Guidelines
for the Conduct of Test for
Distinctiveness, Uniformity and Stability
on

SWEET POTATO

***Ipomoea batatas* (L.) Lam.**

PROTECTION OF PLANT VARIETIES AND FARMERS' RIGHTS AUTHORITY

(PPV&FRA)

Government of India

CONTENTS

SWEET POTATO

Sweet potato (*Ipomoea batatas* (L.) Lam) belongs to the family Convolvulaceae. This crop was believed to have originated from Central or South America. Sweet potato is a highly heterozygous crop and has a chromosome number of 2n (6x) = 90, it is considered to be a natural hexaploid. Sweet potato is the second most important root crop with a world production of 103.11 million tones. Sweet potato produced in Asia is mainly used for human consumption, animal feed and to a limited extend as a raw material for industrial purposes as starch and alcohol production. The major breeding methods in sweet potato include germplasm evaluation and clonal selection; intervarietal and interspecific hybridization and selection. Since the flowers are bisexual, emasculation is needed. The flowers when mature open before dawn, even after 2.00AM onwards and remain open for a few hours after dawn and wilt. Majority of the improved varieties have been developed from the progenies from open pollinated seeds. Sweet potato is grown widely in tropical and sub-tropical parts of the world.

In India, it is largely grown in north and eastern parts of India comprising of Odisha, Bihar, Chattisgarh, Jharkhand, West Bengal and Uttar Pradesh which together contributes to 90 per cent of the production in India. In South India, it is grown at several places and is traditionally popular among a large portion of India's population. The tuber is an important source of carbohydrate. Sweet potato has assumed great significance in recent years as a health food due to various bioactive principles. Sweet potato is a three in one tuber combining the properties of cereals, fruits and vegetables owing to its content respectively of starch, pectin and vitamins. Certain varieties having yellow flesh are rich in carotene, a precursor of vitamin A. Sweet potato is a short maturity crop, tolerant to a wide range of growing conditions. Sweet potato is considered as a famine relief crop as it had played a pivotal role in alleviating the Bengal famine of 1942. In India, sweet potato germplasm is maintained at Central Tuber Crops Research Institute field gene bank (1100 accessions) and *in vitro* condition. Out of 1100 accessions, 407 are exotic collection and remaining 693 accessions indigenous collection.

Sweet potato is grown in most parts of the country utilizing the monsoon rains during Kharif (June-August) and with supplemental irrigation during Rabi (October – December).

Ridges and furrow method is widely accepted as the ideal method of planting. The other common methods of planting are mounds and flat beds. It is preferable to plant sweet potato on mounds in areas experiencing problems of drainage. Ridges formed across the slope are recommended in sloppy lands to prevent soil erosion. Planting is done by using vine cuttings which are planted in the soil with both the ends exposed and the middle portion buried in the soil. The ideal depth of planting is 7-10 cm depth. A close spacing is generally recommended for sweet potato to achieve maximum tuber yield. However, when sweet potato is planted on mounds, no specific spacing is followed and vines are planted on mounds by accommodating 3-6 vines per mound. A general spacing of 60x20 cm has been recommended by CTCRI to accommodate 83000 plants per hectare.

Sweet potato is propagated by means of vine cuttings. To obtain vine cuttings, a nursery is raised either from stored tubers or from vines of the freshly harvested crop. Vines obtained from nursery are found to be healthy and vigorous resulting in maximum tuber production. The apical vine cuttings when used as planting material have been reported to secure higher tuber yields in sweet potato. The cut vines with intact leaves are stored under shade for two days prior to planting in the main field to promote better root initiation, early establishment of vines and higher tuber yield. Farm yard manure at the rate of 5 t ha^{-1} is applied at the time of field preparation. Fertilizers recommended are 50:25:50 kg ha^{-1} of NPK respectively. Phophorous fertilzer may be applied at the time of planting as full dose while the N and K may be applied in two equal splits, coinciding with interculture and earthing up operations. Harvesting is done in about 90 to 110 days time depending upon the variety. The tuber yield ranges from 20-25 t/ha.

SWEET POTATO

(*Ipomoea batatas* (L.) Lam.)

I. Subject

These test guidelines shall apply to all varieties, hybrids and parental lines of Sweet Potato (*Ipomoea batatas* (L.) Lam.).

