PRODUCTION, DEFOLIATION AND STORAGE OF CASSAVA LEAVES AS DRY SEASON FORAGE FOR SMALL RUMINANTS IN SMALLHOLDER CROP – LIVESTOCK PRODUCTION SYSTEM.

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Abstract

Experiments were conducted in 2005 and 2006 cropping seasons in south west Nigeria to investigate the yield performance of cassava (Cultivar TMS 30572) as influenced by defoliation time and the chemical composition of the leaf obtained when harvested and stored as dry season forage for small ruminants. Five defoliation treatments of 0, 4, 5, 6 and 7 months after planting were arranged in a randomized complete block design with three replicates. Cassava yielded an average of 925 kg DM/ha of leaves with a corresponding crude protein content of 20%. The cassava tuber yield was 11 966 kg/ha. Generally, cassava tuber yield was not influenced ($P > 0.05$) by defoliation but plants defoliated before 6 months after planting had reduced ($P < 0.05$) leaf yield. The fiber fractions, neutral detergent fiber, acid detergent fiber and acid detergent lignin contents as well as the hydrocyanic content of the leaves increased ($P < 0.05$) with increase in defoliation time. Storing cassava leaves beyond 3 months increased ($P < 0.05$) the DM content, while crude protein content declined ($P < 0.05$) with the length of storage. The study showed that with the variety under investigation, defoliation schedules for cassava which are appropriate for quality forage production involve those made from 6 months after planting without significantly decreasing ($P > 0.05$) the crop tuber yield. Storing cassava leaves for 3 months produced leaves of high nutritive value thereby allowing a continuous supply of feed for smallholder small ruminant production during the dry season.

Key words: forage, cassava, defoliation, storage, small ruminant; South west Nigeria

INTRODUCTION

Cassava is one of the most important staple food crops widely cultivated in the lowland humid tropics. It plays a major role in alleviating the African food crisis because of its efficient production for energy, year round availability, tolerance to extreme conditions, and suitability to present farming and food systems in Africa (IFPRI, 2000). Nigeria is currently the world's largest producer of cassava crop (IITA, 2005) and over four fifth of its cultivable land area has been found suitable for cassava cultivation (Nweke, 1992).

Cassava leaves have continued to be one of the primary sources of feed for small ruminant animals through systematic defoliation (Fasae et al., 2006) and after tuber harvest (Alli-Balogun et al., 2003; Ngi et al., 2006), especially among small holder crop-livestock farmers who keeps the largest proportion of small ruminants in Nigeria (Lapkini, 2002). Cassava leaves have been found to have high nutrient value which can effectively boost the nutrition of small ruminant production when preserved as hay, thereby assisting in formulating and processing of simple, adoptable and low cost feed resource strategy for small ruminants during the dry season when there is scarcity of forage (Wanapat et al., 2000). However, most of these farmers are reluctant to defoliate their cassava because of the envisaged possible reduction in tuber yield which is the primary crop tuber.

This study was aimed at producing a dry season feed for small ruminants thereby establishing the effects of defoliation time on the leaf yield and quality as well as tuber yield of cassava cultivar Tropical Manihot Specie (TMS 30572) which is widely cultivated by most cassava farmers in Nigeria because of it's adaptability to the environment and higher tuber yield (Emerole et al., 2001). The effect of length of storage on the chemical composition of cassava leaf was also evaluated.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Teaching and Research farms, University of Agriculture, Abeokuta, Nigeria. The location is 76 meters above sea level and falls within latitude 7015'N and longitude 3025'E, and situated in the forest transition zone of south western Nigeria. It experiences approximately seven months (April to October) of rainfall that is bimodal in pattern. It receives a mean annual precipitation of 1 037mm, with a mean annual temperature of 34.70C and mean relative humidity of 82%. It has about five months (November to March) of dry season each year, though, irregularity may occur in the rainfall distribution pattern over the year. The field work was conducted on a well drained, deep, sandy/loam soil with pH of 6.5. The experiment commenced during the early cropping season of years 2005 and 2006, respectively.

Cassava cultivation

Tropical Manihot Species (TMS 30572) cultivar of cassava which is popularly called “Texaco” by farmers was planted. Cassava cuttings (20 to 25 cm long) were obtained from matured stems and planted as soon as the rains were established in April, 2005 and 2006 for the first and second year planting, respectively. The cassava plot was randomly laid out into five defoliation treatments of 0, 4, 5, 6 and 7 months after planting (MAP), arranged in a randomized complete block design with three replicates. Cassava stem cuttings were planted at 90 × 90 cm spacing. Weeding was carried out manually using West African hoe at 4 and 15 weeks after planting. Fertilizer was applied at 5 and16 weeks after planting using a compound NPK (15 : 15 : 15) fertilizer at the rate of the 100 kg/ha.

