Breeding for cold tolerant dual purpose sweetpotato

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SWEETPOTATO ACTION FOR SECURITY AND HEALTH IN AFRICA

Introduction

- SP is 3rd most important root crop in SSA
- Source of food, feed, and income
- OFSP is remedy for β-carotene
- Grown in varied Agro EZ ranging from 0-2200masl
- Useful to livestock feeding systems
- Dual-purpose SP varieties required in East African highlands, due to diminishing pasture land.
- Useful in smallholder pig and dairy production systems
- SP forage improve greatly milk production,
- Aims at developing cold tolerant dual purpose varieties of vine/root ratio:1.5 - 3.0.

Materials and methods

- 28,000 polycross seeds from 14 parents germinated at Kiboko Kenya
- selection done at nursery against narrow leafed
- 13000 seedlings planted and screened on station for dual purpose
- 450 clones selected for animal feed traits: without pubescence, vine pigmentation (green- against anthocyanin), with large non serrated leaves and with large above ground biomass, and high yield (no. of storage roots).
- Advanced /Participatory farmer screening of 49 clones + 1 control planted at 3 sites on farm and 1 site on station

Materials and methods

- Laid in a RCBD, replicated 3 times, at rows of 10 hills spacing 3 m X 90cm on molded ridges
- 30 cm long cuttings planted at about 10 cm deep.
- Sites: Tea zones Runyenjes- Embu (very cold), Manyatta- Embu (cold), Kangundo (transitional coffee zone), and Kiboko (a semi-arid zone):
- Differences in maturity observed
- Harvesting; Runyenjes:8 MAP, Manyata: 7 MAP , Kangundo: 6 MAP and Kiboko:5 MAP
- Data on foliage and root biomass, foliage/ root ratio, organoleptic test, collected and analyzed using R statistical software (clone selector).

Results: Weather conditions

	Kiboko (Semi-arid)	Kangundo (Trans. Coffee Zone)	Manyatta (Tea zone)	Runyenjes (Tea zone)
Rain @ Growth (mm)	4.4 +187	216	640.4	1157.5
Irrig. @ Growth (mm)	120	0	0	0
Ann. Rain (mm)	659.3	776.1	1056.7	1326.6
Temp. Range ^{o}C	16.2-30.3	13.5-25	18.2-19.3	13.2-19.2
Temp. Flactuation	14.1	11.5	1.1	5.0
Temp. Mean^{o}C	23.3	19.3	18.8	16.2
%RH	81.2	83.2	87.4	84.4
Elevation (masl)	1090	1545	1805	1810
Dur. To Harv. (Months)	5	6	7	8

Storage roots yields ANOVA

Source	Df	Sum Sq	Mean Sq	Variances	F value	Pr (>F)	LSD
G	49	2840.5	58.0	1.3	2.2	0.000	4.16
E	3	9707.3	3235.8	18.5	7.1	0.012	5.70
R:E	8	3667.4	458.4	8.5	17.0	0.000	
GxE	147	6107.7	41.5	4.8	1.5	0.001	8.33
- Het.Regr.G	49	1974.5	40.3	-	1.0	0.562	
- Dev.Regr.G	98	4133.2	42.2	-	1.6	0.002	
- Het.Regr.E	3	1877.8	625.9	-	21.3	0.000	
- Dev.Regr.E	144	4229.9	29.4	-	1.1	0.255	
Residuals	384	10332.9	26.9	26.9			

- There is genetic variation to base our selection
- There environ./ Interaction effect hence need to breed for stability

