DESCRIPTORS FOR THE CHARACTERIZATION AND EVALUATION OF SWEET POTATO GENETIC RESOURCES

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In August 1980 the International Board for Plant Genetic Resources (IBPGR) convened an ad hoc working group to discuss the Genetic Resources of Sweet Potato. This was held in Charleston, South Carolina, USA. One of the outcomes of that workshop was the development of a list of descriptors to be used for the characterization of sweet potato accessions [1]. This list included descriptors grouped under three major sections: Passport Data, Characterization and Preliminary Evaluation, and Further Evaluation.

The IBPGR list of descriptors has already been tested in the characterization of some fairly large sweet potato collections in Fiji and Papua New Guinea [4, 3, 7]. However, the reports of those evaluations indicated that the IBPGR list required some modifications in the descriptor states (categories) of several morphologic characters as well as some additional descriptors to describe more accurately the variation present in those collections.

Some preliminary work to characterize a collection of about 1500 accessions of sweet potato cultivars from Peru now maintained at the International Potato Center (CIP) has been undertaken in 1986. For this purpose we have used an expanded IBPGR list of descriptors which included all the additions and modifications mentioned above. Our experience was that even this expanded list was not adequate enough to describe all the morphologic variation shown in CIP's collection.

The development of a more comprehensive list of descriptors for the characterization and evaluation of sweet potato genetic resources is considered of major importance at CIP. It is the key factor to facilitate a rapid identification of duplicate cultivars in the collection whose number of accessions is increasing at a very fast rate through numerous collecting expeditions. Therefore, we have gradually been developing an expanded list of descriptors which has been tested in CIP's sweet potato collection.

The list of descriptors that follows includes:

1) Most of the IBPGR descriptors for the characterization and preliminar evaluation [1].

2) The modifications and additions to the IBPGR list developed by Larsen,1984 [4]; Jackson and Breen, 1985 [3]; and Takagi, 1986 [7].

3) A number of characters that were used in publications containing descriptions of sweet potato cultivars such as those published by Groth, 1911 [2]; Thompson, 1922 [8]; and Yen, 1963 [9].

4) The description of plant variation in a large sweet potato collection from countries of the Americas, Polynesia, Melanesia, and S. E. Asia published by Yen, 1974 [10].

5) Several other storage root characters described by sweet potato breeders such as those published by Martin and Rhodes, 1983 [5]; Ruberte and Martin, 1983 [6].

Priorities to record data have been assigned according to the relative importance of each descriptor to differentiate cultivars. New accessions added to the collection are characterized first for those descriptors considered to be the most useful for identification purposes (i.e. key characters). These data are then used to locate the accession close to other accessions in the collection having similar data for those characteristics. The evaluation for other descriptors with lower priority is then continued on groups of plants showing similar characteristics to determine more similarities or differences among accessions maintained in the collection.

These priorities are as follows:

FIRST PRIORITY

Twining
Plant type
Vine pigmentation
Mature leaf shape
Foliage color
Abaxial leaf vein pigmentation
Storage root color
Storage root flesh color

SECOND PRIORITY

Other Plant and Storage root characters.

THIRD PRIORITY

Floral characters.

FOURTH PRIORITY

All characters of Preliminary evaluation.

Once enough data have been recorded for identification purposes and potential duplicates have been grouped, data on descriptors listed under further evaluation should be obtained.

DESCRIPTOR LIST FOR SWEET POTATO

PASSPORT DATA

1. ACCESSION DATA

See IBPGR list.

2. COLLECTION DATA

See IBPGR list.

CHARACTERIZATION AND PRELIMINARY EVALUATION

3. GENERAL

See IBPGR list.

4. MORPHOLOGIC CHARACTERIZATION

PLANT CHARACTERS

With the exception of vine growth rate, all plant characters should be recorded at about 90 days from planting or 10 days before harvest in early maturing cultivars.

Descriptor states related to length or size should be scored as the average value of measurements made on five to ten plants of each accession in the collection growing under the same environment and at the same plant density.

Vine and leaf characters should be recorded as the average expression of the character observed in a section of the main stem located between the 8th and the 10th fully expanded leaf from the apical shoots unless otherwise specified.

4.1 TWINING

Description of the ability of vines to climb adjacent stakes placed in those accessions showing twining characteristics.
0 Non-twining
9 Twining

4.2 PLANT TYPE

Description of the growth habit at about 90 days from planting.

3 Compact
5 Semi-compact
7 Spreading
9 Extremely spreading

4.3 VINE GROWTH RATE

Description of the relative speed of growth of the main vines based on the average length reached at about 60 days from planting.

3 Slow (less than 50 cm)
5 Intermediate (50-100 cm)
7 Fast (more than 100 cm)

4.4 VINE INTERNODE LENGTH/DIAMETER

Described by a 2 digit code where the first digit (tens) indicates the average internode length and the second digit (units) indicates the average internode diameter.

INTERNODE LENGTH	INTERNODE DIAMETER
1 Very short (less than 3 cm)	1 Very thin (less than 4 mm)
3 Short (3-5 cm)	3 Thin (4-6 mm)
5 Intermediate (6-9 cm)	5 Intermediate (7-9 mm)
7 Long (10-12 cm)	7 Thick (10-12 mm)
9 Very long (more than 12 cm)	9 Very thick (more than 12 mm)

4.5 VINE PIGMENTATION

Extent of distribution of anthocyanin pigmentation in the vines.