Storage process

Cassava leaves were defoliated at 6 months after planting (MAP) from the established plot, chopped with a cutlass and thereafter sun dried for 5 days. While drying, the leaves were turned at regular intervals and were then put into bags of 25 kg each. The leaves were stored for five months in a well ventilated room during which chemical changes due to storing were monitored monthly.

Data collection

The leaf yield of cassava at various stages of defoliation was obtained by harvesting half of the leaves on the plant from the soil level. Plant height was obtained as height of ten randomly selected plants per plot from the middle row at harvest from the soil level to the tip of each plant. Number of tubers per plant was obtained by counting the number of tubers per plant at harvest from the ten randomly selected tubers. The fresh tuber yield at 12 months after planting were obtained by harvesting tubers from each replicate from the four middle rows and weighed.

Chemical analyses

The proximate composition of the defoliated and stored leaves was determined by the method of AOAC (1995). The DM was determined by oven drying at 650C to constant weight, crude protein (CP) by Kjeldhal method and fat by Soxhlet fat extraction method. The concentration of neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin in the leaves were also estimated by the method of Van Soest and Robertson (1994). The hydrocyanic acid (HCN) in feed was assessed as described by Bradbury et al. (1999).

Data analysis

Data obtained were based on randomized complete block design and subjected to analysis of variance using the statistical package (SAS, 1999). Significant means were separated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS

The results of the study as shown in Table 1 revealed that defoliating cassava at 4 months after planting (MAP) in the two years produced the least ($P < 0.05$) leaf yield compared to the other defoliation treatments. Cassava defoliated at 5 MAP and beyond produced significantly higher ($P < 0.05$) leaf yield in 2005 which were statistically similar to the control treatment. In 2006, plants defoliated at 4 and 5MAP and those of the control treatment produced lower ($P < 0.05$) leaf yield than other periods of defoliation. Defoliating cassava did not affect ($P > 0.05$) plant height of cassava in both years. The fresh tuber yield of cassava across the defoliation treatments did not also respond ($P > 0.05$) to defoliation.

Tab. 1: Effect of defoliation time on leaf yield, plant height, number of tuber per plant and fresh tuber yield of cassava cultivar TMS 30572 in two planting seasons

Defoliation time	Leaf yield (kg/ha)		Plant height (cm)		Number of tuber/plant		Fresh tuber yield (kg/ha)	
(Months)	2005	2006	2005	2006	2005	2006	2005	2006
4MPA	737b	808c	182.0	183.7	6.3	7.0	11 353	11 908
5MAP	876ab	969abc	184.0	190.0	6.5	6.8	11 628	11 849
6MAP	971a	1 090a	189.3	191.0	6.4	6.6	11 447	11 979
7MAP	966a	1 043ab	186.7	194.0	6.8	7.1	11 933	12 438
UND	918a	870bc	192.7	198.0	7.0	7.1	12 286	12 842
Mean	894	956	187.3	191.3	6.6	6.9	11 748	12 203
SE±	65.8	66.1	10.6	12.9	0.2	0.3	491.1	368.3

[a,b,c] Means in the same column with different letter (s) differ significantly at 5% level of probability using DMRT (Duncan’s multiple range test), [MAP] Months after planting, [UND] Undefoliated

Tab. 2: Effect of cropping year and defoliation time on leaf yield, number of tuber/plant, plant height and fresh tuber yield of cassava cultivar TMS 30572 in two planting seasons

Treatment	Leaf yield (kg/ha)	Plant height (cm)	Number of tuber/plant	Fresh tuber yield (kg/ha)
Year (Y)				
2005	894	187.3	6.6	11 748b
2006	956	191.3	6.9	12 203a
Mean	925	189.3	6.7	11 974
Defoliation time (D)				
4 MAP	772.5b	182.8	6.6	11 630b
5 MAP	922.5ab	187.0	6.7	11 738b
6 MAP	1030.5a	190.2	6.5	11 713ab
7 MAP	1004.5a	190.3	6.9	12 185ab
UND	894.0ab	195.3	7.1	12 564a
Mean	924.8	189.1	6.8	11 966
SE±	10.8	3.1	0.8	26.6
Y × D	*	*	ns	*