Forage yields ANOVA

Source	Df	Sum Sq	Mean Sq	Variances	F value	Pr (>F)	LSD5
G	49	2840.5	58.0	1.9	2.2	0.000	4.2
E	3	9707.3	3235.8	51.9	7.1	0.012	5.7
R:E	8	3667.4	458.4	3.5	17.0	0.000	
GxE	147	6107.7	41.5	11.5	1.5	0.001	8.3
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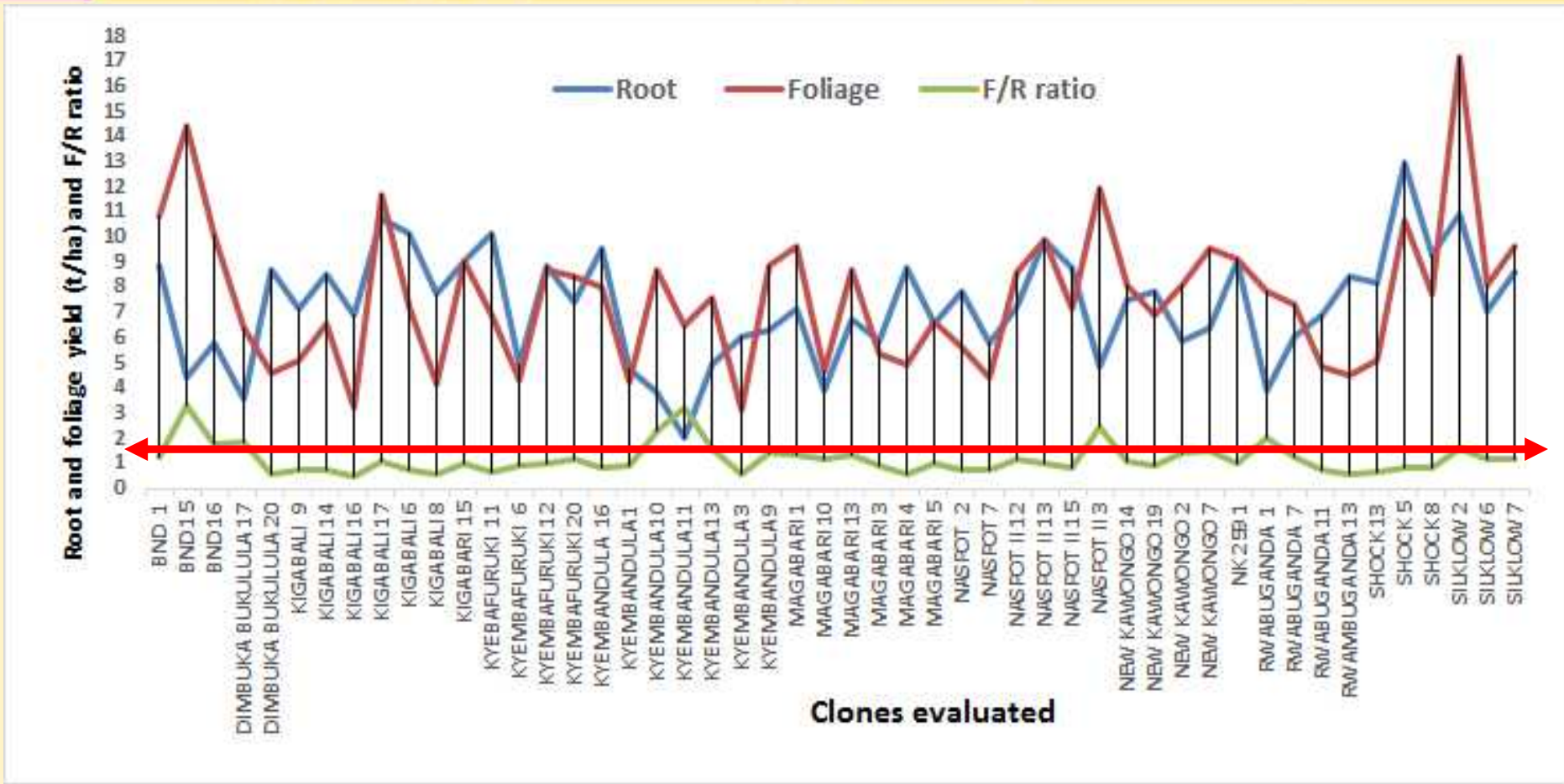
The mean biomass production across environments

Site	Roots	Foliage	Total biomass
Kiboko	8.7	2.8	11.5
Kangundo	7.4	8.6	16
Manyatta	12.0	17.6	29.6
Runyenjes	0.9	1.5	2.4

- Temperature influence root and foliage yield in the various sites
- At Kiboko the crop tended to channel resources to storage root, hence the high root yield of 8.7 t/ha
- Weather conditions at Runyenjes were too cold for the growth

The trials at (a) Runyenjes, (b) Manyata, (c) Kiboko and (d) Kangundo

A graph showing the mean root forage yield and forage (F) / storage root (R) ratio



