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Agronomic Evaluation of Some Local Elite and Released Cassava Varieties in the Forest and Transitional Ecozones of Ghana

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Abstract: Trials were conducted at two different locations in the Forest and Transition ecozones of Ghana in 2004 and 2005. The aim was to evaluate the agronomic performance of four elite varieties against four released varieties and to determine GXE effect on selection of varieties for the Forest and Transition ecozones of Ghana. Eight genotypes involving four local elite and four released varieties were used. Data collected include tuber yield, harvest index, dry matter content, cooking quality, flour, starch and gari yields. Data collected were analysed with Analysis of Variance (ANOVA) including the factors genotype, location and year for all the data collected except cooking quality using Costat. The difference method in which experienced but few people are used, was use to rank the cooking quality of the genotypes on a scale of 1 to 4 with 1 as poor and 4 as excellent. Tuber yield was generally higher for the released varieties than the local elite ones. The opposite was true for the dry matter content. Harvest index was in the range of 0.48-0.64. Cooking quality of the local elite varieties was generally better than the released ones The results show differences in response of the agronomic traits of cassava to different environmental conditions. This justifies specific adaptation as a goal for local breeding. It also shows that these traits are genotype dependent. It is therefore, critical that cassava genotypes are screen across the various cassava growing areas to assess their potential usage before its potential for specific use may be recommended.

Key words: Agronomic, cassava, tuber yield, dry matter, cooking quality

INTRODUCTION

Root and tuber crops are the most important food crops after cereals and grain legumes and cassava because of its potential for higher dry matter production per day stands out among them (Srinivas and Anantharuman, 2000). In Ghana, cassava contributes 16% of the Agricultural Gross Domestic Product (AGDP) which is higher than any other crop including cocoa (Safo-Kantanka, 2004). Its importance is derived from its diverse use for human consumption, animal feed and industrial applications. Cassava improvement programme in Ghana have been based largely on the use of exotic germplasm. Dixon *et al*. (1991a) however stated that native varieties have usually been selected over a long period for adaptability and palatability by farmers. Though the use of local germplasm in Ghana got underway with the establishment of the National Agricultural Research Project (NARP) between 1991 and 1997. There were still large gaps in the local cassava germplasm that was assembled under NARP since the Brong Ahafo region was not covered. Hence to fill some of these gaps, a collection of over 200 local cassava accessions from part of Brong Ahafo region which covers both Forest and Forest-Transition ecological zones of Ghana was made. Selection from on-station trials from these local accessions led to the discovery of four elite genotypes that had potential for further testing and release

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to farmers. According to Dixon *et al.* (1991b), cassava as a crop is widely adapted, but individual cultivars may have limited adaptation because of cassava's sensitivity to genotype by environment (GXE) interaction. To ensure that productivity of a particular genotype is maximised, it must be grown in the adaptable environment. Therefore, studies into the relative response of genotypes across different environment in crop improvement will help to identify varieties with general adaptation and those with specific adaptation.

This change in a cultivar's relative performance over environments, resulting from differential response of the cultivar, to various edaphic, climatic and biotic factors was defined by Dixon *et al.* (1991a) as GXE interaction. GXE interactions limit progress of crop improvement beyond the breeder's station. Thus when GXE interactions are present, the breeder faces the problem of selecting genotypes for performance; since the interaction reduces the correlation between genotype and phenotype, resulting in weak inferences from field data (Ngeve, 1994). Though some GXE studies have been reported on cassava in West Africa (Dixon *et al*., 1991a; Dixon and Nukenine, 2000; Akparobi, 2006), very little is known about its effect on cassava in Ghana. The objective of this work was to evaluate the agronomic performance of four elite varieties against four released varieties and to determine GXE effect on selection of varieties for the Forest and Transition ecozones of Ghana.

