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ADAPTABILITY OF SIFT POTATO GENOTYPES IN DIFFERENT AGRO-ECOLOGIES OF UGANDA

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ABSTRACT

The effect of genotype by environment interaction (G x E) on fresh tuber yield of nine Standard International Field Trials (SIFT) potato (*Solanum tuberosum* L.) genotypes and Kisoro, a local variety, was studied in Uganda using additive main effects and multiplicative interaction (AMMI) model 3. Results indicated that the proportion of the environmental variation was much larger than the proportion due to genotypes and the proportion due to G x E interaction was also larger than the genotype main effects. Genotypes (G), environments (E) and the G x E interactions accounted for 8.43, 57.13 and 34.44% of the treatment sums of squares, respectively. AMMI and the biplot identified genotypes 384866.5, 381381.13, 389746.2, Kisoro and 386209.10 as adapted to four environments. Test genotypes 389746.2, Robijn and 381381.13 were the most stable and had higher yields (> 19 t ha^{-1}) than all genotypes except Torridon, which was also very unstable and specifically adapted to one environment (Kalengyere 2B). Kalengyere 1B and Wanale 2A were identified as similar environments.

Key Words: Adaptation, AMMI analysis, *Solanum tuberosum*, yield stability, Uganda

RÉSUMÉ

L'effet du génotype par l'interaction de l'environnement (GxE) sur le tubercule frais de reproduction de neuf génotypes (*Solanum tuberosum* L.) standard international de terrain d'essai (SIFT), et Kisoro, une variété locale a été étudiée en Ouganda en utilisant principaux effets d'interaction et multiplication modèle 3 (AMMI). Les résultats indiquaient que la proportion de la variation de l'environnement était plus large que la proportion due aux génotypes, et la proportion due à l'interaction GxE était aussi large que les principaux effets du génotype. Les génotypes (G), l'environnement (E) et l'interaction GxE, comptaient pour 8,43,57.13 et 34,44 % respectivement des sommes du traitement des carrés. AMMI et les génotypes biplots identifiés 384866.5, 381381.13, 389746.2 pour kisoro et 386209.10 comme adaptés en quatre types d'environnement. Les tests de génotypes Robijn 389746.2 et 381381.13 étaient le plus stable et avait des productions supérieures. (>19 t ha^{-1}) que tous les génotypes, excepté Torridon, qui était aussi très instable et spécifiquement adapté à un environnement (Kalengyere 2 B). Kalengyere 1B et Wanale 2A étaient identifiés comme environnement similaire.

Mots Clés: Adaptation, analusys AMMI, *Solanum tuberosum*, production stable, Ouganda

INTRODUCTION

National Potato Programmes in Sub-Saharan Africa have continuously focused on selection of high yielding varieties with resistance to late blight (*Phytophthora infestans* Mont De Bary). Currently, Uganda is among the countries in Africa (others are Ethiopia and Kenya) participating in the Standard International Field Trials (SIFT), an international co-operative experiment whose objective is the acceleration of introduction of potato cultivars with durable resistance to late blight worldwide, as well as reduce the dependence on fungicides in developing countries (GILB, 1998). The first set of varieties for SIFT was contributed by European, Latin America and International Potato Centre (CIP) breeding programmes. Each participating country, like Uganda, was expected to identify and recommend varieties for adoption in her various agro-ecologies, depending on varietal performance at the end of the multilocational testing (GILB, 1998). The Uganda National Potato Programme accessed these genotypes through the International Potato Centre sub-Saharan Africa (CIP – SSA) regional office in Kenya in 1999, and embarked on evaluating them for resistance to late blight and tuber yield at Kalengyere Research Station, in southwestern Uganda. After three seasons of evaluation, 10 genotypes were identified for multilocational testing. However, when the SIFT materials grown in Uganda (Kalengyere Research Station) and Kenya were compared, their performance varied significantly amongst seasons and locations (El-Bedewy *et al.*, 2001). The variation in genotype performance was suspected to be due to genotype x environment (G x E) interactions, which is the change on cultivars' relative performance over environments, resulting from differential response of the genotypes to various edaphic, climatic and biotic factors (Dixon *et al.*, 1991).

