

Post-Harvest Evaluation of Sweet Potato Varieties.

Methods Manual
1997

**Rwiza, E, Ndoni, T, Chotta, M, Kilima, MS,
Chilosa, DNV, Mayona, CM, Mtunda, K, van
Oirschot, Q, Rees, D and Kapinga R.**

Introduction

This manual has been written to set out the methods for a series of five trials conducted at A.R.I. Ukiriguru, MARTI-Uyole, Sugar Cane Research Institute (Kibaha), Dakawa (Chollima) and HORTI-Tengeru during 1997 as part of a project to evaluate sweet potato varieties for their quality and storability. The methods have been adapted from those used during a preliminary series of trials conducted at the same sites during 1996.

The objectives of the trials are as follows

1. To determine whether there exists a range of storability within East African germplasm (If this is so, then we can breed varieties with longer shelf-life).
2. To identify characteristics associated with storability.
3. To determine the extent of location effects. i.e. does ranking of varieties change with environment?
4. To establish a methodology for post-harvest evaluation to be used standardly by the breeding programme. This should be simple, and should cover consumer acceptability of fresh roots and suitability for processing as well as storability.

This project is part of a collaboration between the Tanzanian National Root and Tuber Crops Programme and the Natural Resources Institute, Greenwich University, UK. Funding is provided through the Crops Post-Harvest Programme of the Department for International Development (DfID), UK.

Planting trials

Planting Uniform Yield Trials

- (1) The trials are planted in the form of Uniform Yield Trials. Planting material should ideally be obtained using nursery beds on-station. During planting, standardise the cuttings used (e.g. 30 cm from apical and middle portion of the vines.)
- (2) Use a randomized complete block design with 3 or 4 replicates. Each plot should consist of 6 rows of 6 m (3 plants/ m) [324-432 plants per variety) with 1 m between rows. Plant on ridges or flat ground depending on the common practice in the region. Plant a border (e.g. of SPN/O) around the trial.
- (3) Record the information about how the trial was planted, and any observations. Use AYT form 1 to record data such as planting date, soil type, history of the land, and monthly meteorological data for the station. The meteorological data should be obtained from the month prior to planting until the completion of the trial.
- (4) 3 weeks after planting, record establishment by recording the number of plants surviving in each plot (no. estab AYT form 2). Record foliage vigor (canopy cover and closure) using the following rating scale (1: very weak, 2: weak, 3: fair, 4: vigorous, 5: very vigorous) (AYT Form 2 Fol vigor).
- (5) Additional material can be obtained by planting additional plots. In this case, the varieties should be planted in blocks to prevent the effects of land variability.

Procedure to follow, and observations to be made during the harvesting of trials

In cases where a Uniform Yield Trial has been planted, and additional multiplication plots have also been planted, the Uniform Yield Trial should be harvested first, and used to collect the harvest data as described below.

Procedure for harvesting Uniform Yield Trial and recording harvest data.

- (1) Harvest plants by up-rooting with foliage still attached. All plants from each plot should be harvested and used for data collection.
- (2) For each plot, note the following parameters while the foliage is still attached to the roots. Record data on the CIP AYT Forms as indicated:
 - (a) The number of plants harvested per plot (No.Pl.Harv. [AYT Form 3]).
 - (b) The number of plants without storage roots (No.Pl.w/o Roots. [AYT Form 3])
 - (c) An assessment of crown damage by *Cylas*. (1-5 scale see Table 1) (Crown damage, [AYT Form 2])
 - (d) A general evaluation of root appearance for each plot. (1-5 scale see Table 1) (Gen. eval. [AYT Form 3])
- (3) Separate storage roots from crowns, and record the weight of foliage for each plot [AYT Form 3].
- (4) Record the following data from the roots of each plot:
 - (a) Assess *Cylas* infestation by separating roots into 5 classes and calculating the mean root score as shown in Table 2 [AYT Form 2].
 - (b) The number of cracked or defective roots (No. Crack or Defect, [AYT Form 3]).
 - (c) The number of rotten roots (No Rot., [AYT Form 3]).
 - (d) An overall assessment of rough weevil damage (1-5 scale see Table 1) ([Record this under comments in AYT Form 2])

N.B. If the trial is suffering from a serious infestation or disease that is not included in the above, records should be taken of the severity of the problem for each replicate.

- (5) For each plot separate the storage roots into large and small (A small root is one which has a diameter of less than 2cm. Record the number and total weight of each of both large and small roots separately for each plot [AYT Form 3].
- (6) Discard the small roots.

(7) Remove rotten and infested roots (Those scoring greater than 1), and weigh those remaining for each plot. (Record this as marketable yield on AYT Form 3)

Harvesting multiplication plots

(8) Harvest the roots from additional multiplication plots as necessary. Keeping the varieties separate, sort the roots into large and small (A small root is one which has a diameter of less than 2 cm, see above). The small roots should be discarded. In addition discard all roots that show rotting or infestation.

