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Effect of Leaf Harvest Intensity and Frequency on Sweet Potato Weevil (*Cylas puncticollis*) Infestation, Yield and Quality Traits of Sweet Potatoes (*Ipomoea batatas* L.)

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Abstract

Objective: The present study assessed *Cylas puncticollis* (*C. puncticollis*) infestation, foliage, and root yields of sweet potatoes as influenced by the leaf harvest intensity and frequency in the inland valley swamp (IVS) and upland soils of Njala.

Methods: The trial involved 2 varieties namely Kabia and Gbanie; 4 levels of foliage harvests: 0, 30, 60 and 90 days after planting; and 4 levels of leaf harvest intensities: 0, 25, 50 and 100%. The treatments were established in a randomized complete block design and replicated 3 times. The parameters that were investigated included the severity of *C. puncticollis* infestation on vines and storage roots, fresh foliage yield, storage root yields and other related traits (fresh storage root length, width and numbers).

Results: Our findings showed that there were significant differences in foliage and root yields, as well as related traits among different leaf harvest frequency intensities. The 25 and 50% harvest plots produced optimum fresh foliage and storage root yields and other related traits of the crop. *C. puncticollis* infestation in sweet potatoes cultivated during the dry season in the IVS ecology was more severe than that in those grown in the upland during the wet season. The ecology and time of cultivation of sweet potatoes influence infestation by *C. puncticollis* on vines and roots more than the combined effects of putative varieties, leaf harvest intensity and frequency.

Conclusion: Improved agronomic management practices support optimization of fresh leaf and root yields of sweet potatoes. These can be exploited and chosen to achieve optimum productivity and quality of the crop for both the fresh foliage and storage root consumers.

Keywords: foliage harvest regimes, foliage yield, root yield, pest severity, sweet potato

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1 INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is a dicot and food security root crop cultivated in many countries of Sub-Saharan Africa[1]. The crop is a member of the Convolvulaceae family comprising 50 genera and over 1000 species; of which the *I. batatas* is the only economically available species[2]. Sweet potatoes originated from Central and South America[3] and are currently grown in more than 100 countries. Extensive cultivation of the crop occurs in the tropics and subtropics including Africa, Asia and the Pacific[4]. Sweet potatoes are considered the 15th most important economic food security crop, and the 3rd most important root and tuber crop[5]. They are cultivated on 8.6 million ha of land around the globe, with production and average yield estimated at 106 million tons and 12.2t ha^{-1} respectively[5]. China is the leading global producer of sweet potatoes. Other nations that also contribute significantly to the global food basket of the crop include Nigeria, Tanzania, Indonesia, Uganda, Ethiopia, Angola, India, the United States of America, Vietnam and Madagascar[6].

In the Sierra Leonean diet, sweet potato is ranked as the second most cherished root crop after cassava. It is widely grown in the country for both the leaves and roots. Thus, the crop is often grown to target the dual purpose of leaf and fresh storage root harvests in these areas. The harvested leaves are utilized as either vegetables or fodder. The mature leaves are often used for livestock feed, while the immature leaves are utilized as vegetables by human beings[7]. Notwithstanding the dual purpose as food and feed of sweet potatoes grown in Sierra Leone, extensive research is yet to be conducted to unravel the influence of leaf harvest intensity and frequency on infestation with *Cylas puncticollis* (*C. puncticollis*), fresh foliage and storage root yields, as well as related traits of sweet potatoes. It has been reported that leaf harvesting in sweet potatoes reduces root yield by 43%[8]. Accordingly, Masumba[9] opined that increasing proportion of foliage harvest decreases the translocation of photosynthates from leaves to the roots, consequently leading to a reduction in fresh storage root yields. The testing of these assertions using different genotypes, ecologies, and leaf harvest regimes (leaf harvest intensities and frequencies) would deepen our knowledge of its role in determining fresh foliage and storage root yields, as well as the quality of the sweet potatoes.

