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Screening and Identiying Farmers' Prefered Varieties for Adaptability and Resistance to Cassava Mosaic Disease (CMD) in Sierra Leone

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Abstract

Cassava plays an important role as a food security crop in Sub – Saharan Africa. However, yields of cassava in Sierra Leone are generally low. Adoption of improved varieties resistant to the Cassava Mosaic Disease (CMD) which is one of the most limiting factors of production remains low. Therefore cultivation of local varieties infected with the cassava mosaic disease dominates the farming system in Sierra Leone. The study was therefore undertaken with the general objective to screen and identify promising cassava genotypes with resistance to CMD that meets farmers' desired traits. A total collection of 2,000 cassava genotypes introduced from the International Institute of Tropical Agriculture (IITA) and 100 local collections were initially screened at the Njala Agricultural Research Center. This was preceded by multi location trials in a randomized complete block design using cassava mosaic infected varieties an infector rows. The 1-5 scale was used to assess cassava mosaic disease. Culinary traits were assessed. The approach used in the study was a participatory varietal selection process. Most of the cassava genotypes identified by farmers had high resistance to the cassava mosaic diseases with no disease symptom. Yenkessa in the coastal plains had significantly highest severity score of 1.3. Out of the 76 varieties identified and tested, 14 genotypes had good culinary traits for use as food. MM96/7204 (4X) had the highest mean storage root yield of 47.0 t/ha followed by 06/1474 with 43.24 t/ha and were identified for use in the cassava industry. The study concluded that Kabala, Kenema and Makeni were the best environments for growing cassava.

Keywords: Cassava Genotypes; Cassava Mosaic Disease; Farmers' Desired Traits

Introduction

In Sierra Leone, cassava is the second most important food crop after rice, the country's staple. It is also the most important storage root and tuber crop [1]. Cassava is also grown all over the country and remarkable progress has been made in breeding for resistance to the African Cassava Mosaic Virus (ACMV). Cassava processing activities have increased at both domestic and commercial scales, although to varying degrees [2]. Yields of cassava in Sierra Leone are generally estimated at 7.4t/ha tons [3]. Much of this is as a result of the cultivation of local varieties infected with cassava mosaic disease (CMD) over improved cassava varieties that have been released by the Sierra Leone Agricultural Research Institute [4]. Furthermore there is limited access to improved varieties that meet farmers' desired traits. The study was therefore undertaken with the general objective to screen and identify promising cassava genotypes with resistance to CMD that meets farmers' desired traits.

Materials and Methods

Cassava Genotypes

One hundred local varieties were collected country - wide in farmer's fields from different agro-ecologies with varying level of resistance to CMD. These materials were evaluated along with 2,000 genotypes introduced from IITA for the purpose of this study. The 2,000 cassava genotypes and 100 local varieties were collected from major cassava growing regions in the world which were grouped into different families as follows: CIAT High Protein, Stay Green Varieties from Ghana, Yellow root, Varieties from Mozambique, Castor Crosses, Castor Hybrid, Castor Hybrid (4x), High carotene, Varieties from Tanzania, Benin Gemplasm, Yellow root poundable varieties from Brazil, Varieties from Chad, Bukina Faso, Sierra Leone and Liberia, Materials from Uganda,

Pink skin varieties, Colchiploids, IITA 94 series, Genetic gain and TME series. Seventy one cassava genotypes selected by farmers out of the 2,100 genotypes were further evaluated in multi-location for two years 2010/2011 and 2011/2012 planting seasons.

These locations were as follows, Njala (Forest Transition) in the Southern Province, Kenema (Rain Forest) in the Eastern Province and Kabala (Savannah Highlands), Kambia (Savannah Lowlands), Yenkessa (Coastal Plains) and Makeni (Savannah Lowlands) in the Northern Province.

Experimental Design

The general experimental design was a randomized complete block (RCB). In 2009, cuttings 20 – 30 cm long of each of the 2,100 varieties were planted in single row plots. Rows were 10m long with 1m between hills and 1.5m between replications. Infector rows were randomly placed between plots to ensure the presence of the cassava mosaic virus in the field. In the 2010/2011 and 2011/2012 planting seasons, a randomized complete block (RCB) with three factors which includes 76 cassava genotypes, 5 locations and 2 years was used with two replications.