Characterisation of roots

(9) Pool the roots remaining from the Uniform Yield Trials and the multiplication plots (if planted) for each variety. These will be used for the trial. Take the roots inside or to a shaded place to continue assessment.

At this stage the roots could be left in tied sacks and the following assessment might be carried out on the next day.

(10) Assess the characteristics of the storage roots for each variety using the CIP descriptors and the CIP colour chart. Note the following characteristics using datasheet PHE1.

- (a) Root shape
- (b) Surface defects
- (c) Cortex thickness
- (d) Skin colour
 - Predominant skin colour
 - Secondary skin colour
- (e) Flesh colour
 - Predominant flesh colour
 - Secondary flesh colour
 - Distribution of secondary colour

(11) Remove 15-20 medium to large roots for each variety to be used for taste testing. One taste test should be carried out as soon as possible, and another taste test conducted after 2 weeks. The roots to be used in the second taste test should be stored in a sack in the same location as the replicates of the trial (see Appendix B for method).

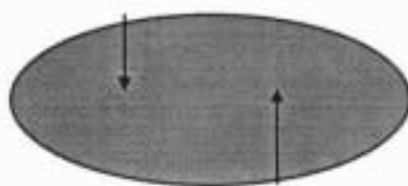
Setting up Cultivar Post-Harvest Evaluation Trial.

- (1) Obtain enough fertiliser-type sacks to allow for 6 per variety to be tested. If the sacks have been used previously, they should be washed with a low concentration of bleach, rinsed and dried.
- (2) Select a location for the trials, (such as a clean room or shed).
- (3) Two treatments will be used in this trial, one control (Treatment 1), and one damage treatment (Treatment 2). Therefore, for each variety select roots at random for 6 replicates (3 replicates of 2 treatments). Use 25 roots per replicate if possible, or less if there are not sufficient roots. Place the roots of each replicate into a fertiliser sack, label with variety, replicate number (1,2,3) and treatment (1,2).

Carrying out damage treatment (Treatment 2)

Previous studies have indicated that the forms of damage that expose the flesh of the storage root are most serious in that they increase the rate of storage root deterioration. For this reason a damage treatment that involves cutting into the flesh of the root has been chosen.

For treatment 2, every root in each sack should be cut twice with a knife as shown in the following diagram.



Assessment of roots in both treatments

(7) Label copies of datasheet PHE2 with varieties, treatments and replicate number. (6 sheets will be needed for each variety).

(8) For each sack, select 6 roots at random and mark them 1-6 clearly with a marker pen. Record the weight of each root as accurately as possible on Datasheet PHE 2.

(9) Sample 2 random roots from each replicate (avoiding the marked roots) and assess for the following characteristics (Datasheet PHE 2)

(a) Fresh weight

(b) Rough weevil (Scale 1-5 see Table 2). This pest is serious at Ukiriguru, but may not be found at other sites - if so, there is no need to record this.

(10) Peel the root.

(c) 2 penetrometer readings should be taken halfway along the root on opposite sides.

Each root should then be cut transversely and longitudinally into four quarters as shown in the diagram. (Be careful to keep all parts together).



(d) By observation of one of the cut surfaces, the root should be assessed for latex production (1-5).

(e) By observation of all of the cut surfaces the root should be assessed for Internal rotting (Scale 1-5 see Table 2)

(f) A measurement should then be made of sugar content using a handheld refractometer (See Appendix C for methodology).

(11) For treatment 1 only keep the remaining parts of the roots in a closed paper bag for determination of dry matter. See Appendix A.

(12) Place the sacks of both treatments, with the tops closed in the trial location, grouped as replicates. One additional sack for each variety containing roots for taste testing, should also be there.

(13) After 2 days untie the top of all the sacks and roll the sides of the sack down to about half height to leave the top open.

Assessment of all replicates to be carried out at weekly intervals.

The following data should be recorded at weekly intervals (starting one week after the first assessment) on copies of Datasheet PHE 2

- (1) For each replicate record an overall assessment of rotting (For scoring see Table 2)
Any roots scoring 4 or 5 in either case should be recorded, but then discarded.
- (2) Record the fresh weight of the 6 marked roots.
- (3) Sample 2 roots from each replicate and assess for the following characteristics. (If a marked root is chosen, return it and pick another, unless there are no unmarked roots remaining.)
 - (a) Fresh weight
 - (b) Rough weevil (Scale 1-5 see Table 2) (If this is a significant pest)
 - (c) Rotting (Scale 1-5 Table 2)

 - (d) The root should then be cut transversely longitudinally into four quarters, as described on the previous page. (Be careful to keep all pieces together if carrying out a measurement of dry matter -see below). By observation of the cut surfaces, the root should be assessed for Internal rotting (Scale 1-5 see Table 2)

 - (e) For weeks 1 and 3 measurement should then be made of sugar content using a refractometer (See Appendix C for methodology).
- (3) Dry matter content should be measured for treatment 1 only after 1 week and again after 3 weeks if the trial lasts that long. In this case keep the remaining parts of the roots in a closed paper bag for determination of dry matter. See Appendix A.

