Descriptors for African yam bean, *Sphenostylis stenocarpa* (Hochst ex. A. Rich.) Harms

Daniel B. Adewale and Dominique J. Dumet
Genetic Resources Center, International Institute of Tropical Agriculture
Ibadan, Nigeria

Introduction to African yam bean

African yam bean (*Sphenostylis stenocarpa* Hochst ex. A. Rich.) Harms is an underutilized tropical African tuberous legume. It belongs to the class *Magnoliopsida;* order *Fabales;* family *Fabaceae;* subfamily *Papilionoideaea;* and genus *Sphenostylis.* There are seven species in the genus *Sphenostylis* (Potter and Doyle 1994). African yam bean (AYB) is the most valuable. The arable tuberous legume is important in most indigenous African food cultures and in peasant agriculture.

The center of diversity, according to the Genetic Resources Information Network (GRIN), spreads from the west through to the east and southern parts of Africa (GRIN 2009) and these areas are suspected to host the genetic resources of AYB. The utilization of AYB has links with sociocultural values in the cultures of some ethnic groups within the area.

AYB is a vigorously climbing herbaceous vine whose height can reach 1.5–3 m or more. The main vine/stem produces many branches which also twine strongly on available stakes. The vegetative growing stage is characterized with the profuse production of trifoliate leaves (Milne-Redhead and Polhill 1971).

From four to ten flowers are arranged in racemes on long peduncles, usually on the primary and secondary branches. The large and attractive flowers blend pink with purple; the standard petals twist slightly backwards on themselves at anthesis. The flowers seem to exhibit self-pollination; up to six pods/peduncle may result after fertilization. The usually linear and long unicarpel pods turn brown when mature (Hutchinson and Dalziel 1958; Dukes 1981).

The pods which may sometimes be flat or raised in a ridge-like form on both margins are usually prone to shattering; they dehisce along the dorsal and ventral sutures when dry. Each pod can yield up to 20 seeds which may be round, oval, oblong, or rhomboid. There are varieties of seed color (Oshodi *et al.* 1995) and size (Adewale *et al.* 2010) with mono-colored or mosaic types. Mono-colored seeds are white, grey, cream, light or dark brown, purple, or black.

AYB is usually grown in mixtures with yam and cassava. Protein content is up to 19% in the tubers and 29% in the seed grain. The crop has medicinal importance (Potter 1992). Assefa and Kleiner (1997) remarked that AYB has very high nitrogen-fixing ability. It has remarkably low susceptibility to most field and storage leguminous pests (Omitogun *et al.* 1999).

CHARACTERIZATION DESCRIPTORS

1.0 Plant descriptors

1.1 Vegetative

1.1.1 Hypocotyl pigmentation

Scored at seedling emergence when the first leaves have fully expanded as:

0 = Absent

1 = Present

1.1.2 Days to 50% twining

Days from seedling emergence until 50% of the stands climb to make the first clockwise twine around the stakes; 5 plants as sampling unit within the plot center

1.1.3 Plant part pigmentation

1.1.3.1 Main stem

0 = Absent

1 = Present

1.1.3.2 Branch

0 = Absent

1 = Present

1.1.3.3 Petiole

0 = Absent

1 = Present

1.1.3.4 Peduncle

0 = Absent

1 = Present

1.1.4 Intensity of pigmentation on plant parts

1.1.4.1 Main stem

1 = Slight

3 = Moderate

5 = Extensive

1.1.4.2 Branch

1 = Slight

3 = Moderate

5 = Extensive

1.1.4.3 Petiole

1 = Slight

3 = Moderate

5 = Extensive

1.1.4.4 Peduncle

1 = Slight

3 = Moderate

5 = Extensive

1.1.5 Leaf color (Methuen color chart code)

1 = Pale green	27A3
2 = Green	27A8
3 = Dark green	27 F8

1.2 Reproduction

1.2.1 Days to peduncle initiation

Days from seedling emergence until 50% of the plant stands within a plot begin to initiate peduncles; 5 plants as sampling unit

1.2.2 Days to 50% flowering

Days from seedling emergence until 50% of the plant stands begin to anthesize; 5 plants as sampling unit

