760 masl. The study was conducted from 29th March to 5th July 2022. A total of 11 locally available genotypes were used as treatment. Treatment consists of Rato bhatte simi, Soste simi, Co1, Co2, Co3, Co 4, Co5, Chhirke simi, Co6, Co7 and Trishuli. The experiment was laid out in a completely randomized block design and replicated three times. A total of 25 seeds/plots were sown with five rows. The size of the plot was maintained 4.62m^2 (3.30mx1.40m) with crop geometry of 75cm×30cm. The recommended dose was N:P:K/ha 80:120:60 and 12 mt/ha well decomposed farm yard manure was applied at the time of field preparation and half a dose of nitrogen was applied after 45 days as a top dressing and all the intercultural operations were carried out on the basis of package of practices of French bean.

Method of data collection and analysis

Data were recorded from randomly selected five sample plants from each plot. Plant height (cm) was measured using meter-scale at the physiological maturity stage from cotyledon scar to the tip of the plant. Stem diameter and pod diameter (mm) were measured using vernier caliper and pod length was measured using a meter scale at fully expanded stage. Green pod weight and dry seed weight (gm) were taken by using a weighing balance. The qualitative traits including flower color, pod color, pod quality, seed color and seed shape were taken according to the procedures given in the International Board for Plant Genetic Resources (IBPGR) descriptors for *Phaseolus vulgaris*. Stem color observed in the seedling stage. Flower color was observed in freshly open flowers. Pod color was recorded on the fully expanded immature pods. Pod quality, seed shape and seed color were assessed by visual observation.

Results

Plant characteristics

The table no.1 shows the plant characteristics of tested genotypes including germination%, plant height, number of clusters/plant, internode length and number of pods/plant were highly significant ($p \leq 0.01$). The average germination% was observed maximum in trishuli (98.67%) followed by rato bhatte, co-6 and minimum was observed in co-1(83.33%). Highest plant height was measured in co-2 (210.8cm) and lowest was measured in soste simi (22.5cm). There was no significant difference between stem diameters among the genotypes. Co-6 genotype produced highest (81.53) number of pods per plant followed by co-2, co-5 and lowest (9) pod number was observed in rato bhatte. Number of cluster/plant was noted maximum in co-6 (49.6) and minimum in co-1(3.87). Maximum internode length was observed in co-2 (20.39cm) and minimum observed in soste simi (6.33cm).

Table 1. Plant morphological characteristics of French bean genotypes in Sankhuwasabha district

Varieties	Germination (%)	Plant height(cm)	Stem diameter(mm)	No of cluster/plant	Internode length(cm)	No of pods/plant
Rato bhatte	96	186.2	0.23	3.87	9.75	9
Soste simi	93.33	22.5	0.25	11.73	6.33	29.4
Co-1	82.67	200.2	0.23	18.2	18.63	35
Co-2	94	210.8	0.23	21.73	20.39	38.27

Varieties	Germination (%)	Plant height(cm)	Stem diameter(mm)	No of cluster/plant	Internode length(cm)	No of pods/plant
Co-3	92	115.6	0.22	16.47	12.41	32.07
Co-4	94	177.3	0.22	16.47	11.45	32.27
Co-5	91.33	189.7	0.23	19.33	11.23	38.2
Chhirke simi	83.33	108.9	0.23	26.87	11.99	32.8
Co-6	96	200.9	0.22	49.6	18.3	81.53
Co-7	86.67	184.5	0.23	17	11.55	31.87
Trishuli	98.67	160.6	0.23	18.53	12.9	34.4
Mean	91.64	159.75	0.23	19.98	13.17	35.89
F-test	**	**	ns	**	**	**
LSD(0.05)	3.468	1.207		8.99	0.83	1.46
CV %	2.2	0.4		26.4	3.7	3.1