G x E interactions are almost unanimously considered by plant breeders to be among the main factors limiting response to selection and, in general, the efficiency of breeding programmes. According to Ngeve (1993), the presence of G x E interaction effects is a serious problem in comparing the performance of an individual cultivar across environments. It reduces the efficiency of genetic progress and leads to unreliable recommendations in terms of yield and adaptability of the genotype. The analysis of G x E, therefore, becomes an important statistical tool employed by plant breeders not only for evaluating varietal adaptation but also in the selection of parents for base populations, in classifying environments, and in improving genotypes with desired adaptability (Lin and Binns, 1988).

This study used the Additive Main effects and Multiplicative Interaction (AMMI) model to assess and rank potato genotypes in SIFT, their stability and adaptability in five potato agro-ecologies of Uganda and to investigate the G x E effects.

MATERIALS AND METHODS

The experiment was conducted for three consecutive seasons, namely, September-December 2001 (2001B), March – July and September-December 2002 (2002A and 2002B). In 2001B, the trials were established at four sites: Kalengyere (2450 metres above sea level (m.a.s.l.)); Kachwekano Agricultural Research and Development Centre (ARDC) (2200 m.a.s.l.); Katukuru-Mbarara (1500 m.a.s.l.) in southwestern Uganda; and, Buginyanya ARDC (1980 m.a.s.l.) in eastern Uganda. In 2002A, one additional site, Wanale (1900 m.a.s.l.), was included as an on-farm site in eastern Uganda. Thus, in 2002A, the study was conducted at five sites but only at four sites in 2001B (Wanale excluded) and 2002B (Mbarara excluded). These sites represented the major potato growing areas of Uganda, except the west Nile region (Sikka *et al.*, 1994). Nine potato genotypes in SIFT namely, 384866.5, 389746.2, 386209.10, 381390.30, 381381.13, 720118, Robijn, Torridon and Kisoro (a local variety) were used in the study. Weather data, i.e., rainfall, temperature and relative humidity were recorded for each experimental site depending on the equipment available (Table 1).

The experimental set-up was a randomised complete block design, with three replications at each site and during all seasons. Each plot consisted of four rows, measuring 3 m by 4 m with 10 - 15 plants (depending on seed availability), spacing was 70 cm by 30 cm. After germination each plot received three to six sprays of a contact fungicide, Dithane M 45 (Mancozeb 80% WP) to control late blight disease. Weeding and hilling were carried out whenever necessary. Dehaulming was done at 90 days after planting, and harvesting 10 – 14 days later. At harvest, data were recorded on fresh tuber weights. Fresh tuber yields were obtained for the genotypes (G) in the different environments (E). Genotypes, environments (season x location combinations) and G x E interactions were considered "treatments" during the analysis.

The Additive Main Effects and Multiplicative Interaction (AMMI) model as described by Gauch and Zobel (1996) was used for data analysis and interpretation of the G x E interaction effects on tuber yield. The model is also reportedly useful for understanding such complex interactions. Gauch and Zobel (1996) reported that results from the AMMI model can be graphed as a biplot which shows both main and interaction effects of genotypes and environments. MATMODEL software Version 2.0 (Gauch and Furnas, 1991) was used to perform the AMMI calculation and to draw the biplot. The AMMI biplot was developed by placing both genotype and environment means (main effects) on the x-axis or abscissa, and the respective eigen vectors or scores of the first principal component (I PCA 1) on the y-axis or ordinate (Zobel, 1990). Furthermore, since Finlay and Wilkinson (1963) suggested that the mean yield and regression coefficient (b) of yield genotypes over environments provides information for selecting cultivars with broad adaptability, joint regression was used to provide further insight into genotype and environment stability.