1.3 Fruits (Pods)

1.3.1 Seed cavity ridges on pods (see Fig. 1)

0 = Absent

1 = Present

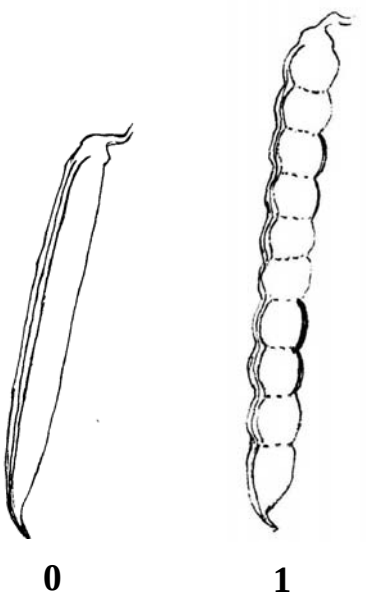

Fig. 1. Seed cavity ridges on pods

1.3.2 Pod dehiscence

0 = Non-shattering

1 = Shattering

1.4 Seeds

1.4.1 Splitting of testa

0 = Absent

1 = Present (testa splits to expose the cotyledons)

1.4.2 Seed shapes (see Fig. 2)

1 = Round/globular

2 = Oval

3 = Oblong

4 = Rhomboid

Fig. 2. Seed shapes

1.4.3 Testa texture

Scored on the seeds by touching the testa surface as:

1 = Smooth
2 = Rough
3 = Wrinkled (folds on the testa)

1.4.4 Testa color variegation

0 = Absent
1 = Present

1.4.5 Testa basal color (Methuen color chart code)

Measured as varieties of colors without variegation

1 = White	A1
2 = Grey	E1
3 = Cream	4A3
4 = Light brown	6D8
5 = Reddish brown	8E8
6 = Dark brown	6F8
7 = Purple	14F8

8 = Variegated (mosaic)

1.4.6 Pattern of testa variegation (see Fig. 3)

1 = Dense black uneven spots/dots on brown background basal color with clean eye
2 = Sparse black dots on creamy brown background with a concentration around the hilum
3 = Patchy light brown dots on dark brown background

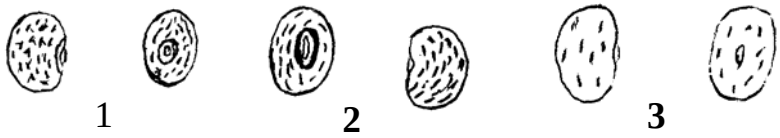

Fig. 3. Pattern of testa variegation

1.4.6.1 Basal color of variegated seeds

0 = Non-variegated seeds
1 = Cream
2 = Brown
3 = Black

1.4.7 Eye color of white seeds

Color around the hilum of white seeds

0 = Non-white seeds
1 = Clean (no color around the hilum)
2 = Brown
3 = Black

1.4.8 Eye color pattern (see Fig. 4)

1 = Brown testa with continuous narrow black stripe around the hilum
2 = Brown testa with dark brown fork-like eye pattern
3 = White/grey testa with incision-like eye pattern
4 = Brown testa with dark brown incision-like pattern below and parallel to the hilum
5 = White testa with reddish brown vase-like eye
6 = White testa with black vase-like eye

