18643-Multi-location evaluation of early maturing and heat tolerant potato clones

OJ Mwenye, Gift Chinoko and Denis Kathabwalika

CIP Malawi

Dec 2020

Executive summary

The International Potato Center (CIP), with funding from the University of St Andrews United Kingdom, is leading the implementation of an 18 months project, Food Security and Health for East Africa; producing new climate resilient and disease resistant potato varieties for tailored to potato production systems (QUICKGRO II). The project's goal is to enhance food security by varieties of potato that are early maturing, high yielding and resilient to the pest and diseases in the warmer environments of east Africa, specifically Malawi and Kenya.

In summary, 60 early maturing and heat tolerant genotypes (diploid 06H1 population) were introduced in Malawi and Kenya from the James Hutton Institute, United Kingdom. These have been evaluated across sites in Malawi and Kenya. The project is advancing 12 best materials from a diploid 06H1 population with targeted traits that were evaluated from a preceding grant with partners. Preference tests will be conducted with different stakeholders in Kenya and Malawi to generate demand for the materials.

Introduction

Potato is an important food and cash crop in sub Saharan Africa (SSA). In Malawi it contributes to food security especially during the hunger months (November to February) and in Kenya it is the second most important food crop after maize. Potato is a valuable alternative to reduce the dependence on maize as it is more nutritious, yields 2-4 times the food quantity per ha, and uses water more efficiently. Although tubers may not become full sized, a tuber yield can be obtained during a short rainy season, so potato is less susceptible than maize to catastrophic crop failure in droughts.

Potatoes in Malawi and Kenya are mostly grown in highland regions because they do not tuberize in the hotter weather experienced at lower altitudes. There are many factors that affect the yield of potato in SSA region; among them is disease load and a massive shortage of healthy planting material (clean seed). Most current research and development efforts are focused on developing varieties that are pest and disease resistant and in building up the seed systems and markets to provide clean seed. Previous grants to the James Hutton Institute, St Andrews University, CIP, and national partners, DARS in Malawi and MMUST of Kenya focused on introducing new varieties, applying modern diagnostics and capacity building. This new initiative was different in that it had a new and innovative objective to develop potato varieties that are heat and disease tolerant and produce tubers in a much shorter growing season than is currently possible. This will be of value in avoiding threats from extreme weather events and diseases affecting potato production in the region.

Overall Objective

The main objective is producing new climate resilient and disease resistant potato varieties tailored to potato production system.

Specific Objective

i. To determine agronomic performance of selected high performing, early maturing varieties at field scale in two regions (Kenya and Malawi).

Trial locations and season

The grant has introduced 60 genotypes for agronomic evaluation; and has identified 12 best performing genotypes in Kenya and Malawi. These will be evaluated further in multi-locational trials (National yield performance trials in Kenya). The sites for the agronomic evaluation have been presented in Table 1. The seasons in both countries received normal rains; however, the rains cut-off mid-March in Malawi (Fig 1 and Fig 2). The sites are categorized as traditional and non-traditional. Trials went as planned in the non-traditional sites. However, plans to conduct a second season (winter) crop did not materialize in Malawi due to COVID 19 restrictions.

Table 1. Agronomic trial locations and their agro-climate attributes

Kenya				Malawi			
Site	**Elevation (masl)**	**Precipitation (mm)**	**Average Temp. (°C)**	**Site**	**Elevation (masl)**	**Precipitation (mm)**	**Average Temp. (°C)**
Kakamega KARLO	1580	1600 - 2000	Min 14 Max 27 Mean 20	Makoka	1029	1044	Min 15.6 Max 25
Alupe KARLO	1100	1000 - 1400	Min Max Mean 23	Kasinthula	60	700	Min Max
Sang'alo	1920	1400 - 1800	Min Max Mean 18.5	Chitedze	1146	892	Min16 Max 24