Clones that had ratio >1.5

- BND 1, BND 15, Dimbuka kulula 17,
- Kyembandula 10, Kyembandula 11, Kyembandula 13, Kyembandula 9
- Naspot II 3, New Kawongo 7,
- Rwambuganda 1, Rwambuganda 7,
- Silk Low 2, Silk low 6.
- Clones with very ratio indicated very low root yield and could only be used for forage production (Uni-purpose)
- Clone Kyembandula 11 had the highest F/V ratio of 17 with root yield of 0.9 t/ha, which indicates this variety can be used for forage only (Uni-purpose).

Genotype environment effects derived through AMMI analysis

	Clones	Roots			Foliage			
		Manyatta	Kangundo	Kiboko	Runyenjes	Manyatta	Kangundo	Kiboko	Runyenjes
1	KYEMBAFURUKI 12	9.9	-2.6	-5.1	-2.2	0.8	2.9	-2.5	-1.3
2	KYEMBAFURUKI 20	9.1	-2.6	-5.9	-0.6	9.9	-6.1	-2.5	-1.3
3	NASPOT II 12	8.2	-3.7	-2.7	-1.8	1.8	-2.8	0.9	0.1
4	KYEBAFURUKI 11	6.9	-4.2	-0.8	-1.9	-1.8	-0.4	0.1	2.2
5	SHOCK 5	5.7	5.9	-5.9	-5.7	-0.4	6	-3.1	-2.5
6	KIGABALI 6	5.4	-1.8	-0.8	-2.8	1.5	-0.8	-0.8	0
7	NASPOT 2	4.9	-0.6	-4	-0.2	-6.4	1	2.2	3.1
8	NASPOT II 13	4.9	-0.7	-1	-3.3	0.1	6.1	-3	-3.3
9	NEW KAWONGO 19	4.6	-0.3	-3.8	-0.5	0	-3	2.4	0.7
10	BND 1	4.4	3	-5.1	-2.3	3.1	3.4	-2.7	-3.8
11	NEW KAWONGO 7	4.2	-2.5	-2.3	0.6	7.7	-3.8	-1.7	-2.1
12	KYEMBANDULA 9	3.9	-3.6	-1	0.8	7.5	-6.3	-0.2	-1.1
13	KYEMBANDULA 16	3.7	1.8	-2.7	-2.8	2.1	-0.2	-0.6	-1.3
14	KIGABARI 15	3.7	-1.3	-1.5	-1	8.4	-5.4	-2.1	-0.9
15	MAGABARI 1	2.7	-3.3	-1.2	1.8	3.6	-2	-1.2	-0.4
16	DIMBUKA BUKULULA 20	1.9	-5.9	-1.5	5.5	-8.9	0.8	3.8	4.3

Genotype environment effects

- Clones with +ve effects in roots and foliage yields can be considered for dual use
- Clones with +ve effects for roots yield in Manyata and +ve effects in Runyenjes for forage and root yield could be selected for dual use
- Have potential to tolerate coldess and yield high in both roots and forage
- Stable clones had +ve effects across sites