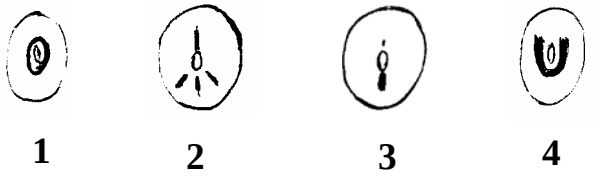

Fig. 4. Eye color pattern

1.4.9 Brilliance of seeds

1 = Matt
2 = Medium
3 = Shiny

1.5 Tubers

1.5.1 Tuber production

0 = No
1 = Yes

1.5.2 Tuber population

1 = One tuber
2 = ≥ Two tubers

1.5.3 Tuber shape (see Fig. 5 a, b, c, and d)

1 = Round
2 = Ovate
3 = Spindle
4 = Irregular

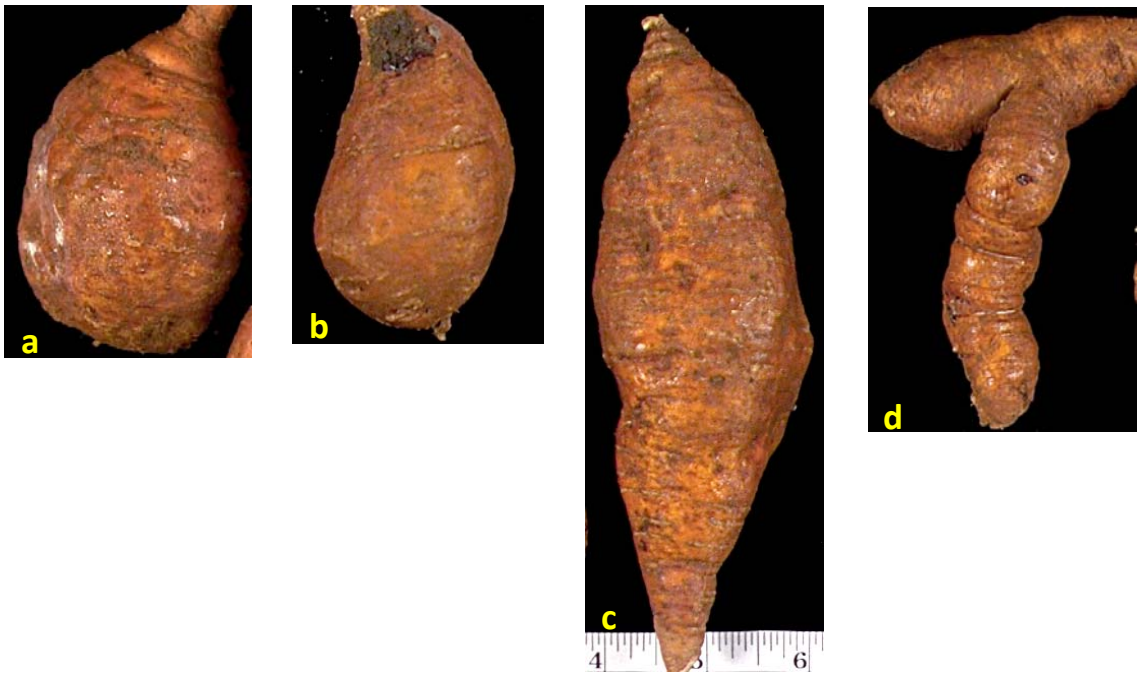

Fig. 5. Tuber shape

1.5.4 Tuber skin color (Methuen color chart code)

1 = Cream	4A3
2 = Brownish orange	6C8
3 = Pink	12A4

1.5.5 Tuber branching

Offshoot from the main tuber

0 = No

1 = Yes

1.5.6 Extent of tuber branching

1 = Slightly branched

2 = Branched

3 = Highly branched

EVALUATION DESCRIPTORS

2.0 Plant descriptors

2.1 Vegetative

2.1.1 Days to 50% seedling emergence

Days from sowing until 50% of the seedlings emerge on the sown stands

2.1.2 Hypocotyl length [cm]

Mean length of 10 hypocotyl seedlings measured from the base to the tip when the first primary leaves have fully expanded (see Fig. 6)

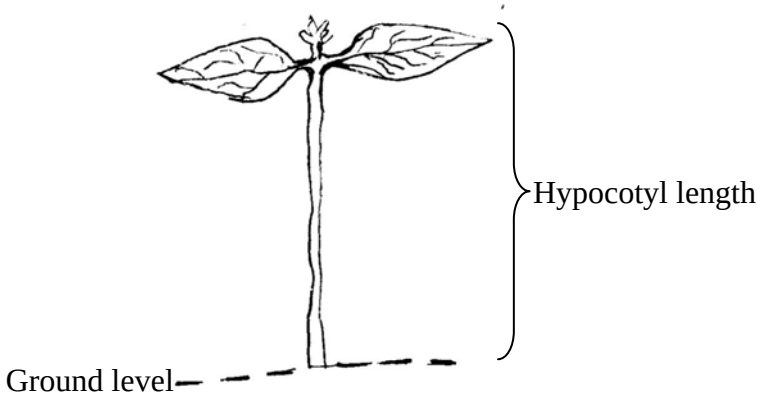

Fig. 6. Hypocotyl length

2.1.3 Number of leaves

Number of leaves on a meter length of branch; 10 branches as sampling unit; measured at full reproductive stage of the plant

2.1.4 Internode length [cm]

Distance in centimeters on a branch between two consecutive leaf nodes, 10 branches as sampling unit; measured at full reproductive stage

2.1.5 Terminal leaf length [cm]

The average metric distance from the pulvinus to the apical tip of 10 fully developed terminal leaflets taken from 5 different plants at the peak of flowering (see Fig. 7)

