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Research article

Morpho-agronomic study of some varieties of Golden Sweet Potato for their utilization as food and forage

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Abstract: Our study aimed to characterize morpho-agronomically, the sweet potato germplasm. This experiment was carried out at the experimental farm of the "Participatory Rural Development Foundation (PRDF)" located at 59 Canal Road, Shivpur-Shahbazganj, Gorakhpur, Uttar Pradesh, India. At the experimental farm, evaluations were done for the soil properties, and morpho-agronomic traits of the aboveground part of the sweet potato germplasm. Results of the soil analyses exhibited low soil fertility at the study site. Among the sweet potato accessions, greater variability were observed for vine internode length (2.0–6.0 cm), internode diameter (1.5–3.0 cm), leaf lobe type (deep to very light teeth), the number of lobes per leaf (1–6 lobed), the height of the central lobe (9.0–17.5 cm), mature leaf size (93.5–332.0 cm), and general leaf shape (lobed to triangular). Based on our findings, the sweet potato being cultivated at the PRDF experimental farm exhibited high phenotypic variability in morpho-agronomic traits, and the morphological characterization was highly efficient in detecting genetic variability among the accessions. Therefore, our study suggests that the PRDF experimental farm is capable for conserving sweet potato genotypes with expressive genetic diversity, and this crop shows a good prospect for the breeding program.

Keywords: Sweet potato - Beta-carotene - Accessions - Germplasm - Morphological traits - Propagation.

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INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam.] belongs to Convolvulaceae family, and is one of the most hardy and versatile tuber crops consumed as a staple food or an alternative food across the world (Mohanraj & Sivasankar 2014). Due to anthocyanin pigmentation, generally, the colour of stem and leaves vary from green to purple (Laurie & Niederwieser 2004). There are several varieties of sweet potato which differ in texture, sweetness, and shape and size of tubers (Reddy *et al.* 2018). The crop exhibits a short growth cycle, and generally matures in 3–4 months, therefore it can be grown 2–3 times in a year (Reddy *et al.* 2018). After rice, wheat, potato, maize and cassava, it is the sixth important food crop across the globe (International Potato Center 2018). It produces maximum food per unit area (25–35 ton ha^{-1}) and per unit time than any other food crop (Loebenstein 2016). Out of 106.5 million tons of the crop produced in the world, China produces 81.6 million tons, while India produces about 1.1 million tons (Mishra *et al.* 2019, FAO 2011). In India, Uttar Pradesh is the second-largest producer (2,64,830 tons) state after Odisha (Allolli *et al.* 2011, Vanitha *et al.* 2013).

Sweet potato (*Ipomoea batatas*) has a diverse range of positive attributes like high yield with limited inputs, short duration, high nutritional value, and tolerance to various biotic and abiotic stresses (Mishra *et al.* 2019). Due to increasing public awareness, health benefits, and production of many value-added products, the

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production and consumption of sweet potato has considerably increased in the modern world (Wadl *et al.* 2018). This crop is low in fats and cholesterol, while it is a rich source of carbohydrates, vitamins, A, C, B1, B2, B3, B6, E, biotin, and pantothenic acid, as well as, potassium, copper, manganese, iron, and dietary fibre (Wang *et al.* 2016, Wadl *et al.* 2018). Nowadays, the orange-fleshed sweet potato (OFSP) is emerging as an important type of sweet potato, especially to tackle the problem of vitamin-A deficiency, as noted by Mukherjee *et al.* (2003, 2009) (Fig. 1). Several other studies have also found OFSP to be the potential solution for vitamin-A deficiency (Purcell & Walter 1968, Tsou & Hong 1992, Simonne *et al*. 1993, Takahata *et al*. 1993, Laxminarayana 2013). These studies have shown that OFSP is a rich source of β-carotene, which is converted to vitamin-A inside the human body (Haskell 2012).

Figure 1. Picture of golden Sweet potato [*Ipomoea batatas* (L.) Lam.]

The deficiency of vitamin-A causes various eye problems, such as, blindness, Bitot's spot, xerophthalmia, and susceptibility to infectious disease like diarrhea, measles, etc. (Akhtar *et al.* 2013). Currently, various kinds of sweet potato varieties are available, which have very high levels of β-carotene (precursor of vitamin-A), however, the Orange-fleshed Sweet Potato (OFSP) or Golden Sweet Potato (GSP) or *Sunahari Shakarkand*, are being largely targeted to ameliorate prevalent vitamin-A deficiency in Uttar Pradesh (state) (Chaudhary *et al*. 2016, Chaudhary & Sahani 2017). It may be kept in mind that in eastern Uttar Pradesh, on average 40.9% of children suffer from vitamin deficiency, while more than 6% of children in Uttar Pradesh suffer from a clinical vitamin-A deficiency, which is highest among the Indian states (Kansal 1997).

