NEPALESE LANDRACES OF SPONGE GOURD FOR THE PRODUCTION OF TENDER FRUITS

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ABSTRACT

Evaluation of landraces is necessary for better management of agricultural biodiversity on-farm. The objective was to evaluate the farmers' named landraces of sponge gourd that are being maintained on-farm for tender fruit production. A total of 21 sponge gourd landraces collected from six districts of Nepal were evaluated in a randomized complete-block design with three replications at Agriculture Research Station, Malepatan, Pokhara, Nepal. These landraces were significantly (p = 0.05) different for first harvest days (p = 0.05) and fruit yield perplant (p = 0.05), highly significant (p < 0.01) for last harvest days, fruit-skin thickness, flesh thickness, fruit length, fruit perimeter, fruit weight and fruit number. Variation for tender fruits among these landraces can be utilized for improving the genotypes of sponge gourd as well as for long-term production in diverse environments.

Key words: Evaluation, fruit vegetable, Luffa cylindrica, sponge gourd landraces

INTRODUCTION

Luffa [*Luffa cylindrica* (L.) Roem Syn. *L. aegyptiaca* Mill.], commonly called sponge gourd, loofah or dishcloth gourd, is a member of cucurbitaceae family. It has the multiple use values. For examples, tender fruit is used as vegetable, whereas mature sponge gourd is used for cleaning utensils and in bathroom. Fresh juice from leaf is used for healing wounds and also used as primer in doors and windows by Nepalese farmers. Dried sponge, which is fibrous, is used in commercial filters and for insulation (Porterfield, 1955). The seeds yield colorless, odorless, tasteless oil that can be used in cooking (Porterfield, 1955).

In Nepal, two cultivated species (*L. cylindrica* and *L. acutangula*) and one wild species (*L. echinata*) are found. National Genebank (NGB), Khumaltar, Nepal, has conserved 60 accessions of sponge gourd (Gupta et al., 2000). Nepalese farmers call *Ghiraula* for *Luffa cylindrica*. It is a summer season vegetable grown from Tarai (lower belt) to High-hill in Nepal. Mid-hill is the most important zone where most of the farmers grow sponge gourd. Farmers let vines climb on living tree, dead branches, walls or roof.

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The crop is cross-pollinated; therefore, insect pollinator is necessary for better fruit production. The flowers are produced in the leaf axil with four to 20 staminate flowers and one pistillate flower in the same axil. The flower opens in the early morning and remains open only for one day (Porterfield, 1955). *L. cylindrica* and *L. acutangula* are monoecious (Singh 1958), but other species of *Luffa* have four types of inflorescences: monoecious, andro-monoecious, gynoecious and hermaphroditic (Davis, 1996).

Despite its importance as a vegetable, limited efforts have been made to improve sponge gourd in Nepal. Only one variety, Kantipure, has been released in Nepal (NARC, 2000). Landrace diversity and farmers' preferred traits of sponge gourd were studied by Rana et al. (2000a, b). Based on diversity of Nepalese landraces, descriptors for sponge gourd were developed by Joshi et al. (2004). On-farm agro-morphological characterization was done by Bajracharya et al. (1999), Pandey et al. (2003), and Yadav et al. (2003). Cruz et al. (1997) studied correlation and variability of morphological and biochemical characters, and reported that, *L. acutangula* had lower overall variation compared to *L. cylindrica*.

Existence of many landraces indicates that there is great possibility to increase yield through improvement in genetic and agronomic practices. Some landraces are better for sponge and others are good for fruit vegetables. Landraces are adapted to tropical to subtropical to temperate climate. As genetic erosion of landrace diversity is increasing (Joshi et al., 2005), their evaluation has become a necessity for on-farm and ex-situ conservation, at least, for most important types. The primary objective of this study was to evaluate landraces collected from different areas of Nepal for tender fruits that can be used as a vegetable.