II. Planting material required

1. The Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA) decide when and where and in what quantity and quality the seed/planting material is required for testing the variety denomination applied for registration under the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001. Applicants submitting such planting material from a country other than India shall make sure that all customs and quarantine requirements stipulated under relevant national legislations and regulations are complied with. The material is to be supplied in the form of medium size storage roots or in the form of vine cuttings.

2. The minimum quantity of plant material, to be supplied by the applicant, should be 150 vine cuttings (each one with a length of 30cm with 5 to 8 buds) for both centres. The diameter of the vine cuttings to be delivered should be between 2-3 cm taken from the middle part of the mature plant.

3. The plant material supplied should be visibly healthy, not lacking in vigor, nor affected by any important pest or disease.

4. The plant material should not have undergone any chemical or bio-physical treatment which would affect the expression of the characteristics of the variety, unless the competent authorities allow or request such treatment. If it has been treated, full details of the treatment must be given.

III. Conduct of tests

1. The minimum duration of DUS tests shall normally be at least two independent, similar growing seasons with two consecutive plantings, the second being a replanting with the planting material harvested from previous season/trial.

2. The test shall normally be conducted at least at two test locations. If any essential characteristics of the candidate variety are not expressed for visual observation at these locations, the variety shall be considered for further examination at another appropriate test site or under special test protocol on expressed request of the applicant.

3. The field tests shall be carried out under conditions (irrigated/rainfed) favouring normal growth and expression of all test characteristics. Each test shall include about 75 plants in the plot planted at a planting space specified below across three replications. Separate plots for observation and for measurement can only be used, if they have been subjected to similar environmental conditions. All the replications shall be sharing similar environmental conditions of the test location. The design of the tests should be such that plants or parts of plants may be removed for measurement or counting without prejudice to the observations which must be made up to the end of the growing cycle.

4 Test plot design

No. of rows : 5
No. of plants per row:5
Spacing : 60 x 20 cm ;
Plants/ replication : 25
Number of replications : 3

6. Observations should not be recorded on the plants in border rows.

7. Additional test protocols for special tests shall be established by the PPV & FR Authority as and when needed.

IV. Methods and observations

1. The characteristics described in the Table of characteristics (see section VII) shall be used for the testing of varieties for their DUS test.

2. For the assessment of Distinctiveness and Stability, observations shall be made on at least 30 plants or parts of 30 plants, which shall be equally divided among three replications (10 plants per replication) and any other observations made on all plants in the test, disregarding any off-type plants. Maximum off types allowed is two for every 100 plants.

3. For the assessment of Uniformity, a population standard of 1% and an acceptance probability of at least 95 % shall be applied.

4. For the assessment of all colour characteristics, the latest Royal Horticultural Society (RHS) colour chart shall be used.

5. Unless otherwise indicated, all observation on the plant, observations on leaf and the vine should be made before the end of the growing phase, during the full expression time at physiological maturity. Unless otherwise indicated, all observations on the shoot should be made on the main vine.

6. Vine and leaf characters should be recorded as the average expression of the character

observed in the main vine.

7. All observations on the tubers shall be made at the time of harvest.

8.Determining whether a difference between two varieties is clear depends on many factors, and should consider, in particular, the type of expression of the characteristic being examined, i.e. whether it is expressed in a qualitative, quantitative, or pseudo-qualitative manner. One means of ensuring that a difference in expression of characters, observed in a growing trial, is sufficiently consistent is to examine the characteristic in at least two independent growing cycles.

9. Therefore, it is important that users of these Test Guidelines are familiar with the recommendations contained in the General Introduction prior to make decisions regarding distinctness.

V. Grouping of varieties

1. The candidate varieties for DUS testing shall be divided into groups to facilitate the assessment of Distinctiveness. Characteristics, which are known from experience not to vary, or to vary only slightly within a variety and which in their various states are fairly evenly distributed across all varieties in the collection are suitable for grouping purposes.

2. The following characteristics shall be used for grouping of sweet potato varieties:

   i. Plant growth habit (characteristic 1)

   ii. Vine pigmentation (characteristic 3)

   iii. Mature leaf shape (characteristic 5)

   iv. Tuber shape (characteristic 21)

   v. Tuber: predominant skin colour (characteristic 23)

   vi. Tuber flesh colour (characteristic 24)

VI. Characteristics and symbols

1. To assess Distinctiveness, Uniformity and Stability, the characteristics and their states as given in the Table of characteristics (Section VII) shall be used.