Screening for field resistance to cassava mosaic disease

Data were collected on severity of the Cassava Mosaic Disease based on 1-5 scale (IITA, 1990) from all the 10 plants per row except the infector rows. Plants with mean CMD scores of "1" were classified as highly resistant (HR), those with a score of "1.1 to 2" were classified resistant (R), those with a score of "2.1 to 3" were classified as Moderately susceptible (MS) and those with scores of "3.1 to 4" were classified as Susceptible (S) and "4.1 to 5" were classified as highly susceptible (HS) [5].

Varietal selection process was done in a participatory manner. Forty farmers from three villages around the Njala Agricultural Research Centre's experimental and demonstration site comprising producers, processors and marketers were selected for participation in the varietal selection process. These villages included Foya, Mosongo and Njala. The Criteria set by farmers for selection from 2,100 cassava genotypes were as follows: High yield, disease resistance, pink outer skin colour of tubers, sweet taste and good cooking ability. Above ground as well as below ground characteristics were evaluated by careful examination of the leaves, stems and roots which were carefully uprooted and placed along paths of the experimental plots. Farmers were given the free will to select cassava genotypes based on their potential to meet the agreed criteria. The check varieties in this trial included five released varieties SLICASS 1 to SLICASS 4 which are known to be high yielding and resistant to African Cassava Mosaic Disease (ACMD) and Cocoa, a local susceptible variety to ACMD. Test to assess the culinary ability and consumer preference was conducted based on the character codes as follows:

1. Easily peel: 1= Easy (E), 2= Hard (H)
2. Outer skin colour: 1= White (W), 2= Yellow (W), 3= Pink (Pi), 4= Purple (P), 5= Creamy (C), 6= Red (R), 7= Green (G)
3. Inner appearance: 1= White (W), 2= Yellow (W), 3= Pink (P), 4= Creamy (C)
4. Cooking texture: 1= Cooked (C), 2= Slightly cooked (SC), 3= Hard (H)
5. Smell: 1= Good (G), 2= Fair (F)
6. Taste: 1= Sweet (S), 2= Slightly sweet (SS), 3= Bitter (B)
7. Pounding characteristics: 0= Hard (H), 1= Fairly poundable (FP), 2= Poundable (P), 3= Soft (S)

Yield estimated was based on the projection of ten tagged plants.

Data analysis

Data collected on various parameters were subjected to analysis of variance (ANOVA) using the general linear model (GLM) for multivariate analysis and with statistical analysis system (SAS) version 9.3. Student-Newman-Keuls Test was used to test for significance at 5 % probability ($p<0.05$) using lower case letters. Genotype, Genotype by Environment (GGE) bi-plot analysis was used to determine the best environment for growing cassava in Sierra Leone. Culinary traits analysis was subjected to simple statistics based on means and percentages.

Results

Response of 2,100 Cassava Genotypes to the Cassava Mosaic Disease

Cassava families reacted differently to the African Cassava Mosaic Disease. CIAT High protein, Ghana, Liberia, Mozambique, High carotene, yellow root poundable and TME series were the most susceptible families to ACMD with above 60% of the genotypes showing symptom of the disease. Stay green, yellow root, Castor crosses, castor hybrid (4x) and materials from Uganda provided higher number of resistant genotypes that could be also used in disease resistant breeding programmes.

Varieties collected from Sierra Leone based on field observation indicated that 12 varieties (14.8%) were ranked as highly resistant, 9 varieties (11.1%) were resistant, 25 varieties (30.8%) were moderately susceptible and 32 varieties (39.5%) were classified as highly susceptible to cassava mosaic disease.

Most of the cassava genotypes selected by farmers in 2009 exhibited high level of resistance to ACMD when screened in the field. A total of 1,827 (87%) of the 2,100 cassava genotypes assessed were classified as highly resistant with no symptom expression at 3 and 6months after planting (MAP). Another 273, (13%) of the cassava genotypes were however susceptible to ACMD. The TME series were the most infected and included TME 235 and TME 643 with the highest severity score of 4, higher than popular local variety which had a severity score of 3. Disease symptom expression was consistent with that of cutting borne infection for all plants assessed.