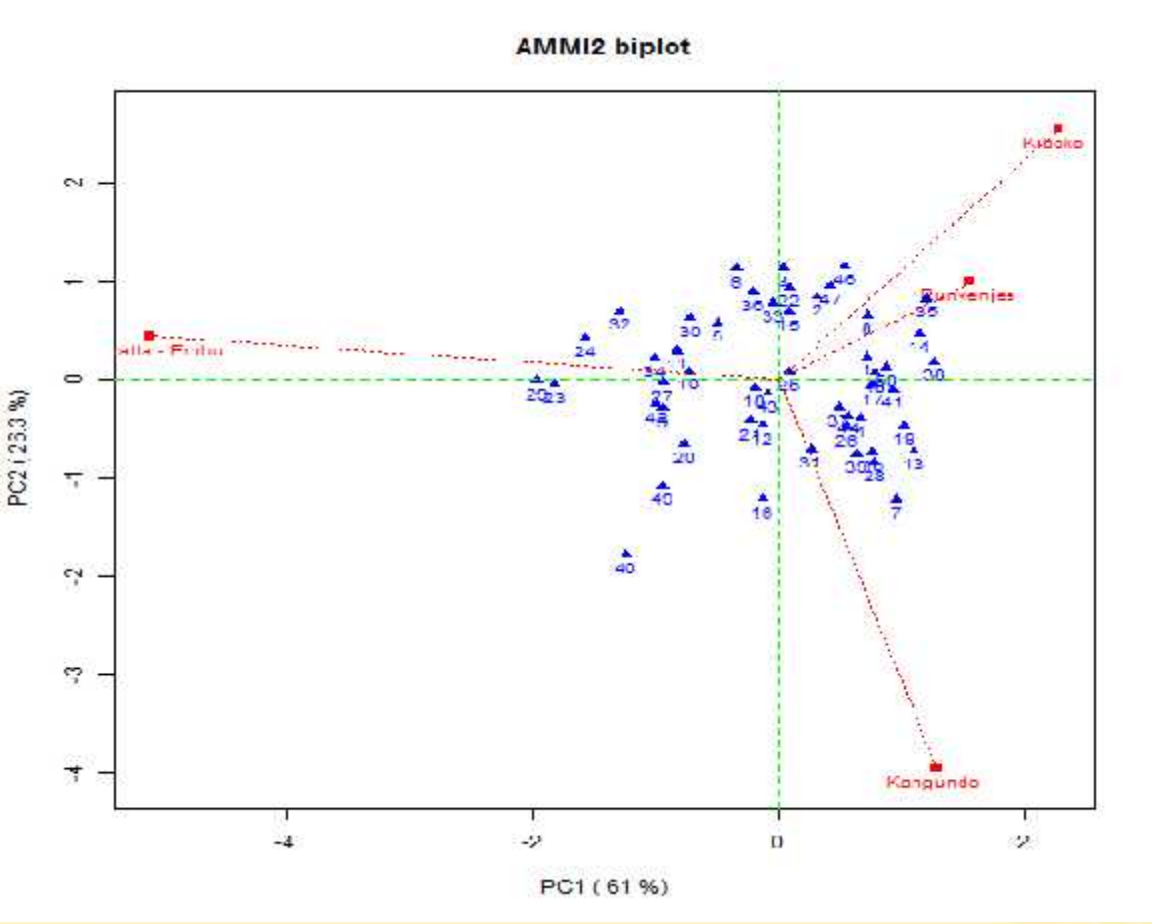
Farmers taste tests

- Selected good clones had highest mean score
- Orange fleshed scored high

Taste test; where 1=very bad and 9=very good

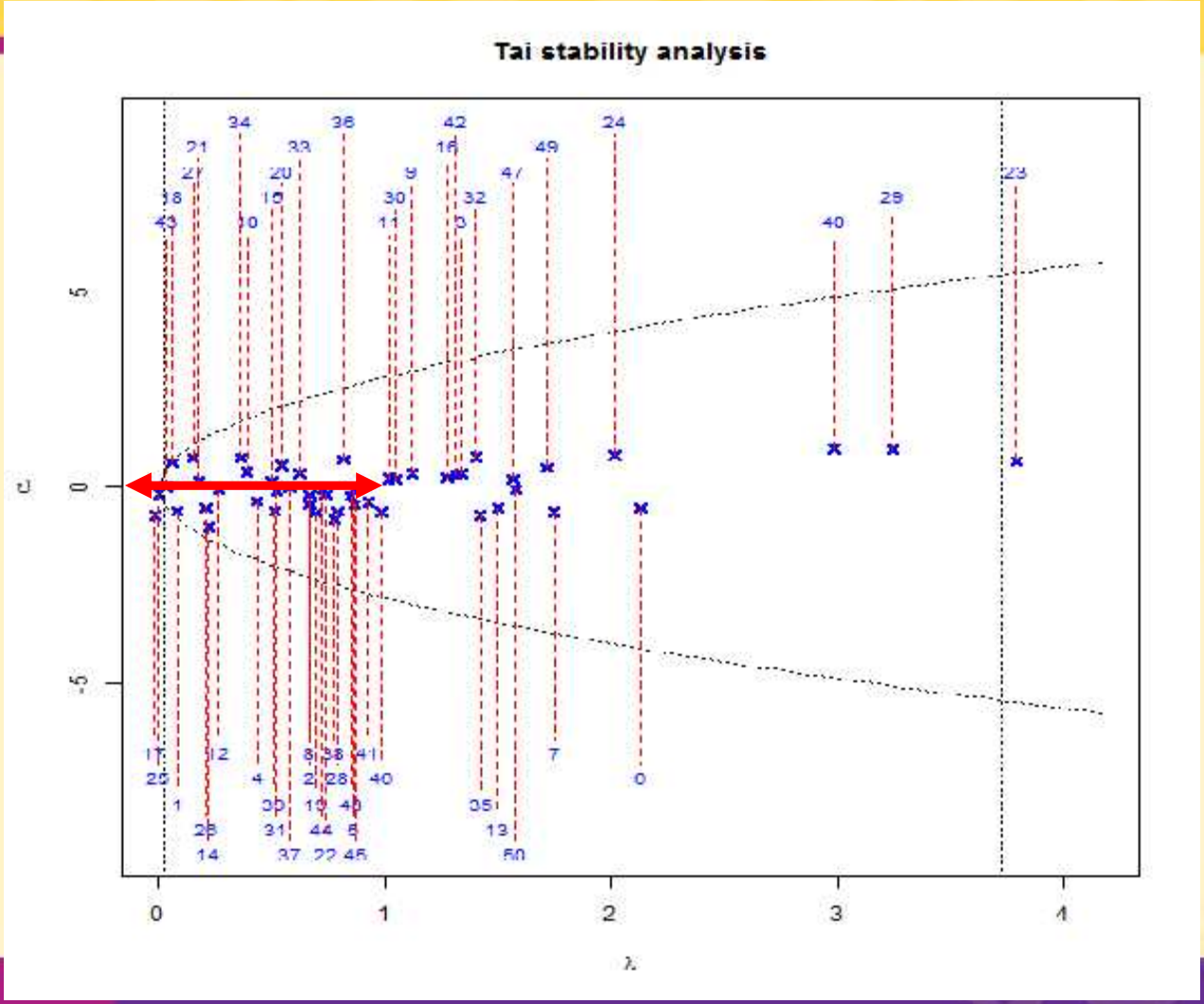
Sn	Clone	Fibre	Sweetness /sugar	Texture	Cooked taste	Cooked appearance	Mean	Comment
1	MAGABARI 1	9	9	9	9	9	9	yellow
2	MAGABARI 5	9	9	9	9	9	9	
3	KIGABARI 15	9	9	9	9	9	9	
4	SHOCK 8	9	9	9	9	9	9	shape bad
5	NASPOT II 15	7	9	9	9	9	9	GOOD
6	SILKLOW 6	7	9	9	9	9	9	orange
7	KIGABALI 16	7	9	7	9	9	8	GOOD
8	SHOCK 5	9	9	7	7	9	8	shape not bad
9	SILKLOW 2	9	9	7	7	7	8	shape fair
10	BND 1	8	7	8	7	8	8	Good shape
11	NASPOT II 13	7	7	7	7	7	7	GOOD
12	KIGABALI 6	7	7	7	7	7	7	GOOD
13	NASPOT 2	7	7	8	6	7	7	un smooth skin

Principal component analysis Storage roots AMMI2 biplot



- Manyata: Naspot II 13, Kyembafuruki 11, and Kigabali16 yielded well
- Runyenjes: DimbukaKulula 17 (35), Kyembadula 11 (14), Kigabali 16(12) yielded higher
- Kiboko: DimbukaKulula 17 (35), Naspot 7 (46) and Shock 13 (47) yielded higher.
- Kangundo: New Kawongo 14 (7), NK 259 1 (16), and Shock 5 (40) yielded higher
- Clones within the origin of the plot indicates stability and further away reduced stability
- Clones yielded better in sites they are close to
- These may also be seen in the Tai stability analysis plot