India is among the top few countries accounting for vitamin-A deficiency, as 60,000 children go blind annually (Bhandari & Zaidi 2004). Vitamin-A deficiency among children from poor and middle-class families in Uttar Pradesh averages to 41% (as high as 65% in the 3-year age group) (Bhandari & Zaidi 2004). Consequently, to eliminate vitamin-A deficiency, the government of India, supported by the Canadian International Development Agency (CIDA), Helen Keller International (HKI), Micro-nutrient Initiative (MI), United Nations International Children's Emergency Fund (UNICEF), United States Agency for International Development (USAID) and the World Bank Group (WBG), distributed free vitamin-A capsules, 15 years ago (Chaudhary & Sahani 2017). Results of these developments were positive and dramatic but met failure, unfortunately due to corruption in regional government bodies. In such circumstances, the sustainable solution, with no costs to the government is the popularization of OFSP and GSP varieties (Chaudhary *et al.* 2016, Chaudhary & Sahani 2017), which show yellow or orange flesh due to very high level of β-carotene (precursor of Vitamin A) (Chaudhary & Sahani 2017). Moreover, the GSP also supply the required quantity of potassium, iron, dietary fibre, and energy (Chaudhary & Sahani 2017).

Sweet potato exhibits high phenotypic and genotypic variability (Veasey *et al*. 2007) which confers its adaptability to various edaphoclimatic conditions. This crop has been empirically cultivated by many farmers, and the occurrence of same cultivar with different names is quite common (Daros *et al*. 2002, Moulin *et al.* 2012). Sometimes, the sweet potato germplasm collected from rural properties, although belong to the same genotype, they may have different accessions in a gene bank.

For identification of duplicate genotypes in gene banks, the morphological characterization of the germplasm is the most feasible method, which is frequently used for quantification of the genetic diversity of the duplicate genotypes (Ritschel & Huáman 2002). The traditional approach of characterization and evaluation involves the cultivation of accession sub-samples and their morphological and agronomical description; a procedure facilitated by the use of internationally recognized descriptor lists (Erskine & Williams 1980, Chaudhary *et al.* 2016, Chaudhary & Sahani 2017).

Germplasm collection of crop plants is an excellent source of economically useful plant characters. However, in many crops, the number of available accessions greatly surpasses the time a breeder can devote to a screening operation. The breeders must have a means of choosing the accessions that most likely possess the traits of interest. If the trait characteristics of accessions are known, the targeted and more efficient utilization of germplasm by plant breeders can be achieved (Sudré *et al*. 2010). The present study was undertaken to access and evaluate the genetic diversity in GSP germplasm collected from diverse origin on the basis of quantitative traits and to identify superior genotypes for future use.

The agronomic characterization contributes information for GSP breeding for commercial cultivation, and for determining the use of accessions. According to Reddy *et al.* (2018), due to declining productivity of food grains, and extensive loss of crops by natural disasters, sweet potato is gaining importance in several states in India. In such situations, the morphological descriptors could provide information for selecting desirable traits that meet the market demands. For sweet potato, the traits important for commercial productivity, adaptability and stability of accessions in a particular growing region, also include the occurrence of skin defects, resistance to pests, etc. (Chipungu *et al.* 2018). Moreover, the evaluation, characterization and documentation of the germplasm is essential for maintaining the real variability of the conserved ecotypes for their effective use by botanists, breeders, or even farmers. In this study the authors aimed to characterize the morpho-agronomically resilient varieties in the GSP group, which will give additional benefit to the people or agencies involved in its cultivation.