2. States of expression are given for each characteristic to define the characteristic and to harmonize descriptions. Notes (1 to 9) shall be used to describe the state of each character for the purpose of digital data processing and these notes shall be given against the states of each characteristic. In the case of qualitative and pseudo-

qualitative characteristics, all relevant states of expression are presented in the characteristic. However, in the case of quantitative characteristics with 5 or more states, an abbreviated scale may be used to minimize the size of the Table of Characteristics.

Legend

(*) Characteristics that shall be observed during every growing season on all varieties and shall always be included in the description of the variety, except when the state of expression of any of these characters is rendered impossible by a preceding phenological characteristic or by the environmental conditions of the testing region. Under such exceptional situation, adequate explanation shall be provided.

(+) See explanations on the Table of characteristics in section VIII. It is to be noted that for certain characteristics the plant parts on which observations to be taken are given in the explanation or figure(s) for clarity and not for the colour variation.

4. The optimum stage of plant growth for assessment of each characteristic is given in the sixth column of the Table of characteristics are described below:
Wherein the following table of characteristics these are mentioned?

Growth stages	Code
40 days after planting	04
90 days after planting	09
At harvest	12

5. Type of assessment of characteristics indicated in column seven of Table of characteristics is as follows:

MG: Measurement by a single observation of a group of plants or parts of plants
MS: Measurement of a number of individual plants or parts of plants
VG: Visual assessment by a single observation of a group of plants or parts of plants
VS: Visual assessment by observations of individual plants or parts of plants.

VII. Table of characteristics

Sl.No.	**Characteristics**	**States**	**Note**	**Example varieties**	**Stages of observation**	**Type of assessment**
1	**2**	**3**	**4**	**5**	6	7
1. (*) (+)	Plant growth habit(cm)	Semi erect(75-150)	3	Sree Bhadra	04	VG

		Spreading (151-250)	5	Sree Rethna, Varsha		
2. (+)	Vine: length of internode (cm)	Short (<5)	3	Konkan Aswin	04	MS/VG
		Medium(5-10)	5	Sree Vardhini, Sree Rethna		
		Long (>10)	7	Sree Bhadra		
3. (*) (+)	Vine pigmentation	Green (Yellow green group 145)	1	Sree Arun	04	VS
		Green with purple spots (Purple group N77+Green group 138)	3	Sree Bhadra, Sree kanaka		
		Mostly purple (Purple group N77)	5	Tripthy, Samrat		
4. (*) (+)	Vine tip pubescence	Sparse	3	Bidhan Jagannath,Co-1	04	VS
		Moderate	5	Sree Bhadra		
		Dense	7	Indira Nandini		
5 (*) (+)	Mature leaf shape	Rounded	1	-	04	VG
		Reniform	2	Pusa Safed		
		Cordate	3	Sre Nandini, Sree Arun, RS-5		
		Triangular	4	Gouri, Goutham		
		Hastate	5	Sankar		
		Lobed	6	Sree Rethna, Kanjangad		
		Almost divided	7	Co-1		
6 (*) (+)	Leaf lobe type	No lateral lobes	1	Sree Bhadra	04	VG
		Very slight teeth	2	S-35		
		Slight teeth	3	S-9, Sree Arun		
		Moderate	5	S-21, Sree Varun		
		Deep	7	S-43,Varsha		