Yield estimates of selected cassava genotypes at Njala in 2009

The selected cassava genotypes showed very promising yield with zero fertilizer application. Storage root yield estimates of some of the selected cassava genotypes ranged between 22 t/ha to 48t/ha. The highest yielding cassava genotypes assessed includes, 94/0069 which had the highest yield of 48t/ha followed by 01/1551 with 41t/ha while the local check cocoa had 13t/ha. Other released varieties such as SLICASS 4, and 6 had 24t/ha and 20t/ha respectively.

Multi location screening of farmer preferred cassava genotypes in Sierras Leone

From a total of 2,100 genotypes initially screened in 2009, seventy one (71) genotypes identified by farmers and five check varieties SLICASS1, 2,4,6, and the local variety Cocoa were selected for multi-location evaluation based on the general criteria adopted for selection by farmers with special emphasis on mosaic resistant varieties.

Severity of cassava mosaic disease on farmers' preferred genotypes assessed for two years: Most of the cassava genotypes selected by farmers had high resistance to the cassava mosaic diseases. The overall mean of the genotypes assessed was 1.1. The mean severity score for most genotypes assessed were below the local check variety Cocoa with a score of 1.92 which was significantly highest score (P<.0001) but not significantly different from SLICASS 2 with a score of 1.75 (Table 1). Other check varieties released by SLARI which included SLICASS1 SLICASS 4 and SLICASS 6 exhibited no symptom of the cassava mosaic disease. Out of the 76 genotypes assessed, 59 (77.63%) showed no symptom of the disease. In general there was no significant difference in the performance of the varieties selected in the two years of assessment (P<0.05), however it was clear that symptom expression was inconsistent among some genotypes which could be attributed to the resistance of the genotypes and the environmental condition in which the crop was grown.

[a]CLONE	[b]ACMD severity
COCOA (Local check)	1.92a
SLICASS 2	1.75b
96/0595	1.50c
01/0025	1.33d
TME 203 (4X)	1.33d
TME 1674	1.21de
IFO 7010	1.17e
07/0498	1.17e
05/0127	1.08ef
MM97/3069	1.08ef
SM 1406-1	1.08ef
05/1652	1.08ef
05/0303	1.00f
CV%	20.6
SE±	0.048

[b]List not exhausted
[a]Means with the same letter are not significantly different.
Table 1: Some Mean Severity of Cassava Mosaic Disease on Farmer Preferred Genotypes assessed in 2010 and 2011

Severity of Cassava Mosaic Disease on farmers' preferred genotypes across locations: The severity of cassava mosaic disease among cassava genotypes selected was low (P<.0001). Yenkessa in the coastal plains had significantly highest severity scores of cassava mosaic disease (1.32) compared to all other locations. No significant difference was observed in disease expression among genotypes in Kabala (1.013), Kambia (1.013), Kenema (1.023), Makeni (1.012) and Njala (1.013) (Table 2). This result can best be presented using the GGE biplot analysis (Fig.1). The concentric circles which shows the best mega environments in response to ACMD. Yenkessa location was the worst affected location followed by the Kenema environment. Kabala, Kambia, Makeni and Njala had one cluster indicating safe environments for growing cassava.

Location	[a]ACMD severity
Yenkesa	1.32a
Kenema	1.02b
Makeni	1.02b
Kabala	1.01b
Njala	1.01b
Kambia	1.01b
CV%	
SE±	

[a]Means with the same letter are not significantly different.

Table 2: Severity of Cassava Mosaic Disease on farmers' preferred varieties across six locations in Sierra Leone