Flowering and Maturity characteristics

Days required to first flowering were significant among the genotypes ($p \leq 0.05$). Days of first harvest and number of harvest were highly significant among the genotypes ($p \leq 0.01$). Days of flowering varies from 38.33 to 41 days. Minimal (38.33) days of flowering was observed in soste simi whereas rato bhatee, co-2, co-3, co-4, co-5, co-6, co-7 and trishuli required maximum (41) days for flowering followed by chhirke simi and co-1. Ratto bhatte took maximum (78) Days for first pod harvest. The minimal (63) days was counted for pod harvest in chhirke simi and trishuli. Total 1 to 4.3 harvests were taken during crop period. Highest picking (4.3) was found in soste simi and rato bhatte provide only one harvest.

Table 2. Days of flowering and harvesting of French bean genotypes in Sankhuwasabha

Varieties	Days of flowering	Days of 1st harvest	No of harvest
Rato bhatte	41	78	1
Soste simi	38.33	64	4.3
Co-1	39.67	73.67	2
Co-2	41	69	3
Co-3	41	69.3	2.66
Co-4	41	71	2
Co-5	41	66	2.66
Chhirke simi	39	63	3
Co-6	41	65	4
Co-7	41	65	3
Trishuli	41	63	3
Mean	40.45	67.91	2.78
F-test	*	**	**
LSD(0.05)	1.759	1.868	0.504
CV %	2.6	1.6	10.6

Pod characteristics

Pod characteristics including pod length, pod diameter, pod weight/plot and pod weight/plant, No of seeds/pod and test weight of seed showed highly significant differences ($p \leq 0.01$) among the tested genotypes. Highest pod length (19.13cm) was measured in co-6 and lowest (6.94cm) measured in rato bhatte. Maximum pod diameter (0.41cm) was noted in co-3 and minimum (0.33cm) noted in rato bhatte. Maximum (9.06) number of seed per plant was observed in Co-7 and minimum (4.267) was observed in rato bhatte. Highest pod weight/plant (68.5gm) was weighted in Co-6 and lowest (17.15gm) weighted in rato bhatte. Among the genotypes, Co-6 had maximum (68.29gm) and rato bhatte had minimum (17.64 gm) pod weight per plot. Maximum test weight (40.47gm) was observed in soste simi and minimum (13.6) test weight was observed in Co-6.

Table 3. Pod morphological characteristics of French bean genotypes in Sankhuwasabha district

Varieties	Pod length(cm)	Pod diameter (mm)	No of seed/pod	Pod wt/plant (gm)	Pod wt/plot(gm)	100 Seed wt(gm)
Rato bhatte	6.94	0.3333	4.267	17.15	17.64	20
Soste simi	11.5	0.36	4.73	29.86	30.41	40.47
Co-1	17.58	0.39	7.67	60.56	60.97	29.4
Co-2	17.85	0.37	7.33	57.49	57.97	32.73
Co-3	17.43	0.41	8	64.56	64.49	16.93
Co-4	17.39	0.36	7.93	63.91	63.5	38.87
Co-5	16.56	0.36	6.13	45.62	46.52	35
Chhirke simi	16.86	0.37	7.4	62.74	63.32	18.27
Co-6	19.13	0.38	8.53	68.5	68.29	13.6
Co-7	16.76	0.38	9.06	64.69	65.08	23.6
Trishuli	17.2	0.40	6.8	55.79	56.27	38.4
Mean	15.92	0.37	7.07	53.71	54.09	27.93
F-test	**	**	**	**	**	**
LSD(0.05)	0.727	0..015	0.3528	1.160	1.247	1.811
CV %	2.7	2.4	2.9	1.3	1.4	3.0

Cluster analysis

Cluster analysis was used to study the interrelationships of genotypes on quantitative characters. Clustering was performed on standardized variables using Euclidean distance for single linkage method and represented by a dendrogram in fig no.1. There were three clusters, among which cluster III consisted of the highest number of genotypes (Table 4). Two genotypes namely Rato bhatte and Soste simi made separate clusters individually i.e. cluster I and Cluster II indicating distinct characters among the 11 genotypes of French bean.