RESULTS AND DISCUSSION

There were highly significant ($P<0.001$) differences among genotypes, seasons, locations, environments (location x season combinations), season x genotype, location x genotype and genotype x environments interactions (results not shown). Results in Table 2 indicate that across seasons, the highest yield was recorded at Buginyanya (22 t ha^{-1}), followed by Kachwekano (18.4 t ha^{-1}), Kalengyere (15.2 t ha^{-1}), Wanale (14.2 t ha^{-1}) and lastly Mbarara (9.9 t ha^{-1}). Considering the individual seasons (results not shown), the highest total yield was recorded at Kalengyere in 2002A (22.4 t ha^{-1}) and the lowest at Mbarara in 2002A (1.8 t ha^{-1}). The best genotype was 389746.2 (21.2 t ha^{-1}) and the worst was 386209.10 (11.6 t ha^{-1}). Only 2 test genotypes (386209.10 and 384866.5) had lower total yields than the local check, Kisoro.

These results imply that the performance of SIFT potato genotypes varied with location and season. These differences were attributed to differences in agro-ecological conditions (Table 1). The significant differences in the performance of the genotypes across seasons and locations could, therefore, be attributed to differences in genotype x environment interactions.

The G x E interactions were further studied using the additive main effects and multiplicative interaction (AMMI) model. The AMMI analysis of genotype yields across environments, and environment across genotypes indicated highly significant treatments (Table 3). This suggests that the genotypes' responses varied from one

TABLE 1. Weather and altitude of the experimental sites during the growing seasons: 2001B, 2002A and 2002B

Site	Altitude (m.a.s.l.)	Mean temperature (^{o}C)			Mean Rainfall (mm)			Mean Relative Humidity (%)		
		2001B	2002A	2002B[2]	2001B	2002A	2002B	2001B	2002A	2002B
Kalengyere	2450	11.8	16.3	NA	NA	60.1	NA	NA	84.1	NA
Kachwekano	2200	18.1	18.1	17.9	159.1	64.5	104.9	82.0	78.9	76.0
Buginyanya	1980	19.3	19.2	19.0	135.0	203.5	140.1	NA	NA	NA
Wanale	1900	NA	29.6	29.8	NA	128.5	145.0	71.8	73.6	72.9
Mbarara	1500	20.9	17.1	21.0	154.0	76.4	92.7	75.9	73.2	73.8

[1]NA = data not available; Source: Meteorology Department, Kampala, Uganda

[2]2001B, 2002A and 2002B correspond to September - December 2001, March - July 2002 and September - December 2002 seasons, respectively

environment to another. The ANOVA results partitioned the main effect treatments into genotypes (G), environments (E) and the G x E interactions with highly significant (P<0.001) differences among all the components. It also partitioned the G x E interaction effects into principal components. The genotype, environment and G x E interaction effects accounted for 8.43, 57.13 and 34.44% of the treatment sums of squares, respectively. This is an indication that the proportion of environmental and G x E interaction variation for fresh tuber yield was much larger than that due to genotypes main effects. Earlier G x E studies (Gauch and Zobel, 1996; Ntawuruhunga *et al.*, 2001; Abalo *et al.*, 2003) suggested that the proportion of sums of squares due to G x E was usually larger than genotype main effects. The G x E study on yield stability of some elite potato genotypes in Uganda (Abalo *et al.*, 2003) suggested that one could rely more on

TABLE 2. Mean fresh tuber yield (t ha^{-1}) of nine potato genotypes in SIFT and one local variety across three seasons (2001B, 2002A and 2002B) at five locations in Uganda[a]

Genotype	Kalengyere	Kachwekano	Buginyanya	Wanale[b]	Mbarara[b]	Overall mean
ROBIJN	18.7	21.6	23.8	10.1	11.5	17.1
386040.9	11.8	16.6	24.1	14.7	9.3	15.3
386209.10	10.1	15.7	12.1	10.6	7.9	11.6
381381.13	17.2	21.7	22.5	10.6	10.4	16.7
KISORO[2]	8.9	16.0	20.8	20.4	8.5	14.9
389746.2	15.5	23.6	30.7	19.5	15.2	21.2
384866.5	12.0	16.5	15.8	15.6	7.4	13.7
720118	15.4	15.9	21.2	15.6	11.6	16.2
381390.30	18.8	13.7	27.6	13.3	8.6	16.6
TORRIDON	21.8	21.7	21.1	10.9	8.6	17.3
Grand mean	15.2	18.4	22.0	14.2	9.9	16.2
$SED_{0.05}$	3.0***	4.4 n.s	3.5***	4.2***	2.6*	3.5***
CV (%)	23.9	28.9	21.0	39.8	31.9	26.3