MATERIALS AND METHODS

Study site and climate

The present study was carried out from June 2018 to June 2019 on the Participatory Rural Development Foundation (PRDF) experimental farm (Lat. 26° 47' 11.652"N; Long. 83° 23' 37.824"E; Alt. 95 m.a.s.l) (Fig. 2) of 50 m × 50 m area, located at 59 Canal Road, Shivpur–Shahbazganj, Gorakhpur 273014, India. The district Gorakhpur is one of the most important cities of Eastern Uttar Pradesh and comprises 19 blocks. The city enjoys rich vegetation due to fertile Gangetic alluvium soil. The climate of the study area is sub-tropical monsoon. The total average annual rainfall is 1814 mm, of which about 85% occurs during the wet or monsoon season spanning around only three months (*i.e.*, July–September). The dry period is relatively longer, extending about eight months (*i.e.*, December–June), where the monthly rainfall is less than 100 mm. The average maximum temperatures during summer and winter are 38ºC and 26ºC, respectively, while the average minimum temperatures are 28ºC and 12ºC, respectively. The annual average relative humidity of the study area is about 87% during day, and 74% during night time.

Figure 2. Picture of golden sweet potato cultivation farm.

Soil sampling and measurement

The soil samples were collected from the three random locations of the PRDF experimental farm, upto 20 cm depth, and were pooled together for analyzing chemical and physical properties *viz.*, pH, electrical conductivity, lime percentage, organic matter concentration, nitrogen, phosphorus, and potassium concentration, available sulphur, zinc, iron, manganese and copper, following various protocols reported in the scientific literature (Khan 2012, Khan *et al.* 2014, Iqbal *et al.* 2015, Ahmad *et al.* 2016, Bibi *et al.* 2016, Khan *et al.* 2016).

Plant sampling and measurement

The plant material used in this study consists of accessions of sweet potato from the Germplasm Bank of PRDF experimental farm, considering 9 verities, *viz.*, Orange Chingorwa, Carrot C, Naspot 12, Mayal, Naspot 13, Zambe 31, Kabode, Kaphulira W - 151, Kaduabwevere. The morphological characterization of the above-ground part was carried out throughout the growth period after the vine planting. For each variety, we selected healthy plant samples for the morphological measurements, and the number of samples were more than 10. The vegetative parts were evaluated using the following 18 descriptors: Vine Character, Plant type, Internodes diameter, Internodes length, Vine strength, Predominant color of the vine, Secondary color of the vine, Vine tip pubescence, Number of nodes per 20 cm of vine, General leaf outline, Type of leaf lobes, Height of central leaf lobe, Mature leaf size, Abaxial leaf vein pigmentation, Mature leaf color, Immature leaf color, Petiole pigmentation, Petiole length, and Leaf to leaf distance.

Data analysis

The measurements in replicates for each of the plant morphological characters were averaged, and the soil parameters were calculated and analyzed with the help of Microsoft Office Excel 2016.

RESULTS

Soil characters

The summary of soil analyses results are given in table 1 and 2. These results show that the soil fertility of the PRDF experimental site was of neutral pH, and low quality. According to results, only available manganese and available copper concentrations were of A (high) grade, and the available sulphur and available potash were of M (medium) grade. Among other soil properties, available zinc, available iron, and available nitrogen were of L (low) grade while, available phosphate was of VL (very low) grade.

Table 1. Soil analyses results. [A, high; M, medium; L, low]

	Available Sulphar		**Available Zinc**		**Available Iron**		**Available Manganese**		**Available Copper**	
	PPM	**Fertility grade**	**PPM**	**Fertility grade**	**PPM**	**Fertility grade**	**PPM**	**Fertility grade**	**PPM**	**Fertility grade**
Soil	14.4	M	0.51	L	3.84	L	4.27	A	0.90	A

Table 2. Soil analyses results. [M, medium; L, low; VL, very low]

	pH	**Available Nitrogen**		**Available Phosphate**		**Available Potash**		**Salinity of soil sample**	
		%	**Fertility grade**	**Kg ha^{-1}**	**Fertility grade**	**Kg ha^{-1}**	**Fertility grade**	**E.C.M. cm^{-1}**	**Zypsum**
Soil	6.8	0.25	L	9.0	VL	126	M	0.67	-

Plant morphology

The morphological characteristics of accessions of sweet potato from the Germplasm Bank of PRDF are given below (Table 3),

1. *PRDF - I - 1*

It was a unique variety. Characteristically, its vine was not circular, instead, it was crawling on the ground surface. The internode of the vine ranged up to 2 cm in length, and 2 cm in thickness. The vine was strong enough.

The color appearance of the vine was primarily green and secondarily dark green. The dark green color was dominant on the top portion. Within the range of 20 cm, 5 nodes of vines were found. Leaves were lobed, deep incised, Penta-lobed. The middle height of the old leaf was 9 cm, whereas the mature leaf height ranged up to 93.5 cm. The dorsal surface was dark green, whereas immature leaves were green. Petiole was green and 120 cm in length. The characteristics of the tuber, as well as its color were unknown.

