

# Effect of Genotype and Periodic Pruning on Storage Root Yield and Yield Components of Some Cassava Genotypes Under Rain-Fed Conditions In Ghana

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## Abstract

Cassava (*Manihot esculenta* Crantz) is cultivated primarily for its starchy roots which provide a staple for millions of people in the tropics. The foliage contains high levels of protein which can be harvested for human and animal feed. Twenty five cassava genotypes were arranged in a randomized complete block design with three replications to investigate their tolerance to periodic pruning with respect to effect on root yield and yield components. The cassava plants were periodically pruned starting from three months after planting and at three months intervals until root harvest at 12 months after planting. Storage root yields ranged between 8.3-26.2 t/ha and 28.9-85.5 t/ha for the pruned plants and the control respectively. The pruned plants produced average root yield of 14.7 t/ha compared with 51.5 t/ha from the control. Though periodic pruning resulted in significant reduction in all components measured, genetic variations were observed in the level of reduction. Observed root yield reduction ranged between 40-80%. Five genotypes; 96/1642, *Afisiafi*, *Esambankye*, *Agbelifia* and *Bankyehemaa*, recorded storage root yield reduction of less than 50% of their respective controls. Starch content and mean storage root weight were also significantly reduced by periodic pruning. The significant genetic variations in the reduction of these traits indicated different levels of tolerance which can be exploited in further studies to identify ideal cassava genotypes for dual purpose utilization for foliage and root production.

**Keywords:** cassava, genotypes, periodic pruning, storage root yield, percentage yield reduction

## 1. Introduction

Breeding of cassava (*Manihot esculenta* Cranz) solely for root yield and its characteristics in Ghana has led to the neglect of genotypes that are good foliage producers. Though cultivation of cassava solely for foliage productivity is a common practice in Asia (Indonesia, China and Thailand) and some parts of Africa (Lockard et al., 1985; Bokanga, 1994; Limsila et al., 2007; Umuhozariho et al., 2011), the practice is not common in Ghana. Past breeding efforts have focused on developing early bulking, high storage root yield, pest and disease tolerant, low hydrocyanic acid content genotypes with good cooking quality (Annor-Frempong, 1994; Nweke et al., 1994). Boampong (2001) also stated that storage root yield and its characteristics as the most important goal of cassava breeding and ranks high in the choice of variety by farmers. Therefore agronomic practices such as foliage harvesting that will interfere with storage root yield are avoided by farmers.

Apart from the starchy storage roots, the fresh foliage is also utilized in several regions of the world for animal and human consumption (Chavez et al., 2005). Several researchers have reported the nutritive value of cassava foliage which makes it a major source of protein, minerals and vitamins in human diets in certain parts of Africa (Bokanga, 1994). The leaves which are rich in minerals and vitamins, contain 17-34% protein (dry weight basis) and are used for human consumption in certain parts of Africa (Bokanga, 1994; Kobawila et al., 2005; Adjebeng-Danquah & Safo-Kantanka, 2013). The leaves together with the unligified upper part of the stem constitute a very good source of protein for both human and animal consumption (Ravindran and Rajaguru, 1988; Bokanga, 1994; Limsila et al., 2007). In Rwanda, cassava leaves constitute a very important vegetable which is used in several food preparations (Umuhozariho et al., 2011). However in Ghana only the roots are of economic

importance and was ranked number one in Ghana after the country produced over 1.45 million metric tons in 2013 with over US\$ 1.51 million in foreign exchange (FAO, 2014). The potential of the foliage has not been fully exploited due to its possible interference with root yield (Hunt et al., 1977; Fasae et al., 2009).

Tung et al. (2001) reported possible decline in storage root yield as a result of intensive pruning. This is because defoliation reduces root weight due to reduced carbohydrates synthesized per plant (Wright, 1962) and hence reduced quantity of photoassimilates available for storage. The choice of an ideal cassava variety for foliage production therefore depends on its ability to tolerate periodic pruning without a significant reduction in storage root yield. However there is scanty information on the genetic variation among different cassava cultivars in terms of tolerance to periodic pruning (Tung et al., 2001). Many factors such as the differences in maturity and plant architecture could account for this variation. Early bulking genotypes begin carbohydrate accumulation at an earlier stage than late bulking types and so they are likely to be less affected by pruning than late bulking types (Okogbenin & Fregene, 2002).