[a]2001B, 2002A and 2002B = Second rains (September – December) of 2001, first (March-July) and second rains of 2002, respectively; [4]SIFT= Standard International Field Trials

[b]two seasons' data; *,*** = means significantly different at 5% and 0.1% probability levels, respectively; n.s = means not significantly different at 5% probability level; [1]SED= Standard error of difference between means and CV(%) Coefficient of variation; [2]local check

TABLE 3. AMMI analysis of fresh tuber yields of 10 potato genotypes

Source of Variation	DF	SS	MS	Probability
Total	389	33147.701	85.213	
TRT	129	28422.565	220.330	***
GEN	9	2394.871	266.097	***
ENVT	12	16238.271	1353.189	***
G X E	108	9789.422	90.643	***
I PCA 1	20	3846.687	192.334	***
I PCA 2	18	1954.763	108.598	***
I PCA 3	16	1345.554	84.097	***
Residual	54	2642.410	48.934	***
Error	260	4725.137	18.174	***

*** Significant at 0.1% probability level; PCA = Principal component axis; TRT = Treatment; GEN = Genotype; ENVT = Environment; G x E = Genotype x environment interaction crop management and suitability of the environment to attain high yields rather than on the genotypic differences alone.

Results shown in Table 4 indicate that both AMMI and unadjusted means selected the same genotypes as best yielding in 7 environments (53.8%) but selected different best yielders in 6 environments (46.15%). The largest AMMI 3 gain of 6.72 or 39.14% of the grand mean occurred in environment 12 (Mbarara 2001B), where data selected test genotype 389746.2 but AMMI selected test genotype 386209.10 as highest yielding. AMMI estimation selected test genotypes 386040.9, 381381.13, 720118, Torridon, Robijn, 386209.10 as the best yielder in at least one environment. This suggests that the noise in adjusted means elevated some genotypes such as Kisoro, the local variety (to the fourth position). Similar results have been reported from earlier studies in potato (Abalo *et al.*, 2003), cassava (Ntawuruhunga *et al.*, 2001), maize (Crossa *et al.*, 1991) and soybean (Gauch and Zobel, 1988). They found that AMMI estimates differentially ranked top performing entries in over half the environments when compared with unadjusted means. Consequently, AMMI estimation was recommended, since ranking discrepancies between AMMI and unadjusted means were attributed to random variation. According to Gauch and Zobel (1996), AMMI estimate has a profound effect in producing sharper and stratified ranking patterns. Based on this, therefore, Torridon, ranked as best yielder by AMMI in 5 environments would be considered more adapted to a wide range of environments than the rest. Without AMMI estimates, therefore, noise in the data blurs adaptation patterns of genotypes to the extent that relatively well adapted genotypes may be grouped by chance (Crossa *et al.*, 1991). Consequently, a relatively poorly adapted genotype may sometimes occur at the top.

The AMMI results are also presented as a biplot (Fig. 1), which allows visualisation of relationships between the eigen values for the first principal components axis (PCA1) and the genotype and environment means (main effects). It also shows the variation in genotypes' responses to the environmental changes. Genotypes or environments, which appear almost on a perpendicular line, have similar means; those

TABLE 4. Ranking by AMMI estimates and unadjusted means (in parenthesis) for fresh tuber yield of 9 potato genotypes in SIFT and one local check grown in 13 environments (location by season combinations)