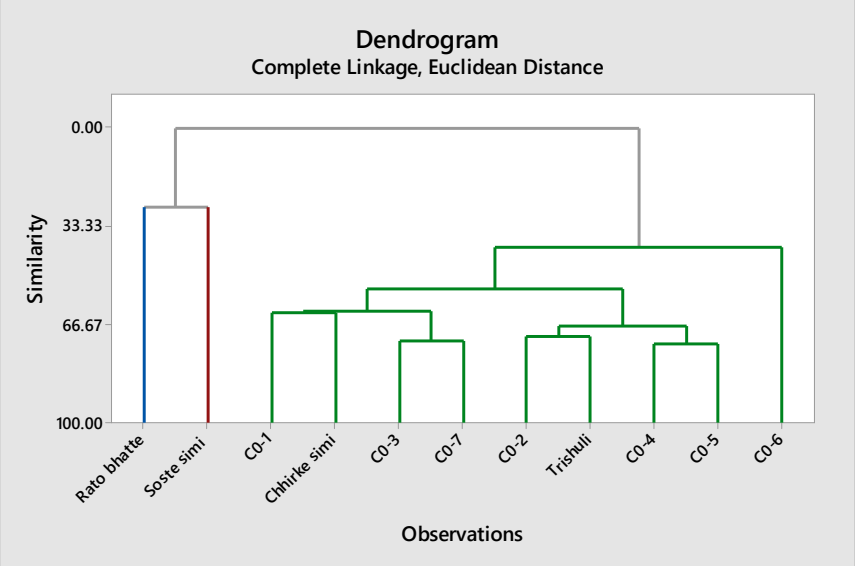

Figure 1. *Cluster analysis showing interrelation among French bean genotypes on the basis of 15 quantitative traits.*

Table 4. Distribution of genotypes in different clusters based on quantitative traits

Cluster	No of genotypes	Name of genotypes	Percent
I	1	Rato bhatte	0.09
II	1	Soste simi	0.09
III	9	CO-1,C0-2,CO-3,CO-4,CO-5,Chhirke simi, CO-6, CO-7,Trishuli	81

Principle component analysis

The three major principle components were formed with Eigen value>1 with cumulative diversity of 78.1% (Table 5). The first principal component (PC1) which explained 45.2% variation was associated mainly with pod weight/plant and pod weight/plot. The second principal component (PC2) was responsible for about 21.8% of the variation and was mainly related to number of harvest and third principle component (PC3) was accounted for about 11.1% of the variation and was mainly related to pod weight/plot.

Table 5. Eigen analysis of first three components using 15 quantitative traits

	PC1	**PC2**	**PC3**
Eigen value	6.7823	3.2677	1.6661
Proportion (%)	45.2	21.8	11.1
Cumulative (%)	45.2	67.0	78.1
Variables	**Eigen vector**		
Germination %	-0.068	-0.082	-0.666
Plant height (cm)	0.163	-0.427	-0.121
Stem diameter(mm)	-0.254	0.345	0.030
No of clusters/plant	0.305	0.120	-0.291
Internode length (cm)	0.268	-0.176	-0.052
No of pods/plant	0.295	0.130	-0.369
Days of flowering	0.131	-0.405	-0.288
Days of 1st harvest	-0.139	-0.446	0.133
Number of harvest	0.120	**0.475**	-0.265
Pod length (cm)	0.358	0.078	0.069
Pod diameter(mm)	0.257	0.117	0.183
No of seed/pod	0.353	-0.027	0.192
Pod wt/plant (gm)	**0.364**	0.036	0.181
Pod wt/plot (gm)	**0.364**	0.039	**0.185**
100 seed wt (gm)	-0.132	0.136	-0.067

Qualitative characters

The variation in quantitative characters among the genotypes was found through visual observation. Stem color observed in seedling stages varies from green to red color. Green, White and yellowish white color flower color were observed among the genotypes. Pod color, shape and seed shape and color showed distinct characters among the genotypes.