This study sought to evaluate some advanced cassava genotypes to (1) determine the extent of variation of among cassava genotypes in terms of storage root yield following periodic pruning (2) identify cassava genotypes that show least significant reduction in storage root yield with periodic pruning for possible dual-purpose utilization and (3) determine the effect of periodic pruning on storage root yield components in cassava.

## 2. Materials and Methods

### 2.1 Plant Materials

The study was conducted using 25 cassava genotypes obtained from different sources (Table 1). They were made up of eleven elite local accessions obtained from the Wenchi Agricultural Experimental Station of the Ministry of Food and Agriculture. These materials were being screened for early maturity and cooking quality. Five of the genotypes were also advanced breeding materials obtained from the International Institute of Tropical Agriculture (IITA). Nine already released varieties were also used in the study.

Table 1. List of cassava genotypes used for the study

Genotype	Background/origin	Genotype	Background/origin
96/0160	Exotic accession from IITA	DMA 004	Elite local accession
96/0603	Exotic accession from IITA.	<i>Dokuduade</i>	Released variety (IITA)
96/1565	Exotic accession from IITA	<i>Esambankye</i>	Released variety(IITA)
96/1569	Exotic accession from IITA	<i>Gblemoduade</i>	Released variety (IITA)
96/1642	Exotic accession from IITA	<i>IFAD</i>	Released variety (local)
<i>Abasafitaa</i>	Released variety (IITA)	<i>Kyempe</i>	Elite local accession.
ADI 001	Elite local accession.	<i>Nkabom</i>	Released variety (local)
ADI 002	Elite local accession	TANO 001	Elite local accession.
<i>Adugyama</i>	Elite local accession.	TANO 003	Elite local accession.
<i>Afisiafi</i>	Released variety (IITA)	TCH 001	Elite local accession.
<i>Agbelifia</i>	Released variety (IITA)	TCH 002	Elite local accession.
AWO 001	Elite local accession.	TCH 004	Elite local accession.
<i>Bankyehemaa</i>	Released variety (IITA)		

### 2.2 Field Experiment

The field experiment was laid out as a randomized complete block design (RCBD) experiment with three replications. The 25 cassava genotypes represented the treatments. Cuttings from the 25 cassava genotypes were planted on the flat using a spacing of 60 cm × 60 cm which is considered as the optimum spacing for foliage production (Limsila et al., 2007). Each plot consisted of four rows of plants with 10 plants in a row. The plot size was thus 2.4 m × 6 m resulting in a plant population of approximately 27,778 plants/ha. Cassava foliage (comprising the unligified young stems, leaves and petioles) was hand harvested following Limsila et al. (2007).

Foliage harvesting commenced at three months after planting and was repeated at three months' intervals with the fourth harvest coinciding with root harvest (12 MAP). At root harvest, data were collected on storage root yield (t/ha), starch content (%), harvest index, number of storage roots per plant, mean storage root weight (g) and storage root dry matter (%). The starch content of the storage roots of each genotype was determined based on the specific gravity using the *Reimann* scale balance method as outlined by Prammanee et al. (2010). For dry matter content determination, random samples of storage roots of each of the 25 genotypes were taken and chopped into smaller pieces. These were then mixed thoroughly after which sub samples of 100g each were taken for oven drying at 80 °C for 48 hours. The dry matter content (%) was estimated based on the final dry weight as a percentage of the initial fresh weight taken.

### 2.3 Data Analysis

The data was subjected to analysis of variance (ANOVA) for randomized complete block design (RCBD) using the GenStat Release 12.1 for windows (GenStat, 2009). Genotypes and pruning were considered as factors to assess the genotypic response to pruning. Significant differences between genotypes under pruning and no pruning were tested using their standard errors of differences. Two sample t-test was performed to compare the mean performance of all genotypes under pruning and no pruning using GenStat (GenStat, 2009).