1 Green
2 Green with pigmented nodes
3 Slightly pigmented
4 Slightly pigmented with pigmented nodes
5 Moderately pigmented
6 Moderately pigmented with pigmented nodes
7 Totally pigmented - red
9 totally pigmented - purple

4.6 VINE TIP PUBESCENCE

Degree of hairiness of immature leaves recorded from the apex of the vines.

0 None
1 Very sparse
3 Sparse
5 Moderate
7 Heavy
9 Very heavy

4.7 MATURE LEAF SHAPE

Described by a 3 digit code where the first digit (hundreds) indicates the type of the most common expression of leaf lobing; the second digit (tens), the average total number of lobes; and the third digit (units) indicate the shape of the central lobe of leaves (see Fig. 1,2,3).

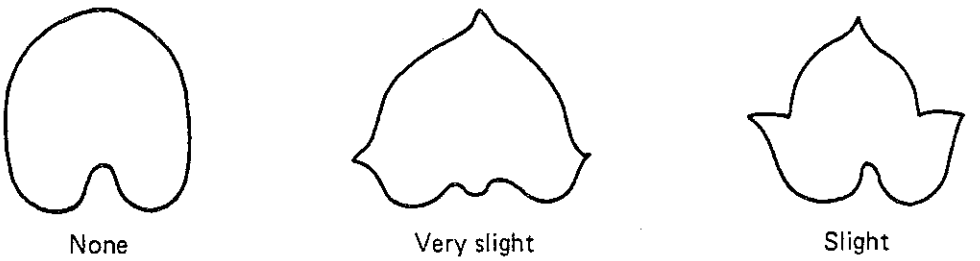
TYPE OF LEAF LOBING	NUMBER OF LOBES	SHAPE OF CENTRAL LOBE
0 None	0	0 Absent
1 Very slight (teeth)	1	1 Broad teeth
3 Slight	3	3 Semi-circular
5 Moderate	5	4 Semi-elliptic
7 Deep	7	5 Elliptic
9 Very deep	9	6 Lanceolate
		7 Oblanceolate
		9 Linear

4.8 MATURE LEAF SIZE

3 Small (less than 8 cm)
5 Medium (8-15 cm)
7 Large (more than 15 cm)

Fig. 1. Examples of mature leaf shape

Fig. 2. Type of leaf lobing



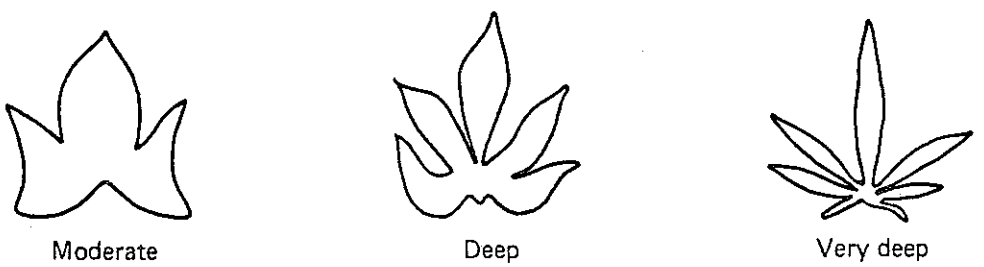
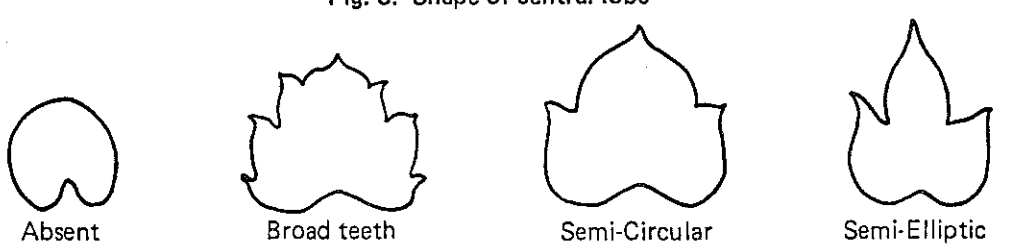
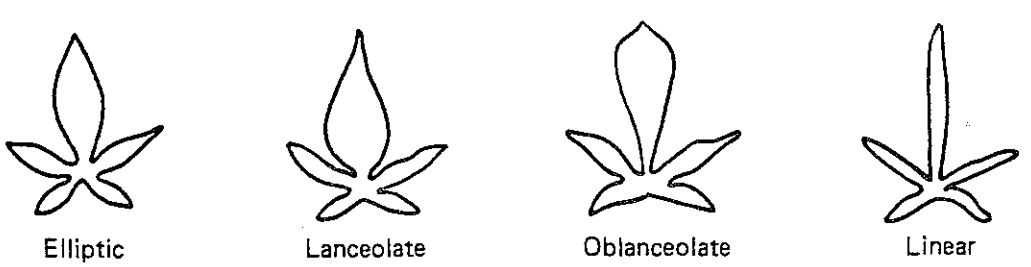


Fig. 3. Shape of central lobe





4.9 FOLIAGE COLOR

Description of the overall foliage color considering the color of fully expanded mature and immature leaves shown by several plants. The variegation in leaf color due to virus symptoms should not be recorded. This character is described by a two digit code where the first digit describes the mature leaf color and the second digit, the immature leaf color.