Temperature and Humidity Measurements.

The temperature and humidity at the location of the trial should be measured at midday each day during the trial, using the wet-dry bulb thermometer. The data should be recorded on Datasheet PHE3.

Make sure that the plastic pot containing the wick of the wet bulb thermometer is at least 2/3 full. If it is low, fill it up and wait at least 30 minutes before recording data.

Summary of Activities

Day 0	Harvest roots Measure harvest parameters Harvest additional roots (as nec) Select suitable roots Taste test (or day 1)
Day 1	Characterise roots Divide into replicates Carry out damage treatment Weigh 6 roots, sample 2 for destructive assessment Start measurement of dry matter contents Start storage
Day 3	Open sacks
Day 8	Assess for rotting etc Weigh 6 roots, sample 2 Dry matter contents
Day 15	Assess for rotting etc Weigh 6 roots, sample 2 Taste test
Day 22	Assess for rotting etc Weigh 6 roots, sample 2 Dry matter contents
Day 29	Assess for rotting etc Weigh 6 roots, sample 2 Taste test

TABLE 1: SCORING SYSTEM FOR OBSERVATIONS MADE IMMEDIATELY FOLLOWING HARVEST TO ASSESS STATE OF WHOLE PLOTS.

	Scoring				
	1	2	3	4	5
Crown Damage	No Damage	V. little Damage	Moderate Damage	Severe Damage	V. Severe Damage
Root Appearance	V. poor	Poor	Fair	Good	Excellent
Rough Weevil	Average % surface damage				
	0%	1-25%	26-50%	51-75%	76-100%

TABLE 2: SCORING SYSTEM FOR ROOTS.*a) External observations*

	Scoring				
	1	2	3	4	5
<i>Cylas</i> infestation	% of surface showing infestation				
	0%	1-25%	26-50%	51-75%	76-100%
Mechanical damage	No Damage	Slight Damage (1-25% surface damage)	Moderate Damage (26-50% surface damage)	Severe Damage (51-75% surface damage)	V. severe Damage (76-100% surface damage)
Rough Weevil Damage	% of surface showing damage				
	0%	1-25%	26-50%	51-75%	76-100%
Rotting	% of surface showing rotting				
	0%	1-25%	26-50%	51-75%	76-100%

b) Observations of cut roots

	Scoring				
	1	2	3	4	5
Latex production	No Latex	Low Latex	Moderate Latex	High Latex	V. High Latex
<i>Cylas</i> Infestation	% of cut surface showing infestation				
	0%	1-25%	26-50%	51-75%	76-100%
Rotting	% of cut surface showing rotting				
	0%	1-25%	26-50%	51-75%	76-100%

To calculate the overall score for a collection of roots

Count the number of roots in each class and calculate the mean root score as:

$$(n_1+2.n_2+3.n_3+4.n_4+5.n_5)/(n_1+n_2+n_3+n_4+n_5)$$

Where n_1 is the no. roots scoring 1, n_2 the no. of roots scoring 2 etc.

APPENDIX A

MEASUREMENT OF DRY MATTER CONTENT

(data sheet DRY WT)

Dry matter content will be measured for each replicate of treatment 1 at the start of the trial and at 1 week and 3 weeks.

- (1) For each variety and replicate, cut thin transverse slices of the root material. If large roots are used, the slices should be taken from halfway along the root. Mix the slices thoroughly.
- (2) Weigh out two samples of 100 g (In the case of large trials it may be necessary to reduce this to one sample per replicate). If the sample is not exactly 100 g then record the actual weight. This is the fresh weight, FW. Put each sample in a suitable container (such as a cut down paper bag, aluminium foil tray or weighing tray), which is labelled with date, treatment, variety and a label such as a or b to distinguish the two samples.
- (3) If possible dry in an oven at 70-80°C for 48 hours. If an oven is not available, sun dry until the weight is constant.
- (4) Reweigh the sample. This is the dry weight, DW.
- (5) Calculate the dry weight as DW/FW .
- (8) Record the final dry weights on Datasheet PHE 2.

APPENDIX B

TASTE TEST.

The samples for taste testing at the start of the experiment should be taken from the roots selected for the trial, as described. For the samples to be used in taste tests after a period of storage, for each variety, 10 medium-large roots should be stored in an extra sack. These sacks should be kept closed for 2 days, and then opened, as are the other sacks.

