Evaluation of Stability Performance of Orange-fleshed Sweetpotato Clones in East African Regional Trials

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Outline

Introduction
Vitamin A Deficiency (VAD) Status
Conduct of Orange-fleshed Sweetpotato (OFSP) Regional Trial in 7 East African Countries, 2004-2006
Materials and Methods
Results and Implications

Micronutrient Malnutrition

- Primarily Due to Diets Poor in Bioavailable Vitamins and Minerals
- Widespread, Very Serious Problem in Developing Countries
- Fe, Zn, and Vitamin A Deficiencies Affect >3.5 Billion People

Underlying Cause of Micronutrient Malnutrition

- Poor Quality Diets
- High Intake of Food Staples
- Low Consumption of:
  a) Animal and Fish Products
  b) Plant Sources Rich in Bioavailable Minerals & Vitamins

Status of Vit A Deficiency

- 3 Mill Pre-school Age Children Visible Eye Damage
- 250,000 – 500,000 Go Blind Annually, 2/3 Die After 1 Month (167,000 – 333,000)
- Vit A Essential For Immune Function

Consumption of OFSP High in Provitamin A Improves Body Stores of Vitamin A, Reduces Risk of VAD (Clinical Trial, 4-8 Year Old Children, S. Africa)
**Biofortification of Staple Food Crops**

- Increased Interest
- To Complement Sustainable Approaches to Alleviate Micronutrient Deficiencies
- Biofortification is Development of Micronutrient-dense Staple Crops Using Best Traditional Breeding and Modern Biotechnology Practices

**Regional Effort to Improve Consumption of OFSP to Alleviate VAD in SSA**

- PRAPACE, CIP, NARS
- Elite Sweetpotato Clones Undergo Rigorous Testing Before Official Release
- GxE Trial Reported Here
- Objective: Evaluating Quality of Data Generated by Participating Countries
- Preparation For Regional Collaborative Biofortification Research Effort to Improve β-carotene Content in Sweetpotato

**Materials and Methods**

1) 20 Clones (2 Pathogen-tested OFSP In vitro Plantlets/Clone) Sent From CIP, Lima, Peru to CIP, Muguga (Kenya), and Namulonge (Uganda) Nov 2002
2) Material Micropropagated in Tissue Culture Labs and Screenhouses at Mugaga and Namulonge 2003

**Mini-vine Cuttings of 7 OFSP Promising Clones in Uganda Sent From Muguga Quarantine Station, Kenya to 7 Collaborating Countries, 2005. Each Country Multiplied the Clones, Including Common Check (SPK004) For Trial**
G x E Sites Regional Trial

- Selection of Sites Based on Altitude, Agroclimatic Conditions, and Food Systems
- Clone Selection Based on Vine Availability
- Vine Tip Cuttings, 30 cm Long
- Each Clone 4 Ridges, 0.3 m between plants (1 m x 6 m) [33,300 Plants/ha]
- RCBD, 3 Reps
- Standard Data Collection: Establishment, Vigour, SPVD, Root Traits at Harvest
- Middle 2 Rows Harvested 4-6 Months After Planting

Table 1. Estimates of stability parameters for storage root yield of 8 OFSP clones in 11 sites, 2004/2005

<table>
<thead>
<tr>
<th>CP Code</th>
<th>Clone name or Root yield</th>
<th>Regression estimates</th>
<th>Tai stability test</th>
</tr>
</thead>
<tbody>
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</table>