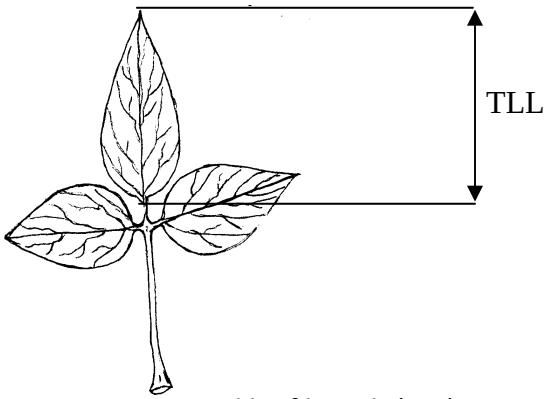

Fig. 7. Terminal leaf length (TLL)

2.1.6 Terminal leaf width [cm]
The average metric distance measured along the widest part of 10 fully developed terminal leaflets taken from 5 different plants at the peak of flowering (see Fig. 8)

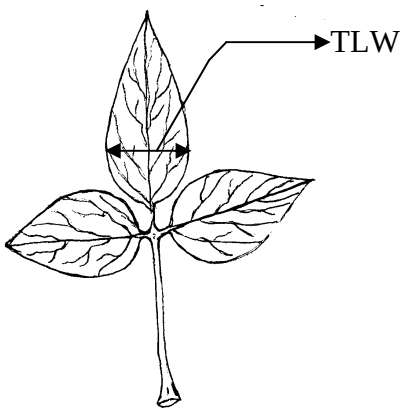

Fig. 8. Terminal leaf width (TLW)

2.1.7 Petiole length [cm]
Mean length of the 10 petioles from 5 sample plants, measured from the base to the point where the three leaflets join (see Fig. 9)

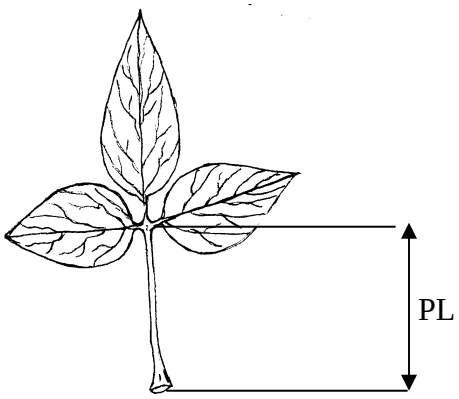

Fig. 9. Petiole length (PL)

2.1.8 Stem diameter [cm]
The circumference (girth) of the stem measured at 10–15 cm above the ground at the peak of flowering
2.1.9 Peduncle length [cm]
Measured on 10 fully grown, flower/pod-bearing peduncles from 5 sample plants
2.1.10 Peduncles/plant
Mean number of peduncles from 5 sample plants at harvest

2.1.11 Days to maturity
Days from seedling emergence until 90% of the pods in a plot are mature

2.2 Reproduction

2.2.1 Days to 50% peduncle initiation
Days from seedling emergence until 50% of the stands in a plot initiate the offshoot of peduncles at nodes on the stems

2.2.2 Days to 50% flower bud initiation
Days from seedling emergence until 50% of the stands initiate flower buds on the peduncles

2.2.3 Flowers/peduncle
Counted on 10 peduncles from 5 plants in the middle of the plot

2.2.4 Calyx lobe length [mm]
Length from the receptacle end to calyx end

2.2.5 Flower bud size [mm]
Length of 10 fully developed flower buds from 5 sample plants prior to anthesis

2.2.6 Flowering duration
Days from the first flower until 50% of the plants cease flowering

2.3 Fruits (pods)

2.3.1 Pod length [cm]
Mean length of 10 randomly selected pods; measured from peduncle stalk end to pod beak end

2.3.2 Pod weight [g]
Mean weight of 10 randomly selected pods

2.3.3 Locules/pod
Mean number of seed cavities in 10 randomly selected pods

2.3.4 Pods/peduncles
Mean number of pods from 10 peduncles from 5 sample plants at harvest

2.3.5 Pods/plant
Mean number of pods from 5 sample plants at harvest

2.3.6 Pod weight/plant [g]
Mean weight of total pods produced by the 5 plants constituting the sampling unit

2.3.7 Pod beak length [cm]
Mean length of 10 pods measured from the end of the last seed cavity to the tip of the pod

1 = Short (0.10–0.79 cm)
2 = Intermediate (0.80–1.24 cm)
3 = Long (≥ 1.25 cm)

2.3.8 Grain filling period
Mean number of days from anthesis until 80% of the pod wall turns brown during the maturity/ripening period