2. *PRDF - I - 2*

This sweet potato was a special variety. Characteristically, its vine was not circular; instead, it crawled on the surface of the field. The internode of the vine was 4 cm in length, and 2 cm in diameter, and the vines were strong. The color appearance of the vine was primarily green and secondarily dark purple. The top portion of vines hold a light green color. Within the range of 20 cm, 5 nodes of vines were found. Leaves were lobed. The middle height of the mature leaf was 13 cm, and the overall height ranged up to 143 cm. Leaves were cordate shape, mono-lobed. The dorsal surface of leaves was of purple color. Mature leaves were dark green in color, whereas immature leaves were light green. The petiole was purple and 4cm in length, and was present at a distance of 4 cm from other leaves. The shape of the tuber, as well as its color, was unknown.

3. *PRDF - II - 3*

The length of internode of the vine was 5 cm, and the diameter was 2 cm. Initially, the vines were green and later of dark green color. In the range of 20 cm of the vine, 6 nodes were found to be present. Leaves were lobed & deep incised. The middle portion of the leaf measured 2 cm, whereas overall leaf ranged up to 156.25 cm. The dorsal surface of leaves have vines of light green color. Petiole 4 cm, and at a distance of 5 cm from other leaves.

Table 3. Characteristic features of Golden Sweet Potato New Varieties. PRDF, Participatory Rural Development Foundation.

	PRDF-I-1 Orange Chingo-Rwa	PRDF-I-2 Carrot C	PRDF-I-3 Naspot 12	PRDF-I-5 Mayal	PRDF-I-6 Naspot 13	PRDF-I-7 Zambe 31	PRDF-I-8 Kabode	PRDF-I-10 Kaphulira	PRDF-I-11 W-151	PRDF-I-12 Kaduab wevere
General character										
Vine character	Non twining	Non twining	Non twining	Non twining	Non twining	Non twining	Non twining	Non twining	Non twining	Non twining
Plant type	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading
Vine Pigmentation										
Predominant color	Green	Green	Green	Green	Green	Light Green	Light Green	Green	Light Green	Light Green
Secondary color	Light Green	Light Green	Purple	Dark Green	Dark Green	Light Green	Dark Green	Purple	Purple	Green
Vine tip pubescence	Light Green	Light Green	Light Green	Light Green	Green	Light Green	Light Green	Green	Green and purple	Light Green
Vine node and internode										
Number of nodes per 20 cm	5 nodes	7 nodes	5 Nodes	4 Nodes	6 Nodes	3 Nodes	6 Nodes	5 Nodes	4 Nodes	6 Nodes
Internode length	2.0 cm	4.0 cm	4.0 cm	6.0 cm	5.0 cm	5.0 cm	4.0 cm	5.0 cm	6.0 cm	4.5 cm
Internode diameter	2.0 cm,	1.5 cm	2.0 cm	2.0 cm	2.0 cm	1.5 cm	3.0 cm	2.5 cm	1.5 cm	2.0 cm
Internode strength	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong
Leaf character										
General outline	Lobed	Lobed	Lobed	Lobed	Lobed	Cordate	Lobed	Cordate	Triangular	Lobed
Type of lobes	Deep	Deep	Cordate	Deep	Deep	Very light teeth	Very light teeth	Very light teeth	Very light teeth	Moderate
Number of lobes	5 Lobed	5 Lobed	1 Lobed	6 Lobed	5 Lobed	3 Lobed	6 Lobed	3 Lobed	3 Lobed	5 Lobed
Height of central lobe	9.0 cm	10.5 cm	13.0 cm	15.0 cm	12.5 cm	12.3 cm	17.5 cm	17.0 cm	13.0 cm	14.0 cm
Mature leaf size	93.5 cm	135.0 cm	143.0 cm	225.0 cm	156.3 cm	151.3 cm	332.0 cm	255.0 cm	175.5 cm	210.0 cm
Abaxial vein pigmentation	Light Green	Light Green	Purple	Light Green	Light Green	Light Green	Green	Purple	Purple	Light Green
Mature leaf color	Green	Green	Green	Green	Green	Dark Green	Light Green	Dark Green	Green	Green
Immature leaf color	Light Green	Light Green	Light Green	Light Green	Light Green	Purple and Green	Dark Green	Green	Green	Light Green
Petiole pigmentation	Green	Green	Purpule	Green	Green	Purple and Green	Light Green	Purple and Green	Green	Light Green
Petiole length	120.0 cm	125.0 cm	150.0 cm	145.0 cm	120.0 cm	150.0 cm	120.0 cm	160.0 cm	150.0 cm	120.0 cm
Leaf to leaf Distance	4.0 cm	4.0 cm	4.0 cm	6.0 cm	5.0 cm	5.0 cm	4.0 cm	5.0 cm	6.0 cm	4.0 cm