MATERIAL AND METHODS

A total of 21 landraces, collected from six districts of Nepal were evaluated (Table 1) in 2004. Among these, 15 landraces were collected directly from two agro-ecological sites, i.e., Begnas in Kaski district and Kachorwa in Bara district. Six diverse landraces were selected from National Genebank (NGB), Khumaltar, Nepal, on the basis of the collection sites and local names. The name of three collections from Bara was the same, i.e., Ujarka, even though there was variation in seed color. Therefore, these three collections were prefixed with the first name initial of the farmer who provided the seeds, e.g., Ujarka-B. Some of them have been characterized on-farm by Pandey et al. (2003) and Yadav et al. (2003).

Experiment was conducted in a randomized complete-block design with three replications at Agriculture Research Station, Malepatan, Pokhara in 2004. Coordinates of experimental site are 28^{o} 15' N latitude and 84^{o} 00' E longitude at an altitude of 848 m above sea level in a subtropical area having loam soil. Three to five plants of each landrace were maintained in each plot. Seeds were sown directly in pits containing three kg compost. Plants were spaced at 2.5-x2.0-m. Later, 10 g urea/plant was top-dressed at one and half month after seeding. Each plant was supported by a dead tree branch. Manual weeding and guarding were done to protect the fruits from weeds and birds.

Table 1. Landraces of sponge gourd evaluated in Malepatan, Pokhara, Nepal

Landrace	Farmer /donor name	Collection site	Altitude, m
Basaune	Diversity fair	Begnas, Kaski	848
Harihar Tagwa Bhadaiya	Sharada Devi Jaisawal	Kachorwa, Bara	85
Hariharka	Maha Narayan Prasad Yadav	Kachorwa, Bara	85
Hariyo Basaune	Debendra Adhikari	Begnas, Kaski	848
Hariyo Chhoto	Bhoj Raj Poudel	Begnas, Kaski	848
Hariyo Lamo	Krishna Maya Tiwari	Begnas, Kaski	848
Hariyo Bose	Shiva Raj Subedi	Begnas, Kaski	848
Jangali Ghiraula	NGB, Khumaltar	Ratnapuri-1, Bara	250
Jhimni	NGB, Khumaltar	Ratnapuri-1, Bara	250
Jhingani	NGB, Khumaltar	Laxmipur, Udaypur	NA‡
Lamka Ujarka	Pun Kumari Devi Gupta	Kachorwa, Bara	85
Lamo Bose	Dev Raj Poudel	Begnas, Kaski	818
Sagputti Ghiraula	NGB, Khumaltar	Santapur-4, Rautahat	300
Sano Ghiraula	NGB, Khumaltar	Pipladi-6, Kanchanpur	NA
Seto Basaune	Dev Raj Poudel	Begnas, Kaski	848
Seto Bose	Bishnu Prasad Tiwari	Begnas, Kaski	848
Seto Lamo	Hari Maya Poudel	Begnas, Kaski	848
Toriya	NGB, Khumaltar	Garamani, Jhapa	NA
Ujarka-B	Badri Prsad Kushwaha	Kachorwa, Bara	85
Ujarka-N	Nisahara Khatun	Kachorwa, Bara	85
Ujarka-R	Raj Kali Devi Gupta	Kachorwa, Bara	85

† SN = Serial Number. ‡ NA = Not available. Plant Genetic Resources Unit. NGB = National Genebank.

Climatic parameters (temperature, rainfall and relative humidity) during the growing period were recorded and analyzed (Figure 1). Eleven traits related to tender fruit production were recorded as described by Joshi et al. (2004a). Details of traits studied are given in Table 2. Sample size to measure the data ranged from 3 to 5 fruits and/or 3 to 5 plants. Three fruits from each plant were left for seed production; therefore, actual tender fruit yield was less by three fruits. Selfed seeds of each landrace were given to NGB, Khumaltar for ex-situ conservation. Data were subjected to multivariate analysis of variance (MANOVA), analysis of variance (ANOVA) and mean separation (Duncan's New Multiple Range Test). Data were processed in MS Excel and analyzed using MINITAB and MSTATC.