		Very Deep	9	S-457		
7. (*) (+)	Shape of central leaf lobe	Teeth	1	RS-35, RS-5	04	VG
		Triangular	2	RS-47, Samrat		
		Semi circular	3	Pusa Safed		
		Elliptic	4	-		
		Lanceolate	5	Sree Vardhini		
		Ob-lanceolate	6	Kanjangad		
		Linear	7	Sankar, Varsha		
8. (+)	Mature leaf size(cm)	Small(<8)	1	Sourin	04	MS
		Medium(8-15)	5	Pusa Red		
		Large(>15)	7	Sree Rethna		
9. (*) (+)	Abaxial leaf vein pigmentation	Absent or weak	1	Sree Vardhini, Sree Rethna	04	VG
		Medium	5	Sree Nandini, Sree Varun		
		Strong	7	Tripthy		
10. (*) (+)	Immature leaf colour	Green (Green group 138)	4	Sree Arun	04	VG
		Green with purple edge (Green group 137, purple group N77)	5	Sree Vardhini, Sree Varun		
		Slightly purple (Purple group N77C)	6	Bidhan Jagannadh,Indira Nandini		
		Mostly purple (Purple group N77A)	7	Sree Bhadra, Konkan Aswin		
11. (*) (+)	Mature leaf colour	Yellow green (Yellow green group N144)	3	S1800	04	VG
		Green (Green group 138)	4	Sree Nandhini, Sree Rethna		
		Green with purple edge (Green group 137, purple group N77)	5	Sree Vardhini, Varsha, Sree Kanaka		
		Purple (Purple group N77A)	7	S1801		

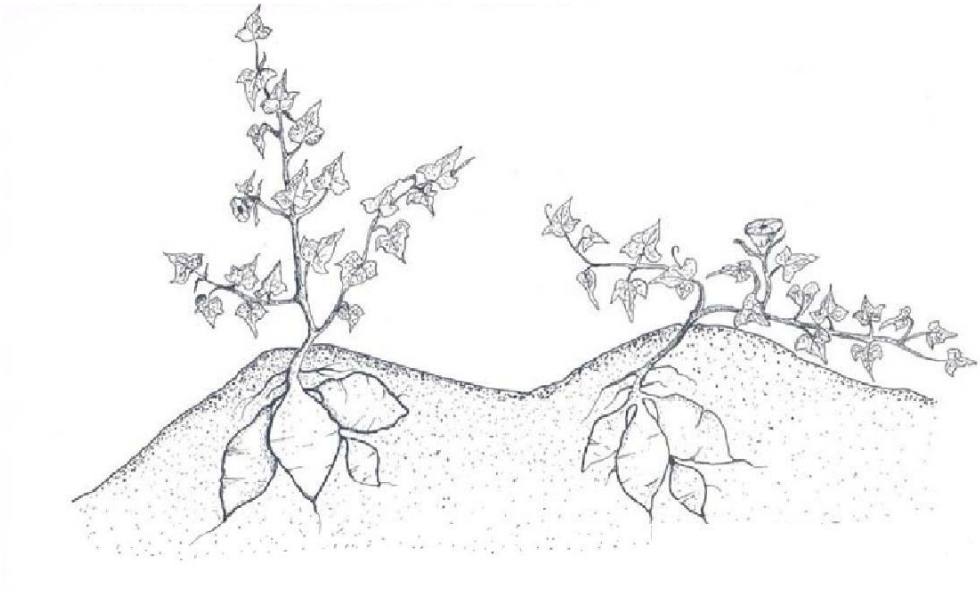
12 (+)	Petiole length (cm)	Very Short (<10)	1	Sree Vardhini, Co-CIP-1	04	MS/MG
		Short (10-20)	3	VLS-6, Konkan Aswin		
		Medium (21-30)	5	Sree Nandini, Sree Arun		
		Long (>31)	7	Sree Bhadra		
13. (*) (+)	Petiole colour	Green (YG group 145)	1	Sree Kanaka, Goutham	04	VG
		Green with purple (Green group 137, purple group N77C)	5	Sree Arun, Sankar		
		Purple (Puple group N77A)	7	Tripthy, ST-14		
14. (*)	Presence of flower	Absent	1	Samrat	09	VG
		Present	9	Varsha		
15. (*)	Flower colour	White (White group 155)	1	S-1	09	VG
		Pale purple limb with purple throat (Purple violet group N82-C&A)	3	Sree Vardhini		
		Purple (Purple violet group N82- A)	5	-		
16. (*)	Flower length (cm)	Short(>3)	1	Varsha, Sree Rethna	09	MS
		Medium (3-5)	3	Sree Bhadra		
		Long(>5)	5	Gouri, Goutham		
17. (*) (+)	Shape of flower limb	Semi-stellate	3	Co-3,Tripthi	09	VG
		Pentagonal	5	Sourin, Konkan Aswin		
		Rotate	7	Gouri, Goutham		
18. (*)	Colour of stigma	White (White group	1	Bidhan jagannath,	09	VG