4. *PRDF - I - 5*

The internode distance measured up to 5 cm, with a diameter of 2.5 cm. The initial color of the vine was green, while later changed to purple color. Within the range of 20 cm, 5 nodes were present. Leaves were cordate, slightly lobed, tri-lobed. The lobes were at a distance of 4 cm from each other. Overall, the leaf ranged up to 160 cm. The dorsal surface of leaves possessed vines of purple color. Petiole possessed both purple and green color, 4 cm in length. Leaves were separated at a distance of 5cm from each other.

5. *PRDF - I - 6*

The internode of vine accounted the length of 6 cm, and a diameter of 1.5 cm. The primary color appearance of vine was the light green, while the secondary color was purple. The top-most vines were both green and purple, 4 nodes were present between the length of 20 cm of the vine. Leaves were triangular. Lobes were small; tri-lobed; The distance between lobes of the mature leaf was 4 cm, whereas total leaf ranged up-to 175.5 cm. Purple vines were present on the dorsal surface of the leaf. Petiole green, 5 cm in length, and 6 cm away from each other.

6. *PDRF - I - 7*

The length of internode was 4.5 cm, and the diameter was 2 cm. The initial color of the vine was green, and later dark green. 6 nodes were found across the vine of 20 cm. Leaves lobed, regular, penta-lobed; distance between mature lobes was 5 cm, whereas overall measured up to 210 cm length. Dorsal leaf surface exhibited vine of light green color. Petioles were of 4 cm in length, and were located 4 cm away from each other.

7. *PDRF - I - 8*

The internode was 6 cm, and the diameter was of 2 cm. The early stages bear green vines, whereas later stages bear dark green vines. Within the distance of 20 cm of length, 4 nodes were present. Leaves lobed, hexa-lobed. Distance between lobes was 15 cm, and the whole leaf ranges up to 225 cm. Dorsal surface leaf had vine of light green color. Petiole, 12 cm long, and leaves were separated at 6 cm distance from each other.

8. *PRDF - I - 10*

Internode was 4cm in length, and the diameter was 3 cm. The initial color of vine was dark green, later color was green. The topmost dominant color of the vine was light green. Between 20 cm of internode, 6 nodes were present. Leaves were lobed, but small, hexa-lobed. The distance between lobes of the mature leaf was 4 cm, and the overall leaf ranged up to 332 cm. The dorsal surface of the leaf possessed a vine of green color. Mature leaves were dark green, whereas immature leaves were light green. Petiole was light green, 12 cm, and leaves at 4 cm distance from each other.

9. *PRDF - I - 11*

The length of internode was 2 cm, and thickness was 2 cm too. The initial color of vines - dark green, the final color of the vine - light green. Topmost color - Light green. Within 20 cm of the vine, 5 nodes were found to be present. Leaves were lobed, deeply incised, penta-lobed. Distance between the lobes of old leaves was 9 cm, whereas overall leaf increases up to 93.5 cm. The dorsal surface of leaves has a vine of light green color. Mature leaves were dark green, whereas immature leaves were of light green color. Petiole green, 15 cm in length; 4 cm distance from leaf to leaf.

10. *PRDF - I - 12*

The internode was 5 cm, and the thickness was 15 cm. Earlier the vine depicted dark green color, but later it depicted light green color, along with the top most region of the vine. 3 nodes were present along 20 cm length of vine. Leaves cordate, and small lobes emerged out from it. Leaves tri-lobed, with the distance of 9 cm among them, the mature leaf measured about 151.29 cm. Mature leaves were of green color, whereas immature leaves were of purple color. Petioles were purple, and also of light green color. The length of petiole was 13 cm, and the distance between leaf to leaf was 4 cm.