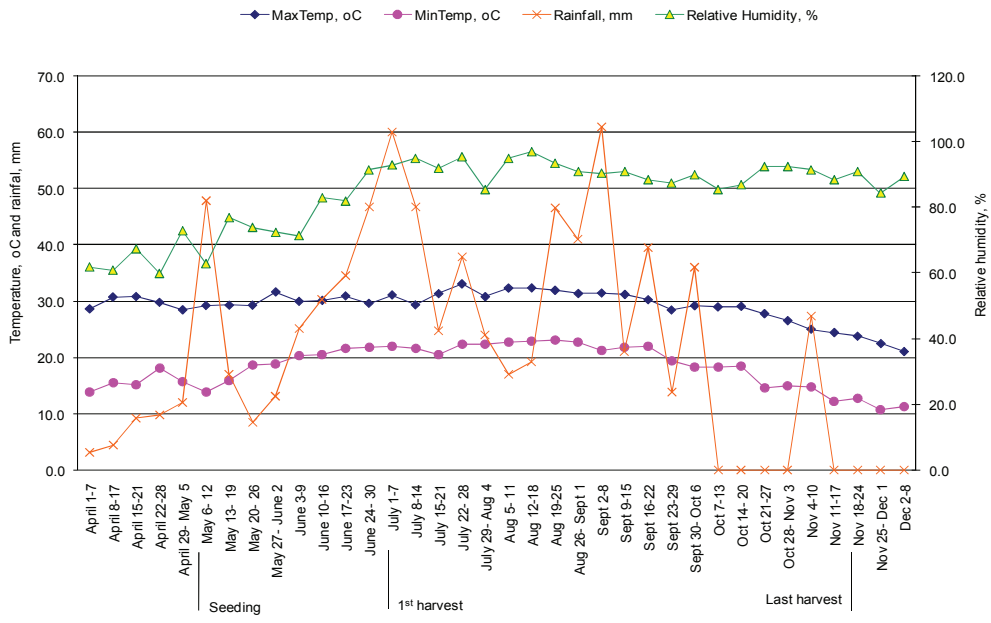

Figure 1. Climatic parameters (weekly average) during growing season of sponge gourd in Malepatan, Pokhara, Nepal.

Table 2. Evaluation descriptors for sponge gourd used in this study

SN	Descriptor	Method
1	Days to emergence	Number of days between seeding to emergence. Recorded date of seeding and date of emergence to calculate
2	Days to first harvest for vegetable use	Number of days between seeding and first harvest for vegetable use
3	Days to last harvest for vegetable use	Number of days between seeding and last harvest for vegetable use
4	Harvesting period of fruit for vegetable use	Days to last harvest minus days to first harvest
5	Fruit skin thickness	Average of three fruits of different plants measured at central part of fruit during harvest for vegetable use
6	Flesh skin thickness	Average of three fruits of different plants measured at central part of fruit during harvest for vegetable use
7	Fruit length	Average of 3 fruits of different plants measured from blossom end to stem end during fruit harvest for vegetable use
8	Fruit perimeter	Average perimeter of three fruits of different plants measured in three parts (petiole end, center and blossom end)
9	Fruit weight	Average weight of three fruits from different plants during harvest for vegetable use
10	Fruit number/plant	The number of fruits suitable for vegetable use during crop season. Average of three plants
11	Fruit yield/plant	Weight of total fruits harvested for vegetable use. Average of three plants

SN = Serial number.

RESULTS AND DISCUSSIONS

The landraces represented two eco-regions, Mid-hill and Tarai of Nepal. While Tarai has tropical climate, Mid-hill has sub-tropical to temperate climate. All these landraces grew well and produced fruits in this sub-tropical experimental site. All climatic parameters during crop growing period were higher than other period (Figure 1). During initiation of fruit harvest for use as a vegetable, minimum and maximum temperature, rainfall and relative humidity were high. It indicated that temperature was an important factor for tender fruit production. Davis (1996) reported that cool night and warm day were favorable for high yields and cool night, warm day, and humidity induced female flowers in sponge gourd.

Multivariate analysis of variance indicated the overall significance of differences (Wilk's P = <0.001) among these landraces. After obtaining a significant multivariate test, we examined the univariate F test for each variable to interpret the respective effects. Analysis of variances indicated that these landraces were significantly ($p = 0.05$) different for first harvest days and fruit yield/plant, highly significant ($p < 0.01$) for last harvest days, fruit-skin thickness, flesh thickness, fruit length, fruit perimeter, fruit weight and fruit number, but were not significant for days to germination (Tables 3 and 4).