## 3. Results

### 3.1 Analysis of Variance

Analyses of variance indicated highly significant ( $P < 0.01$ ) genotype effect for root yield (t/ha) and mean root weight (g) and very highly significant ( $P < 0.001$ ) genotype effect for starch content and storage root dry matter content (Table 2). The effect of pruning on all traits was also very highly significant ( $P < 0.001$ ). However the interaction between genotype and pruning effect on all traits were not significant ( $P > 0.05$ ).

Table 2. Mean squares for root yield and yield components of 25 cassava genotypes under pruning and no pruning

Source of variation	D.f.	Root yield (t/ha)	Mean root weight (g)	Starch content (%)	Harvest index	Dry matter content (%)
Rep	2	1877.70	0.08	2.76	0.081	3.12
Genotypes (G)	24	453.80**	0.02**	25.37***	0.034***	36.75***
Pruning (P)	1	45197.10***	2.66***	272.57***	1.193***	219.13***
GxP	24	263.40NS	0.12NS	2.72NS	0.010NS	3.65NS
Residual	98	231.10	0.11	3.03	0.009	5.73
Total	149					

\*\* , \*\*\* = significant at  $P < 0.01$ , and  $P < 0.001$  respectively. NS = Not significant ( $P > 0.05$ ).

### 3.2 Root Yield

Storage root yield was generally reduced when the plants were pruned as compared with the control (Table 3). Significant differences ( $P \leq 0.05$ ) were established between the different genotypes in terms of this reduction. The pruned plants gave an average storage root yield of 14.7 t/ha as against 51.5 t/ha from the control. The reaction of the genotypes to the periodic pruning as given by their yield relative to their control could be grouped into classes of 10-20, 20-30, 30-40 up to 80-90 t/ha. Storage root yield from the pruned plants fell within the lower classes (Figure 1). Genotypes like TANO 003, DMA 004 and TCH 002 all had root yields below 10 t/ha. Most of the pruned plants recorded storage root yields that fell within the 10-20 t/ha and included 96/1565, *Dokuduade*, *Agbelifia*, 96/0603, etc. The highest storage root yield recorded in the pruned plants fell within the 20-30 t/ha class included *Afisiafi*, *Esambankye* and 96/1642. The highest yielding genotype under pruning was 96/1642 which gave 26.2 t/ha and this was significantly different ( $P \leq 0.05$ ) from most of the other genotypes. The storage root yields from the control plants were quite high as they ranged between 20-30 t/ha and 80-90 t/ha. Only one genotype (*Bankyehemaa*) from the control produced a storage root yield within the 20-30 t/ha class which was the least. Majority of the genotypes including ADI 001, 96/1642, ADI 002, etc. recorded storage root yields which fell within the 40-50 and 60-70 t/ha classes. *Gblemoduade* gave the highest yield of 85.5 t/ha fell in the highest class of 80-90 t/ha category.

Storage root dry matter content (%) was also varied significantly ( $P < 0.05$ ) among the genotypes under pruning and the control (Table 3). Under pruning, dry matter content ranged between 32.1% and 41.3% for TANO 003 and IFAD respectively. The lowest storage root dry matter content from the control was obtained from 96/1565 (34.5%) whilst IFAD had the highest dry matter content (43.3%). Pruning resulted in significant reduction in dry matter content. Average root dry matter contents were 37.1% and 39.5% for pruned plants and the control respectively which were significantly different according to the t-test ( $P < 0.05$ ). However significant genetic variation was observed among the genotypes in the extent of reduction. The lowest reduction was recorded in 96/0160 (1.6%) with TANO 003 having the highest reduction in dry matter content (17.2%).