11. *PRDF - I - 13*

The internode equals 2 cm in length, and 2 cm in thickness. Vine initial color dark green. The final color light green. Uppermost color of the vine portion was also light green. Within the range of 20 cm long vine, 5 nodes were present. Leaves were incised and penta-lobed. Mature leaves had lobe difference of 9 cm, while the oldest leaf had an overall length of 93.5 cm in total. Dorsal surface of the leaf bear light green color vine. The mature leaf had a dark green color. The immature leaf exhibited a light green color. The petiole was green, 15 cm in length, and leaf to leaf distance was 4 cm.

12. *PRDF - I - 14*

The distance between internode was 2 cm, along with the thickness of 2 cm. The initial /primary color of vine was dark green and the secondary color of vine was light green. The uppermost portion of vine was light green, and within the range of 20 cm vine length, 5 nodes were present. Leaves were lobed and incised, penta-lobed, lobes were at the distance of 9 cm from each other, and overall leaf measured about 93.5 cm. The dorsal surface of leaves was of light green color. Older leaves dark green, new leaves light green, petiole green, 15 cm, and leaf to leaf distance was 4 cm.

RESULTS AND DISCUSSION

We observed differences for the evaluated accessions regarding all morphological variables of golden sweet potato. The overall morphological characterization data showed major variations among seven qualitative traits of sweet potato. Following leaf shape, we found 70% of accessions exhibiting lobed shape, 20% chordate shape, while only 10% triangular shape. The lobed shape leaves have also been reported in other similar studies, across the globe. For instance, Moulin *et al.* (2012) found lobed (50%), triangular (38%), cordate (7%), lanceolate (4%) and round (1%), while Cavalcante (2008) documented lobed (46%), triangular (27%), lanceolate (18%) and cordate (9%). In few other studies, Daros *et al.* (2002) reported 93% accessions with lobed shape, whereas Ritschel & Huamán (2002) found chordate shape as the dominant trait present in 50% of the accessions.

We observed a great deal of differences in mature leaf size of various varieties. Kabode, supercedes every variety as its leaf size was 332 cm. Whereas next come Kaphullira at 255 cm. The lowest leaf size was of Orange Chingorwa (93.5 cm). The rest of the varieties range between 143 to 260 cm. In our study, 80% accessions exhibited medium leaf size. Similarly, in other studies as well, medium leaf size has been reported dominant trait in sweet potato accessions. For instance, Moulin *et al.* (2012) observed medium leaf size in 66% of the accessions, while Ritschel & Huamán (2002), and Daros *et al*. (2002) classified 80% and 100% accessions of sweet potato as medium sized, respectively.

Petiole length is also important since it also shows a pattern of variation. Kaphullaria showed the maximum length of the petiole (160 cm), followed by Zambe (150 cm), and next behind Mayal (145 cm), whereas Orange chingorwa accounted for the lowest (120 cm). Similar to our findings, Daros *et al.* (2002) and Veasey *et al*. (2007) also reported great variability in petiole traits of the sweet potato, which suggests great heterogeneity in this trait.

The morphological parameters provide insight into the biomass of a plant (Chaturvedi *et al*. 2012, Chaturvedi & Raghubanshi 2013) which also decides quantity of forage for animals. The leaves of the golden sweet potato are rich source of β-carotene and vitamin-A. The total carotenoid content of yellow and deep yellow tubers is greater than that in white potatoes, ranging from 1.5 to 28 $\mu g\ g^{-1}$ dry wt. (Ezekiel *et al.* 2013, Lachman *et al.* 2016), which can be utilized for domestic purposes. During the process of domestication, we provide food, shelter and security to the animals, and they provide us food, such as dairy products with health benefits. The vitamin-A may be transferred to the human body through milk. In this study, root characters have not been explored due to time constraints, since the stored root takes 3–4 months for maturation. We also suggest further studies on the effects of water stress on the morphological and physiological attributes of sweet potato germplasm for facilitating their growth in arid regions.

CONCLUSION

We reported variability in morphological characteristics of the sweet potato genotypes in different accessions. These variations in morphological traits have a direct effect on plant physiology, tolerance to abiotic stress (drought tolerance), resistance to diseases, and yield parameters. Based on our findings, the morphological characterization of sweet potato germplasm cultivated at the PRDF experimental farm was highly efficient in detecting genetic variability among the accessions. Therefore, our study suggests that the PRDF experimental farm is highly capable for conserving sweet potato genotypes with expressive genetic diversity, and this crop shows a good prospect for the breeding program.

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