masl-meters above sea level

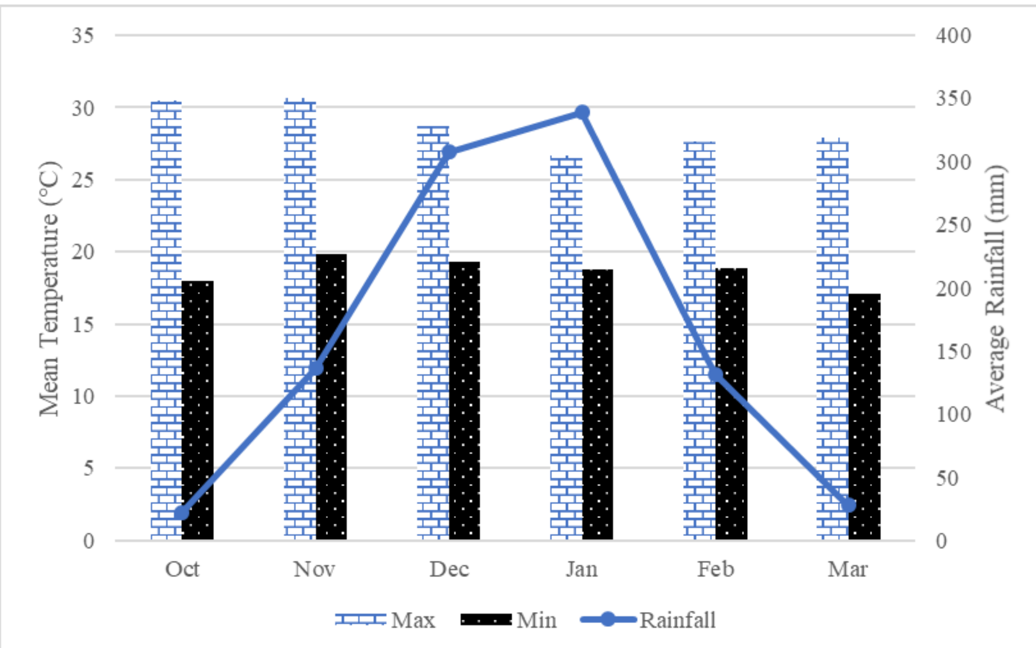

Figure 1. Rainfall (mm) and temperature (°C) data for Makoka, Malawi, 2019/2020 season

To determine agronomic performance of selected high performing, early maturing varieties at field scale in two regions (Kenya and Malawi).

The 60 genotypes were introduced (Appendix) in Malawi and Kenya in the previous grant from the GCRF (Quickgro I). The introduced genotypes are a sub-set of the 06H1 population (*S. tuberosum* Group Phureja clones) developed at the James Institute, Scotland, United Kingdom. This sub-set is non-transgenic. These have been planted at the sites for the past 2 seasons. However, due to other circumstances only Makoka (Malawi) and Sang'alo (Kenya) had complete data sets. Data for Kenya will be presented by MMUST.

The agronomic evaluation trials planted in December; and were laid out in a randomized complete block design (RCBD) with 3 replicates. The gross plot area was 0.3 x 0.9m in size with 1 ridge, which was a net plot (4 tubers per replication). The potato tubers were planted at 30 cm apart. For basal dressing, D-compound (NPK) fertilizers was used at the rate of 250 kg/ha), and CAN was used for top dressing at the rate of 150 kg/ha.

Data collected included emergence after 2 weeks of planting. Pests and diseases, scores were taken on monthly basis. At harvest (70 days after planting), data on stand count and number of tubers per plant and weight per plot were recorded. Tubers were graded into marketable (>35mm) and non-marketable (<35mm) based on sizes and each grade was weighed separately. Total yield was recorded per plot and converted.
Table 2 gives summary results for tuber yield and yield components for clones at Makoka, Malawi. Tuber size (g), number of tubers per plant, total yield and marketable yield showed significant differences among the clones while tuber yield for non-marketable showed no significant differences among the clones. Highest yield was recorded on genotype 295 (13.29 t/ha) followed by genotype 229 (12.64t/ha). Other performing genotypes included 14 (2.04 t/ha), genotype 95 (10.09 t/ha) and genotype 21 (10.04 t/ha). The highest marketable yield was recorded on genotype 295 (12.08 t/ha) followed by genotype 229 recording (11.21t/ha). Lowest marketable tuber yield was recorded with genotype 222 (6.2 t/ha). The yields of the clones are generally low as compared to the national production figures for potato as reported by the Ministry of Agriculture. One of the reasons for such low yields could be the fact that the Makoka site, as indicated, is a warmer environment and the rainfall in this site is generally low and did cut-off very early which could have affected some of the clones.

For number of tubers per plant, genotype 295 recorded the highest number of 20 tubers per plant followed by genotype 229 (14 tubers per plant), whilst genotype 165 recorded lower number of tubers per plant (5.75). Results on tuber size showed that among the tested clones, 165 produced bigger tubers of 39.86g followed by genotype 13 (33.05g), genotype 239 (31.59g) and genotype 95 (27.43g). Overall yield performance of the entire 60 clones is presented in the annex.

Out of the 60 genotypes that were sent; 12 have been selected best on yield performance. These traits include yield attributes i.e. tuber side, number of tubers produced, and tuber quality (tuber shape, tuber skin colour and tuber flesh colour). Furthermore, clones will also be subject for organoleptic and processability test. This will assist to assess whether the 06H1 clones, though they have been bred for warmer environments can also do well in cool and high altitude.