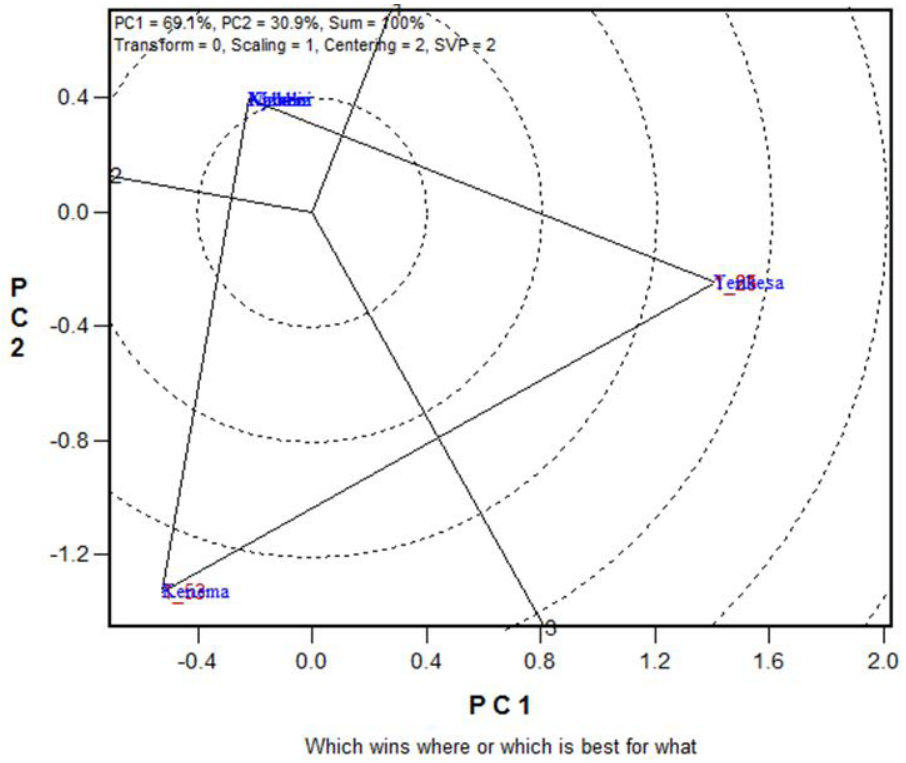

Figure 1: GGE biplot showing the best enviroment for avoiding the cassava mosaic disease in five locations in Sierra Leone. (PC1=69.1% PC2=30.9% SUM =100) Njala, Makeni, Kabala, Kambia falls within the same culster

Culinary traits possessed by farmers' preferred cassava genotypes

Cooking Time: Significant difference was observed among genotypes tested for their cooking ability. Most of the genotypes tested had poor cooking ability. Out of the 76 varieties tested for two consecutive years, 14 possessed the ability to cook under 20 minutes. These genotypes includes 94/0069, 95/0166, 95/0902 and 96/0097. The local check Cocoa was easily cooked at 20mins. Thoses that did not cook after 20minutes were considered as hard or slightly cooked varieties.

Pounding characteristics of farmers' preferred varieties: Based on the criteria adopted for poundabity, 14 out of the 76 genotypes tested were considered soft after boiling for 20 minutes. These include genotypes 88/00279, 91/00143 (4X), 92/0326, 94/0069, 95/0166, 95/0902, 96/0097, 96/0595, 96/1172, CC 055, CC 2365, MM02/2101, Mocuba and an Unknown 6 (Table 3).

Easy to peel varieties: Out of 76 genotypes tested by farmers, 42% (32) genotypes were found to be easy to peel. Among them included easy and hard to cook genotypes, genotypes with different inner appearance and level of poundability. Easy to peel genotypes identified included 01/0025, 02/0431, 02/0572, 03/025, 05/1652, 05/1654, 05/1661, 06/2064, 91/00143 (4X), 92/0326, 92/0475, 96/0160 (4X), 96/0409, 99/00110, CC 054, CC 103, CC 107, IFO 7010, MM001/0146, MM02/2101, MM3412, MM96/3665, MM96/5267, MM96/9181, 91B/00462, MOCUBA, TME 643, UNKNOWN 2, 3 and 6, W-820447, Z96/0012, respectively (Table 3).

Taste and smell of cassava genotypes: Out of the 76 genotypes tested by farmers, 92.1% of the 76 genotypes identified were considered to have a sweet taste. Two (2) varieties were considered to be slightly sweet and four were considered to be bitter. 85.5% i.e. 65 genotypes were considered to have a good smell. Other varieties were considered to be odourless or fair (Table 3).