[a,b] Means in the same column with different letter(s) differ significantly at 5% level of probability using DMRT (Duncan's multiple range test), [MAP] Months after planting, [UND] Undefoliated., * Significant at 5% level of probability, [ns] Not significant

Tab. 3: Dry matter, crude protein, fiber and hydrocyanic acid compositions of cassava leaves at different defoliation time in two planting seasons

Defoliation time (Months)	Dry matter		Crude protein		Neutral detergent fiber		Acid detergent fiber		Acid detergent lignin		Hydrocyanic acid	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
4 MAP	90.1b	89.0b	24.5a	26.8a	51.0b	46.9b	30.8b	29.9b	5.5c	5.5b	22.8d	20.9c
5 MAP	90.3b	89.2b	23.4a	24.2ab	51.9b	49.2ab	32.8ab	31.1b	5.8c	6.1ab	25.3cd	22.1c
6 MAP	90.7b	90.8ab	20.5b	22.6bc	52.8b	51.4ab	34.4a	35.1a	6.2bc	6.3a	26.4bc	22.4c
7 MAP	91.6ab	91.3a	18.9c	19.7cd	53.0b	52.9a	35.1a	35.5a	7.6ab	6.8a	32.7a	27.2ab
UND	92.5a	92.0a	16.3d	16.9d	56.3a	54.3a	35.9a	37.1a	8.0a	7.4a	32.7a	29.2a
Mean	91.0	90.5	21.1	22.0	53.0	51.0	33.8	33.7	6.6	6.4	27.3	24.4
SE±	0.6	0.4	0.4	0.5	0.9	0.8	0.6	0.8	0.4	0.3	0.5	0.4

[a,b,c, d] Means in the same column with different letter(s) differ significantly at 5% level of probability using DMRT (Duncan's multiple range test), [MAP] Months after planting., [UND] Undefoliated

Tab. 4: Effect of length of storage on the chemical composition (%) of cassava leaves in two planting seasons

Months of storage	Chemical constituents											
	dry matter		crude protein		neutral detergent fiber		acid detergent fiber		acid detergent lignin		hydrocyanic acid	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
1	90.7 b	90.9b	20.5a	22.6a	51.1	51.4	34.4	35.1	6.1	6.8	26.4a	22.4a
2	91.1b	90.9b	19.9a	22.1a	51.3	51.9	34.4	35.2	6.2	7.2	25.9a	22.0a
3	91.8b	92.6ab	19.0a	21.9a	51.9	52.2	34.8	35.7	6.2	7.6	25.1ab	20.9b
4	92.8ab	93.3a	18.8ab	19.1b	52.0	52.8	34.9	36.1	6.5	7.8	24.2b	19.7b
5	93.4a	94.1a	18.2b	18.6b	52.7	53.0	35.4	36.2	7.0	7.9	20.9c	18.6bc
Mean	91.9	92.4	19.3	20.9	51.8	52.3	34.9	35.7	6.4	7.5	24.5	20.6
SE±	0.24	0.29	0.08	0.08	0.31	0.42	0.23	0.21	0.03	0.04	0.22	0.17

[a,b,c] Means in the same column with different letter (s) differ significantly at 5% level of probability using DMRT (Duncan's multiple range test)

The results of the combined analyses (Table 2) for leaf yield, plant height and number of tuber per plant across the treatments revealed that the effect of year was not significant ($P > 0.05$), while tuber yield differed significantly ($P < 0.05$) across the years. The interaction effect of cropping year by defoliation time on leaf yield plant height and tuber yield was significant ($P < 0.05$) while that of number of tuber per plant was not significant ($P > 0.05$).

Table 3 shows that the effect of defoliation time on the chemical composition of cassava leaves differed significantly ($P < 0.05$) across the treatments in both years. Defoliated plants recorded lower ($P < 0.05$) DM contents relative to the control treatment. The CP contents of the leaves decreased ($P < 0.05$) as the defoliation time increased. Cassava leaves defoliated at 4 months after planting (MAP) which ranked the same with those defoliated at 8 MAP had higher ($P < 0.05$) CP contents compared to the other defoliation treatments. The fiber fractions NDF, ADF and ADL contents of the leaves increased ($P < 0.05$) with defoliation time. The NDF contents in the defoliated treatments were lower ($P < 0.05$) than the control treatment while the hydrocyanic acid (HCN) content of cassava leaves increased ($P < 0.05$) with increase in defoliation.
The effects of five months of storage on the chemical composition of cassava leaves are shown in Table 4. The results revealed that storing cassava leaves beyond 3 months from the onset of storage increased ($P < 0.05$) the DM contents while there was a reduction ($P < 0.05$) in the crude protein contents The fiber fractions, NDF, ADF and ADL contents of the stored leaves were not affected ($P > 0.05$) by storage period. Storing cassava leaves beyond 3 months significantly reduced ($P < 0.05$) the HCN and across the treatments.