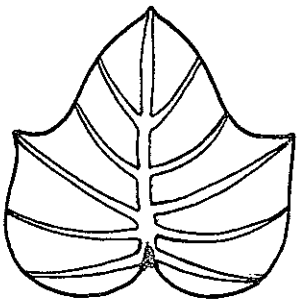
MATURE LEAF COLOR	INMATURE LEAF COLOR
1 Yellow	1 Yellow
2 Yellow-green	2 Yellow-green
3 Green	3 Green
4 Green with pigmented edge	4 Green with pigmented edge
5 Greyish-green (due to heavy pubescence)	5 Greyish-green (due to heavy pubescence)
6 Slightly pigmented	6 Slightly pigmented
7 Moderately pigmented	7 Moderately pigmented
8 Mostly pigmented	8 Mostly pigmented
9 Totally pigmented	9 Totally pigmented

4.10 ABAXIAL LEAF VEIN PIGMENTATION

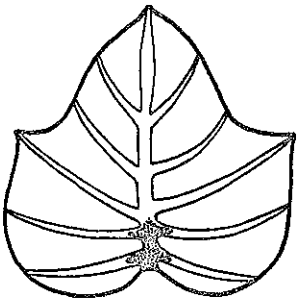
Description of the distribution of anthocyanin pigmentation shown in the veins of the lower surface of leaves. The most frequent expression should be recorded (see Fig.4).

1 Yellow
2 Green
3 Pigmented spot in the base of main rib
4 Pigmented spots in several veins
5 Main rib partially pigmented
6 Main rib mostly or totally pigmented
7 All veins partially pigmented
8 All veins totally pigmented
9 Lower surface and veins totally pigmented

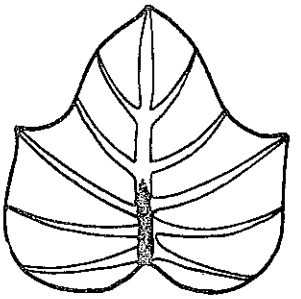
Fig. 4. Abaxial leaf vein pigmentation



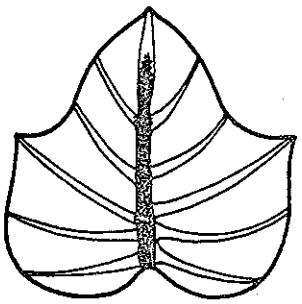
Pigmented spot in main rib



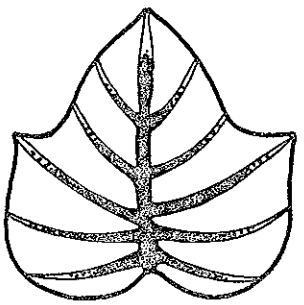
Pigmented spots in several veins



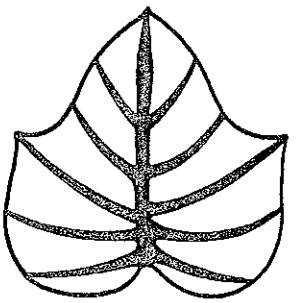
Main rib partially pigmented



Main rib mostly pigmented



All veins mostly pigmented



All veins pigmented

4.11 PETIOLE LENGTH

The average petiole length of leaves located between the 8th and the 10th node from the apical shoots.

1 Very short (less than 10 cm)
3 Short (10-15 cm)
5 Intermediate (16-20 cm)
7 Long (21-25 cm)
9 Very long (more than 25 cm)

4.12 PETIOLE PIGMENTATION

Distribution of anthocyanin pigmentation in the petioles of leaves. The most predominant color is always indicated first.

1 Green
2 Green and pigmented close to the stem
3 Green and pigmented close to the leaf
4 Green and pigmented close to the stem and leaf
5 Partially pigmented throughout petiole
6 Pigmented and green close to the stem
7 Pigmented and green close to the leaf
8 Pigmented and green close to the stem and leaf
9 Totally or mostly pigmented

STORAGE ROOT CHARACTERS

All storage root descriptors should be recorded considering the most representative expression of the character shown in medium to large sized storage roots of several plants.

4.13 STORAGE ROOT SHAPE

Described as the storage root outline shown in a longitudinal section (see Fig. 5).

1 **Round** - an almost circular outline with a length to breadth (L/B) ratio of about 1 to 1.
2 **Round elliptic** -a slightly circular outline with acute ends. The L/B ratio not more than 2 to 1.