MATERIALS AND METHODS

This study was a component of data collected for breeding programmes aimed at identifying cassava genotypes that were suitable for indigenous preparations, processing and fitting into the existing farming practices in the Forest and the Transition ecozones of Ghana. The experiment was set up at Kwame Nkrumah University of Science and Technology (KNUST) and Wenchi Agricultural Research Station representing the Forest and the Transition ecozones, respectively. The experiment was carried out in 2004 and 2005, respectively. Four elite varieties which were at an advanced state of evaluation prior to release were used. These were NKZ-009, NKZ-015, DMA-002 and WCH-037. These four elite varieties were compared to four already released varieties namely Afisiafi, Abasafitaa, Gblemoduade and a mutant variety Tek-bankye. Land preparation in the Forest included slashing and removal of stumps. For the Transition ecozone, the land was ploughed and harrowed before planting. The spacing was 1×1 m. No fertilizer or herbicide was applied in the course of the experiment and weeding was done thrice at three months interval starting from three months after planting. Harvesting was done at 12 months after planting. Data taken included harvest index, tuber yield, dry matter content, cooking quality, flour yield, gari yield and starch yield. In order to assess the yield of flour, gari and starch, 25 kg fresh tubers of each variety was given to some women processors who had been trained how to process these products by Women in Agricultural Development (WIAD) of the Ministry of Food and Agriculture (MoFA) at their local factory at Ashanti Mampong. Analysis of variance (ANOVA) including the factors genotype, location and year were performed for all the data collected except cooking quality using Costat. The difference method in which experienced but few people are involved was used to rank the cooking quality of the genotypes on a scale of 1 to 4 with 1 as poor and 4 as excellent.

RESULTS AND DISCUSSION

Combined analyses of variance for all the traits showed significant ($p<0.01$) mean squares for genotype except starch yield (Table 1). This may result in variation in the response of the genotypes across different environment. While location effect was significant for only harvest index and gari yield, the year effect was significant for only the tuber yield and the flour yield (Table 1). The differences in location and years effect for the harvest index and gari yield and the tuber and flour yields indicates

Table 1: Combined analyses of variance over two locations and two years for mean squares of tuber yield, harvest index, dry matter content, flour, starch and gari yields of 8 cassava genotypes

Source of variation	df	Tuber yield (t ha^{-1})	Harvest index	Dry matter content (%)	Flour yield (t ha^{-1})	Gari yield (t ha^{-1})	Starch yield (t ha^{-1})
Year (Yr)	1	1189.14*	3.13ns	0.66ns	45.75*	1.08ns	1.00ns
Location (L)	1	248.02ns	0.01*	5.94ns	29.47ns	54.13*	1.73ns
Genotype (G)	7	293.77*	0.01*	76.49*	12.98*	1.35*	1.91ns
G×L	7	251.93ns	0.01*	14.46ns	23.94ns	4.35*	2.14ns

ns: not significant at 0.05 levels of probability, *: Significant at $p<0.05$

Table 2: Mean tuber yield (t ha^{-1}) and harvest index for the 8 cassava genotypes

Genotypes	Tuber yield	Harvest index
DMA-002	31.17	0.48
WCH-037	36.79	0.54
NKZ-009	41.38	0.61
NKZ-015	37.91	0.53
Tek-bankye	32.25	0.53
Afisiafi	50.02	0.64
Abasafitaa	42.34	0.64
Gblemoduade	56.17	0.61
LSD (5%)	20.12	0.02

that cassava respond differently to variation in environmental conditions between and within locations for these traits. These justify specific adaptation as a goal for local breeding programmes (Akparobi, 2006).

Tuber yield of the varieties range from 31.17 to 56.17 t ha^{-1} (Table 2). The highest and the lowest yield were given by Gblemoduade and DMA-002, respectively. In general, tuber yield of the released varieties was higher than the elite local varieties. Dixon and Nukenine (2000) also found genotypic effect on tuber yield of cassava in a multilocation trial conducted over a 3 year period in Nigeria. Varietal differences were also established between the varieties for harvest index (Table 2). The range was 0.48 to 0.64 and was also generally higher for the released varieties than the elite local varieties. The differences in tuber yield of the varieties may be attributed to differences in the partition efficiency as explained by the differences in harvest index (Table 2). Harvest index was higher ($p<0.05$) at Wenchi (0.59) than KNUST (056).