DISCUSSION

The results of this study revealed that cassava leaves defoliated from 6 MAP has little or no influence on tuber yield and that cassava foliage could be harvested from 6 MAP to ensure more leaves, high nutrient content and avoid reduction in tuber yield. This is similar to the results of a study by Montaldo and Montilla (1977) on the production of foliage from cassava for use as protein feed where best results were obtained with successive removals of foliage after four months of planting. Contrary results were however reported by Singh and Chaudhury (1985) when cassava was defoliated in the second, fourth and sixth months after planting. They found out that defoliation of cassava at any stage of the crop was observed to be harmful to the plants. It is reasonable to attribute the variation in the above reports to environmental conditions and the defoliation pattern employed which might probably have led to reduction in effective photosynthetic activities of the plant.
The mean cassava leaf yield of about 1.0 t/ha across the defoliation treatments is lower than the range of 1.4 to 2.0 t/ha reported by Ebong et al. (1995) when the effect of spacing and interval of cutting on the forage value of cassava foliage was assessed. Preston and Rodriguez (2004) however, reported higher foliage yield of 2.0 to 3.0 t/ha when cassava was managed as a perennial crop with repeated harvesting of the foliage at eight week interval. The period, quantity of plants defoliated and intervals of defoliation which were not the same with those of this study might be responsible for the difference.
The mean cassava fresh tuber yield of 11.7 t/ha and 12.1 t/ha, respectively reported in this study for both years at 12 MAP is higher than 10.6 t/ha and 11.9 t/ha reported by Ayoola and Adegbola (2004) for cassava under the influence of planting patterns and different pruning methods. Nweke (1992) reported higher values of 14.7 t/ha as the average yield of cassava from none pruned plots in Nigeria. The variation may be attributed to the cultivar used, time of defoliation coupled with the cultural practices employed. The higher tuber yield in the second year of experimentation could be due to the use of residual nutrient from the previous year fertilization, and the fact that crop residue from the first year was not removed totally from the field.
The values for number of tuber per plants is higher than 5.1 to 6.9 reported by Ayoola and Adegbola (2004) for cassava under the influence of planting patterns and different pruning methods on tuber yield of cassava harvested at 12 MAP. The difference could be due to the cultivar used and management practice employed.
The variation in the chemical composition of cassava leaves at different stages of defoliation is in line with the reports of earlier workers that chemical composition of forages changes with age and stage of development (Kalu et al., 1985; Babayemi et al., 2002). However, the increase in the DM content of cassava leaves with increase in defoliation time shows an increase in the DM of forages with increasing stage of maturity. On the other hand, the decrease observed in the CP contents of the leaves as the week of defoliation increases could be as a result of advanced maturity of the plants. This indicates that higher CP could be obtained with plants harvested at a much earlier age as age of harvest influences the nutrient composition of forages (Wanapat et al., 1997). The results of the NDF, ADF and ADL contents of the cassava leaves that increased significantly as the weeks of defoliation increased show that fibre level increases with age of forage, thereby suggesting that rapid lignification with its attendant decreases in nutritive value are obtained as the plants matures. The increase in HCN content of cassava leaves with the time of defoliation shows that HCN content of cassava leaves increases with forage maturity.
The increase in DM values of the leaves as the storage period increases indicate loss in moisture. The decline in CP contents of the leaves as storage length increases agrees with the findings of Oladotun et al. (2003) who observed reduction in these nutrients during feed storage. At the end of the storage, the CP content of cassava leaves was higher than the level (11 to 12%) required for moderate level of ruminant production (Gatenby, 2002), thereby suggesting its adequacy for ruminant production. The decline in HCN content of cassava leaves with the length of storage shows that the HCN content in cassava leaves can be reduced by sun drying with long term storage.

CONCLUSION

Based on the results of this study, it could be concluded that defoliation schedules for cassava which are appropriate for forage production involved those made from 6 months after planting which had no adverse effect on the tuber yield. Storing cassava leaves for 3 months produced leaves of high nutritive value, thereby allowing a continuous supply of feed for smallholder small ruminant production during the dry season.

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