Varieties	**Stem color**	**Flower color**	**Pod Color**	**Pod surface**	**Pod shape**	**Seed color**	**Seed shape**	**Growth habit**
Rato bhatte	Green	White with purple inner coat	Red	Rough	Straight	Red stripes	Round	Pole
Soste simi	Green	White	Green with red spot	Rough	Straight	Dark red with stripes	Flattened	Bush
C0-1	Green	White	Green	Rough	Slightly curved	Blackish coffee	Elongated	Pole
C0-2	Green	White	Reddish green	Rough	Slightly curved	light black speckled	Elliptic	Pole
C0-3	Dark red	Purple	White with black linings	Smooth	Straight	Black	Kidney	Pole
C0-4	Red lower end & green upper end	Yellowish white	Green	Rough	Slightly curved	Yellowish white	Elliptic	Pole
C0-5	Green	White with inner red coat	Green with red stripes	Smooth	Straight	Dark red	Flattened	Pole
Chhirke simi	Green	purple	Green with black stripes	Smooth	Slightly curved	Dark black speckled	Oval	Pole

Varieties	Stem color	Flower color	Pod Color	Pod surface	Pod shape	Seed color	Seed shape	Growth habit
C0-6	Red	Purple	Green	Smooth	Straight	Black	Oval	Pole
C0-7	Green	purple	Green	Smooth	Straight	Maroon	Flattened	Pole
Trishuli	Green	White	Green	Smooth	Straight	Dark cream	Elliptic	Pole

Discussion

The result showed significant variation in quantitative and qualitative characters among the genotypes. The study is in line with findings of Neupane et al. (2008) that the variation in plant height, number of pods/plant, number of seeds per pod was observed among the tested genotypes. The study revealed with findings of Luitel et al. (2021) that French bean genotypes showed the significant differences in plant height, number of pod per plant, pod length and diameter, number of seed per pod, hundred grain weights among the genotypes. Genotypes showed distinct characteristics in terms of flower, pod, seed and stem. The study is in line with findings of Dhakal et al. (2019) that the flowering and fruiting days were influenced by genotypes and significant differences among the genotypes were observed on plant uniformity, number of pods/plants, fresh pod yield/plant. According to findings of Pandey et al. (2011), Diversity of French bean in mid hills of Nepal was highly observed. Sari et al. (2016) mentioned that the combination of cluster analysis and principal component analysis has a purpose to result in a fundamental empirical role of morphological characters in grouping accession. The variability among the French bean genotypes indicated distinct characters on vegetative, floral and pod characteristics. Qualitative characters including pod and seed shape showed variation among the genotypes (Neupane et al., 2008). The findings of Sharifi (2015) indicated that the studied genotypes of faba bean differed significantly for all of the vegetative and reproductive traits. The study is accordance with findings of Pandey et al. (2011) that the variation was observed in flower color, pod and seed color and shape among the French bean genotypes.