Dry matter content of the varieties ranged from 34.24 to 46.348% (Table 3). These values were given by Gblemoduade and DMA-002 and WCH-037, respectively (Table 3). In general, the elite local varieties gave higher dry matter content than the released ones (Table 3). Dixon and Nukenine (2000) also observed genotypic effect on dry matter content of some cassava genotypes studied in Nigeria. Cooking quality depends on a number of factors including variety and environment (Safo-Kantanka and Asare, 1993; Safo-Kantanka and Acquistucci, 1996). The results show most elite local varieties being more superior to the released ones. The differences may be due to variations in their dry matter content (Table 3). This is because the elite local varieties which gave higher dry matter content produced better cooking quality. This observation was made by Safo-Kantanka and Owusu-Nipa (1992) and it agrees with Safo-Kantanka and Asare (1993) who reported a positive correlation between dry matter content and cooking quality of cassava. This may be the reason why farmers seem to have attached so much importance to dry matter content and either by their own effort or that of their ancestors selected higher dry matter genotypes and conserved in their fields to meet their food needs. For example, Gblemoduade which was the highest tuber yielding variety had the lowest dry matter content, hence poor cooking quality.

Flour, Starch and Gari Yield

The flour yield was in the range of 8.18-13.22 t ha^{-1} (Table 4). These values were given by DMA-002 and Gblemoduade. The rage for the gari yield was 6.02 to 9.66 t ha^{-1} (Table 4). These

Table 3: Mean dry matter content (%) and cooking quality for the 8 cassava genotypes

Genotypes	Dry matter content	Cooking quality (Score 1-4)+
DMA-002	46.34	2.88 (3)
WCH-037	46.34	3.13 (2)
NKZ-009	39.93	1.25 (6)
NKZ-015	45.87	2.63 (4)
Tek-bankye	42.54	2.50 (5)
Afisiafi	39.17	1.00 (7)
Abasafitaa	45.17	3.63 (1)
Gblemoduade	34.24	1.00 (7)
LSD (5%)	9.75	

+: 1 = Poor; 2 = Good; 3 = Very good; 4 = Excellent, Cooking quality ranking in parentheses: 1 = Highest and 8 = Lowest

Table 4: Mean flour, gari and starch yields (t ha^{-1}) for the 8 cassava genotypes

Genotypes	Flour yield	Gari yield	Starch yield
DMA-002	8.18	6.25	2.31
WCH-037	9.27	6.87	1.62
NKZ-009	10.27	7.21	3.34
NKZ-015	9.42	6.02	2.21
Tek-bankye	7.58	6.18	1.78
Afisiafi	11.51	7.71	3.20
Abasafitaa	10.00	6.87	2.55
Gblemoduade	13.22	9.66	3.37
LSD (5%)	4.64	3.08	2.03

values were given by NKZ-015 and *Gblemoduade*. Gari yield was higher ($p<0.05$) at Wenchi (8.38 t ha^{-1}) than KNUST (5.78 t ha^{-1}). The range for the starch yield was between 1.62 t ha^{-1} (WCH-037) and 3.37 t ha^{-1} (Gblemoduade) (Table 4).

The higher dry matter content of the elite local varieties was not reflected in the flour, starch and gari yields. The only exception was NKZ-009. It is doubtful if there are no real relationships between dry matter content, flour, starch and gari yields. The lack of association may be attributed to inefficiencies in the local commercial processing method used since according to Safo-Kantanka *et al*. (2003), this method is 50% or more, less efficient compared with laboratory method. This therefore, demands technological improvement on the local commercial method for producing flour, starch and gari. Another possible reason is that reduction in dry matter content may be due to the sieving out of fibres and other undesirable solid materials in the tubers during processing. Hence, the yield of flour, starch and gari obtained may not reflect the potential yields of the varieties.

CONCLUSION

The results show differences in response of the agronomic traits of cassava to different environmental conditions. This justifies specific adaptation as a goal for local breeding. It also shows that these traits are genotype dependent. It is therefore, critical that cassava genotypes are screen across the various cassava growing areas to assess their potential before its potential for specific use may be recommended.

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