Identification of sweet potato clones with optimum economic fresh foliage and storage root yields contributes to increasing food and feed production and productivity desired by various actors in the sweet potato value chain. The detection and selection of optimum foliage harvest frequency and intensity that results in economic fresh leaf and storage root yields would facilitate increased production, productivity and availability of the crop for food, feeds and various industrial applications. The findings of this work could be relevant as useful resource material for the incorporation of leaf harvest regime, intensity and proportion of foliage harvest in germplasm assessment, and new population development objectives. The present study aims at assessing *C. puncticollis* infestation, fresh foliage yields and storage root yields of sweet potatoes as influenced by foliage harvest intensity and frequency in the IVS and upland soils of Njala.

2 MATERIALS AND METHODS

2.1 Description of the Study Area

A field experiment was carried out at the IVS lowland ecology and the upland of Njala during the dry and rainy seasons of 2019. The geographical positioning system of Njala depicts an elevation of 54 meters above sea level on latitude 8°06′N and longitude 12°06′W. The prevailing vegetation at the experimental site is predominantly secondary bush, which mainly comprises of *Andropogon gayanus*[10,11]. Njala exhibits two distinct seasons: The first is the rainy season, which runs from April to November, and the second is the dry season which runs from December to March. The dry season trial at the lowland ecology was irrigated every other day to field capacity until establishment for 2 months after planting using watering cans. During the dry season trial, the average monthly relative humidity at the trial site was 69.9% and the monthly air temperatures ranged between 23.4°C and 34.9°C. The mean monthly relative humidity was 83.9% and air temperatures ranged between 20.4°C and 33.8°C during the rainy season at the upland trial (Sierra Leone Agricultural Research Institute Weather Station, 2019).

The soils at Njala are slightly acidic, with moderate availability of plant nutrients[11]. They are classified as well-drained, sandy clay *Orthoxic palehumult* soils, belonging to the Njala series with a pH of 5.4-6.0[11].

2.2 Experimental Site Preparation, Design and Treatments

The trial site was brushed and burnt prior to layout, ridging and planting. The experimental area measured 26m by 19m. Ridging was done using a digging hoe, whereas the garden hoe was used for pulverizing the large soil clods. The trial was laid out in a randomized complete block design with three (3) replications. The 26 treatment combinations used in the experiment comprising two varieties [(Gbanie (V1) and Kabia (V2)], four levels of leaf harvest regimes (0, 30, 60 and 90d after planting); and four leaf harvest intensities (0, 25, 50 and 100%) are shown in Table 1.

2.3 Trial Management

The planting materials were healthy vine cuttings each measuring 30cm. The cuttings were planted in the lowland ecology in holes created on a crest of ridges on February 7, 2019. Vine cuttings were planted at a 0.30m × 1m spatial arrangement giving a population of 33,333 plants ha^{-1}. The wet season planting on the upland was done on May 29, 2019 with the same spatial arrangement. Cultural practices such as weeding and earthing up were done on a monthly basis at both ecologies. No agrochemicals (fertilizer and pesticides)

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Table 1. Treatment Combinations for Sweet Potato Trial

Variety	Leaf Harvest Regime	Leaf Harvest Proportion (%)	Treatment Combination
Gbanie	R0	P0	V1P0R0
	R1	P25	V1P25R1
	R1	P50	V1P50R1
	R1	P100	V1P100R1
	R2	P25	V1P25R2
	R2	P50	V1P50R2
	R2	P100	V1P100R2
	R3	P25	V1P25R3
	R3	P50	V1R3P50
	R3	P100	V1P100R3
	R1,2,3	P25	V1P25R1,2,3
	R1,2,3	P50	V1P50R1,2,3
	R1,2,3	P100	V1P100R1,2,3
Kabia	R0	P0	V2P0R0
	R1	P25	V2P25R1
	R1	P50	V2P50R1
	R1	P100	V2P100R1
	R2	P25	V2P25R2
	R2	P50	V2P50R2
	R2	P100	V2P100R2
	R3	P25	V2P25R3
	R3	P50	V2P50R3
	R3	P100	V2P100R3
	R1,2,3	P25	V2P25R1,2,3
	R1,2,3	P50	V2P50R1,2,3
	R1,2,3	P100	V2P100R1,2,3

Notes: R0,1,2,3: leaf harvest regime at 0, 30, 60 and 90d after planting; P0: 0% leaf harvest, P25: 25% leaf harvest, P50: 50% leaf harvest, P100: 100% leaf harvest.

were applied in the trial established in both seasons.