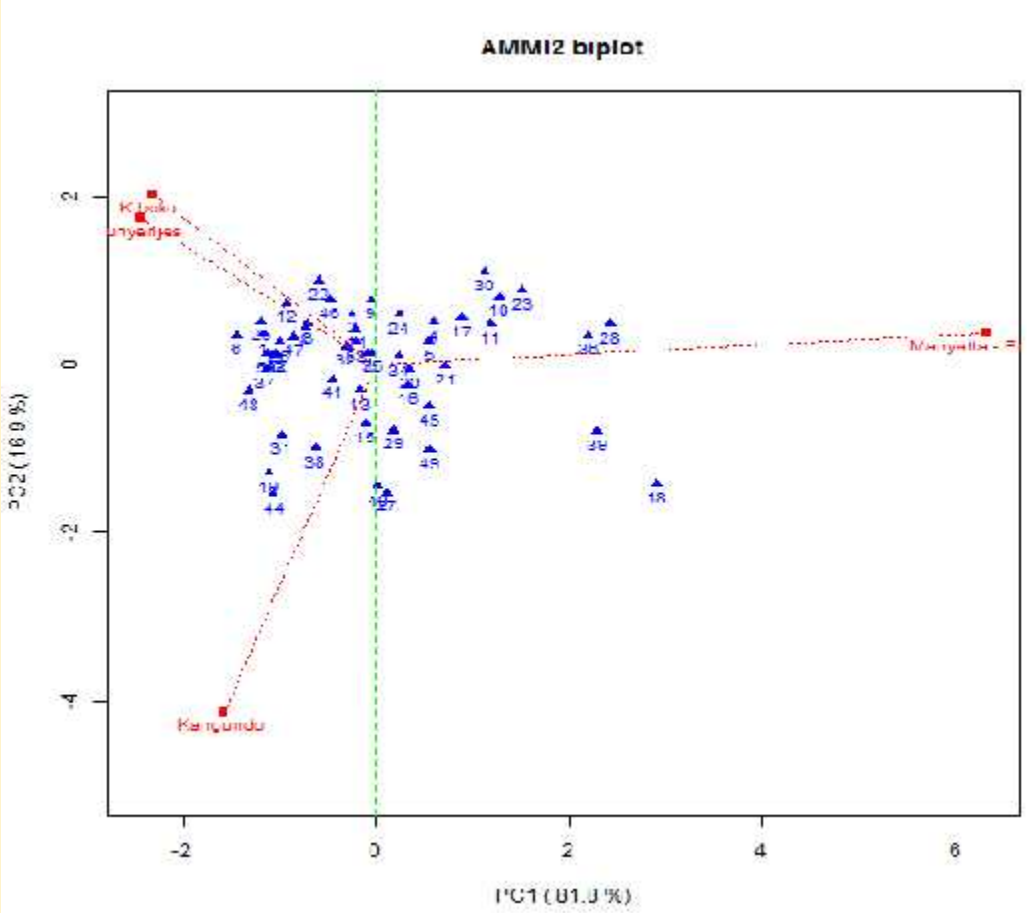
Tai stability analysis plot for storage roots yields



Clones close to α=0 λ=1 are have average stability :