Table 3. Storage root yield and dry matter content of 25 cassava genotypes under pruning and no pruning

Genotypes	Storage root yield (t/ha)			Dry matter content (%)		
	Pruned plants	Control	% reduction	Pruned plants	Control	% reduction
96/0160	12.00	73.51	80.41	36.20	36.81	1.60
96/0603	17.90	64.42	72.61	35.20	36.40	2.91
96/1565	19.80	70.20	70.10	32.61	34.51	5.32
96/1569	17.20	41.30	58.10	38.70	40.40	2.41
96/1642	26.20	59.02	50.31	33.90	37.11	8.52
<i>Abasafitaa*</i>	15.40	41.30	62.80	38.22	40.21	4.91
ADI 001	11.20	56.02	79.30	39.80	41.70	4.52
ADI 002	14.90	55.70	58.60	38.10	40.30	5.21
<i>Adugyama</i>	10.00	47.50	76.90	34.71	38.61	9.42
<i>Afisiafi*</i>	20.90	52.90	55.51	36.20	40.71	10.90
<i>Agbelifia*</i>	18.10	52.92	52.71	33.41	34.72	3.92
AWO 001	14.80	56.20	74.01	35.92	41.13	12.80
<i>Bankyehemaa*</i>	14.60	28.90	40.10	38.01	42.31	10.32
DMA 004	8.30	37.81	69.71	38.20	39.82	3.60
<i>Dokuduade*</i>	18.70	62.30	65.80	36.22	38.03	4.71
<i>Esambankye*</i>	22.50	48.51	53.61	38.61	39.61	2.32
<i>Gblemoduade*</i>	16.50	85.52	80.41	33.91	35.22	3.70
<i>IFAD*</i>	14.40	45.31	65.61	41.30	43.31	4.63
<i>Kyempo</i>	8.90	41.90	78.00	41.22	41.90	1.71
<i>Nkabom*</i>	11.80	30.81	63.22	38.70	40.83	5.12
TANO 001	12.30	44.71	70.60	40.51	41.31	2.03
TANO 003	9.60	35.01	51.41	32.22	38.82	17.22
TCH 001	10.01	41.42	75.90	38.91	40.20	3.21
TCH 002	9.60	71.50	68.62	40.10	43.31	7.42
TCH 004	12.50	41.90	68.21	37.42	41.62	10.15
Mean	14.70	51.46	65.70	37.13	39.56	5.94
SED	3.63	20.44	13.48	2.11	1.82	6.16
t (cal)(means)	12.35			3.29		
$t_{0.05(2), 48}$	2.011			2.011		

\* Released varieties.

