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Full Length Research Paper

Morphological and agronomical characterization of Sweet potato [*Ipomoea batatas* (L.) Lam.] germplasm collection from Tanzania

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One hundred and thirty six sweet potato (*Ipomoea batatas)* landraces collected from three different agro-ecological zones of Tanzania [Lake Victoria basin (LZ), Eastern (EZ) and Southern Highlands Zones (SHZ)] were characterized morphologically and agronomically using International Potato Centre (CIP) descriptors in two seasons. The cluster analysis revealed existence of two major groups, 1 and 2 with low genetic variability of 0.52. Number of roots, weight of roots, fresh weight/plant and dry matter content differed significantly among and within agro- ecological zones. Landraces Lubisi from southern highlands zone had the highest number of roots (12 per plant) and Shinamugi from Eastern zone had highest dry matter content of 39.4%. Overall, landraces from Lake Zone recorded highest average root weight of 8,977.7 kg ha^{-1} followed by Southern highlands (7,561.2 kg ha^{-1}) and Eastern zone (4,333.0 kg ha^{-1}). Principal coordinate analysis (PCA) indicated variances accumulated by the first five components of the six major morphological characters was 52.5% and produced similar groups corresponding to those of cluster analysis. Our data indicate low genetic variation despite significant variations shown by agronomical traits. Many landraces recorded in different names from three different agro ecological zones showed close resemblance and grouped into two major groups suggesting presence of dupl-icates or mislabelling.

Keywords: Morphological traits, agronomical traits, diversity, germplasm characterization, *Ipomoea batatas*, sweet potato

INTRODUCTION

Sweet potato, *Ipomoea batatas* (L.) Lam., is an important subsistence food crop grown in almost all agro-ecological zones of Tanzania. It ranks second to cassava in terms of root crop production. With annual production of 1.05 millions metric tons (FAO, 2006), Tanzania ranks the seventh world producer and second in East Africa after Uganda (Tairo, 2006). The production is however constrained mainly by biotic factors such as viruses and lack of improved high yielding cultivars. The consequences of virus infections are not only limited to reduction in crop yield but also undermine the ongoing efforts in genetic improvement for yield, quality and development of virus resistant cultivars. Several cultivars have been reported in the region with possible varying levels of reaction to viruses and other agronomic traits such as high yield of storage root, high dry matter (DM) content, vigorous foliage growth and ground cover (Gichuki et al., 2003).

To enhance sweet potato productivity in Tanzania, in the past two decades the improvement programme has made significant progress resulting in the release of six cultivars namely Jitihada, Mavuno, Simama, Sinia, Ukerewe and Vumilia with improved attributes for food quality and marketability (Chirimi et al., 1999). In spite of these efforts, breeding and selection of sweet potato cultivars in Tanzania with novel or improved characteristics is limited by lack of knowledge of genetic diversity of landraces available in Tanzania. The fact is that traditional cultivars (landraces) in Tanzania have not been adequately characterized. Moreover, considerable variation of local

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Abbreviations: LZ, Lake Zone; EZ, Eastern Zone; SHZ,Southern highlands Zone; LR, Landrace; BL, Breeding line. CIP, International Potato Centre

Table 1. List of key morphological descriptors used for characterization

Foliage characters	Leaf lobe descriptors	Agronomical descriptors
Plant type	Abaxial leaf vein pigmentation	Number of roots/stool
Vine color	Shape of central lobe	Shape of the root
Mature leaf color		Skin colour
Petiole pigmentation		Flesh colour
		Total weight of the roots harvested/landrace
		Fresh weight of the roots sampled for DM determination
		Dry matter content (%)

names exists in the naming/identification of a variety. About a hundred different names have been reported from five agro-ecological zones of Tanzania and reports showed each agro-ecological zone has its own unique set of names for different cultivars, and same cultivar name may be given to different cultivars and vice versa (Kapinga et al., 1995). This diverse system of naming cultivars not only limits the proper identity of the cultivar but also hinders monitoring and follow up of the newly released improved cultivars from research stations once they reach the farmers. Therefore, comprehensive information concerning locally available sweet potato germplasm is of vital importance for advancement of breeding works. To overcome these constraints there is need for better understanding and reliable information about the genetic diversity that exists within the locally available sweet potato germplasm. This work was set to assess sweet potato genetic variation in Tanzanian germplasm using morphological and agronomical traits.

MATERIAL AND METHODS

Plant material

A set of one hundred and thirty six sweet potato accessions were collected in April 2006 and established at Chambezi sub-station in Bagamoyo district, Tanzania. In *situ* planting of materials was done on ridges with distance between the ridges fixed at 1 m to give enough room for the spread of vines and avoid mixture of stems. Four vines per cultivar were established in each ridge at the space of 0.3 m between plants. Established plants were weeded twice and fertilized twice using Nitrogen Phosphate Potassium (NPK 20:10:10) to stimulate vegetative growth.