2.4 Seeds

2.4.1 Seeds/pod

Mean number of well formed seeds in 10 randomly selected pods

2.4.2 Seed set percentage [%]

The mean ratio of seed number and loculi number/ pod multiplied by 100; measured on 10 randomly selected pods

2.4.3 Seed weight/pod [g]

Mean weight of seeds/pod from 10 randomly selected pods

2.4.4 Seed weight/plant [g]

Mean weight of seeds produced by the 5 sampling units

2.4.5 Shelling percentage [%]

The ratio of the seed weight/plant to pod weight/plant multiplied by 100

2.4.6 Seed metrics

Mean of measurements on 10 seeds selected in replicates from seed lots

2.4.6.1 Seed length [mm]

Distance measured between the two ends of the seed, parallel to the hilum (see Fig. 10)

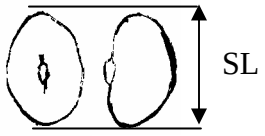

Fig. 10. Seed length (SL)

2.4.6.2 Seed width [mm]

Distance on the seed measured from hilum to the keel (see Fig. 11)

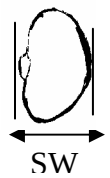

Fig. 11. Seed width (SW)

2.4.6.3 Seed thickness [mm]

Distance on the seed measured perpendicular to the seed length (see Fig. 12)

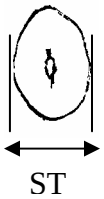

Fig. 12. Seed thickness (ST)

2.4.7 100-seed weight [g]

Mass of 100 randomly selected seeds taken from total seed yield in replicates

2.4.8 Seed-volume [cm^3]

Volume of 100 randomly selected seeds in 94% ethanol

2.4.9 Grain yield [kg/ha]

Weight of dried seeds (at 12% moisture content)

2.5 Tubers

2.5.1 Number of tubers

Mean number of tubers produced/plant; 5 plants as sampling unit

2.5.2 Tuber weight [g]

Mean weight of tubers produced/plant; 5 plants as sampling unit

2.5.3 Length of tubers [cm]

Mean of the longest 5 mature tubers measured from the crown to the tip

2.5.4 Width of tubers [cm]

Mean of the broadest circumferences of 5 mature tubers

2.5.5 Tuber length to width ratio

The proportion of the tuber width to its length

2.5.6 Tuber fresh yield [kg/ha]

Total weight of harvested tubers; calculated on 10 plants at harvest

References

Adewale, B.D., O.B. Kehinde, C.O. Aremu, J.O. Popoola, and D.J. Dumet. 2010. Seed metrics for genetic and shape determination in African yam bean. African Journal of Plant Science. 4(4): 107–115.

Assefa, F. and D. Kleiner. 1997. Nodulation of African yam bean (*Sphenostylis stenocarpa*) by *Bradyrhizobium* sp. isolated from *Erythrina brucei*. Biology and Fertility of Soils 25: 209–210.

Dukes, J. A. 1981. Pages 220–222 *in*: Handbook of Legumes of World Economic Importance. Plenum Press, New York, USA.

GRIN. 2009. Genetic Resources Information Network (GRIN). GRIN Taxonomy for Plants. http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?35250#dist. [5 February 2010].

Hutchinson, J. and J.M. Dalziel. 1958. Pages 232–241 *in* Flora of West Tropical Africa.Vol.1 (2). Crown Agents for Oversea Governments and Administrations. Millbank, London.

Milne-Redhead, E. and R.M. Polhill. 1971. Pages 670–674 *in* Flora of Tropical East Africa. Crown Agents for Oversea Governments and Administrations., Millbank, London.

Omitogun, O.G., L.E.N. Jackai, and G. Thottappilly. 1999. Isolation of insecticidal lectin-enrich extracts from African yam bean (*Sphenostylis stenocarpa*) and other legume species. Entomologia Experimentalis et Applicata 90: 301–311.

Oshodi, A.A., K.O. Ipinmoroti, E.I. Adeyeye, and G.M. Hall. 1995. *In vitro* multienzyme digestibility of protein of six varieties of African yam bean flours. Journal of Science, Food and Agriculture, 69: 373–377.

Potter, D. and J.J. Doyle. 1994. Phylogeny and systematics of *Sphenostylis* and *Nesphostylis* (Leguminoseae: Phaseoleae) based on morphological and chloroplast DNA data. Systematic Botany, 19(3): 389–406.