2.4 Data Collection

The data collected in the trial included above ground traits (vine diameter, severity of *C. puncticollis* infestation on vines and fresh foliage weight), and below ground traits (severity of *C. puncticollis* infestation on roots, storage root length, diameter and number of roots per plant, as well as fresh storage root weight). The diameter measurements were done using the vernier caliper, whereas the length measurements were done using the meter rule. The root diameter measurement was done from the middle portion of selected storage root organs. Severity of *C. puncticollis* infestation was assessed on a scale of 1-5, where 1 represented no visible symptoms of infestation; 2 represented mild infestation; 3 represented low infestation; 4 represented intermediate infestation; and 5 represented high infestation[12]. The fresh foliage and storage root organs were weighed using the weighing balance. Fresh storage root harvesting at both ecologies was done at 120 days after planting (DAP). At harvest, big, medium and small storage root categories were randomly selected for root organ measurements as well as assessment of other underground traits.

2.5 Statistical Analysis

The data collected was analyzed on the basis of variance of Genstat statistical package, while differences between treatment combinations were compared using the least significant difference[13].

3 RESULTS

3.1 *Cylas puncticollis* Infestation on Vines and Roots of Sweet Potatoes As Influenced by Ecology, Leaf Harvest Frequency and Proportion

Ecology significantly affected *C. puncticollis* infestations on vines and roots of sweet potato ($P<0.05$) (Table 2). However, treatment and ecology × treatment interaction did not significantly affect *C. puncticollis* infestation on vines ($P=0.894$ and $P=0.467$ respectively). Similarly, treatments and ecology × treatment interactions did not significantly influence *C. puncticolis* infestation on the fresh storage roots of sweet potato (P=0.599 and P=0.799 respectively). The pest pressure on vines and storage roots was generally mild for all treatments during the rainy season cultivation in the upland ecology compared to the dry season cultivation in the lowland ecology, which exhibited low levels of pest attack for most of the treatments. The severity of *C. puncticollis* infestation on the vines and fresh storage roots were mild for all treatments during the rainy season cultivation in the upland ecology compared to the dry season cultivation in the IVS ecology, which had low levels of pest attack for most treatments. These findings implied that ecology and time of cultivation of sweet potatoes influence *C. puncticollis* infestation on vines and roots of the crop more than the combined effects of putative varieties, leaf harvest frequency and intensity.

3.2 Leaf Yield of Sweet Potatoes As Influenced by Ecology, Leaf Harvest Frequency and Proportion

Treatment, ecology, and ecology × treatment interaction significantly (P<0.05) affected the foliage yield of sweet potatoes (Table 3). Foliage harvest of treatments V1P100R1, 2, 3 and V2P100R1, 2, 3 at 100% intensity and at 30, 60 and 90 days intervals exhibited the highest leaf yields at 26.30t ha^{-1} and 14.07t ha^{-1} in the upland and lowland ecologies respectively (Table 3). Leaf harvest of treatment VIP25R1 at 25% intensity and at 30 DAP was among the treatments that produced the lowest leaf yield at 1.11t ha^{-1} in both ecologies. For both varieties utilized in the treatment combinations, higher proportion and frequency of defoliation resulted in higher foliage yield. The mean foliage production in the upland was higher (5.65t ha^{-1}) in comparison to that in the lowland (4.60t ha^{-1}) (Table 3). These findings indicate that leaf harvest frequency and intensity influenced fresh leaf production and foliage yield in the sweet potatoes. Complete defoliation at 30, 60 and 90 days increased foliage yield of the studied varieties and agro-ecologies, indicating that foliage yields increase with increasing leaf harvest frequency and intensity. These results are consistent with those obtained by Kiozya et al.[8] and Samai et al.[14] who noted that plots with higher foliage harvesting frequencies produced higher foliage yields than those with little or no leaf harvest. The findings are also consistent with those obtained by Lebot[15] who opined that three or four leaf harvests can be done per growing season at 50% defoliation and 20 days intervals. The results are partially consistent with the view that foliage yield increases with delayed leaf harvesting[16]. The variance might be due to the different varieties used and trial environments. In this study, some treatments with leaves harvested twice or thrice at 50% defoliation also produced reasonable yields.