		155A)		Sourin		
		Purple (Purple violet group N82- A)	3	Konkan Aswin		
19. (*) (+)	Stigma exertion	Embedded	3	Indira Naveen, DOP-93/19	09	
		Same height as highest anther	5	Varsha, Sree Nandini		
		Exerted	7	Samrat, VLS-6		
20. (*)	Length of peduncle (cm)	Short (<8)	1	Sree Nandini	09	MG
		Medium(8-15)	3	Sree Vardhini		
		Long(>15)	5	Varsha,Sree Varun		
21. (*) (+)	Tuber shape	Rounded	1	Sree Arun, RS-92	12	VG
		Ovate	2	Sree Rethna, Gouri, RS-5		
		Elliptic	3	RS-35, Konan Aswin, Co-CIP-1		
		Obovate	4	Sree Nandini, Sree Arun, Bidhan Jagannath		
		Oblong	5	-		
		Irregular	6	Kanjangad, Goutham		
22. (*) (+)	Tuber cortex thickness (mm)	Thin (<1.5)	3	Sree Vardhini, Sree Nandini	12	MG/VG
		Intermediate (1.5-3)	5	Samrat, ST-14		
		Thick (>3)	7	Sree Bhadra, Sree Varun		
23. (*) (+)	Tuber: predominant skin colour	Cream (Yellow white Group 158)	1	Konkan Aswin	12	VG
		Yellow (Yellow Orange Group 23)	2	Sree Varun, RS-92		
		Light Pink (Red Purple group 73)	3	Sree Arun		
		Pink (Red Purple Group 73)	4	Kanjangad		
		Purple red (Red Purple Group63)	5	Sree Bhadra, Goutham		

		Dark purple (Red Purple Group 71)	6	ST-13		
24. (*) (+)	Tuber flesh colour	White (White Group NN155)	1	Sourin, Co-2	12	VG
		Cream (Orange White Group159)	2	Sree Vardhini, Kanjangad		
		Yellow (Yellow Orange Group16)	3	Co-3		
		Orange (Orange Group24)	4	Sree Kanaka		
		Dark orange (Orange GroupN25)	5	ST-14		
		Strongly pigmented with anthocyanin (Purple Violet Group N80)	6	ST-13		
25. (+)	Tuber latex	Absent	1	Sree Vardhini, Samrat		VG
		Present	9	Sree Bhadra, Indira Nandini		

III Explanation for the Table of characteristics

Characteristic 1. Plant growth habit. Determined by the length of main vines recorded during active vegetative growth stage.



5.Spreading

3.Semi erect

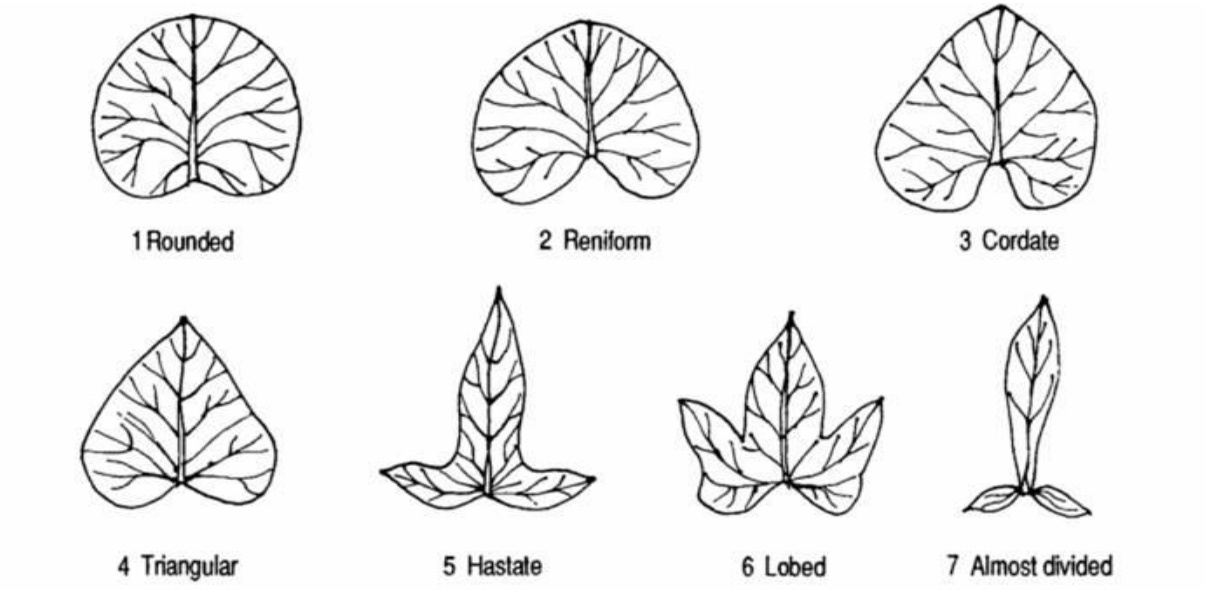
Characteristic 2. Vine: length of internode: Average expression of at least three internodes located in the middle section of the vine recorded during active vegetative growth stage.