Fig. 5. Storage root shape

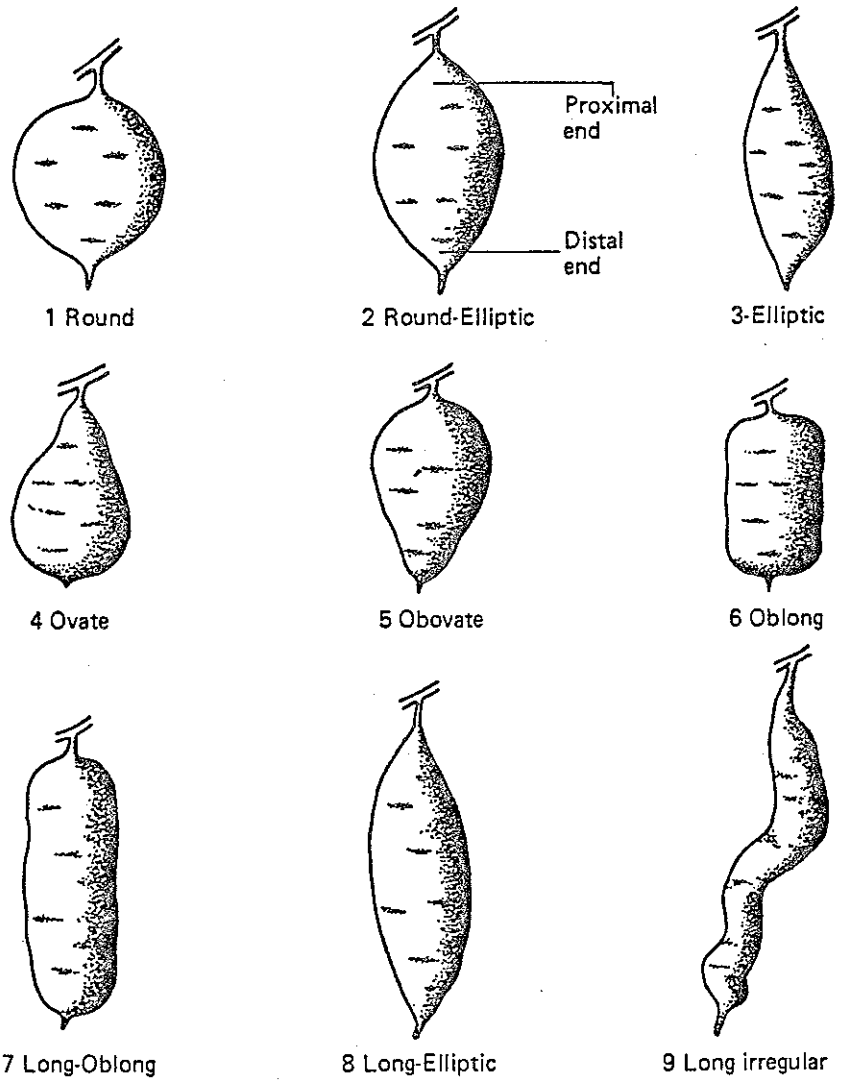
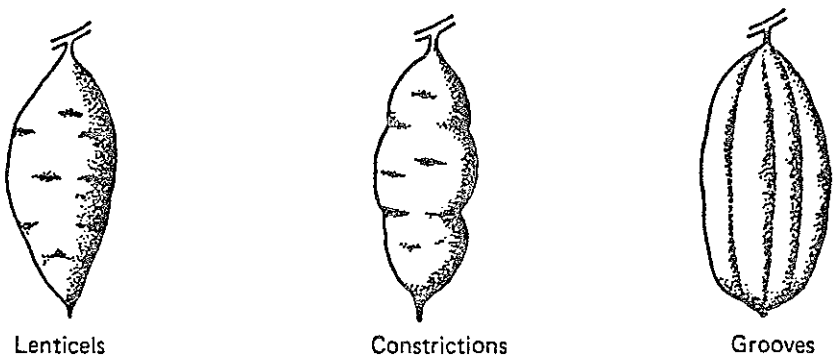


Fig. 6. Storage root surface defects



3 **Elliptic** - an outline with about the same breadth at equal distance from both ends which are slightly acute. The L/B ratio should not be more than 3 to 1.
4 **Ovate** - an outline resembling the longitudinal section of an egg. The broadest part is in the distal end (i.e. opposite to the root stock).
5 **Obovate** - an outline which is inversely ovate. The broadest part is in the proximal end (i.e. close to the root stalk).
6 **Oblong** - an almost rectangular outline with sides nearly parallel and corners rounded. The L/B ratio about 2 to 1.
7 **Long oblong** - an oblong outline with a L/B ratio of at least 3 to 1.
8 **Long elliptic** - an elliptic outline with a L/B ratio of at least 3 to 1.
9 **Long irregular or curved**

4.14 STORAGE ROOT SURFACE DEFECTS

See Fig. 6.

0 Absent
1 Few lenticels
2 Many lenticels
3 Shallow constrictions
4 Deep constrictions
5 Shallow longitudinal grooves
6 Deep longitudinal grooves
7 Deep constrictions and deep grooves

4.15 STORAGE ROOT CORTEX THICKNESS

1 Very thin (< 1 mm)
3 Thin (2 mm)
5 Intermediate (2-3 mm)
7 Thick (3-4 mm)
9 Very thick (> 4 mm)

4.16 STORAGE ROOT SKIN COLOR

Freshly harvested storage roots should be washed and dried prior to evaluation. The color recorded should correspond to the most representative color of the cultivar. It is described by a 3 digit code where the first digit (hundreds) indicates the predominant skin color; the second digit (tens), the intensity of the color; and the third digit (units) indicates the presence of a secondary color distributed either as spots or small areas.