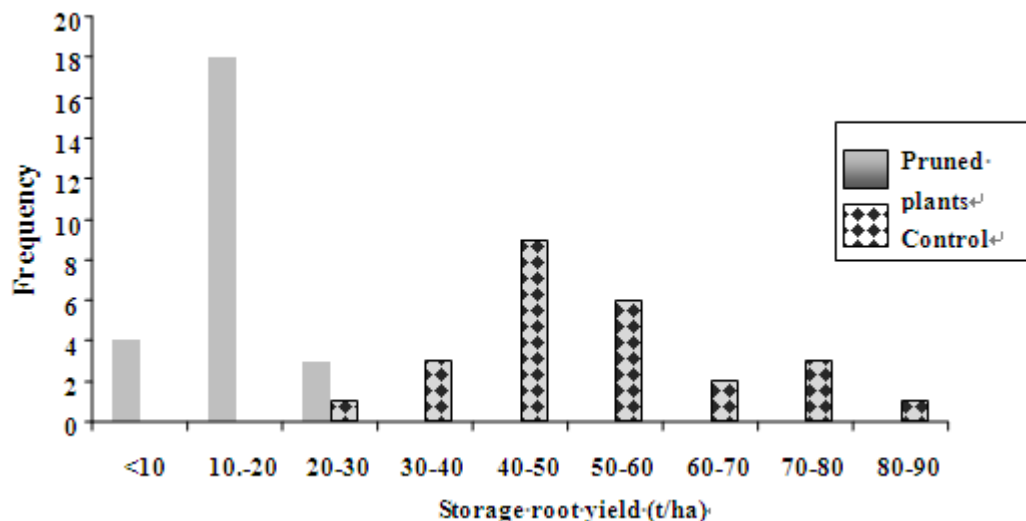


Figure 1. Range of storage root yield from the pruned plants and the control

There were also significant differences ( $P \leq 0.05$ ) among the different genotypes in terms of storage root yield reduction as a percentage of the yield from the control plants (Table 3). The percentage (%) reduction was also used as an index of tolerance of the different genotypes to pruning. In other words genotypes that recorded the least reduction in storage root yield were considered tolerant to pruning and as against susceptible genotypes which recorded relatively high percentage reduction. The average percentage reduction for the different genotypes which ranged between 80.4% and 40.1% can again be categorized into classes of 40-50, 50-60, up to 80-90% reduction (Figure 2). Majority (8) of the genotypes like ADI 001, *Kyempo*, TCH 001, TANO 001, etc. recorded reductions that fell within the 70-80% category with equal number of seven each being recorded in the 50-60 and 60-70% categories. Only one genotype (*Bankyehemaa*) recorded a reduction within the 40-50% category. Two genotypes, *Gblemoduade* and 96/0160 suffered yield reductions which fell within the 80-90% category.

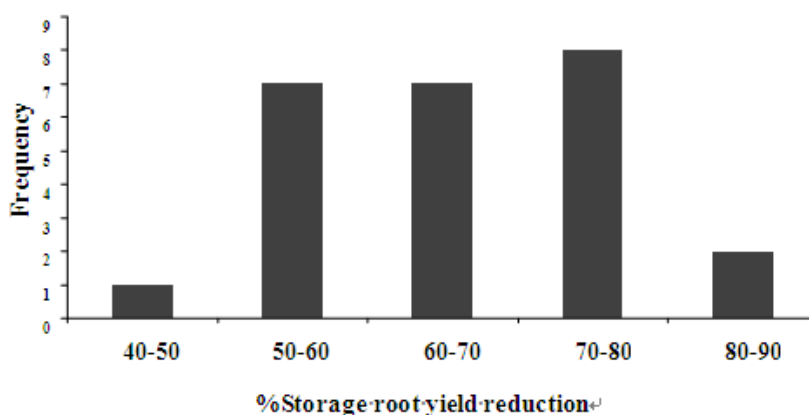


Figure 2. Frequency distribution of the range of % storage root yield reduction

### 3.2 Mean Storage Root Weight and Starch Content as Affected by Pruning

Storage root yield in cassava is determined by the number and the size of storage roots. Periodic pruning had a significant effect ( $P \leq 0.05$ ) on mean storage root weight (Table 4). Generally smaller storage roots were produced by the periodically pruned plants as compared with the control plants that produced relatively bigger

storage roots. The average mean storage root weight of the pruned plants was 180 g which was significantly ( $P \leq 0.05$ ) lower than those of the control plants which produced an average mean storage root weight of 450 g. Mean storage root weights from the pruned plants ranged between 120 g for *Kyempo* and 250 g for 96/1642. Genotypes like AWO 001, 96/1569, *IFAD*, *Agbelifia*, *Esambankye*, *Gblemoduade* and 96/1642 all produced mean storage root weights that were above the average values recorded in the pruned plants. The mean storage root weight from the control also ranged between 290g and 600g for DMA 004 and AWO 001 respectively. Genotypic variation was observed in the reduction in mean root weight in the pruned plants compared with the control as indicated by the percentage reduction which varied from a low of 41.9% for *Agbelifia* and 73.4% for *Kyempo* (Table 4).