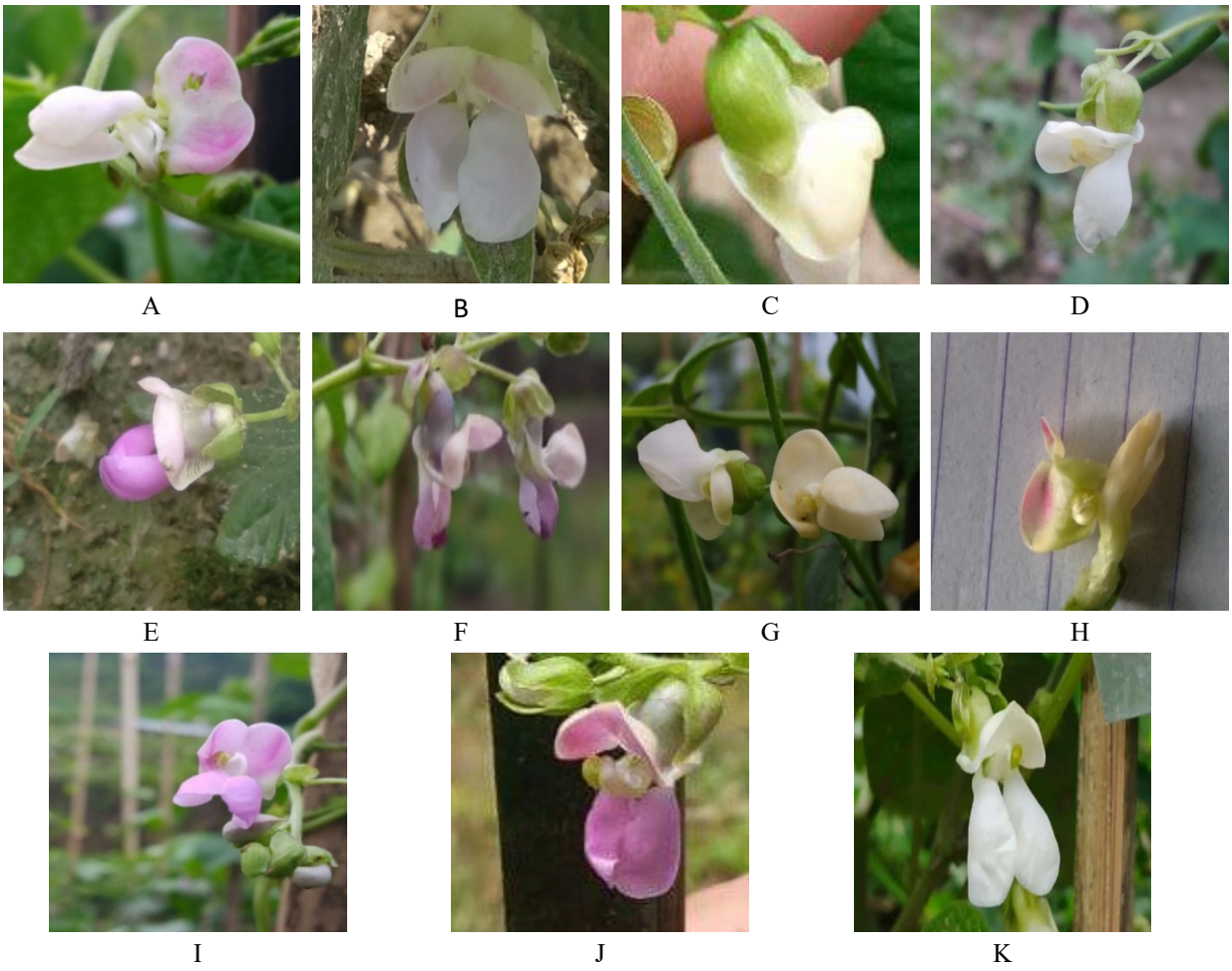

Figure 2. *Flower morphology of French bean genotypes evaluated at Sankhuwasabha district, 2022; A= Rato Bhatte; B= Soste simi; C= C0-1, D= C0-2; E= C0-3; F=C0-4; G=C0-5; H=Chhirke simi; I=C06; J= C07; K= Trishuli*

Figure 3. *Pod morphology of French bean genotypes evaluated at Sankhuwasabha district, 2022; A= Rato Bhatte; B= Soste simi; C= C0-1, D= C0-2; E= C0-3; F=C0-4; G=C0-5; H=Chhirke simi; I=C06; J= C07; K= Trishuli*