Data collection

In this work morphological characterization was based on aerial parts. Data were collected at 90 days post planting (dpp) and at 180 (dpp). Shoot samples were collected at 90 days and quickly stored at - 80^{O}C for further molecular characterization. Characterization was achieved using standard descriptors; six morphological and seven agronomical descriptors developed by CIP (Huaman, 1992) as shown on Table 1. Data collections were done twice at the interval of 3 months. Quantitative characters for the aerial parts were deliberately avoided because of variation leading to differences in the plant development. To have fairly reliable data for qualitative morphological data, in each cultivar an average of four plants were scored twice in three-month intervals.

Storage root and dry matter content determination

Determination of DM was done using the method described by Carey and Reynoso (1996) using oven and a balance with an accuracy of 0.1 g. To avoid post harvest changes in DM content prior to DM determination, initial steps were carried out within 24 h after harvest. Medial sections of 5 undamaged market sized roots were chopped into small flakes mixed thoroughly and a 400 g sample was taken for next step. The samples of 400g fresh weight were placed in paper bags and dried at 60^{O}C for 72 h to a stable weight. The dried samples were weighed and the resulting figure used for calculating dry matter content as DM% = (dry weight/fresh weight) x100.

Multivariate analysis

Each character was scored as numbers and later transformed into a binary matrix. “1” for present or “0” when absent. Using CIP Guide 36 (Huaman, 1992), 90 above ground morphological variables were scored. Of the 90 characters scored, six major characters (Table 1) were subsequently used to generate a dendrogram based on the simple matching coefficient. The matrix was analyzed by Unweighted Pair -Group Method with Arithmetic Average (UPGMA) provided by the computer program NTSYS- pc 2.1 (Rolfs, 1994). In addition, a three dimensional scatter plot was generated using principal component analysis (PCA).

Quantitative agronomical descriptors were calculated for each agro-ecological zone. The descriptive analysis was performed by the SPSS 9.0 software (Inc, USA) for seven quantitative traits. Variation within and between agro ecological zones were determined by analysis of variances (ANOVA) and authenticity of the data were checked by Pearson correlation analysis of the SPSS statistical package.

RESULTS AND DISCUSSION

Cultivar grouping and naming

Morphological analysis based on six characters; plant type, vine colour, shape of central lobe, abaxial leaf vein pigmentation, mature leaf color and petiole pigmentation