Genotype	[1]KAL [2]2001B	KAL 2002A	KAL 2002B	KAC 2001B	KAC 2002A	KAC 2002B	BUG 2001B	BUG 2002A	BUG 2002B	WAN 2002A	WAN 2002B	MBR 2001B	MBR 2002A
ROBIJN	3 (4)	3 (4)	2 (2)	1 (3)	2 (2)	2 (4)	1 (2)	2 (3)	6 (5)	4 (1)	2 (4)	7 (9)	5 (3)
386040.9	8 (10)	8 (7)	8 (5)	4 (6)	6 (9)	8 (9)	8 (8)	5 (6)	7 (4)	8 (10)	9 (9)	9 (7)	1 (1)
386209.10	7 (7)	6 (8)	10 (9)	9 (9)	5 (3)	9 (7)	10 (10)	6 (7)	3 (3)	7 (5)	8 (5)	1 (3)	7 (7)
381381.13	2 (1)	1 (3)	5 (6)	5 (7)	1 (1)	4 (3)	2 (5)	7 (8)	2 (2)	3 (7)	6 (2)	8 (8)	3 (2)
KISORO	9 (9)	10 (9)	9 (10)	6 (4)	10 (7)	10 (10)	7 (7)	9 (5)	10 (10)	10 (4)	10 (10)	10 (10)	2 (4)
389746.2	6 (5)	4 (5)	4 (4)	2 (1)	3 (5)	3 (2)	4 (1)	4 (4)	5 (7)	6 (8)	4 (6)	6 (1)	4 (5)
384866.5	10 (8)	9 (10)	6 (7)	7 (5)	8 (8)	7 (6)	9 (9)	3 (2)	9 (9)	9 (9)	7 (8)	3 (4)	6 (6)
720118	1 (3)	5 (2)	7 (8)	10 (8)	4 (6)	6 (8)	5 (3)	10 (9)	1 (1)	2 (2)	5 (7)	5 (6)	8 (10)
381390.30	5 (2)	7 (6)	3 (3)	8 (10)	9 (10)	5 (5)	6 (6)	8 (10)	4 (8)	5 (6)	3 (3)	4 (2)	10 (8)
TORRIDON	4 (6)	2 (1)	1 (1)	3 (2)	7 (4)	1 (1)	3 (4)	1 (1)	8 (6)	1 (3)	1 (1)	2 (5)	9 (9)

[1]KAL=Kalengyere; KAC=Kachwekano; BUG=Buginyanya; WAN=Wanale; MBR=Mbarara; [2]2001B, 2002A and 2002B correspond to second rains (September – December) of 2001, first rains (March-July) and second rains of 2002, respectively. Figures in parenthesis are rankings by unadjusted means

falling on a horizontal line have similar interaction patterns. The biplot graph accounted for 79.1% of the treatment sums of squares. In the biplot (Fig. 1), displacement along the x-axis reflects differences in main effects, while displacement along the y-axis shows differences in interaction effects (Zobel *et al.*, 1988). Genotypes or environments on the same parallel line relative to the y-axis have similar yield and a genotype or environment on the right side of the midpoint of the axis has higher yield than those on the left side. According to Crossa *et al.* (1991), the abscissa reflects the overall quality for environment and general improvement status for genotypes while the ordinate discriminates early (positive PCA scores) to late (negative PCA) maturing genotypes and correspondingly, the length of growing season of location.

Basing on this argument, test genotypes 386040.9, 386209.10, 384866.5, 383381.13 and 3897646.2 were categorized as early and Robijn, 720118, 381390.30 and Torridon as late maturing varieties by the AMMI biplot. Kisoro, the local variety, was also considered early maturing.

Genotypes or environments with large first IPCA scores (either positive or negative) have large interaction; those with values close to zero have small interaction and are considered stable (Hill *et al.*, 1998). When the PCA 1 values of genotypes and environments are close to zero, the entry has small interaction effects and its general response pattern across the environments parallels the mean of all the genotypes in the trial and is thus considered stable (Fox *et al.*, 1990; Cooper and Byth, 1996; Hill *et al.*, 1998). Test genotypes Torridon, Robijn, 389746.2 and 381381.13 were displayed on the right hand side of the midpoint for the x-axis and were thus higher yielding than 386040.9, 386209.10, 384866.5, 720118, 381390.30 and Kisoro, which were on the left hand side. Torridon at the extreme right and Kisoro on the extreme left were the best and least yielders, respectively.

