The Importance & heritability of vine survival in drought-prone areas: Preliminary Results from Mozambique

By

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Southern Africa

- Southern African countries have significant proportions of their land area that are highly prone to dry weather

- Breed for orange-fleshed sweetpotato (OFSP) populations for **drought-prone regions** in the region

- Continue to improve **population development in SSA** through the validation of **improved breeding methods**, linked with **participatory varietal selection and seed systems**

Drought

- In Africa, by 2020, 75-250 million people will be exposed to increase water stress due to climate change (IFPRI,2009)
- *Impact on dietary diversity and reduce overall food consumption*
- Lead to malnutrition
- *For drought-tolerant genotypes, the most important factor is to be assured that the genotypes are subjected to water stress at several periods of their growth in the field*

Drought: Challenge in Seed Systems

- How do we increase the availability of healthy planting materials in timely manner and sustain vine multiplication effort?
- Improve timely availability of vines for on-farm vine production and commercial multipliers following dry periods?
- Maintain strong vines during the dry season and rapid re-sprouting in the rainy season)?

Drought

- Frequent exposure to drought causes decline in yield, weevil infestation and shortages of planting material

- In sweetpotato many different specific adaptations can be found driven by hexaploid highly heterozyous genetics of sweetpotato.

One common challenge across

- Survival of planting material – vine survival

Considerable amount genetic variation for vine survival

- Integrated approach needed Agronomy & Breeding

Sweetpotato planting materials

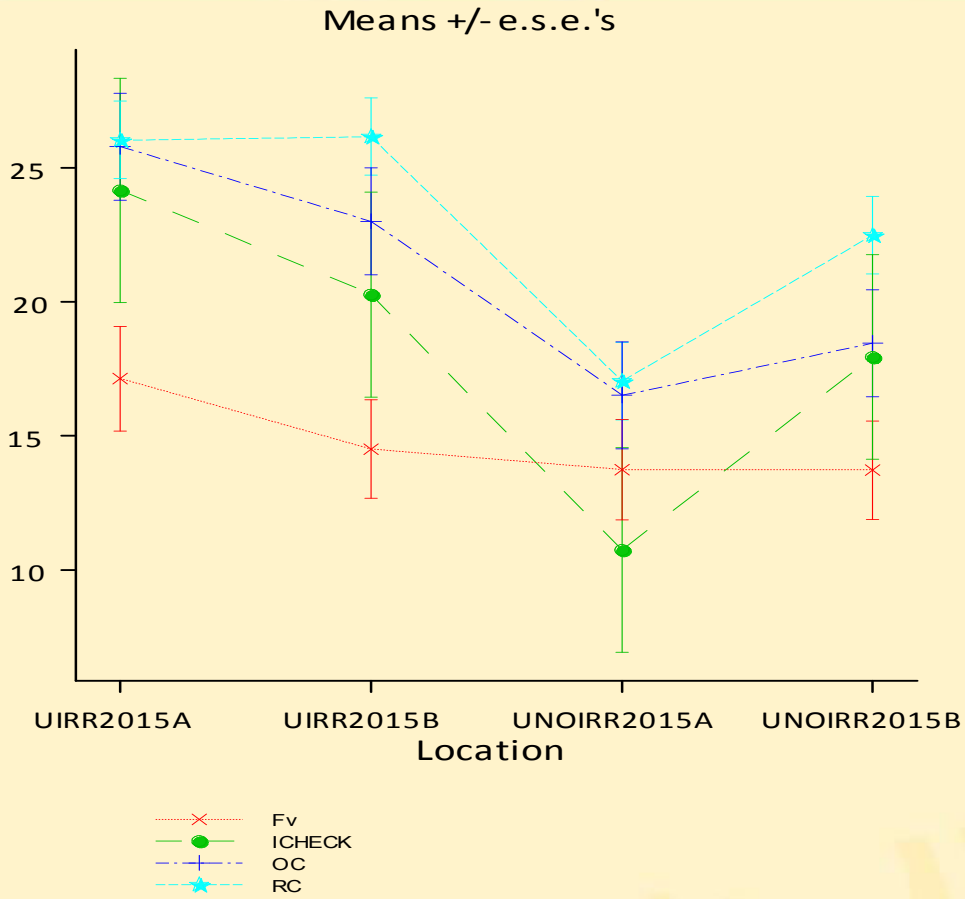
- Planting material is among **the most important constraints** to sweetpotato production in tropical areas
- **Lack of planting is particularly acute for farmers in areas with** prolonged dry seasons
- Scarcity occurs at **the onset of rains**
- **Adoption of sweetpotato cultivars BY** farmers is related to availability of planting material & **Survival of vines**
- **Difficult to conserve planting material in drought prone areas**
- Months are lost at the start of the rainy season in SSA (farmers are re-establishing vines from re-sprouting roots or secondary growth from harvested field
- **Some cultivars survive better than others under stress**