Pruning also had a significant effect on the starch content of the different cassava genotypes being especially higher in the control than the pruned plants (Table 4). The different genotypes however responded differently to the starch content reduction. *IFAD* had the highest starch content of 19.7% which was significantly different ( $P \leq 0.05$ ) from the most of the other genotypes when pruned. The starch content was however lower than the starch content obtained from the control (22.8%). Genotypes 96/1565 and 96/1642 recorded the least starch contents of 12.1% and 12.2% respectively. In the case of the control, TCH 004 recorded the highest starch content of 23.2% with 96/1565 recording the least starch content (12.7%). *Nkabom*, *Dokuduade*, *Bankyehemaa* and *IFAD* were the released varieties that maintained relatively high starch content when pruned. Average starch content for all genotypes under pruning was also significantly lower under pruning than the control according to the two-sample t-test as well as the difference in starch contents expressed as a percentage of the control. The least percentage reduction was recorded in 96/1565 (3.0%) with 96/1642 having the highest percentage reduction in starch content (26.3%) in the pruned plants compared with the control.

Table 4. Storage root yield components as affected by pruning

Genotypes	Mean storage root weight (g)			Starch content (%)		
	Pruned plants	Control	% reduction	Pruned plants	Control	% reduction
96/1642	250.00	420.00	42.60	12.20	16.70	26.30
<i>Esambankye</i> *	240.00	490.00	43.90	16.70	20.50	17.60
<i>Afisiafi</i> *	210.00	390.00	43.00	16.00	18.50	13.70
96/1565	140.00	430.00	64.90	12.10	12.70	3.00
<i>Dokuduade</i> *	180.00	550.00	64.40	17.10	18.80	9.90
<i>Agbelifia</i> *	200.00	380.00	41.90	14.30	15.10	5.10
96/0603	230.00	450.00	50.20	14.70	16.40	10.10
96/1569	200.00	350.00	42.30	17.20	20.30	15.00
<i>Gblemoduade</i> *	200.00	570.00	65.50	13.10	15.70	16.00
<i>Abasafitaa</i> *	180.00	450.00	59.40	16.00	18.90	14.70
ADI 002	160.00	510.00	65.00	15.10	19.30	21.40
AWO 001	240.00	600.00	59.90	15.50	20.30	23.50
<i>Bankyehemaa</i> *	130.00	290.00	56.20	16.90	21.10	20.40
<i>IFAD</i> *	210.00	490.00	57.90	19.70	22.80	12.40
TCH 004	150.00	420.00	62.80	18.00	23.20	22.30
TANO 001	150.00	470.00	65.30	16.90	19.20	12.40
96/0160	170.00	480.00	63.80	17.30	19.80	12.20
<i>Nkabom</i> *	180.00	430.00	49.30	18.90	20.30	6.90
ADI 001	150.00	510.00	69.70	17.70	18.60	4.70
<i>Adugyama</i>	140.00	410.00	65.20	14.30	18.80	23.60
TCH 001	120.00	430.00	71.30	17.50	19.50	10.30
TCH 002	140.00	470.00	52.10	15.30	17.20	15.90
TANO 003	160.00	480.00	64.60	18.20	21.80	11.30
<i>Kyempo</i>	120.00	460.00	73.40	17.70	18.50	4.40
DMA 004	130.00	280.00	49.50	16.10	18.10	9.10
Mean	180.00	450.00	57.8	16.20	18.90	13.70
SED	41.35	82.20	11.33	1.52	1.32	4.21
t (cal)(means)	15.99			4.40		
t <sub>0.05(2), 48</sub>	2.011			2.011		

\* Released varieties.

### 3.4 Effect of Pruning on Harvest Index (HI)

Significant differences ( $P \leq 0.05$ ) were observed for harvest index in both the pruned and the control plants (Table 5). Genotype 96/1642 recorded the highest HI of 0.54 in the pruned plants with the least being produced by TANO 003 (0.22). Generally the pruned plants produced lower HI as compared to the control. *Agbelifia*, *Abasafitaa*, 96/0160, 96/1565 and 96/0603 had quite high HI in the control plots. The comparison from the control also reveals that most of the genotypes with high HI in the control plants also had lower HI in the pruned plants except *Agbelifia*, *Esambankye* and 96/0603 which produced quite high HI both in the control and the pruned plants. Significant ( $P \leq 0.05$ ) percentage (%) reduction in harvest index in the pruned plants relative to the control was also observed. *Esambankye* had the least percentage reduction in HI (3.85%) which was significantly lower than most of the other genotypes. The highest percentage reduction was observed in *Kyempo* (59.32%).