Characteristic 3. Vine pigmentation : The predominant colour of the whole vine from base to tip recorded during active vegetative growth stage

Characteristic 4. Vine tip pubescence : Degree of hairiness of immature leaves recorded from the apex of the vines .

Sparse(3) **Moderate(5)** **Dense(7)**

Characteristic 5. Mature leaf shape : The predominant expression of the leaves located in the middle section of vine to be recorded.

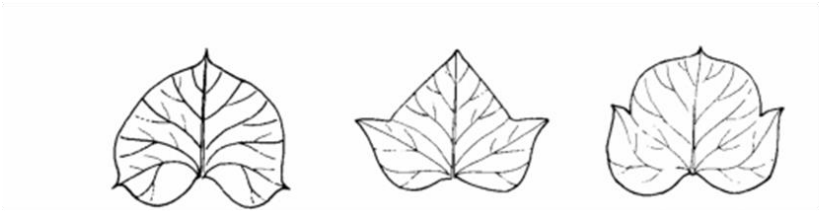


Characteristic 6. Leaf lobe type : The predominant expression of the leaves located in the middle section of vine .

1.No lateral lobes 2. Very slight teeth 3.Slight teeth

5. Moderate 7. Deep 9.Very deep

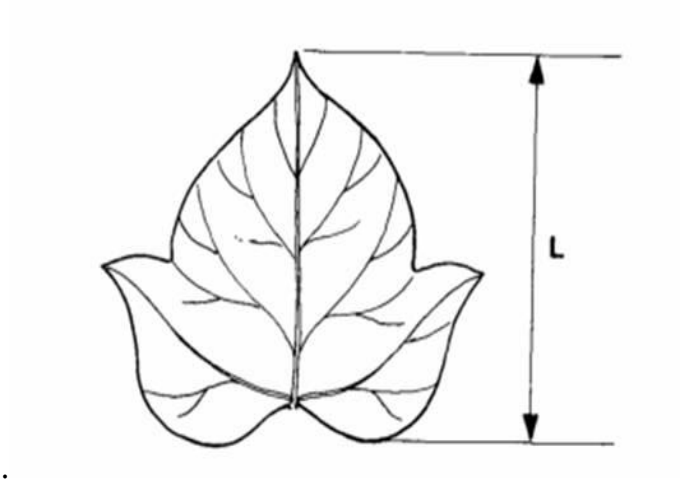
Characteristic7. Shape of central leaf lobe : The predominant expression of the leaves located in the middle section of vine.



1. Teeth 2. Triangular 3. Semi circular

4. Elliptic 5. Lanceolate 7. Ob-lanceolate 7. Linear

Characteristic 8. Mature leaf size: Length from basal lobe to the tip of the leaves. Average expression of three leaves located in the middle section of the vine during active vegetative growth stage.



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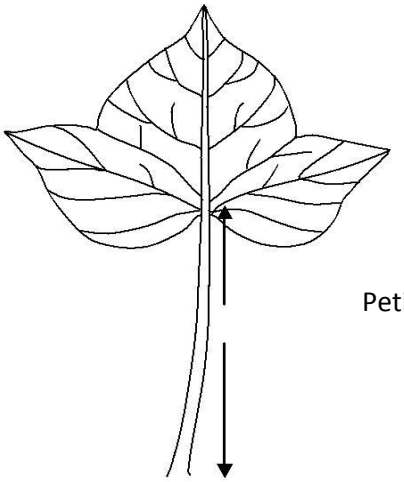
Characteristic9. Abaxial leaf vein pigmentation : The frequent expression of the distribution of anthocyanin (purple) pigmentation shown in the veins of the lower surface of the leaves during active vegetative growth stage.