Clones with good performance in both Drought and Irrigated conditions

Interaction Trt and Drought effect	Effects	Name of Trt	Estimate	Std Error	DF	t Value	Pr > |t|
Regime*Trt	Drought	Xitsekele	15.72	1.61	536	9.75	<.0001
Regime *Trt	Drought	Admarc	11.16	1.61	536	6.92	<.0001
Regime *Trt	Drought	1998_12_3	10.67	1.61	536	6.61	<.0001
Regime *Trt	Drought	Xiadla xa kau	10.57	1.61	536	6.55	<.0001
Regime *Trt	Irrigation	1998_12_3	20.49	1.61	536	12.71	<.0001
Regime *Trt	Irrigation	Admarc	13.33	1.61	536	8.27	<.0001
Regime *Trt	Irrigation	Xiadla xa kau	11.52	1.61	536	7.15	<.0001
Regime *Trt	Irrigation	Xitsekele	6.69	1.61	536	4.15	<.0001

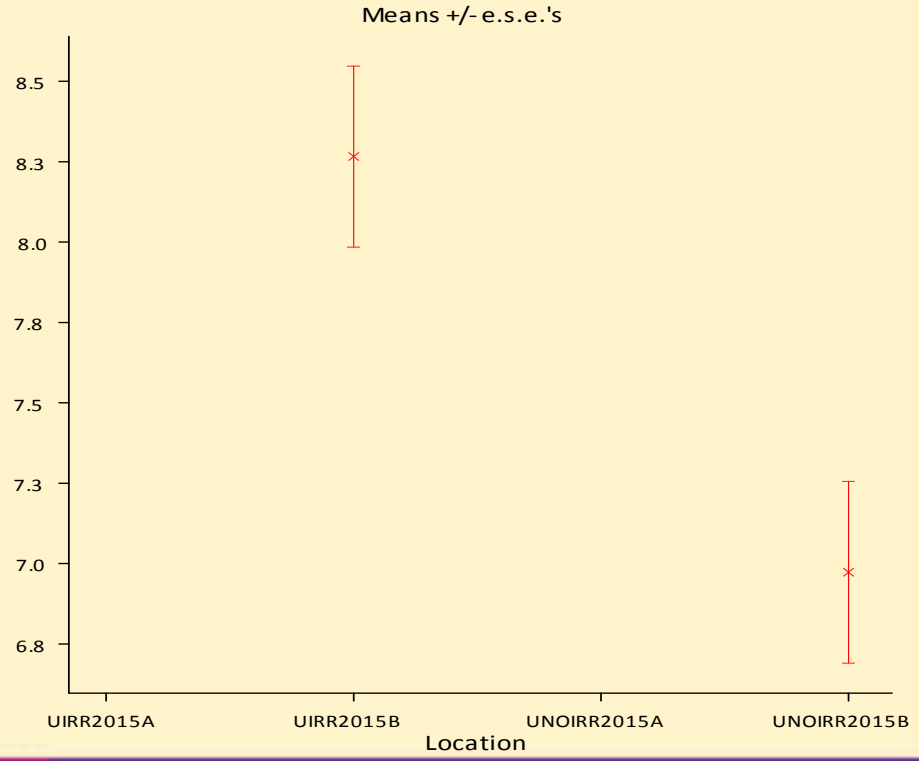
Yield under irrigation are higher than drought with exception of Xitsekele