Considering environment, the second seasons, i.e., 2001B and 2002B were more productive at Kalengyere and Kachwekano (highest altitudes) than the first season (2002A), which was productive only at Wanale and Buginyanya, the

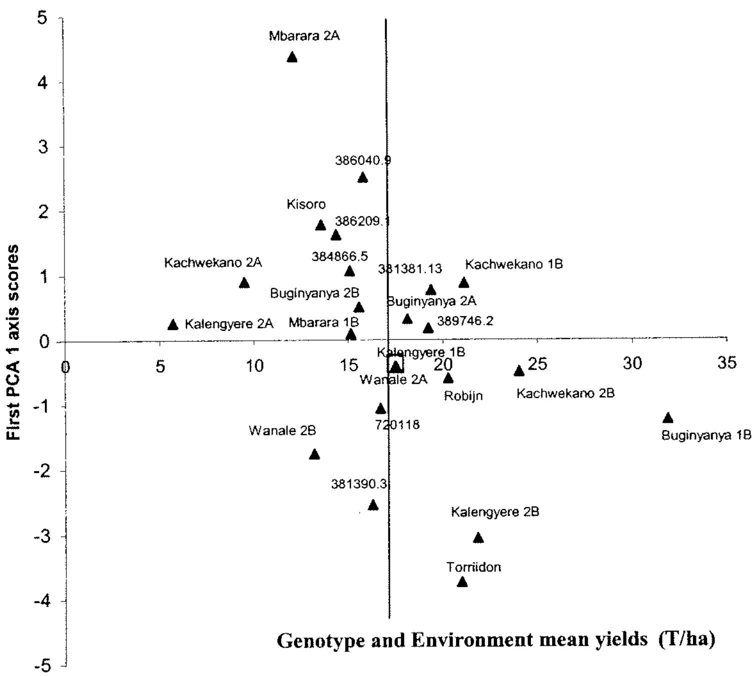

Figure 1. AMMI model biplot of genotype and environment main effects (abscisa) and the first IPCA axis (ordinate) for fresh tuber yield (mt ha^{-1}) of potato genotypes in SIFT in Uganda.

two sites in eastern Uganda. This may be due to the long rains at Kachwekano and Kalengyere during 2001B and 2002B as shown in Table 1, conditions that are very favourable for potato growth and development. Consequently, the first season (2002A) at Kalengyere and Kachwekano, ranked lowest, while Kachwekano and Buginyanya ranked highest during the second season (2001B). However, Kachwekano and Kalengyere ranked as the best yielders during 2002B, still due to the heavy rains during this season. Although the rains were more at Kalengyere and Kachwekano (at higher altitudes) during 2001B and 2002B than at Buginyanya, the latter out-yielded the former probably due to the fact that the heavy rains that favour potato growth and development also favour late blight development and spread, which might have affected the yield at these two sites. The first rains of 2002A were short and not well distributed in southwestern Uganda, thus the low yields at these sites.

Three test genotypes namely 389746.2, Robijn and 381381.13 had negligible interaction with the environments, while seven environments (Wanale 2A, Kalengyere 1B, Buginyanya 2A, and 2B, Kachwekano 2B, Kalengyere 2A and Mbarara 1B) had negligible interaction with the genotypes. Therefore, these genotypes and environments were considered stable, implying that the three genotypes can give high yields in any of these environments, while the respective environments can support growth of any of the genotypes studied. Genotypes 389746.2, Robijn and 381381.13 were the most stable and had higher yields than all genotypes except Torridon, which was also the least stable. Generally, Mbarara 1B, Kalengyere 1B and 2A, Wanale 2A, Buginyanya 2A and 2B were the most stable environments, although Mbarara 1B and Buginyanya 2B had poor yields. Kalengyere 1B and Wanale 2A were identified as similar environments. Although not all the genotypes were stable, AMMI and the biplot identified genotypes 384866.5, 381381.13, 389746.2, Kisoro and 386209.10 as adapted to Kachwekano 2A, Kalengyere 2A, Buginyanya 2A and 2B. Test genotypes 389746.2, Robijn and 381381.13 were the most stable and had higher yields than all genotypes except Torridon, which was unstable.