PREDOMINANT COLOR	INTENSITY	SECONDARY COLOR
1 White	1 Pale	0 Absent
2 Cream	2 Intermediate	1 White
3 Yellow	3 Dark	2 Cream
4 Orange		3 Yellow
5 Brown		4 Orange
6 Pink		5 Brown
7 Red		6 Pink
8 Purple-red		7 Red
9 Dark purple		8 Purple-red
		9 Dark purple

4.17 STORAGE ROOT FLESH COLOR

Described in cross sections made about the middle of freshly harvested storage roots.

1 White
2 Cream
3 Dark cream
4 Pale yellow
5 Dark yellow
6 Yellow with orange or viceversa
7 Pale orange
8 Dark orange
9 Strongly pigmented with anthocyanins

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4.18 DISTRIBUTION OF ANTHOCYANIN PIGMENTATION IN FLESH

See Fig. 7.

0 Absent
1 Narrow ring in cortex
2 Broad ring in cortex
3 Scattered spots
4 In the vascular cambium
5 In the cortex and vascular cambium
6 In the cortex and central parenchyma
7 In the vascular cambium and central parenchyma
8 In the cortex, vascular cambium and central parenchyma
9 Totally or mostly pigmented

4.19 STORAGE ROOT SPROUTING

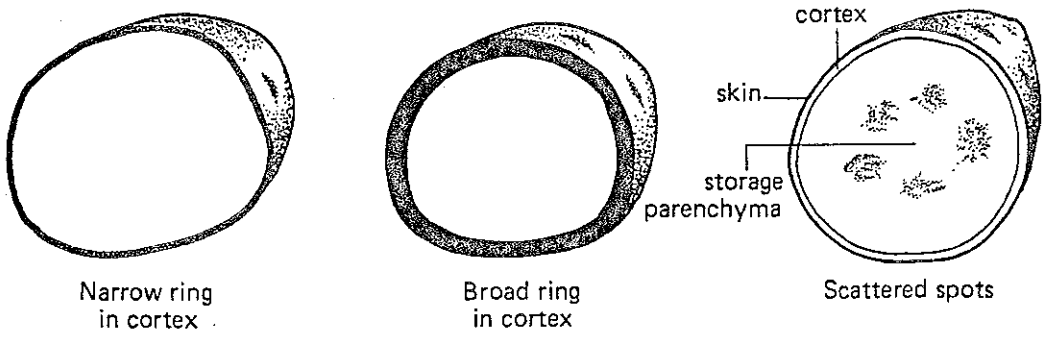
Medium sized storage rots stored in paper bags should be evaluated for their natural sprouting ability. This is described by a 2 digit code where the first digit (tens) indicates the speed of sprouting and the second digit (units) indicates the sprouting uniformity.

SPROUTING RESPONSE	SPROUTING UNIFORMITY
0 Absent	3 Uniform
1 Very fast	5 Slightly variable
3 Fast	7 Moderately variable
5 Intermediate	9 Highly variable
7 Late	
9 Very late	

FLORAL CHARACTERS

Although characters related to the flower are very important and not influenced by environmental conditions, there are strong differences among cultivars in their flowering ability. Flowering can be stimulated by water stress or trelliswork. However, in difficult cases grafting or chemical treatment might be needed (see Fig. 8).

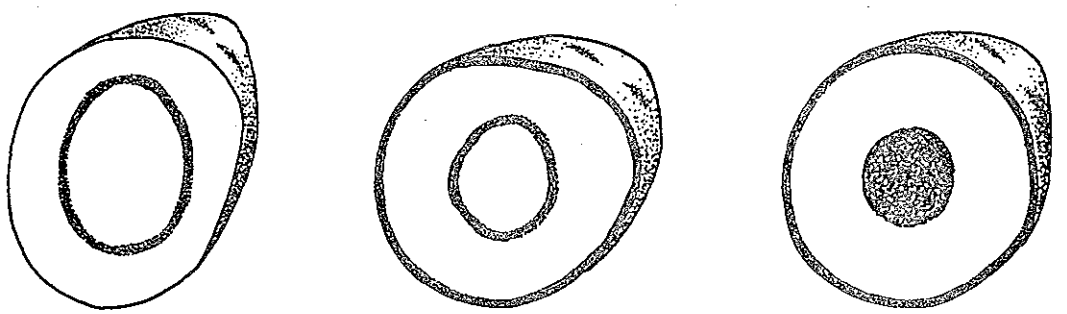
Fig. 7. Distribution of anthocyanin pigmentation in storage root flesh