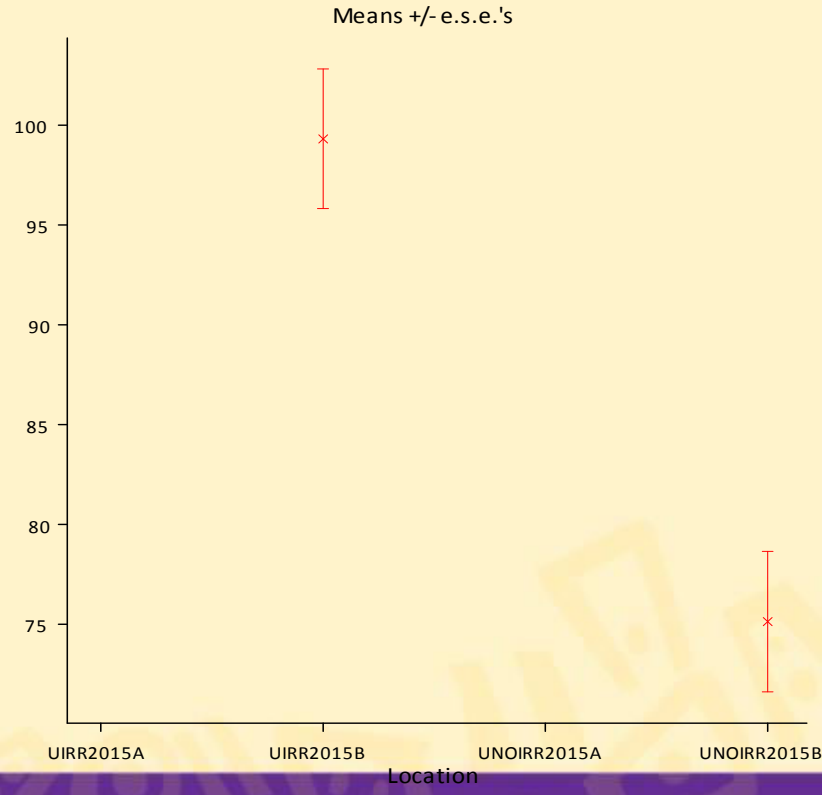
Mean root yield of four groups of clones tested in two seasons at Umbeluzi; planted in February 2015; & August 2015. Fv – farmer cultivar; ICHECK – international check; OC – cultivar from other countries; RC – released cultivar in Mozambique.



Plant length (cm) under two treatments in 2015; planted in February & August 2015 in Umbeluzi

- Total plant length was significantly reduced under the not irrigated treatment. Internode length was another trait affected by drought stress and has a positive correlation with the biomass produced. Photosynthetic area is significantly reduced under the not irrigated treatment.





Objectives of the study

Our objectives were to:

(i) estimate survival of vines under drought stress in a collection of sweetpotato cultivars

(ii) Measure sprouting ability of sweetpotato cultivars

(iii) Measure nutrient changes of storage roots stored for 3 months under triple S

(IV) Heritability estimates of traits

Materials & Methods

- Three treatments (different harvesting times set as **5, 9 and 11 months** after planting) were established at Umbeluzi, Nwallate and Gurue in February 2015
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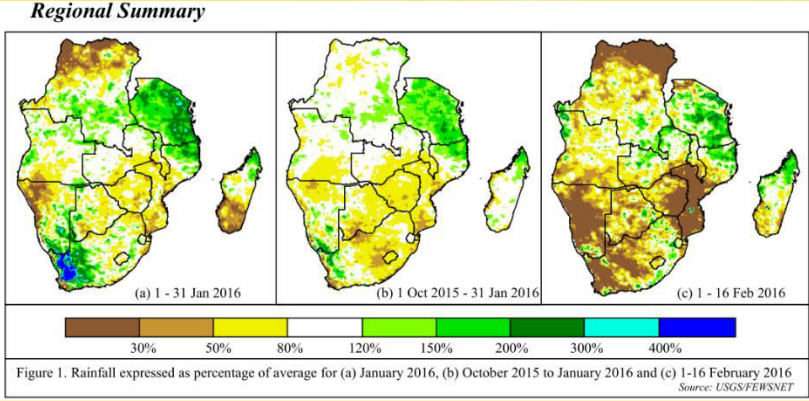
- In each treatment, 36 sweetpotato clones (19 released varieties, 10 landraces and 7 foreign introductions) were evaluated in a randomized complete block design with two replications.