Tender fruits were harvested the earliest from the Kachorwa's landraces. Among these landraces, Jhingani produced fruits ready for harvest within the shortest time and Lamo Bose took the longest time to produce fruit for harvest. Standard deviation of days to first harvest was the highest in landraces collected from NGB, Khumaltar, probably because these collections consisted of landraces collected from different locations. The earliest harvest may help get high market price and provide green vegetable during dry seasons. Many agronomical and indigenous practices can be used for better crop harvest. For example, transplants result in a better plant stand than the direct-seeded plants (Davis, 1996). He reported that yield from transplanting was 1.2 times higher than those from direct-seeded plants, however transplanting is not practiced by farmers in Nepal. Farmers in Nepal hang some weight, usually long chain of maize spadix on vine of sponge gourd for higher fruit yield and earlier fruiting and some farmers pinch the vine for the same purpose in Nepal. This traditional knowledge needs to verify. Tender fruits were harvested up to 169.3 days after seeding from Toriya. Sagputti Ghiraula had the shortest period from seeding to last harvest. The collections from NGB had a high standard deviation for days to last harvest (Table 3). The period of tender fruit harvest of all landraces is given in Figure 2. Toriya had the longest fruit-harvesting period, followed by Hariyo Bose. Jhimni had the shortest period of fruit harvest. Fruit harvesting period is important for getting higher yield as well as for regular supply of green vegetables. Farmers who grow very few plants in their home gardens prefer varieties having long harvesting period. Landraces from Kachorwa had longer period of fruit harvest compared to other sites.

Farmers in Begnas and Kachowra did not report fruit-skin thickness as their selection criterion. However, fruit having thin skin is preferred for cooking purposes. Variation in fruit skin among these landraces indicated the possibility of

selecting genotypes of desired skin thickness. Fruit-skin thickness ranged from 2.01 to 3.61 mm and it is suggested to explore the role of skin thickness on fruit shelf life. Seto Bose had the thickest and Jhimni the thinnest skin. Standard deviation of skin thickness was similar among these landraces. Flesh thickness is an important trait as compared with skin thickness. Means of flesh thickness were not significantly different among Kachorwa landraces, whereas the collections from Kaski and NGB had significantly different flesh thickness. Variation was higher in NGB collections. Lamo Bose had the thickest flesh, followed by Jangali Ghiraula (edible and available in Bara district), and Sagputti Ghiraula had the thinnest flesh (Table 3).

Table 3. Phenologcial, fruit skin and flesh characteristics of sponge gourd landraces