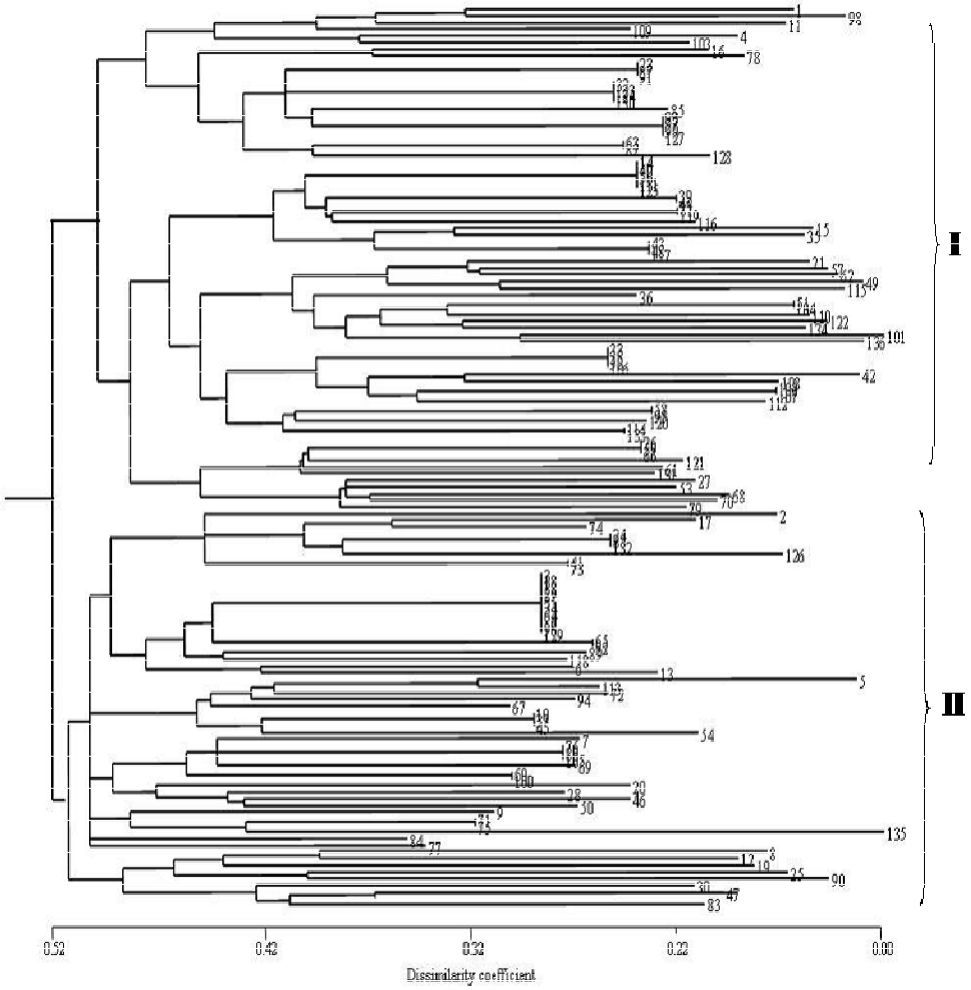

Figure 1. Cluster analysis of six morphological characters of 136 accessions of *Ipomoea batatas*. The dendrogram is based on simple matching coefficient of similarity and the neighbor joining method. Two major groups I and II are shown. Name of the cultivars represented by numbers in the dendrogram are shown in Table 5.

showed low polymorphism of 0.52 within 136 sweet potato accessions. Cluster analysis classified accessions into two major groups (Figure 1) with group 1 having two sub groups 1a and 1b and main group 2 with eight sub groups 2a, 2b, 2c, 2d, 2e, 2f, 2g and 2h. The dissimilarity matrix between the two major groups and within sub groups is shown in (Table 2). Within these two major groups, all accessions clustered randomly with no specific clustering linked to agro- ecological zone. Of the two major groups, majority of the individuals clustered in a major group two (Figure 1). Most of the individuals in major group 2 were closely related and grouped in the same branches with genetic dissimilarity range of 0.20-0.29 indicating low diversity within members. Among the eight sub groups of group 2, sub groups 2a, 2d and 2e had many accessions clustered together in the same branches though recorded in different names from different agro-ecological zones. In contrast to group 2, individuals in major group 1 were randomly distributed within the dendrogram with few individuals clustered together.

Although, two accessions Chanuo and Sinia Ukiriguru were clustered in the main group 2, these two landraces showed considerable variations from their respective members mainly due to differences in leaf appearance. Landrace “Chanuo” had leaf outline and lobe characteristics (medium-sized leaves with deep serrated leaf blades resembling a comb) that had no match with the prescribed descriptors in the CIP manual (Huaman, 1992). Furthermore, this cultivar did not produce any root tubers even after 180 days post planting instead developed many fibrous roots. This particular landrace presents interesting information that requires further investigation before being considered as useful genetic material for breeding purposes.

According to Kapinga et al. (1995), farmers in Tanzania classify cultivars based on leaf outlines, time to maturity,

Table 2. Pair wise comparison of genetic distances of sweet potato morphological characters within and between groups from cluster analysis.

Major groups	Sub groups	Dissimilarity co-efficients within and between groups and subgroups									
		1a	1b	2a	2b	2c	2d	2e	2f	2g	2h
1	1a	0.00-0.40									
	1b	0.20-0.43	0.00-0.45								
2	2a	0.14-0.52	0.20-0.49	0.00-0.56							
	2b	0.20-0.45	0.20-0.45	0.20-0.52	0.00-0.40						
	2c	0.25-0.49	0.29-0.47	0.29-0.53	0.14-0.47	0.00-0.45					
	2d	0.20-0.45	0.20-0.47	0.20-0.52	0.20-0.47	0.20-0.45	0.00-0.40				
	2e	0.20-0.45	0.20-0.45	0.29-0.52	0.20-0.45	0.20-0.45	0.00-0.45	0.00-0.45			
	2f	0.20-0.45	0.20-0.47	0.29-0.52	0.29-0.49	0.20-0.49	0.20-0.49	0.20-0.49	0.00-0.45		
	2g	0.20-0.45	0.20-0.43	0.29-0.52	0.29-0.49	0.20-0.52	0.29-0.45	0.29-0.45	0.20-0.45	0.00-0.45	
	2h	0.29-0.49	0.29-0.52	0.29-0.55	0.20-0.52	0.29-0.52	0.20-0.49	0.20-0.49	0.29-0.49	0.20-0.49	0.00-0.49

color of the root tuber and flesh and some organoleptic traits. However, in this study we found some of the cultivar names were associated with the locality where it was first obtained or a person who brought it first e.g. cultivar Hidaya, Dorotea, Berena, which bear names of people. This diverse system of naming limits the proper identity of the cultivar as the same cultivars may be given different names in different localities. For instance in this study, the majority of landraces with different names from different agro-ecological zones were found to be morphologically identical and clustered together indica-ting presence of duplicates. This can be attributed to the use of unstandardized system of naming. It was further noted that officially released cultivars like Mavuno, Jitihada, Vumilia, Simama, Sinia and Ukerewe collected from different agro-ecological zones when compared with those from the research station grouped differently. Based on the fact that these cultivars have been fairly well characterized these observations were unexpected suggesting misnaming or cultivar mixing. This mislabeling partly contributes to loss of materials since improved materials released by research stations lose their true identity after one season when a contact farmer shares them with a neighbors or transfers materials from one agro-ecological zone to another.