According to Finlay and Wilkinson (1963), mean yield of entries across environments and regression coefficients are important indicators of cultivar adaptation. The joint regression analysis (Table 5) also indicated highly significant ($P<0.001$) statistical linear relationships between all sources of variation. The significant differences between the G x E interactions with environments and also with genotypes suggest that the heterogeneity was also significant and accounted for a large part of the interaction. This is in agreement with the ANOVA and AMMI results reported earlier. All the G X E components were highly significant ($P<0.001$) and, thus, had a big effect on the response of the test genotypes to the variations in the test environments. Finlay and Wilinson (1963) further demonstrated that regression coefficient values increasing above 1.0 describe genotypes with increasing sensitivity to environmental change. On the other hand, regression coefficients decreasing below 1.0 provide a measure of greater resistance to environmental change, thus above average stability.

Based on these arguments, the joint regression model selected test genotype 386209.10 ($b = -0.64$, $R^2 = 0.59$) as the most stable followed by test genotype 381390.30 ($b = 0.09$, $R^2 = 0.01$), while Robijn ($b = 0.23$, $R^2 = 0.185$) was identified as the least stable (Table 6). This is contrary to the AMMI results, which ranked test genotypes 389746.2 and Torridon as the most and least stable, respectively. Regression coefficients have been used by Lin and Binns (1988) in the selection of stable genotypes. Lin and Binns (1988) asserted that a stable genotype is one, which, on average responds to all environments in a similar way. According to this definition, the stability of 389746.2 (according to the AMMI analysis) is the static concept, which occurs when the yield of the test genotype is constant across the test environments. This is stability in the homeostasis sense.

In conclusion, the AMMI model was successfully used to investigate the G x E interaction and stability of fresh tuber yield of the potato genotypes in SIFT. There is an indication that the SIFT materials were very sensitive to variations in environments as most of them were unstable, thus, lowering their adaptability and

TABLE 5. ANOVA table for joint regression analysis

Source	df	SS	MS	Probability
Total	389	33147.701	85.213	
TRT	129	28422.565	220.330	***
GEN	9	2394.871	266.097	***
ENVT	12	16238.271	1353.189	***
G X E	108	9789.422	90.643	***
Joint Regrs	1	710.816	710.816	***
GEN Regrs	8	683.043	85.380	***
ENVT Regrs	11	1183.388	107.581	***
Residual	88	7212.174	81.957	***
Error	260	4725.137	18.174	

***Significance at 0.1% probability level; PCA = Principal component analysis; TRT = Treatment; GEN = Genotype; ENVT = Environment; G x E = Genotype x environment interaction; Regrs = regression

TABLE 6. Linear regression parameters for the nine potato genotypes in SIFT and one local check

GEN	Mean	Slope	R-squared	Index *
Robijn	20.29	0.23	0.185	10
386040.9	15.82	-0.23	0.08	6
386209.10	14.37	-0.64	0.59	1
381381.13	19.39	-0.09	0.02	8
Kisoro	13.56	-0.04	0.00	9
389746.2	19.25	0.34	0.28	5
384866.5	15.10	-0.18	0.09	4
720118	16.69	0.14	0.03	7
381390.30	16.27	0.09	0.01	2
Torridon	20.97	0.39	0.13	3

* Rank given to each genotype based on the regression analysis

stability to varying growing conditions. Test genotype 389209.10 on average had a low magnitude of the G x E interaction, and good yield performance across all the environments. The most stable environments were Mbarara 1B, Kalengyere 1B and 2A, Wanale 2A, Buginyanya 2A and 2B and may be considered good sites for evaluation of new potato genotypes in Uganda. Wanale 2A and Kalengyere 1B were similar sites and it may not be necessary to conduct a similar experiment during the second season at Kalengyere and the first season at Wanale. Torridon, the highest yielding but least stable genotype was however, adapted to Kalengyere 2B, which was also very unstable. This study is of significance in genotype development, because large numbers of genotypes have previously been discarded based on results from a single location (Kalengyere). Therefore, resources permitting, potato selection programmes in Uganda should be carried out in targeted ecologies. It has been reported that high yield under stress conditions is associated with morphological and physiological characters, which are different from those associated with high yield under optimum conditions, usually found at the research stations (Ceccarelli *et al.*, 2001).

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