Table 5. Harvest index (HI) from pruned plants and the control

Genotypes	Harvest index		% reduction
	Pruned plants	Control	
96/1569	0.54	0.63	14.29
<i>Agbelifia</i> *	0.53	0.68	22.06
<i>Esambankye</i> *	0.50	0.52	3.85
96/0603	0.48	0.61	21.31
96/1642	0.44	0.51	13.73
<i>Abasafitaa</i> *	0.44	0.68	35.29
<i>IFAD</i> *	0.43	0.58	25.86
96/1565	0.42	0.63	33.33
<i>Afisiafi</i> *	0.40	0.58	31.03
<i>Nkabom</i> *	0.37	0.54	31.48
<i>Bankyehemaa</i> *	0.37	0.39	5.13
AWO 001	0.36	0.56	35.71
<i>Gblemoduade</i> *	0.35	0.61	42.62
TCH 001	0.35	0.56	37.50
<i>Adugyama</i>	0.34	0.58	41.38
96/0160	0.34	0.60	43.33
TCH 002	0.34	0.42	19.05
<i>Dokuduade</i> *	0.31	0.57	45.61
ADI 002	0.31	0.48	35.42
ADI 001	0.30	0.57	47.37
TANO 001	0.29	0.47	38.30
TCH 004	0.27	0.47	42.55
DMA 004	0.27	0.45	40.00
<i>Kyempo</i>	0.24	0.59	59.32
TANO 003	0.22	0.37	40.54
Mean	0.37	0.55	32.53
SED	0.08	0.07	14.29
t (cal)(means)	7.37		
t <sub>0.05(2), 48</sub>	2.011		

\* Released varieties.

#### 4. Discussion

##### 4.1 Effect of Pruning on Storage Root Yield and Dry Matter Content

Even though periodic pruning at 2-3 month intervals have been reported to result in marginal reduction in storage root yield (Dahniya et al., 1981; Lockard et al., 1985) the results from this study suggested otherwise. Periodic pruning generally had a significant negative effect on storage root yield but there were genotypic differences in the extent of reduction. For example the reduction in yield as a percentage of the control varied from as high as 80% for *Gblemoduade* to as low as 40% for *Bankyehemaa*. Similar observed variations in cassava genotypes in terms of their ability to tolerate periodic pruning have been reported (Ravindran & Rajaguru, 1988). Therefore careful varietal selection would be very critical in choosing cassava for foliage production. The decline in storage root yield resulting from pruning could be expected since the foliage is the



photosynthetic apparatus and therefore responsible for photosynthesis. The foliage removal therefore led to reduction in the amount of photosynthates produced and stored in the roots. Hunt et al. (1977) asserted that deposition of starch in storage roots can be reduced if the supply from the top is interrupted as occurs when much of the leaf and stem materials are removed. Genotypic differences were however observed in the extent of reduction in root yield resulting from pruning. Many factors such as variation in maturity and plant architecture could account for these genetic differences. Early bulking genotypes begin carbohydrate accumulation at an earlier stage than late bulking types and so they are likely to be less affected by pruning than late bulking types. Okogbenin and Fregene (2002) observed that late bulking cassava genotypes have the foliage as the active growing sinks for the first seven months after planting whilst in fast or early bulking genotypes, rapid increase in storage root development occur in the first six months of growth. In this case the fast bulking genotypes might have accumulated some amount of photosynthates at the time the pruning was initiated compared with the late bulking genotypes. Another trait that could affect a variety's tolerance to pruning in terms of root yield is the plant's architecture (whether erect or profuse branching at an early stage of growth). Erect non-branching genotypes are more likely to be severely affected as compared with profuse branching genotypes owing to their rapid initial vegetative growth at the expense of storage root bulking. In a study involving two cassava varieties with different growth habits, Dahniya et al. (1981) reported a greater storage root yield reduction in an erect local cassava variety *Isunikakiyan* than TMS 30211, a branching type when they were both pruned. From the results of this study, it can be inferred that 96/1642, *Afisiafi*, *Esambankye*, *Agbelifia* and *Bankyehemaa* are relatively tolerant to periodic pruning as their storage root yield reduction was just around 50%. Storage root dry matter content was also significantly reduced when the plants were pruned though genetic variability was observed among the genotypes in terms of the reduction. Similar declines in dry matter content among pruned plants were observed in Thailand by Chantaprasarn and Wanapat (2003) in a study involving a local cassava variety, Rayong 60. The reduction in dry matter content of the pruned plants could be attributed to the need to remobilize the stored carbohydrates for regrowth of new shoots any time the plants were pruned but this was not the case in the control plots where the foliage were left intact (Sagrilo et al., 2003). These periodic disturbances might have interfered with the accumulation of carbohydrates leading to the reduction as reported by other studies (Oliveira et al., 2010; Andrade et al., 2011). The significant genetic variation in the extent of reduction observed among the cassava genotypes provides opportunity for selection in the genetic improvement of cassava for tolerance to periodic pruning.