SN	Landrace	Germination, d		1st harvest, d		Last harvest, d		Fruit skin thickness, mm		Flesh thickness, cm	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Begnas, Kaski										
1	Hariyo Chhoto	7.67b	1.16	106.3abcd	14.01	163.0ab	6.24	2.440cde	0.51	4.380bcde	0.54
2	Hariyo Basaune	8.00b	0.00	94.0abcde	7.00	156.3abc	11.50	3.000abcd	0.33	4.200bcde	0.29
3	Hariyo Lamo	7.00b	0.00	96.0abcde	11.36	153.3abcd	10.79	2.890abcde	0.19	4.010bcde	0.52
4	Lamo Bose	9.20ab	3.54	112.4a	1.41	150.2abcd	31.80	3.300abc	0.47	4.930b	0.87
5	Hariyo Bose	7.67b	1.16	90.3abcde	7.09	155.0abc	6.56	2.890abcde	0.84	3.910cde	0.40
6	Seto Bose	8.33b	0.58	105.7abcd	5.13	154.7abc	15.31	3.610a	0.10	4.470bcd	0.27
7	Seto Lamo	7.00b	0.00	103.7abcd	9.87	154.0abc	5.29	2.890abcde	0.54	3.820de	0.34
8	Seto Basaune	8.33b	0.58	106.7abcd	6.03	162.3ab	9.81	3.440ab	0.20	4.000bcde	0.22
9	Basaune	8.33b	0.58	97.30abcde	16.20	151.3abcd	5.77	2.500cde	0.50	4.430a	0.49
	Mean	7.95	0.70	101.38	7.25	155.57	4.43	3.00	0.40	4.23	0.35
	NGB, Khumaltar										
1	Jhingani	11.67ab	6.43	80.70e	10.60	148.3abcd	9.50	2.330de	0.58	3.470e	0.79
2	Toriya	7.00b	0.00	101.3abcde	5.69	169.3a	6.35	3.220abcd	0.19	3.700de	0.16
3	Jangali Ghiraula	11.67ab	5.51	111.3ab	19.10	165.0ab	7.00	2.670bcde	0.76	4.820bc	0.92
4	Jhimni	6.50b	0.00	104.5abcd	14.80	138.3cd	0.00	2.010e	0.00	4.570bcd	0.42
5	Sano Ghiraula	8.00b	0.71	103.0abcde	21.20	138.3cd	0.00	2.510cde	0.71	4.550bcd	0.04
6	Sagputti Ghiraula	11.67ab	6.43	85.70de	11.24	133.0d	10.39	3.060abcd	0.42	2.520f	0.60
	Mean	9.42	2.51	97.75	11.88	148.70	15.19	2.63	0.45	3.94	0.88
	Kachorwa, Bara										
1	Harihar Tagwa Bhadaiya	8.30b	0.71	103.1abcde	24.70	167.0a	2.83	2.450cde	0.12	4.340bcde	0.57
2	Ujarka-B	8.00b	0.00	87.30cde	10.97	149.3abcd	16.07	2.560bcde	0.20	4.230bcde	0.12
3	Lamka Ujarka	11.33ab	6.66	110.0abc	11.27	163.7ab	8.02	3.220abcd	0.19	3.730de	0.37
4	Hariharka	12.00ab	6.08	89.00bcde	10.82	150.3abcd	6.81	2.330de	0.34	4.590bcd	0.10
5	Ujarka-R	15.33a	6.35	92.00abcde	12.17	144.0bcd	12.29	3.280abc	0.68	4.620bcd	0.54
6	Ujarka-N	7.33b	0.58	96.70abcde	6.11	155.7abc	6.81	3.330abc	0.34	4.610bcd	0.41
	Mean	10.38	3.08	96.35	8.80	155.00	8.90	2.86	0.46	4.35	0.35
	P value	0.203		0.05		0.009		0.005		<0.001	

SN = Serial number. SD = Standard deviation. Values followed by the same letter/s are not significantly different at 0.05 level by DMRT. d = Days

Fruit characteristics and yield of sponge gourd landraces are given in Table 4. Fruit length and fruit number per plant have been considered as important criteria for selection by sponge gourd growers. Existence of highly significant differences in these traits indicates that variation is being maintained by Kachorwa and Begnas farmers. Collections in NGB represent unique genotypes. Landraces from Begnas had longer fruits and collections from NGB had shorter fruits. Hariyo Lamo had the longest fruit, followed by Hariyo Bose. Sano Ghiraula and Sagputti Ghiraula produced the shortest fruits. Name of these landraces also indicates the length of fruits, e.g., Sano means small and Lamo means long. The landraces from Begnas had more diverse fruit length. Large genetic diversity was detected among the landraces by Bajracharya et al. (1999). Landraces from Kachorwa were not significantly different for fruit length. Fruit characters are the most important descriptors used by farmers for distinguishing and naming the sponge gourd landraces (Bajracharya et al., 1999; Pandey et al., 2003; Yadav et al., 2003).

For fruit width, collection from NGB had more variation. Collection from Begnas had landraces having fruit of similar width. Similar was the case for Kachorwa collection. Perimeter of Hariharka was the largest and that of Sano Ghiraula, the smallest.

For commercial cultivation, fruit weight is an important trait. Landraces from Begnas had higher fruit weight than the others. The heaviest fruit was produced by Lamo Bose, followed by Seto Basaune. Sano Ghiraula and Sagputti Ghiraula produced the lightest fruits. Single fruit weight in these landraces ranged from 49 to 334.3 g. Fruit weight was not significantly different among landraces of Kachorwa (Table 4). Fruit number was a relatively more important criterion for farmers. More variation in fruit number was found in NGB collections. This may be because of collections being from different locations. Fruit number was not significantly different among landraces of Begnas and Kachorwa. Number of fruits per plant ranged from 5 to 74. Sano Ghiraula produced the highest number of fruits per plant. Sano Ghiraula and Sagputti Ghiraula were the two landraces that produced significantly higher number of fruits than others. The lowest fruit number was produced by Harihar Tagwa Badaiya. Landraces having longer fruit size produced lower number of fruits ($r = 0.44^{**}$).