Characteristics of testing locations

Site	Soil type	Average annual rainfall (mm)	Altitude (m)	Length of dry season
Umbelúzi	Alluvial, sandy loam at the top and sandy at the bottom	679	12	May-September
Nwalate	vertisol	623	33	April-November
Gurué	Deep clay loam	1996	600	July-September

Recent reality of drought episodes – affecting the planting 2015/16 season in Southern



	Umbeluzi, 2015			Gurue, 2015		
Month	**Tmax (ºC)**	**Tmin (ºC)**	**Precipation (mm)**	**Tmax (ºC)**	**Tmin (ºC)**	**Precipation (mm)**
January	32.5	22.0	36.4	28.2	20.4	624.6
February	32.7	21.3	49.4	29.8	19.9	292.9
March	33.4	20.3	11.4	30.3	19.4	127.9
April	30.2	18.5	15.4	29.8	17.6	31.4
May	31.0	15.4	12.9	29.1	15.8	2.3
June	28.2	11.1	0.0	26.5	13.4	8.3
July	27.8	12.7	6.3	27.2	13.1	0.0
August	29.3	16.3	0.0	28.5	13.7	18.8
September	29.3	16.5	0.0	30.6	16.5	29.6
October	32.3	18.9	16,8	33.7	19.8	24.3
November	31.9	19.4	13.1	32.7	20.2	91.5
December	34.8	22.5	9.1	33.0	21.0	133.6
Mean	**31.1**	**17.9**	**14.2**	**30.0**	**17.6**	**115.4**

Methodology – survival of vines

- **Multiplication of virus free planting material**

- Each treatment had two replications

Plot sizes were :

- 2 rows, 3m long,
- 30 cm spacing between plants

Traits measured

At 5 months	At 9 months	At 11 months
stem length (cm)	storage root yield (t/ha)	storage root yield (t/ha)
petiole length (cm)	foliage biomass (t/ha)	foliage biomass (t/ha)
leaf size (cm)		
storage root yield (t/ha)		
foliage biomass (t/ha)		

Method - Storage of roots in sand at Nwalate (after 5 months)

Ten small to medium sized roots were stored at Nwalate (from Umbeluzi and Nwalate)

Using plastic dishes &

Newspapers

Dry sand

Cool environment

Method – Sprouting of Roots

Three equal roots (small sized) were planted in beds on 1m single rows (from stored roots)

- Two replications
- RCBD
- Watered after planting once a week by bucket
- After 3 weeks furrow irrigation was used

Traits measured

At 2 weeks	At 3 weeks	At 5 weeks
number of sprouts per root	number of sprouts per root	Stem length (cm)

Data analysis

A combined analysis of variance for the traits measured was done in SAS

- Significant differences were observed for all traits measured ($P<0.001$)

Genotypic reaction - yield

Best group: increase in yield over months

	rytha	rytha	rytha
Cultivar	**5months**	**8 months**	**11 months**
Namanga	19,75	22,73	24,05
Lourdes	17,23	17,60	23,13
Ininda	20,93	20,23	23,28
Irene	26,35	30,85	43,02
Xitsekele	**11,13**	**19,38**	**28,49**
NASPOT 5	17,28	17,68	26,73
Mwazambane	15,18	20,33	29,39
Chissicuana 3	13,93	20,65	27,75
Ivone	21,31	28,54	42,09

Genotypic reaction - yield

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Less resisting group: decrease in yield over months

	rytha	rytha	rytha
Cultivar	**5months**	**8 months**	**11 months**
Nhacoongo 1	11,49	4,39	2,14
Resisto	12,05	17,60	11,30
victoria	12,33	19,73	13,61
Alisha	25,80	34,80	18,81
MGSG11016-1	17,25	26,93	10,42
Caelan	17,33	26,63	17,02

Significant decrease in storage root yield

What happens to Vine yield?