An alternative method is to select good roots from the replicates of the trial.

Taste tests should be conducted at the start of the experiment, and after two weeks of storage. If it is possible, extra taste tests could be carried out.

The panel of tasters should be selected either from workers on the station, or local people.

Roots should be cooked and cut into slices. They should be presented to the tasters labelled only with letters, e.g. A-E.

Copies of the questionnaire used at Ukiriguru are included.

APPENDIX C

USE OF PENETROMETER TO MEASURE ROOT FIRMNESS

Penetrometers have been designed primarily to measure the firmness of the flesh of fruit, in order to determine ripeness. However, they can also be used to measure the firmness of other commodities such as sweet potato roots. We are planning to use penetrometers to measure any changes in the firmness of the sweet potato root following harvest.

METHOD

The penetrometer has been provided with two probes of differing diameter. In this case, the smaller probe should be used. The larger probes would be suitable for softer commodities.

For uniformity, measurements should be made halfway along the root.

Remove the skin, using a knife, or the peeler provided, at the point where the measurement is to be made.

Ensure that the penetrometer is reading zero, by pressing the release button.

Hold the root firmly in one hand, or against a firm surface, and the penetrometer in the other hand. Press the plunger against the fruit, and press with increasing strength until the plunger tip has penetrated up to the notch. Take care to apply a steady, continuous, non jerking motion to minimise variability.

Record the reading in Kg (inner scale).

Take a second reading in the same way on the opposite side of the root from the first reading.

APPENDIX D

THE USE OF THE REFRACTOMETER TO MEASURE SUGAR CONTENT.

The concentration of a solution effects its REFRACTIVE INDEX (the extent to which it deflects light). It is possible to use this principle to measure the concentration of sugar solutions using a REFRACTOMETER. Handheld refractometers have been provided so that measurements can be made on the sweet potato varieties included in these trials, in order to detect changes in sugar content during storage.

Previous studies have indicated that the sugar content is not constant along the length of the root, but is higher at the stem end. For this reason it is important that the root tissue used for the measurement is sampled from the same part of the root in each case.

METHOD

Take a root that has been cut across the centre and grate a small amount of the root across the surface.

Squeeze 2 drops of liquid from the sample using the small press onto the centre of the glass surface of the refractometer. Avoid air bubbles

Close the lid of the refractometer. Be sure to hold it closed during the subsequent measurement. This may be done by using light pressure at the edge of the lid being careful not to obscure the light, or by placing an elastic band around the instrument.

Look through the eyepiece and direct the instrument towards the light. A blue circle should be observed divided into a light and dark portion. If the line between light and dark is not distinct, rotate the instrument until it becomes distinct. Note the position of the line on the scale.

The refractometer should be cleaned and dried carefully between measurements. Avoid scratching the glass surface.

INTERPRETATION OF RESULTS

Refractometer measurements have been used successfully to indicate changes in sugar content of sweet potatoes during storage trials carried out in Uganda. However, for comparison between cultivars, the measurement will be effected not only by sweetness, but also by moisture content, and the presence of other substance dissolved in the sap. For this reason, further studies will be carried out at NRI to provide extra information that will help the interpretation of these results at the end of these trials.

Date of harvest:

Variety											
Root Shape											
Root surface defects											
Cortex thickness											
Predominant skin colour											
Secondary skin colour											
Predominant flesh colour											
Secondary flesh colour											
Distribution of Secondary colour											

Post-Harvest Evaluation Trial

Data sheet PHE 2

Cultivar:

Treatment:

Replicate:

<i>Overall assessment of rotting (number of roots per sack)</i>					
Date → ↓ Score					
1					
2					
3					
4					
5					
Total roots removed during trial (accumulative)					
Overall Score					

<i>Fresh weight of 6 marked roots</i>					
Date → ↓ Root number					
1					
2					
3					
4					
5					
6					

<i>Assessment of two sampled roots</i>										
Date										
	a	b	a	b	a	b	a	b	a	b
Fresh Weight										

<i>surface observations</i>										
Rough Weevil										
Rotting										
Penetrometer. 1										
2										

<i>observations of cut roots</i>										
Latex										
Internal rotting										
Cortex thickness										
Refractometer Index										

Post-Harvest Evaluation Trial

Data sheet PHE 3

Station:

Site:

Environmental

Date and Time	Dry bulb temperature	Wet bulb temperature	Relative Humidity

Post-Harvest Evaluation Trial

Data Sheet Dry Matter Content

Variety and Rep	Weight of Container [C] (g)	Fresh Weight of container and sample [FW] (g)	Dry Weight of container + sample [DW] (g)	Dry matter content $\text{DW} - \text{C}$ $= \frac{\quad}{\text{FW} - \text{C}} * \%$