Narrow ring in cortex

Broad ring in cortex

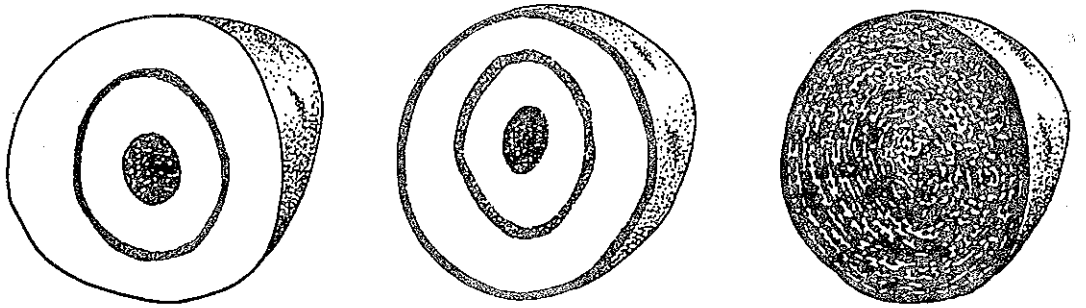
Scattered spots



In vascular cambium

In cortex and vascular cambium

In cortex and central parenchyma



In vascular cambium and central parenchyma

In cortex, vascular cambium and central parenchyma

Totally or mostly pigmented

Fig. 8. Parts of a sweet potato flower

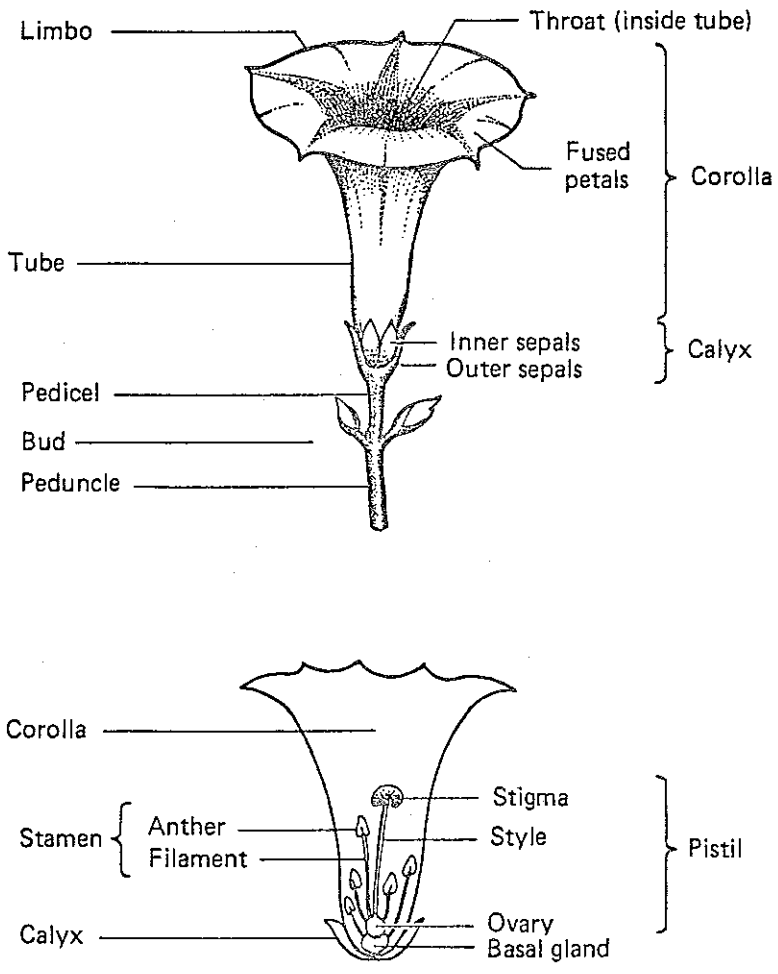
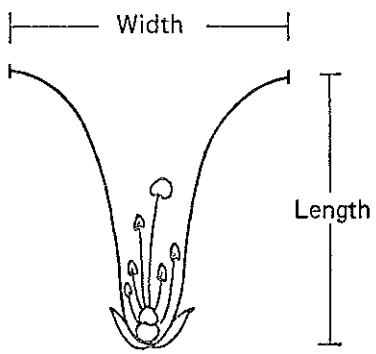


Fig. 9. Flower lenght and width



4.20 FLOWERING HABIT

0 None
1 Scarce
3 Sparse
5 Moderate
7 Profuse
9 Very profuse

4.21 FLOWER COLOR

1 White
2 White limb with purple throat
3 White limb with pale purple ring and purple throat
4 Pale purple limb with purple throat
5 Purple
6 Other (specify)

4.22 FLOWER LENGTH AND WIDTH

Average length and width of ten typical flowers and expressed in centimeters (see Fig. 9).

4.23 SHAPE OF LIMB

See Fig. 10

3 Semi-stellate
5 Pentagonal
7 Rotate

4.24 EQUALITY OF SEPAL LENGTH

1 Outer two shorter
2 Equal

4.25 NUMBER OF SEPAL VEINS

Count of the number of veins observed in the sepals. The most frequent number in ten typical flowers should be recorded.