Cultivar grouping and identification keys

In order to facilitate the identification of the cultivar group, all individuals that clustered together in a dendrogram constructed using all 280 accessions (Data not shown) were assembled as cultivar group (Table 3). Their resemblance was then confirmed using genetic similarities generated by cluster analysis which ranged between 0.00 - 0.57. Using CIP Manual (Huaman, 1992), twelve major classification descriptors which were commonly shared by more than 75% of all individuals in a subgroup were picked for identification. Out of the twelve major classification descriptors identified, six (Table 1) were finally used to ascertain the grouping. The validity of the chosen major classification descriptors were then confirmed by reconstructing similar groups (Figure 1) using the 136 accessions selected from the originally planted 280 accessions. The resulting dendrogram was similar to the one previously constructed using twelve morphological characters and 280 accessions. Therefore, by combining criteria of morphological resemblance and genetic similarities produced by cluster analysis, two major groups consisting of 10 subgroups were formed (Table 3).

However, of the six chosen classification descriptors, none could alone discriminate the accessions reliably to be adopted as the stable morphological character for characterization. Instead the selected six morphological descriptors showed different levels of discrimination. The first three morphological descriptors (Table 1) were monomorphic among all accessions e.g. most accessions had green mature leaf color (93%), vine color (81%) and petiole pigmentation (58%). The other two morphological descriptors, namely abaxial leaf color and plant type showed low similarity of 40 and 49%. Central leaf lobe showed maximum variability within its 10 classes. Accessions were normally distributed within ten classes (Figure 3) of this character at the range of 16-82 accessions per class. The stability and reliability of this character for discrimination of sweet potato landraces was confirmed by reconstructing a dendrogram and the resulting dendrogram (data not shown) produced similar clusters as the one constructed using all six morphological characters. The results however, showed that morphological traits alone have some limit in characterization of sweet potato germplasm and can not reliably identify cultivars.

Table 3. Major morphological groups and traits of the cultivar separated by cluster analysis