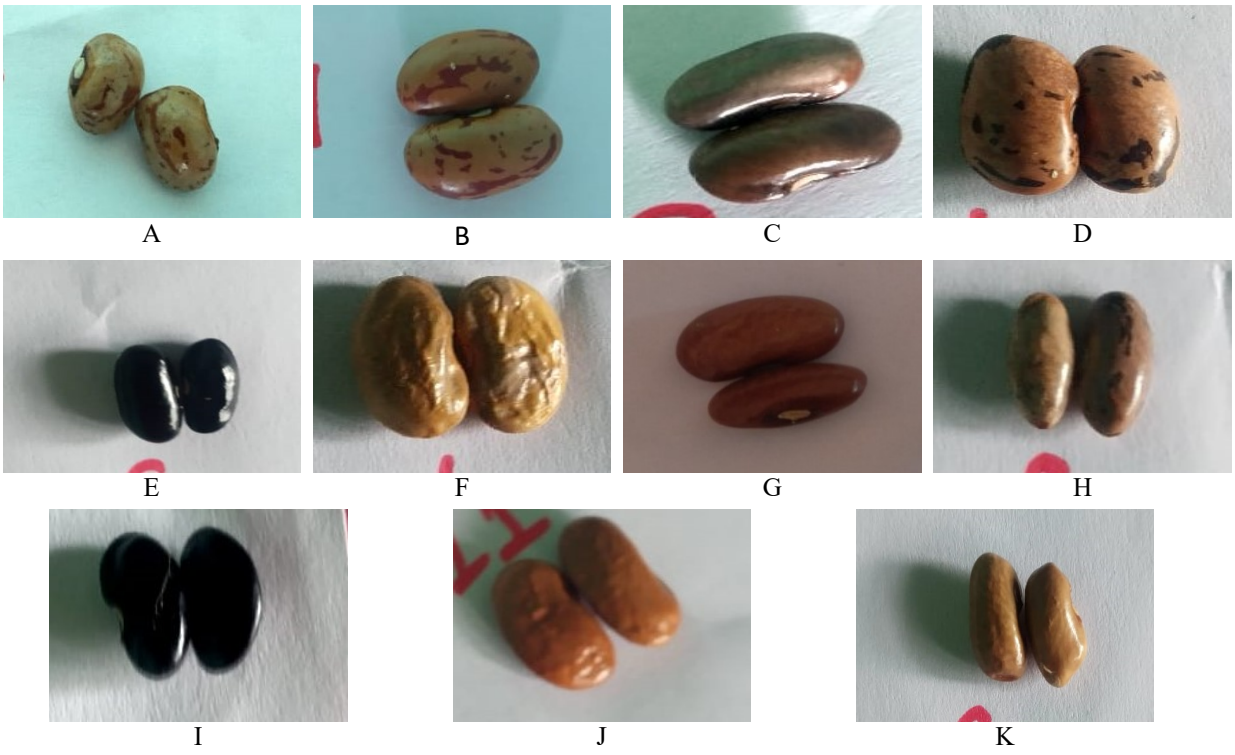

Figure 4. *Seed morphology of French bean genotypes evaluated at Sankhuwasabha district, 2022; A= Rato Bhatte; B= Soste simi; C= C0-1, D= C0-2; E= C0-3; F=C0-4; G=C0-5; H=Chhirke simi; I=C06; J= C07; K= Trishuli*

Conclusion

The study showed significant difference in all quantitative characters except stem diameter and variation was observed in qualitative characters among the genotypes. Major variable responsible for variation was found pod weight. Rato bhatte and soste simi showed prominent quantitative characters in terms pod number, plant height, test weight. This study is useful for promoting the landraces and uses their genetic traits for further improvement in breeding purpose of French bean.

Acknowledgement

Authors are grateful to farmers of Sankhuwasabha district for providing genotypes and agriculture technicians for facilitations for collection of genotypes. We are equally thankful to all the helping hands for their support during research period.

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