Fig. 10. Shape of Limb

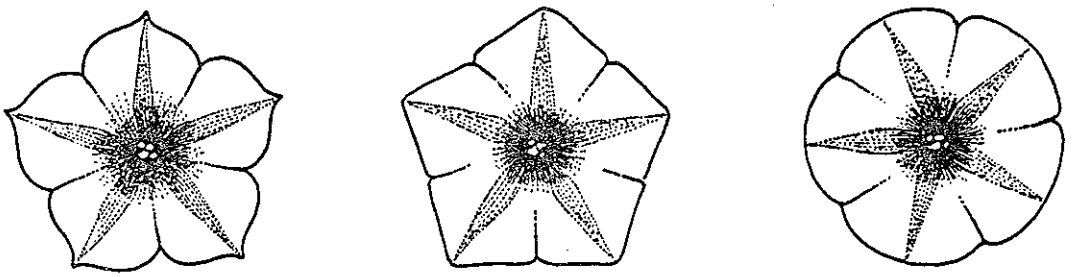


Fig. 11. Sepal shape

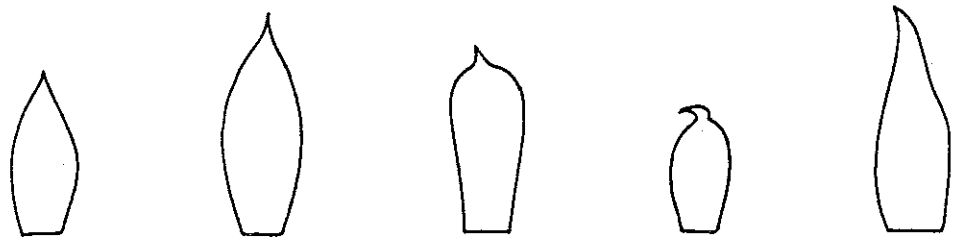
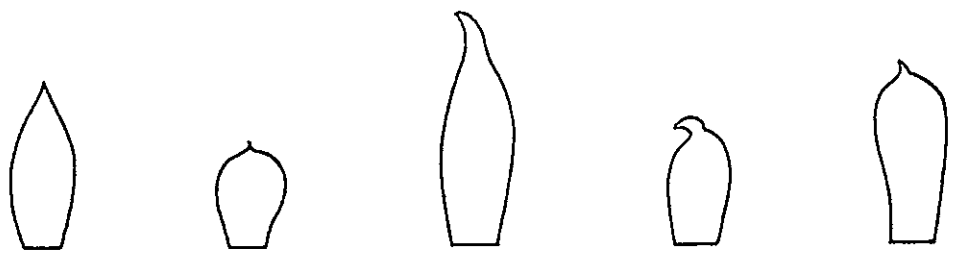


Fig. 12. Sepal apex



4.26 SEPAL SHAPE

See Fig. 11

1 Ovate
3 Elliptic
5 Obovate
7 Oblong
9 Lanceolate

4.27 SEPAL APEX

See Fig. 12

1 Acute
3 Obtuse
5 Acuminate
7 Caudate

4.28 SEPAL PUBESCENCE

0 Absent
1 Very sparse
3 Sparse
5 Moderate
7 Heavy
9 Very heavy

5.

4.29 SEPAL COLOR

1 Green
2 Green with pigmented edge
3 Lightly pigmented
5 Moderately pigmented
6 Some sepals green, others pigmented
7 Totally pigmented - red
9 Totally pigmented - purple

4.30 COLOR OF STIGMA

1 White
5 Pale purple
9 Purple

4.31 COLOR OF STYLE

1 White
3 White with purple at the base
5 White with purple at the top
7 White with purple spots throughout
9 Purple

4.32 STIGMA EXSERTION

The relative position of the stigma as compared to the highest anther (see figure 13).

1 Inserted (shorter than longest anther)
3 Same height as highest anther
5 Slightly exserted
7 Exserted (longer than longest anther)

4.33 SEED CAPSULE SET

0 None
1 Scarce
3 Sparse
5 Moderate
7 Heavy

5. PRELIMINARY EVALUATION

5.1 STORAGE ROOT FORMATION

Description of the arrangement of the storage roots on the underground stems of plants propagated by vine cuttings (see Fig. 14).

1 Closed cluster
3 Open cluster
5 Disperse
7 Very disperse

5.2 STORAGE ROOT STALK

Description of the length of the stalk joining the storage roots to the stems.