Three landraces, Hariharka, Basmatiya and Lamka Ujarka, were characterized by Yadav et al. (2003). Variation was reported in Lamka Ujarka for leaf and node characteristics. Yadav et al. (2003) reported fresh fruit yield of 241.54 g and 166.14 g in Lamka Ujarka and Hariharka, respectively. Chitkavra had the fresh fruit weight of 300 g in Kachorwa (Yadav et al., 2003). Pandey et al. (2003) characterized five landraces (Basaune, Hariyo Chhoto, Hariyo Lamo, Lamo Bose and Seto Lamo) on-farm, out of which, Hariyo Chhoto was the most preferred one, followed by Hariyo Lamo and Basaune in Begnas. Seto Lamo and Basaune were reported as rare landraces. They also reported both inter and intra landrace diversity with most of the landraces having high productivity. Hariyo Chhoto was an early fruiting landrace with prolonged fruiting and remained tender for long period. Hariyo Lamo had long fruit with good yield. Seto Chhoto was less spongy and took relatively short time for cooking. However, the vines produced less number of fruits and set sponge early.

Table 4. Fruit characters and yield of sponge gourd landraces

Landrace	Fruit length, cm		Fruit weight, g		Fruit /plant, n		Fruit yield/plant, g	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Begnas, Kaski								
Hariyo Chhoto	17.11def	0.54	160.2bcdef	29.60	13.00c	11.84	2684abc	2739.00
Hariyo Basaune	25.45abc	3.38	248.2abc	65.20	9.800c	4.99	2160abc	874.00
Hariyo Lamo	29.45a	6.02	255.3ab	114.80	8.900c	2.18	2019abc	528.00
Lamo Bose	27.91ab	4.12	334.3a	209.00	1.300c	3.18	6450c	631.00
Hariyo Bose	28.45a	5.17	225.3abcd	18.10	10.20c	2.80	2255abc	716.00
Seto Bose	28.05ab	4.30	282.9ab	48.00	11.30c	7.05	2352abc	1272.00
Seto Lamo	28.28ab	6.01	249.2abc	107.50	12.40c	5.64	3104abc	1560.00
Seto Basaune	27.33abc	1.59	269.0ab	42.10	18.60bc	7.96	4606ab	2195.00
Basaune	26.25abc	1.25	200.0abcd	27.20	6.000c	3.50	1725bc	1530.00
Mean	26.48	3.71	247.16	49.60	10.17	4.78	2394.44	1072.62
NGB, Khumaltar								
Jhingani	15.58efg	0.72	106.5def	68.20	19.70bc	15.04	1722bc	1525.00
Toriya	16.33def	1.44	188.9bcde	12.73	32.70bc	5.13	5337a	1299.00
Jangali Ghiraula	13.75fg	2.22	173.8bcdef	59.90	30.50bc	18.20	4958ab	2036.00
Jhimni	13.23fg	3.18	112.9cdef	16.30	19.60bc	9.90	2839abc	2167.00
Sano Ghiraula	11.38fg	0.85	49.00f	12.80	74.60a	80.60	2299abc	2171.00
Sagputti Ghiraula	9.850g	0.61	63.00ef	12.13	46.60b	31.80	3105abc	2389.00
Mean	13.35	2.46	115.68	56.66	37.28	20.82	3376.67	1456.41
Kachorwa, Bara								
Harihar Tagwa Bhadaiya	21.11cde	2.95	219.5abcd	110.40	5.000c	2.60	957.0c	733.00
Ujarka-B	26.61abc	3.29	224.2abcd	75.50	9.300c	2.00	2377abc	786.00
Lamka Ujarka	23.89abc	3.78	251.8ab	79.70	12.60c	10.06	2744abc	2385.00
Hariharka	21.05cde	3.93	223.4abcd	52.90	12.10c	7.35	2456abc	1707.00
Ujarka-R	27.36abc	1.33	257.1ab	51.70	9.700c	5.45	1815bc	1203.00
Ujarka-N	23.67abc	2.89	213.1abcd	26.50	13.20c	7.69	3693abc	2684.00
Mean	23.95	2.66	231.52	18.27	10.32	3.05	2340.33	916.18
P value	<0.001		0.001		0.002		0.05	

SN = Serial number. SD = Standard deviation. Values followed by the same letter/s are not significantly different at 0.05 level by DMRT.