Clone	Easy to peel	Outer skin color	Inner appearance	Cooking texture	Smell	Tast	Cooking time (mins)	Pound ability	Yield (t/ha)
88/00279	hard	white	white	cooked	good	sweet	15.00	soft	27.13
91/00143 (4X)	easy	cream	white	cooked	good	sweet	20.00	soft	22.68
92/0326	easy	cream	white	cooked	good	sweet	20.00	soft	33.05
94/0069	hard	white	white	cooked	good	sweet	15.00	soft	28.47
95/0166	hard	white	white	cooked	good	sweet	15.00	soft	22.11
95/0902	hard	white	white	cooked	good	sweet	15.00	soft	21.99
96/0097	hard	white	white	cooked	good	sweet	15.00	soft	34.26
96/1172	hard	white	white	cooked	good	sweet	15.00	soft	27.90
CC 055	hard	white	white	cooked	good	sweet	15.00	soft	26.67
CC 2365	hard	white	white	cooked	good	sweet	15.00	soft	18.49
MM02/2101	easy	white	white	slightly cooked	good	sweet	20.00	soft	41.76
MOCUBA	easy	white	white	slightly cooked	good	sweet	20.00	soft	26.41
UNKNOWN 6	easy	cream	cream	cooked	fair	bitter	20.00	soft	29.76
COCOA	Hard	Pink	White	Cooked	Good	sweet	20.00	soft	16.22

Table 3: Characteristics of some cassava genotypes with poundable trait, good cooking ability for local food

Outer skin colour: Three cassava genotypes had pink skin a trait presumed to be associated with good cooking ability by farmers and they include SM 1406-1 TME 643 and Cocoa the local check. Another 29 genotypes had white outer skin colour, 24 genotypes had a yellow outer skin colour and 20 genotypes had a cream outer skin colour.

Inner appearance of tubers: A total of 71 cassava genotypes, 93.4% out of the 76 cassava genotypes had selected by farmers had a white inner appearance of the tubers. Three cassava genotypes selected were yellow root rich in pro vitamin A and included 05/0127, 05/1654 and CC 103.

Characteristic farmers' preferred genotypes for industries assessed for two year

All cassava genotypes selected were resistant to cassava mosaic disease. Cassava genotypes generally attracted low population levels of whiteflies. The dry season attracted more whiteflies compared to the rainy season which did not exceed 17 whiteflies per plant. Significant difference was observed among cassava genotypes in terms of storage root yield. The highest mean storage root yield taking into account the two years of study was (MM96/7204 (4X) with a mean storage root yield of 47.0 t/ha followed by 06/1474 with 43.24 t/ha. Most of the cassava genotypes selected for industrial uses had tubers which remained hard when subjected to boiling after 20 minutes (Table 4).

[a]Farmers' preferred genotypes	ACMD Severity	Whitefly population rainy season	Whitefly population dry season	Cooking time (Min)	Yield (t/ha)
07/0649	1.00f	1.83mlkihjpqon	10.83kejbidhgcf	24.17f	35.97dce
01/0034	1.00f	3.38melkidhjgefn	6.08kjmihl	18.33l	33.93gfe
LIBRICASS-1	1.00f	2.92melkidhjgpcofn	13.50ejbidhagcf	26.67c	32.43hgi
MM001/0146	1.00f	1.92mlkihjgpqon	8.33kejmihlgf	23.83g	35.90dce
06/1474	1.00f	3.63melkidhjgcf	17.83bdac	24.17f	43.24b
MM96/7204 (4X)	1.00f	1.92mlkihjgpqon	7.58kjmihlgf	24.17f	47.00a
MM02/1807	1.00f	2.96melkidhjgcfn	7.00kjmihlg	20.00j	33.05hgf
91B/00462	1.00f	2.58melkihjgpqofn	15.00ebdhagcf	20.00j	32.20hgi
SLICASS 1	1.00f	0.83pqon	5.33kjmil	26.67c	37.72c
02/0105	1.00f	3.67melkidhjgcf	11.08kejbidhagcf	25.00e	30.71lhkij
SLICASS 6	1.00f	1.83mlkihjpqon	0.00m	24.17f	32.20hgi
96/0097	1.00f	2.21mlkihjgpqofn	14.17ebidhagcf	14.17q	34.23dgfe
96/0409	1.00f	3.75melkidhjgcf	13.25kejbidhagcf	20.00j	30.17lmkij
UNKNOWN 7	1.00f	1.17mpqon	6.75kjmihlg	25.00e	34.94dfe
W-820447	1.00f	2.04mlkihjgpqon	6.08kjmihl	25.00e	31.96hgij
Z99/0094	1.00f	0.25q	6.75kjmihlg	25.00e	30.36lkij
02/0540	1.00f	6.54q	11.50kejbidhagcf	24.17f	31.03hkij