Major groups	Sub-groups	Cultivars	Major characteristics of the cultivar group
I	1a	Nasra, Ex-bwere, Shangazi, Chanika, Uwanja wa Ndege-2, Asilia vimungura, Gairo-ex Chanika, Ex-Kyela, 440144, Hombolo, Ruganza, Mwanatatata, Lyakaya, Kabuche, Mpufya, Mayai, Unknown ex Pangani, Kigandaweyi, Tembele, Berena-Nyeupe, Isamilo, Kibaha, Shinamugi, Naonao, Misalaba, Bongoman, Nyanzara, Mwanatata	Spreading plant type (151-250cm) with green vine color without secondary color, oblanceolated central lobes, green colored abaxial leaf veins, mature leaf colored green with green and purple near leaf petiole color.
	1b	Basarage, 42008, Sinia-B, Naspot-6, Shinyanga, SPKHB2001/264, Zuberi, Unknown-Mwanagesi, Unknown-Mamastella, Evelini, SP/93/73, Mbingusister, Gikaluwabundaga Bolongo, Elias, Mbingu Sister, Kasharazi, Isangi, Hidaya, Butili, Jitihada, Lyochi, Kabuganda, Polista, Kijere	Spreading plant type with green vine color, teethed central leaf lobe and mature green leaf color, and green with purple near leaf petiole pigmentation
II	2a	Isangu-4, Mwaniweyegeke, Kibisi, Didimaki, Babuasilia, Ex-ipungu, Orange Chanika, Katarina, Berena, Mbeya-2, Sungawapima, Katengele, Masyalaba, Kalebe, SP/93/5, TIS2534(A), Ikumbi-2, Kitipa, Jivii, Kibisi-4, Kigambirenyoko, Kitengule-2, Zakienyeji, Carrot, Umeme, Yazamani, Ex-london, Magimbi, Ilula, Kwezikumo, Kabuchenche, Ukowejo, Budagala, Geita, Mwanageni, Chanuo	Erect less than 75 cm, green vine color without secondary color, teethed central lobes, all veins mostly/totally purple abaxial leaf vein pigmentation with green mature leaf color and green petiole color with purple at both ends
	2b	Gairo, Rehema, Shangazi-c, Marieta ex-Pangani, Bikiramaria, Hali Mtumwa Mweupe, Muongu, Simbaechumu, Gairo, Carrot-1, Mbagamawe-2, Pananzala, Mbingusister-2, W-123, 440018, Kasangani, Ex-Liawaya, Ileje, Zakisasa, Frida, SP/069, Zuberi-II, Combeji, Ikumbi-3, Mkombozi, Tembele, Kanshabari	Erect plant type with green vine color without secondary color, teethed central leaf lobe, green abaxial leaf vein pigmentation, mature green colored leaf and petiole with green and purple spot at base of mid rib
	2c	Kibisi-1, Uwanja wa Ndege, Mwekela, Lubisi, Kabakuli, Kilimani, Misalaba, Gairo(A), Naspot-1, Maria, Vumilia, Ikumbi-1, Viazi Jeshi, Viazi Mayai, Carrot, Ex-Nanyali, Kigamboni-ex Pangani, Vaizi Mayai, kupiga Wasami, Mwekela, Tano, Canada, SP/93/13, Shangazi, Matako Mapana, Kibakuli, Mwanakayeba, Ruchumu-B	Erect plant type, green vine color without secondary color, lanceolated central leaf lobe, with all green abaxial leaf vein pigmentation, mature green leaf color with green colored petiole
	2d	Kibisi-2, Lipumba, Tito(A), Mavuno, Mikongeni, Naspoti-1, Rehema-5, Songea, Budagala, Kibaha, Nyamlee, Kalamu ya Bwana, Mbagamawe, Mama Heri, Pajero, Serena, Mbeya, Yellow flesh, Kilimani-1, Nyangeta, Liawaya-2, Sumbugu, SPK004-kakamega, Bilagala, Jonathan, Mafuta, Hali Mtumwa, Mayai, Ijumla, Centineal, Resisto 44001,Uknownkyaka, Zambezi, Kibeji, Kondomwitu, Shangazi-ex Chanika, Mgowa, Butundwe	Extremely spreading type (more than 250cm), green vine color without secondary color, triangular central leaf lobe and green abaxial leaf vein pigmentation with mature green leaf and green petiole pigmentation color
	2e	Kondomwitu, Shangazi ex-Chanika, Mgowa, Butundwe, Haraka, Gairo-Matimbwa, Salvina, Combeji, Mwanahanga B, Carrot ex-Matimbwa, Lipumba-1, Maidule, Dar-Es-Salaam, Ex-Chanika, Kibaha-9, Canada-C, New Kawogo, Budagala, Budagala-2, Nyakasanga, Jitihada, Karoti, SPKBH2001/386, Haraka, Mwanamonde, Mwanatata, Simama, Kalamu ya Nyerere, Guluka	Extremely spreading type (more than 250cm), green vine color without secondary color, triangular central leaf lobe and green abaxial leaf vein pigmentation with mature green leaf and green petiole pigmentation color
	2f	Ex-Masaki, Mbutu, Temebele Bangi, Julfa, Rehema-2, Budagala, Ex-chanika, SPKBH2000/392, Moyo wa Simba, Canada-C, Matamago, Katoke, Rushuru, Mobimba, Mkono wa Nyerere	Spreading plant type (151-250cm), with green vine color without secondary color(11) with lanceolated central lobe type, abaxial leaf vein pigmentation is green with green mature leaf with green petiole color
	2g	Kitengule, Unknown Katulika, Bwankyamayo, Furahisha, Unknown Iwanima, Biganana, Mkono wa Nyerere, Fraisca, Damu ya Mzee	Spreading type (151-250cm), with green vine color without secondary color, oblanceolated central lobe and all veins mostly or totally purple abaxial leaf vein pigmentation.

Table 3. Contd.

	2h	Butundwe, Masinia, Mbeya, Bukoli, Kagingo, Manigake, Toniki, Kajimbole, Sinia Ukiriguru, Mwanike wa Mjini, LP6817, Tembele, Mwananzali, Nyangeta, Dorotea, Moshi, Chilili, Kinyungunyu, Roiyailoiya, Tembele, Miguu ya Bata, Vumilia, Mamastella, Notura, Tuliomushako	Extremely spreading type (more than 250cm), with green vine color with elliptical central lobe, with all veins mostly or totally purple and green mature color and green with purple at both ends petioles

Table 4. Agro-ecological-based means of agronomical traits characterized from the sweet potato germplasm collection

Trait*	**Lake Victoria basin**			**Eastern Zone**			**Southern Highlands Zone**		
	Mean	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**
Number of roots/stool	4.47	10.00	1.00	2.25	6.00	1.00	3.97	12.00	1.00
Shape of the root	2.00	5.00	1.00	2.41	8.00	1.00	2.25	8.00	1.00
Skin colour	4.96	9.30	2.00	4.21	9.30	2.00	5.90	8.20	2.00
Flesh colour	1.90	8.00	1.00	2.69	8.40	1.00	2.09	7.00	1.00
Weight of roots (gm)	888.58	2532.00	117.00	389.97	1857.00	49.00	680.00	1823	88.00
Fresh weight of roots (gm)	311.22	400.00	91.00	209.22	400.00	42.00	319.68	400.00	80.00
Dry matter content (%)	35.06	42.25	26.85	39.23	45.250	29.16	36.10	42.50	35.50

*****Average roots character were characterized from a total of 36 accessions from each agro-ecological zone

Agronomical traits

There was significant variation among sweet potato germplasm from the three agro-ecological zones for number of roots/plant, weight of roots and dry matter content (p<0.001). However, the highest number of roots produced per plant was 12 from landrace Ex-Lubisi from SHZ. Average weight of the roots ranged from 4,333.0 to 8,977.7 kg ha^{-1} and dry matter content from 26.85 - 45.25% with EZ showing the highest values for both agronomical traits followed by LZ and SHZ. Among the highest dry matter content producing landraces, only landrace Shinamugi from EZ exceeded the overall mean DM content of 36.8%. This landrace was collected from EZ, but it is more popular in the Lake zone compared to EZ. Overall, breeding lines (BL) (Table 5) had higher dry matter contents with an average of 37.6% compared to landraces (31.6%). Correlation analysis showed that fresh weight of the roots was significant and negatively correlated with dry matter content were significant and positively correlated but ready as negative correlated with dry matter content.