Farmers usually maintain 1 to 5 plants per household. Therefore, fruit yield per plant is important rather than yield per hectare. On an average, NGB collections produced more fruits than Begnas collections. More variation in fruit yield was also in NGB collections (Table 4). The highest fruit yield was produced by Toriya, followed by Jangali Ghiraula and Seto Basaune. Lamo Bose gave the lowest fruit yield. Significant fruit yield was not observed within Kachorwa landraces. Among Kachorwa landraces, Ujarka-N produced the highest fruit yield per plant. The highest fruit yielder among Begnas landraces was Seto Basaune.

Single plant of landraces can cover a large area if provided enough support. Farmers support vines with tall and large dead branch of trees. Sometimes a single plant can cover entire roof area of a house. In such cases, these landraces may produce higher fruit yield than we have reported here. We supported vines by small dead guava branches. It is likely that because of this restriction on expansion of vines, these landraces may not have yielded to their full potential.

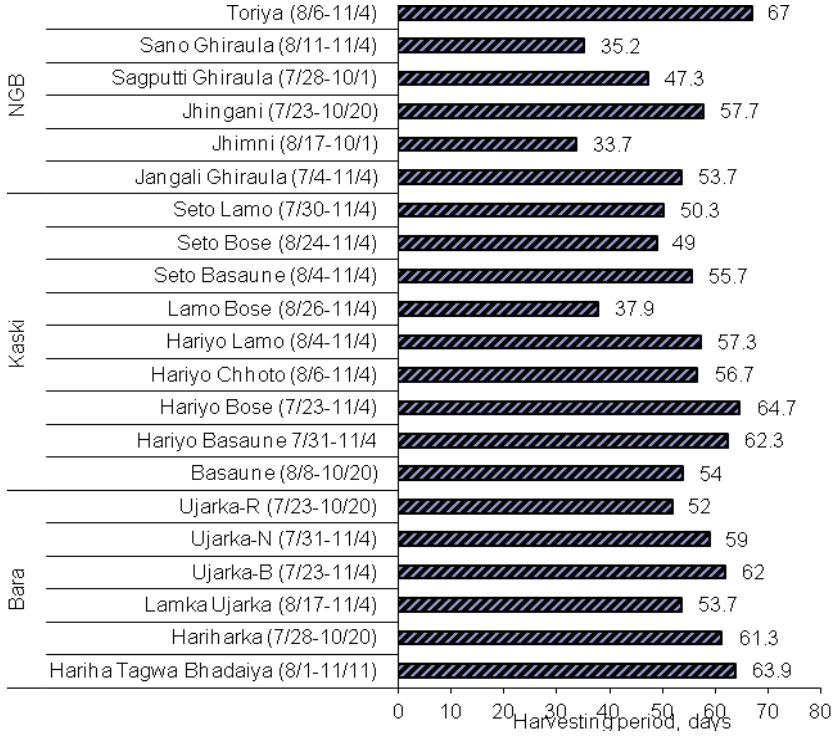

Figure 2. Fruit harvesting period of different landraces of sponge gourd collected from Bara and Kaski districts and National Genebank (NGB), Khumaltar, Nepal.

CONCLUSIONS

There were significant differences among the landraces relative to diversity studied for farmer's preferred traits, e.g., tender fruit yield, fruit weight and fruit harvesting period. Because of diverse needs of farmers in diverse environments, different landraces are being maintained. Options for improving these landraces exist by reshuffling promising attributes e.g. flesh thickness, fruit size and fruit harvesting period, etc. Landrace improvement is another option for better crop harvest. Strategy of maintaining seeds by individual farmers themselves should be considered for conserving landrace diversity on-farm.

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