[a]List not exhausted Means with the same letter are not significantly different

Table 4: Characteristic farmers' preferred genotypes identified for industrial uses assessed for two year. 2010/2011 and 2011/2012

Storage root yield (t/ha) of farmers preferred cassava genotypes across locations for 2011 and 2012

Significant difference in storage root yield was also observed in the overall performance of cassava genotypes tested across locations. Kabala had the highest storage root yield (P> .0001) of 35.89 t/ha significantly higher than all locations followed by Kenema with 34.83 t/ha significantly higher than Makeni with 33.55 t/ha which in turn was significantly higher than Njala with 28.69. Kambia and Yenkesa had significantly the lowest yields of 26.29 t/ha and 18.70 t/ha respectively (Table 5). This result is clearly presented as a GGE biplot for yield in (Figure 2) which shows that the Kabala environment was the best environment followed by Kenema and Makeni. The Yenkesa environment was the worst performing location for growing cassava.

Location	Storage root yield (t/ha)
Kabala	35.89a
Kenema	34.83b
Makeni	33.55c
Njala	28.69d
Kambia	26.29e
Yenkesa	18.70f
CV%	11.6
SE±	11.8

Means with the same letter are not significantly different

Table 5: Storage root yield (t/ha) of farmers preferred cassava genotypes across locations in 2011 and 2012

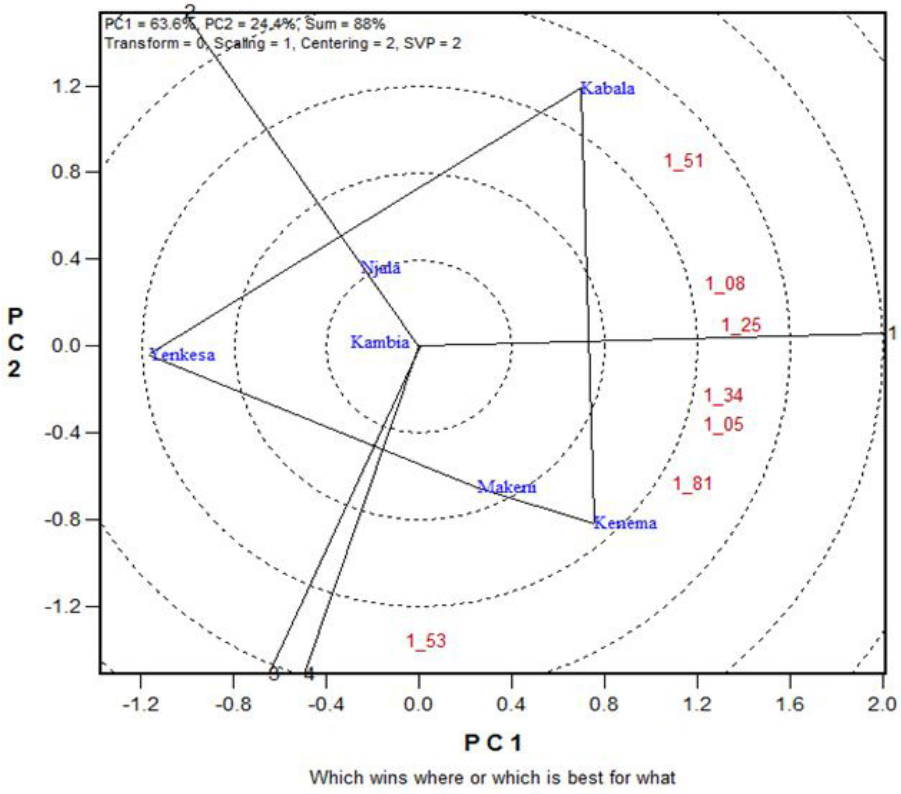

Figure 2: Genotype, Genotype by Environment bi-plot for storage root yield of farmers preferred varieties across locations