Characteristic 10. Immature leaf colour : Overall foliage colour of fully expanded immature leaf shown by several plants during active vegetative growth stage.

Characteristic 11. Mature leaf colour :: Overall foliage colour of fully expanded mature

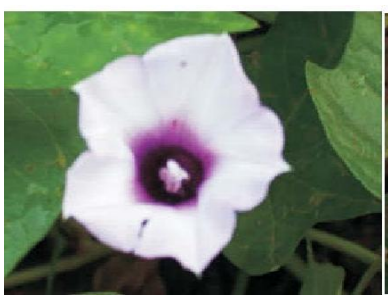
leaf shown by several plants during active vegetative growth stage.

Characteristic 12. Petiole length: Average petiole length from the base to the insertion with the blade of at least three leaves in the middle portion of a main vine.



Characteristic 13. Petiole colour: Most predominant colour (anthocyanin pigmentation in the petioles of leaves .

Characteristic 17.Shape of flower limb



3.Semi-stellate

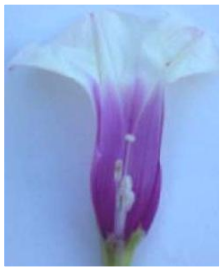
5.Pentagonal

7.Rotate

Characteristic 19. Stigma exsertion : The relative position of the stigma as compared to the highest anther.

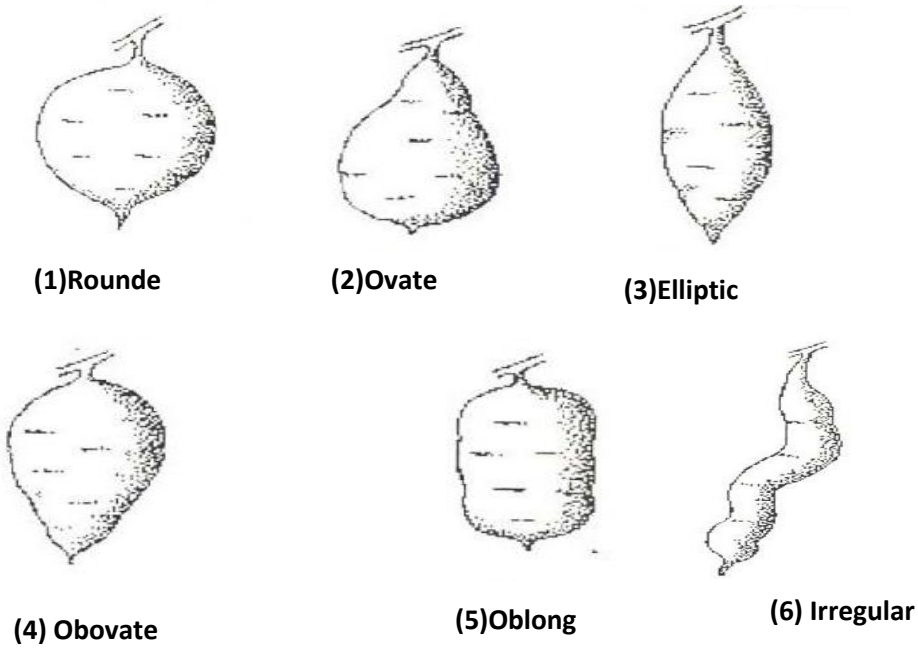
3.Embedded

5. Same height as anther



7. Exerted

Characteristic21. Tuber shape: The most representative expression of the character shown in medium to large sized storage roots of several plants at the time of harvest.



Characteristic 22. Tuber cortex thickness : The most representative expression ofthe character shown in medium to large sized storage roots of several plants at the time of harvest.
Characteristic 23. Tuber: predominant skin colour : Five freshly harvested storage roots should be washed and cured prior to evaluation of the most representative colour.

Characteristic 24. Tuber flesh colour : The colour oft he cross and longitudinal sections made about the middle of freshly harvested storage roots.

IX. Working Group Details

Taskforce for Cassava and Sweet Potato

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X. DUS testing Centre :

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