Variation of dry matter content irrespective of the least weight of the roots shown by the EZ accessions compared to LZ can be attributed to different cropping systems between the two agro- ecological zones. LZ is characterized as lowland semi humid and highlands humid (Kapinga et al., 1995) favourable for crops such as cotton, banana and cassava. Sweet potatoes are grown as off-season crop particularly for home consumption. In contrast, EZ is characterized by lowland and humid climate which supports mainly annual crops. Thus, in EZ sweet potatoes are grown commercially whereas high dry matter content is the most market-preferred traits Therefore, there is deliberate selection and maintenance of landraces with high dry matter content to meet market demands than for LZ.

The low genetic variability shown by the Tanzanian landraces despite large collections from three different agro-ecological zones is not surprising considering the cropping system of sweet potato in Tanzania. The cultivation is largely subsistent, farmers depend yearly on their locally available landraces and for security of planting material for next season; materials are reserved in their homestead gardens. The cultivation is largely subsistent, farmers depend yearly on their locally available landraces. These materials are reserved in their homestead gardens as the source of planting materials for next season. Thus farmers are keeping or sharing landraces that are similar but under different names due to poor record keeping.

One factor that contributes to mislabeling of cultivars and/or maintenance of many landraces with low genetic diversity in Tanzanian sweet potato is the absence of national sweet potato germplasm collection where each accession could have been properly characterized and its passport data established for reference. Instead only seasonal collections with partial characterization are maintained in each zone. This problem is underscored by the our findings in the case of newly released six improved cultivars. Since their release in 2001, several landraces that are morphologically different but bearing the same names as these cultivars have been reported in the surveyed agro-ecological zones. Therefore, identification of a genuine name of a cultivar requires a reference material with clear passport data, something which is not available in Tanzania currently. Therefore, a logical explanation for the large collection of accessions

Table 5. List of sweet potato accessions characterized in this study

SN	Cultivar	Site	Status	SN	Cultivar	Site	Status	SN	Cultivar	Site	Status
1	Roiyiloiya	LZ	LR	48	Simbechumu	LZ	LR	95	Mwanamonde	EZ	LR
2	Mwanakayeba	LZ	LR	49	Kabuche	LZ	LR	96	Canada-m	EZ	LR
3	Notura	LZ	LR	50	Moshi	LZ	LR	97	Bongoman	EZ	LR
4	Berena white	LZ	LR	51	Geita	LZ	LR	98	Naspot-1	EZ	LR
5	Misalaba	LZ	LR	52	Bikira maria	LZ	LR	99	440144	EZ	BL
6	Mama heri	LZ	LR	53	Pajero	LZ	LR	100	SPKBH	EZ	BL
7	Kitengule	LZ	LR	54	Bushashini	LZ	LR	101	Kupiga wasami	EZ	LR
8	Kasharazi	LZ	LR	55	Mwananzari	LZ	LR	102	Ex-Haraka	EZ	LR
9	Mkonowa Nyerere	LZ	LR	56	Kalebe	LZ	LR	103	Kenya	EZ	LR
10	Ushashini	LZ	LR	57	Unknownlwanima	LZ	LR	104	Uwanja wa	EZ	LR
11	Vumilia mama stella	LZ	LR	58	Nyangeta	LZ	LR	105	Ex-lipumba 2	EZ	LR
12	Kamusoma	LZ	LR	59	Kabuchenche	LZ	LR	106	Ex-ikumbi 2	EZ	LR
13	Mwanatatata	LZ	LR	60	Motto wa shule	LZ	LR	107	Viazi mayai	SHZ	LR
14	Fraisca	LZ	LR	61	Unknownkatulika	LZ	LR	108	Songea	SHZ	LR
15	Berena	LZ	LR	62	Manigake	LZ	LR	109	Ileje	SHZ	LR
16	Kigambirenyoko	LZ	LR	63	SP93/13	EZ	BL	110	Babu asilia	SHZ	LR
17	Mwanikewa mjini	LZ	LR	64	Ex-masaki	EZ	LR	111	Za wasukuma	SHZ	LR
18	Ruganza	LZ	LR	65	Mbutu	EZ	LR	112	Ex-lyawaya II	SHZ	LR
19	mwanatata	LZ	LR	66	Matako mapana	EZ	LR	113	Ex-kilimani	SHZ	LR
20	Ex-bwere	LZ	LR	67	Mwanahanga-A	EZ	LR	114	Lubisi	SHZ	LR
21	Kanshabari	LZ	LR	68	Carroti	EZ	LR	115	Ex-ipungu 1	SHZ	LR
22	Kietengule b	LZ	LR	69	Kibakuli	EZ	LR	116	Kibisi 3	SHZ	LR
23	Masinia	LZ	LR	70	Kigamboni-pangani	EZ	LR	117	Mbeya 2	SHZ	LR
24	Nyakasanga	LZ	LR	71	Eliasi	EZ	LR	118	Ex-isangu-2	SHZ	LR
25	Bwankyamayo	LZ	LR	72	Ex-chanika	EZ	LR	119	Ex-mbagamawe	SHZ	LR
26	Unknown mamastella	LZ	LR	73	Viazi-mayai	EZ	LR	120	Ukowejo	SHZ	LR
27	Budagala-2	LZ	LR	74	SPKBH 2001/386	EZ	BL	121	Ex-ichengezya	SHZ	LR
28	Ruchumu-b	LZ	LR	75	Ex-pangani unknow	EZ	LR	122	Kisangani	SHZ	LR
29	Jitihada	LZ	LR	76	Moyo wa simba	EZ	LR	123	Ex-isangu	SHZ	LR
30	Rushuru	LZ	LR	77	Vumilia	EZ	LR	124	Ex-lipumba	SHZ	LR
31	Unknownkyaka	LZ	LR	78	Hombolo	EZ	LR	125	Haraka	SHZ	LR
32	Dorotea	LZ	LR	79	Tano	EZ	LR	126	Mbeya	SHZ	LR
33	Kabuganda	LZ	LR	80	Rehema II	EZ	LR	127	Dar-Es-Salaam	SHZ	LR
34	Polista	LZ	LR	81	Hali mtumwa mayai	EZ	LR	128	Ex-lyawaya 1	SHZ	LR
35	Karoti	LZ	LR	82	Pananzala	EZ	LR	129	Asilia/vimungula	SHZ	LR
36	Butundwe	LZ	LR	83	Kigamboni pangani	EZ	LR	130	Ex-mwekela	SHZ	LR