#### 4.2 Pruning and Root Yield Components

Though periodic pruning significantly reduced the storage root yield and its components, there were differences among the different genotypes on the extent of reduction. Ayoola and Agboola (2004) observed reduction in yield and mean storage root weight when cassava plants were pruned irrespective of the pruning method. This was corroborated by the results of this study. There were however differences in the degree of reduction. The reduction in storage root sizes in the pruned plants could be explained by the fact that as the plants were pruned, photosynthates that should have been used for storage root bulking were used for regrowth of new shoots. This therefore resulted in smaller storage roots due to reduced carbohydrates available for storage root bulking possibly due to reduced carbohydrates synthesized per plant and hence reduced quantity of food available for storage (Wright, 1962).

#### 4.3 Starch Content and Pruning

Pruning generally reduced the starch content of the storage roots compared to the control but there were varietal differences. For example the average starch content of the pruned plants was 16.2% compared to the 18.9% recorded by the control. Genotypes 96/1565 was most affected by pruning giving a starch content of 12% compared to its corresponding starch content of 16.7% in the control. The reduction in starch content when the plants were pruned could be explained by the fact that as the plants were pruned, the stored starch was converted to sugar and translocated to the buds for regrowth. According to Mitchell (1970) carbohydrate reserves are used for regrowth of new leaves until the new leaves can photosynthesize before further starch accumulation can begin sometimes to the original level. As the supply from the top part was curtailed following the repeated pruning, deposition of starch in the roots was reduced (Hunt et al., 1977) resulting in the smaller storage roots compared with the control which was left undisturbed.

#### 4.4 Harvest Index

According to Alves (2002) harvest index is a measure of dry matter distribution to the economically important part and it represents the efficiency of storage root bulking (Fregene & Puonti-Kaerlas, 2002). Harvest index was significantly affected by pruning. This was to be expected since the top growth was periodically removed, more

vegetative growth was promoted at the expense of root production. There were however genetic differences considering the wide range of values obtained for the different genotypes under pruning and the control. For example the harvest indices from the control plots ranged between 0.37-0.68 as against 0.24-0.54 for the pruned plants. Significant genetic differences in cassava genotypes in terms of the harvest index have been reported (Alves, 2002). This therefore provides opportunity for selection for high yield potential under pruning and no pruning regimes (Kawano et al., 1998).

## 5. Conclusion

Cassava research in Ghana has been based mostly on developing improved varieties that are high yielding with high dry matter and also tolerant to common diseases and pests and meet farmers' expectation. Evaluation for tolerance to periodic pruning is seldom considered. This study has opened a new chapter in the area of identifying cassava genotypes that are tolerant to periodic pruning and for that matter suitable for dual purpose production. The identification of genotypic variation in tolerance to periodic pruning will afford researchers the opportunity to explore the cassava gene pool for the ideal genotype that will produce adequate amount of foliage without significant reduction in storage root yield.

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