Discussion

The result of this study shows that efforts by Sierra Leone Agricultural Research Institute and other development agencies in the development and dissemination of improved cassava varieties to farmers have been moderately effective. Morphological screening of 2,000 introduced cassava genotypes from IITA and 100 local collections for CMD resistance based on the 1-5 scale and classification according to, revealed that farmers are interested in disease resistant cassava genotypes [5-7]. The identification of resistant genotypes across agro ecologies for boil and eat purposes as well as industrial purposes provides enormous opportunities for increasing cassava productivity. All the cassava varieties evaluated did not meet all the traits desired by farmers. The relevance of this finding is that breeding efforts should target specific needs that meet both domestic and industrial uses. Clearly, showed that the boil and eat market for poundable cassava varieties such as Cocoa was a more profitable enterprise despite the comparatively

low yield [8]. This implies that breeding efforts should not only be geared towards resistance or pest and diseases but should also focus on other culinary traits such as easy to cook, easy of peeling and resistance to post physiological deterioration. These traits are more relevant along the value chain which addresses concerns from production, processing and marketing to improve the profitability of cassava.

Conclusion

Screening for resistance to cassava mosaic from 2,100 cassava genotypes provided a direction to which cassava families possess resistance and susceptibility to the cassava mosaic virus and from which sources of resistance should be sought. High level of cassava mosaic disease resistance varieties could be sought from families such as stay green, yellow root castor crosses, castor hybrid (4x) and materials from Uganda. Disease symptom expression was consistent with that of cutting borne infection for all plants assessed. Fourteen (14) poundable cassava genotypes and twenty high yielding genotypes resistant to cassava mosaic disease were identified with the participation of farmers for multiplication and distribution across agro ecologies. Varieties identified did not meet all the traits desired by farmers however all varieties exhibited high yield potential and resistance to pests and diseases especially the cassava mosaic disease. Most of the varieties identified for domestic and industrial use had significantly higher yield compared to the check varieties. Kabala, Kenema and Makeni had the best environment for growing cassava in Sierra Leone.

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References

1. Fomba SN, Massaquoi FB, Samura AE, Fornah DS, Benya MT, et al. (2012). Innovative systems to improve small to medium scale cassava processing in Sierra Leone. In Y. U.Okechukwu & P. Ntawuruhunga (Eds.), Proceedings of the 11th Triennial Symposium of the ISTRC (pp. 603-616). International Institiue of Tropical Agriculture, (1990). Cassava in Tropical Africa, A reference Manual. Ibadan, Nigeria: International Institute of Tropical Agriculture (IITA).

2. Sanni LO, Oluwatobi O, Onadipe O, IlonaP, Mussagy MD, et al. (2009) Successes and challenges of cassava enterprises in West Africa: a case study of Nigeria, Bénin, and Sierra Leone. Ibadan, Nigeria: International Institute of Tropical Agriculture.

3. FAOSTAT (2014) FAOSTAT. Rome, Italy.

4. Samura AE, Massaquoi FB, Mansaray A, Kumar PL, Koroma JPC, et al. (2014) Status and diversity of the cassava mosaic disease causal agent in Sierra Leone. Int J Agri Forest 4: 246-54.

5. International Institiue of Tropical Agriculture (IITA) (1990) Cassava in Tropical Africa, A reference Manual, Ibadan, Nigeria: International Institute of Tropical Agriculture (IITA).

6. Ariyo OA, Koerbler M, Dixon AGO, Atiri GI, Winter S (2005) Molecular variability and distribution of cassava mosaic begomoviruses in Nigeria. J phytopathol 153: 226-31.

7. Lokko Y, Danquah E Y, Offei S K, Dixon A G, and Gedil M A (2005) Molecular markers associated with a new source of resistance to the cassava mosaic disease. Africa J Biotechnol 4.

8. Samura AE, Lakoh KA, Nabay O, Fomba SN, Koroma JPC (2017) Effect of Cassava Mosaic Disease (CMD) on Yield and Profitability of Cassava and Gari Production Enterprises in Sierra Leone. J Agricultur Sci 9.