Table 1. Contd.

37	Kagingo	LZ	LR	84	Mbingu sister	EZ	LR	131	Ex-kibisi	SHZ	LR
38	Sinia B	LZ	LR	85	Mwananjemu	EZ	LR	132	Ex-kajimbole	SHZ	LR
39	Sengerema	LZ	LR	86	Ilula	EZ	LR	133	Mkombozi	SHZ	LR
40	Serena	LZ	LR	87	Kibaha	EZ	LR	134	Sungawapima	SHZ	LR
41	Kagole white	LZ	LR	88	Mobimba	EZ	LR	135	Simama/jeshi	SHZ	LR
42	Shinyanga	LZ	LR	89	SP KBH 2001/392	EZ	LR	136	Zakienyeji	SHZ	LR
43	Damu ya mzee	LZ	LR	90	New kawogo	EZ					
44	Kwezikumo	LZ	LR	91	Mbingusister 2	EZ					
45	Naonao	LZ	LR	92	Kigandawei	EZ					
46	Chanika	LZ	LR	93	Japon trenesimo 42000	BL					
47	Bilagala	LZ	LR	94	Shinamugi	EZ					

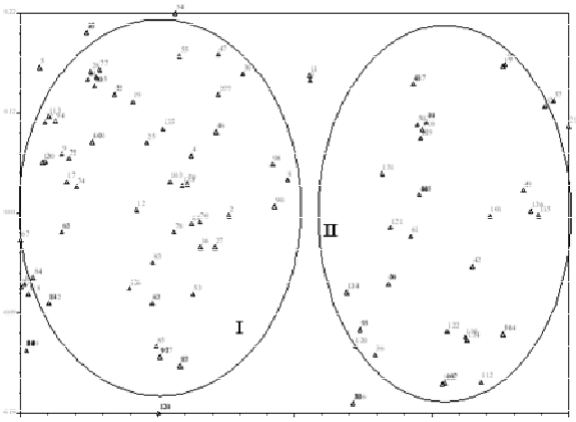

Figure 2. Principal component analysis of 134 accessions of *Ipomoea batatas*.

with narrow diversity shown by similarity matrix in a few collection sites may be due to unknowingly maintenance of duplicates done at farmers' level. Conversely, agronomical results suggest that there is a considerable genetic variation in dry matter content within Tanzania sweet potato landraces which can be utilized in the breeding programs for crop improvement.

Generally, both cluster analysis and PCA showed low genetic variability within Tanzanian sweet potato landraces. The results of the principal component analysis performed on the basis of the dissimilarity matrix of the 136 accessions supports the cluster analysis results (Figure 2). The first five components accounted for 52.5% of the total variations which was relatively low, variability thus not sufficient to make a logical distinction between landraces. However, with the addition of the sixth component the accumulated variation was increased to 58.5%.