Fig. 13. Stigma exsertion

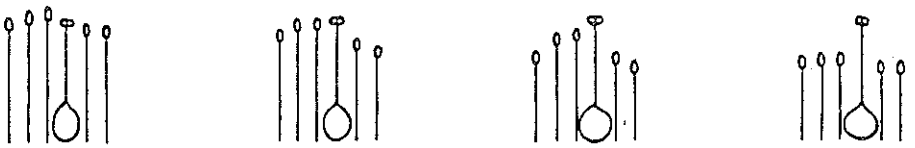
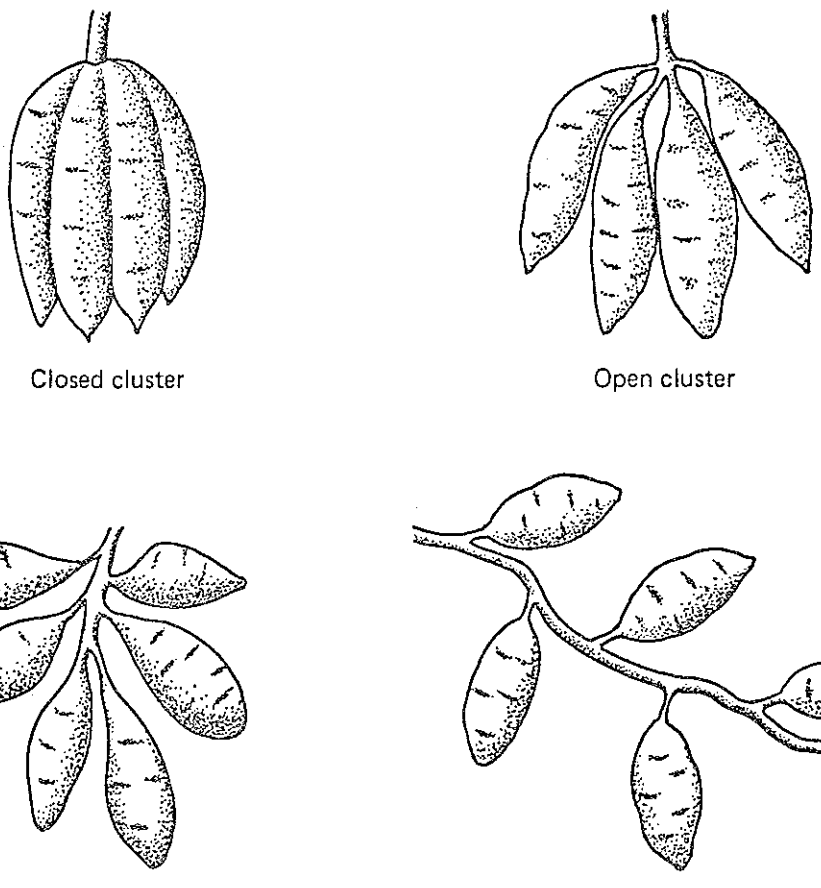


Fig. 14. Storage root formation



0 Sessile or absent
1 Very short (less than 2 cm)
3 Short (2-5 cm)
5 Intermediate (5-8 cm)
7 Long (9-12 cm)
9 Very long (more than 12 cm)

5.3 STORAGE ROOT LENGTH

Storage root dimensions should be recorded on the most predominant size of storage roots produced by ten plants.

Average length of ten storage roots in centimeters.

5.4 STORAGE ROOT DIAMETER

Average of largest diameter of ten storage roots in centimeters.

5.5 NUMBER OF STORAGE ROOTS PER PLANT

Average of ten plants.

5.6 STORAGE ROOT SHAPE VARIABILITY

3 Uniform
5 Slightly variable
7 Moderately variable
9 Highly variable

5.7 STORAGE ROOT SIZE VARIABILITY

3 Uniform
5 Slightly variable
7 Moderately variable
9 Highly variable

5.8 STORAGE ROOT CRACKING

Description of the average cracking shown in ten plants. Consider all cracks caused by growth and/or water stress.

0 Absent
3 Few cracks
7 Many cracks

5.9 LATEX PRODUCTION IN STORAGE ROOTS

Description of the relative amount of latex observed about 5 seconds after the cross section is made in medium sized storage roots.

0 None
1 Very little
3 Little
5 Some
7 Abundant
9 Very abundant

5.10 OXIDATION IN STORAGE ROOTS

Description of the relative amount of oxidation observed 5 minutes after the cross section is made in medium sized storage roots.

0 None
1 Very little
3 Little
5 Some
7 Abundant
9 Very abundant

FURTHER EVALUATION

6. STORAGE ROOT DATA

6.1 STORAGE ROOT DRY MATTER PERCENTAGE

6.2 STORAGE ROOT NITROGEN

6.3 STORAGE ROOT FIBER PERCENTAGE

American Official Analytical Chemistry on cooked roots of at least 3 cm diameter.

6.4 STORAGE ROOT STARCH PERCENTAGE

6.5 STORAGE ROOT WATER SOLUBLE SUGAR PERCENTAGE

6.6 STORAGE ROOT CAROTENE CONTENT

In milligramme per 100 g fresh weight.

6.7 KEEPING QUALITY OF STORAGE ROOTS

3 Poor
5 Medium
7 Good

6.8 SPROUTING ABILITY IN BEDS

3 Poor
5 Medium
7 Good

BOILED STORAGE ROOTS CHARACTERS

Description of these characters should be made on commercial size storage roots of approximately the same dimensions. Roots should be totally inmersed in boiling water for approximately the same time for all accessions compared. The average score of at least 3 people should be recorded.

6.9 CONSISTENCY OF BOILED STORAGE ROOT

1 Watery
2 Extremely soft
3 Very soft
4 Soft
5 Slightly hard
6 Moderately hard
7 Hard
8 Very hard
9 Very hard and non-cooked.

6.10 UNDESIRABLE BOILED STORAGE ROOT FLESH COLOR

0 None
1 Some beige
2 Much beige
3 Slightly green or gray
4 Green
5 Gray
6 Beige and green
7 Beige and gray
8 Beige and pigmented
9 Pigmented

6.11 TEXTURE OF BOILED STORAGE ROOT FLESH

1 Dry
3 Somewhat dry
5 Intermediate
7 Moist
9 Very moist

6.12 SWEETNESS OF BOILED STORAGE ROOT FLESH

1 Not sweet
3 Slightly sweet
5 Moderately sweet
7 Sweet
9 Very sweet

7. PEST REACTION

See IBPGR list.

8. DISEASE REACTION

See IBPGR list.

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