In Malawi, the team failed to conduct a second season crop trial (under residual moisture), due to COVID 19 restrictions. Clones were therefore bulked to have enough tubers for the rain-fed multiple trials, for both Kenya and Malawi. Going forward the best performing clones will be evaluated in multiple sites, including the traditional potato growing areas to assess their stability in these contrasting environments. This will allow the team to generate enough data for possible release of the clones in the respective countries. For Malawi the sites will include, Mulunje, Makoka, Zomba, Ntcheu and Dedza. These sites include both traditional and non-traditional potato producing regions. Planting in Malawi is expected to be done early- to mid-December. Enough seed was harvested from the multiplication and has been sprouted, ready for planting.

Table 2. Field agronomic performance of 06H1 potato clones (top 20 clones) at Makoka, Malawi

Genotype	**Tuber size (g)**	**Total Yield(t/ha)**	**Marketable (%)**	**Marketable Yield (t/ha**	**Tubers /plant**
295	18.23	13.29	51.2	12.08	20.0
229	25.38	12.64	54.9	11.21	14.0
14	27.06	12.04	48	10.6	13.12
95	27.43	10.09	84.2	9.54	9.75
21	25.22	10.04	66.2	9.35	11.12
239	31.59	10.0	49.8	7.46	8.75
299	18.86	8.6	74.5	7.74	6.91
247	18.92	8.19	47.1	6.76	12
278	15.49	8.14	13.3	6.22	13.83
304	18.93	8.1	47.6	6.85	13.38
264	22.17	8.06	53.2	6.53	11
220	24.06	7.95	39.9	6.85	8.78
260	14.69	7.59	43.6	6.39	13.5
184	26.19	7.58	85.9	7.12	7.96
83	27.27	7.55	54.8	6.67	8.38
165	39.86	7.5	83.3	7.13	5.75
199	20.26	7.27	56.0	5.97	10.12
222	24.04	7.04	61.4	6.2	8.38
13	34.05	6.99	65.9	6.44	5.88
121	29.52	6.53	78.8	5.93	6.75
Mean	**24.461**	**8.7595**	**57.98**	**7.652**	**10.468**
Fprob	<0.001	<.001	<.001	<.001	<.001
LSD	10.977	4.144	28.87	3.732	6.038
CV%	7.6	20.7	16.5	19.1	27.5

Key: LSD= Least Significant Difference CV= coefficient of variation

Figure 2. Field agronomic evaluation of the 06H1 clones at Makoka, Malawi

Appendix

Table 3. Agronomic performance of the 06H1 clones at Makoka, Malawi 2019/2020

Genotypes	Total Yield(t/ha)	Marketable Yield (t/ha	Non-marketable Yield (t/ha)
295	13.287	12.083	1.204
229	12.639	11.204	1.435
14	12.037	10.602	1.435
95	10.093	9.537	0.556
21	10.046	9.352	0.694
239	10.000	7.454	2.546
299	8.598	7.737	0.861
247	8.194	6.759	1.435
278	8.139	6.218	1.921
304	8.102	6.852	1.25
264	8.056	6.528	1.528
220	7.951	6.854	1.097
260	7.593	6.389	1.204
184	7.58	7.114	0.466
83	7.546	6.667	0.879
165	7.500	7.13	0.37
258	7.500	5.324	2.176
69	7.333	4.769	2.564
199	7.269	5.972	1.297
222	7.037	6.204	0.833
13	6.991	6.435	0.556
29	6.713	5.602	1.111
32	6.667	5.833	0.834
291	6.657	4.685	1.972
267	6.629	4.945	1.684
121	6.528	5.926	0.602
288	6.524	4.490	2.034
179	6.366	3.574	2.792
261	6.305	5.542	0.763
268	6.204	5.324	0.880
27	6.157	5.231	0.926
129	5.926	4.861	1.065
297	5.806	5.204	0.602
Violet (Control)	5.741	4.722	1.019
58	5.604	4.583	1.021
269	5.481	4.213	1.268
80	5.29	4.614	0.676
187	5.271	4.389	0.882
143	5.000	4.167	0.833
279	4.954	4.120	0.834
276	4.921	3.949	0.972
256	4.861	3.750	1.111
61	4.815	3.426	1.389

Genotypes	Total Yield(t/ha)	Marketable Yield (t/ha	Non-marketable Yield (t/ha)
180	4.722	3.565	1.157
15	4.444	3.657	0.787
253	4.444	3.843	0.601
87	4.205	3.636	0.569
200	4.028	3.750	0.278
246	3.796	2.500	1.296
57	3.704	2.963	0.741
185	3.472	2.639	0.833
28	3.197	2.608	0.589
79	2.703	1.991	0.712
155	2.641	1.744	0.897
78	2.185	1.982	0.203
174	1.938	1.426	0.512
88	1.599	1.303	0.296
Mean	**8.7595**	**7.652**	**1.07**
Fprob	<.001	<.001	<.001
LSD	4.144	3.732	1.131
CV%	20.7	19.1	26.0

Key: LSD= Least Significant Difference CV= coefficient of variation