Conclusion

The present work has provided a preliminary morphological and agronomical characterization of cultivated sweet potato germplasm of Tanzania. Using morphological traits, grouping of cultivars based on similarity and shared characters provided for the first time information on the genetic base of the available sweet potato germplasm in Tanzania and highlighted the constraint of lack of national germplasm collection for reference. The study also showed the limitation of using only morphological traits for characterization of sweet potato germplasm. No single character was found to be sufficient to discriminate cultivars though central leaf lobe showed higher polymorphism among cultivars compared to other characters. Thus this work demonstrated the importance of employing other reliable methods such as DNA based markers to confirm the identified groups. However, whether the groupings are stable or have links to other attributes would be answered by our subsequent work on molecular characterization using Simple Sequence Repeats (SSR) DNA markers.

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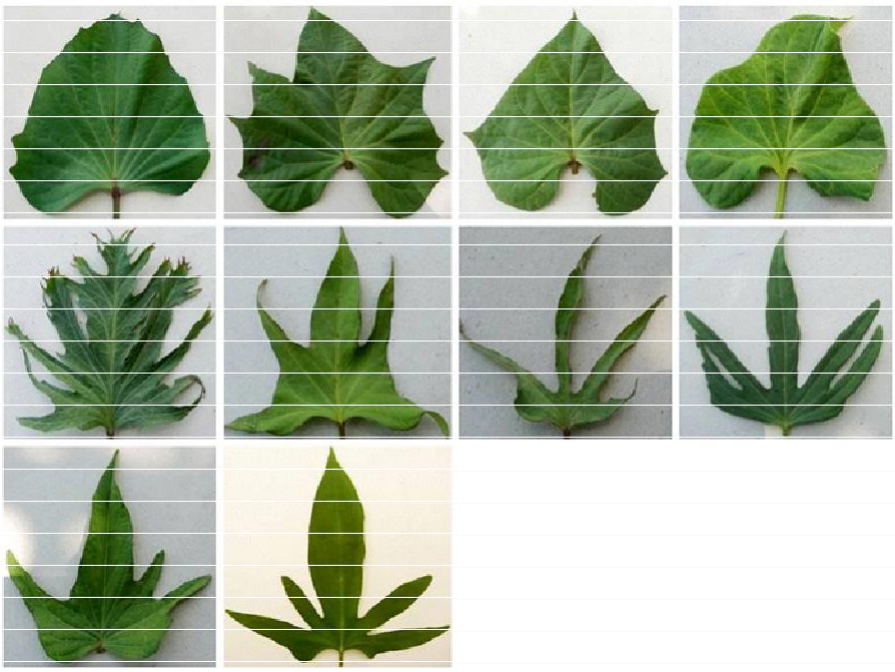

Figure 3. Different central leaf lobes observed from Tanzania sweet potato germplasm

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REFERENCES

Carey E, Reynoso D (1996). Procedures for the evaluation of pathogen-tested sweet potato clones. Sweet potato germplasm management training manual 3.0 Evaluation and breeding: In CIP report.

Chirimi B, Kapinga R, Kanju E, Rugutu C, Caley T (1999). On-farm evaluation of Sweet potato varieties in the Lake Zone of Tanzania. In: Potatoes for Poverty Alleviation, African Potato Association Conference Proceedings. (Edited by Adipala, E; Nampala, P. and Osiru, M). 29 May-2 June 2000, Kampala, Uganda. Vol. 5. Pp125-130.

FAO (2006). FAOSTAT Database (2005). Rome, Italy: Food and Agriculture Organization of the United States. http://apps.fao.org/default.jsp

Gichuki ST, Berenyi M, Zhang D, Herman M, Schmidt J, Glossl J, Burg K (2003). Genetic diversity in sweet potato [*Ipomoea batatas*(L.) Lam.] in relationship to geographic sources as assessed with RAPD markers. Genetic resource and Crop evolution 50:429-437

Huaman Z (1992). Morphological identification of duplicates in collections of *Ipomoea batatas*. CIP research guide, Lima, Peru.

Kapinga RE,.Ewell PT,.Jeremiah SC, Kileo R (1995). Sweet potato in Tanzania Farming and Food Systems: Implication for Research; International Potato Centre (CIP), Nairobi Kenya and Ministry of Agriculture, Dar Es Salaam, Tanzania. 47pp.

Rolfs FJ (1994). NTSYS-pc version 1.8: Numerical Taxonomy and Multivariate Analysis System. Exeter Software, New York, NY.

Tairo F (2006). Molecular resolution of genetic variability of major sweet potato viruses and improved diagnosis of potyviruses co-infecting sweet potato. Doctoral diss. Dept. of Plant Biology and Forestry Genetics. SLU. Acta Universitatis agriculturae Sueciae vol. 2006: 5.