The less resisting group

Cultivar	vytha 5months	vytha 8 months	vytha 11 months
Nhacoongo 1	30,88	25,13	0,00
Resisto	15,13	12,38	0,00
Victória	22,20	15,03	12,27
Alisha	32,85	18,20	11,10
MGSG11016-1	14,13	11,80	2,99
Caelan	32,53	31,85	8,24

Root harvest for Resisto and Nhacoongo 1 at 11 months show no ability of roots to stay in the soil

Heritabilities of measured traits

Traits	Broad-sense heritability (h^2) (%)
Leaf size (cm)	**84.48**
Petiole length (cm)	**79.08**
Number of branches	**68.54**
Stem length (cm)	**56.62**
Number of sprouts at 3 weeks	**56.42**
Foliage biomass (kg/ha) at 9 months	39.49
Storage root yield (kg/ha) at 9 months	28.67

Nutritional changes during storage

Nutrient	At 5 months (harvest)	After 3 months in storage
Dry matter (%)	27.81	25.37
Starch (%)	59.33	54.88
Sucrose (%)	7.52	10.47
Glucose (%)	3.20	6.37
Fructose (%)	4.23	4.31
Beta-carotene (mg/100mgDW)	24.58	24.43
Iron (mg/100mgDW)	1.44	1.75
Zinc (mg/100mgDW)	0.86	1.14

Do the genotypes have the ability to give vines by sprouting 5 months after normal harvest

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Early sprouters

	No. of sprouts/root
Cultivar	**2 weeks**
Bita	9,89
LO-323	9,75
Delvia	9,50
Lawrence	9,46
Ivone	8,50
TACNA	8,41
Xiada-xikau	8,33
Gloria	8,17
5 houras	8,04
Jane	7,92
Ininda	7,67
Chissicuana 2	7,50
Mean	**8,60**

Best sprouters at 3 weeks

	No. of sprouts/root
Cultivar	3 weeks
Delvia	12,42
Jane	11,34
Bita	11,13
Caelan	10,63
Ivone	10,59
Lo323	9,92
SPK-004	9,78
Mean	**10,83**

Are Cuttings Possible After 5 weeks

The good ones: for rapid multiplication

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Variation for vine length

5.82 (Bie) to 126.82 cm (Bita)

On average of 9 cuttings

10 cm length

	vine length (cm)
Cultivar	**5 weeks**
Bita	126.82
Alisha	107.20
Xiada-xikau	101.13
TACNA	95.57
Mwazambane	94.18
Xitsekele	90.00
Chissicuana 3	87.15
Caelan	85.75
5 houras	81.83
Jonathan	76.55
Mean	**94.62**

Conclusion

- Clone performance varied significantly within treatments.

- There was a significant drop in vine yield as the harvesting period increased from 5 months at all sites
- Introduced variety **Resisto had the highest average stem length** but no vines remaining **after 9 months at all sites.**
- Length and thickness of vine in a clone **could be traits responsible for drought tolerance** in sweetpotato.
- Spatial soil differences affected survival of vines. Most clones could not survive after seven months at Gurue where the soils are lighter in texture with **low water holding capacity.**

Conclusion

- At Gurue, the inability to survive for long periods was exacerbated by **virus infection.**

- The ability of some clones to reach 9 months and 11 months with few vines at Umbeluzi and Nwallate offers a source of planting material for the subsequent season

- The rates of sprouting were also significantly different among clones.
- Total biomass is key to vine survival under long dry spells in sweetpotato
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- Drought tolerance could be more related to survival rather than yield

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