**ANOVA of additive main effect and multiplicative interaction (AMMI) model for total root yield (tha^-1) of 8 sweetpotato clones in 11 locations with three replications each in the regional trial in 2004/2005.**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of squares</th>
<th>Mean squares</th>
<th>F-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>263</td>
<td>32529.3</td>
<td>32529.3</td>
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<tr>
<td>Treatment</td>
<td>109</td>
<td>27590.6</td>
<td>253.12</td>
<td>7.89</td>
<td>&lt;0.0001</td>
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<tr>
<td>Blocks (Env’t)</td>
<td>32</td>
<td>17335.9</td>
<td>541.75</td>
<td>51.73</td>
<td>&lt;0.0001</td>
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<tr>
<td>Genotype (G)</td>
<td>7</td>
<td>1514.5</td>
<td>216.36</td>
<td>6.75</td>
<td>&lt;0.0001</td>
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<tr>
<td>G x E</td>
<td>70</td>
<td>9021.2</td>
<td>128.87</td>
<td>4.02</td>
<td>&lt;0.0001</td>
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<tr>
<td>IPCM1</td>
<td>14</td>
<td>2567</td>
<td>183.36</td>
<td>5.72</td>
<td>&lt;0.0001</td>
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<tr>
<td>IPCA2</td>
<td>12</td>
<td>1603</td>
<td>133.44</td>
<td>4.16</td>
<td>&lt;0.0001</td>
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<tr>
<td>Residual</td>
<td>28</td>
<td>232.4</td>
<td>8.3</td>
<td>1.02</td>
<td>0.4104</td>
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<tr>
<td>Error</td>
<td>154</td>
<td>4938.8</td>
<td>32.07</td>
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<td></td>
</tr>
</tbody>
</table>

Significance of AMMI = F > critical F at 5% probability. Significance of Tai = F > critical F at 5% probability. Significance of the interactions = F > critical F at 5% probability.

**Fig 1.** Biplot of principal component analysis (PCA) axis 1 vs. axis 2 for mean root yield for eight sweetpotato clones grown in 2004-2005 in eleven environments (locations) Clone codes: A) 199004.2, B) 199005.11, C) 199013.13, D) 199024.1, E) 199026.1, F) 199027.3, G) 199034.1, H) SPK004.

**Fig 2.** Biplot of principal components analysis (PCA) axis 1 vs. mean root yield for eight sweetpotato clones grown in 2004-2005 in 11 environments (locations). Clone codes: A) 199004.2, B) 199005.11, C) 199013.13, D) 199024.1, E) 199026.1, F) 199027.3, G) 199034.1, H) SPK004.
Fig 3. Distribution of Tai’s statistics of root yield (t/ha) for 8 potato cultivars grown in 2004/2005 in 11 environments. Tai’s average stability region is defined by the intersection area of the hyperbola representing a 95% prediction interval for $\lambda = 0$; and the vertical lines that limit a 95% confidence interval for $\alpha = 1$.

Codes: A = 199004.2 (CC89.147 x OP), B = 199005.1 (CHGU x OP), C = 199015.1 (LM92.032 x OP), D = 199024.2 (SR91.109 x OP), E = 199026.1, F = 199027.3 (SR92.095 x OP), G = 199034.1 (SR95.628 x OP), H = SPK004.

Application of Results: E.g., Cost of Production of OFSP Seed Reduced

Around 100,000 SP Seedlings are Screened at Start of Each Breeding Cycle

Accelerate Adoption

Improve Nutrition: OFSP High in β-Carotene/ Vitamin A
High Dry Matter (>30%)

OFSP Cost: 3 US$ Per Person/Year (100g/Day)
Vit A Capsules Cost: US$54-108 Per Person/Year

Spotato Breeding Scheme Uganda

Local, Introduced & Improved Gemplasm & Breeding lines

Crossing Block (Polycross)

Seedling Nursery (Yr 1)
100,000 Seedlings

Clonal Evaluation (Yr 2)
2,000 Clones (No Reps)

Preliminary Yield Trial (Yr 3)
100 Clones (Replicated)

Intermediate Yield Trial (Yr 4)
50 Clones (Replicated)

Advanced / Multi-Location Trials (Yrs 5,6)
25 Clones Replicated

On-farm Trials (Yr 7)
5 Clones (Replicated)

Variety Release (Yr 8)
Acknowledgement

- NARO (National Agric Res Org), Uganda
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- CIP
- PRAPACE
- NARS (DR. Congo, Ethiopia, Rwanda, Kenya, Tanzania)