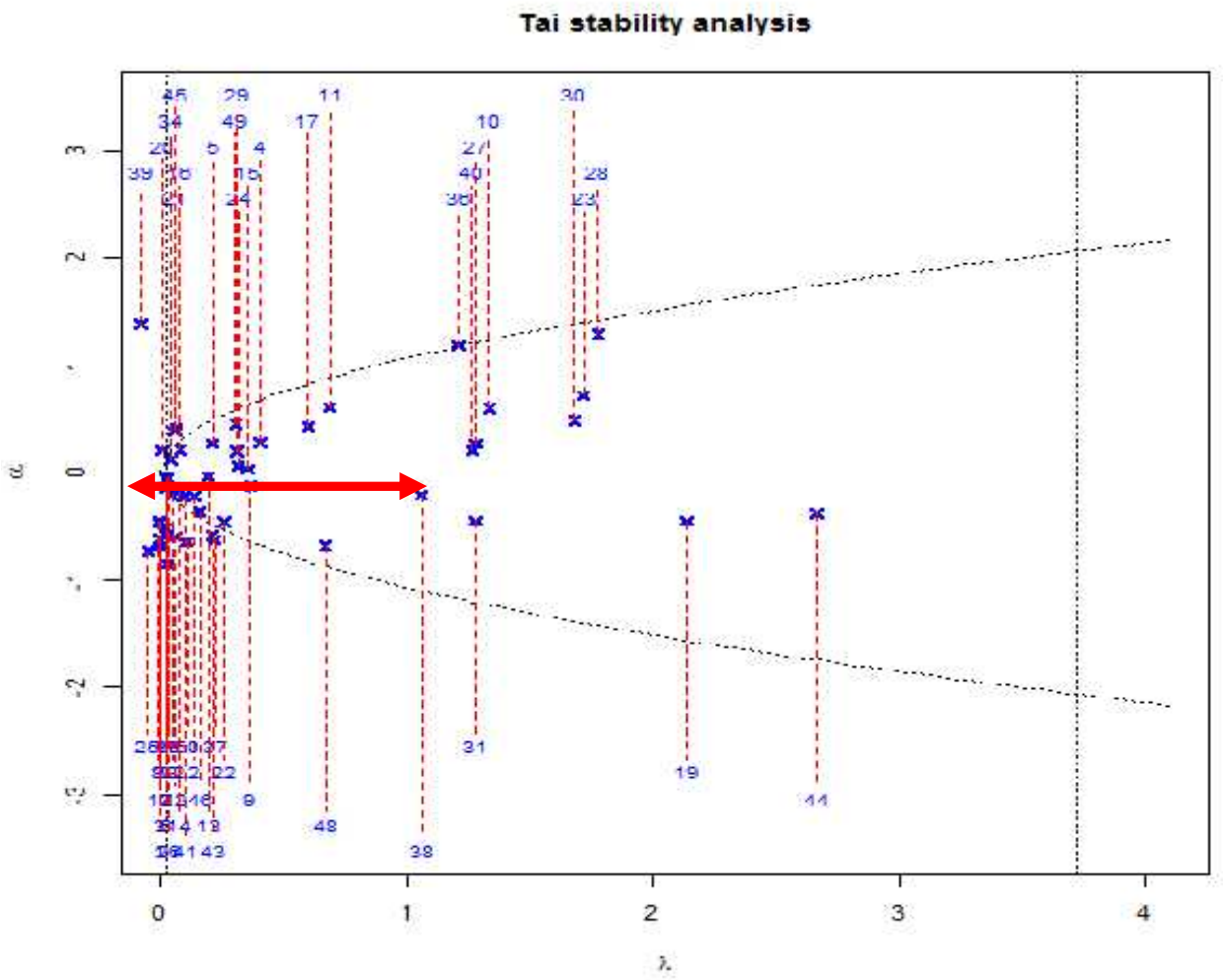
- Silk low 2 (18),
- Kigabali 6 (34),
- Kyembandula 9 (30),
- Magabari 3 (8),
- Silk low 6 (15)

Forage AMMI2 biplot



- Kangundo: Shock 8 (44), Naspot II 13 (27), Kyembandula 13 (19) and shock 5 (40) performed well
- Manyata: Silklow 2 (18), BND 15 (39), Kigabali 17 (36), Naspot II 3 (28) performed well
- Kiboko and Runyenjes lied close to one another, indicating the clones near them had similarly low foliage yield.
- Manyatta lies on the positive sides of PC1 and PC2 an indication the varieties performed the best in this site.
- Clones within the origin of the biplot indicate that they are relatively stable.
- These are also shown in the Tai stability plot

Tai stability analysis plot for foliage



Clones close to α=0 λ=1 have average stability:

- Silklow 7 (21)
- Kyembandula 3 (25),
- Silklow 6 (15)

Conclusion

- 13 clones were selected by farmers and did well in more than one site hence had some level of stability and would be advanced for cold tolerant dual purpose evaluation.
- These clones are being further tested in 3 on farm sites and in SPVD hot spot site
- The clones that perform well will be registered to NPT for consideration of release towards end of the year

  - Kyembandula 3
  - Kyembandula 9
  - New Kawongo 7
  - Shock 5
  - Silklow 6
  - Bnd 1
  - Kigabali 16
  - Kigabali 17
  - Kigabali 6
  - Magabari 1
  - Magabari 3
  - Naspot II 13

Way forward

- Nutrient contents / quality aspects determination
- Animal palatability tests
- Virus test/ cleaning the infected of the selected clones,
- Bulking for NPT trials.

Thank you

SASHA
Sweetpotato Action for Security and Health in Africa