3.3 Fresh Root Yield and Related Attributes of Sweet Potatoes As Influenced by Ecology, Leaf Harvest Frequency and Proportion

Generally speaking, there were no significant ecology × treatment interactions for root yield and related attributes. However, the root yields, root length, and root width varied significantly (P<0.05) among various treatments, but there was no significant variation between the lowland and upland ecologies (P=0.320). Mean root length and width were higher in the lowland compared to the upland ecologies (Table 4). The extent of defoliation affected fresh storage root dimensions to varying degrees compared to non-leaf harvested plots. Gbanie defoliated once at 100% leaf harvest intensity at 30 DAP (treatment V1P100R1) had the highest storage root length (13.13cm), and was among the treatments with the highest root width in the lowland. 9 treatments with root lengths ranging from 10.59 to 13.13cm had comparable storage root lengths to the non-leaf harvested plots.

4 DISCUSSION

Our findings revealed that high root measurements (root length and width) are obtainable in Gbanie when foliage harvest is done once at 30, 60 or 90 DAP at 0, 25, 50 or 100% leaf harvest intensities in the lowland ecology. Delayed foliage harvest at 60 DAP, however, consistently contributed to increased fresh storage root lengths and widths of both varieties in the lowland and upland ecologies. This suggests that the frequency of foliage harvest impedes the development of storage root organ dimensions. This is consistent with reports by the Brazilian Archives of Biology and Technology[17]. The results are also consistent with the view that root yield per plant is a function of storage root organ dimensions such as the number, length and girth of the roots per plant[18,19]; and with the findings of Kathabwalika et al.[20] who noted that variations in root yields are influenced by variations in root dimensions.

For storage root number per plant, significant variation was observed among ecology and treatment (P<0.05), while insignificant variation was exhibited by the ecology × treatment interaction (P=0.815). Treatments V1P100R1, 2, 3 (2.55) and VIP25R1 (2.33) had a similar number of storage roots compared to the non-leaf harvested plots in the lowland trial site (Table 4). At the upland ecology, the treatments used exhibited a similar number of storage roots compared to the non-leaf harvested control plots.

In the IVS lowland ecology, 6 treatments (VIP25R1, V1P100R1, V1P25R2, V1P25R3, V1P50R1, and V1P50R2) with fresh storage root yields ranging between 10.45 and 16.44t ha^{-1} were similar to the fresh storage root yields obtained in the non-leaf harvested plots. In the upland ecology, 7 treatments (V1P100R2, VIP25R1, V1P25R1,2,3, V1P25R2, V2P25R1, V2P25R1,2,3 and V2P25R2) with fresh storage root yields ranging from 10.43-13.30t ha^{-1} were found to be similar with the non-leaf harvested plots (Table 4). The results imply that delayed harvesting of foliage of Gbanie and Kabia at 60 DAP and 25% leaf harvest intensity or early leaf harvest of both varieties at 30 DAP and 25% leaf harvest intensity resulted in higher storage root yields in the lowland and upland ecologies. Moreover, Gbanie completely

Table 2. Effects of Severity of *Cylas puncticollis* Infestation on Vines and Roots of Sweet Potatoes

Treatment	Severity of *Cylas puncticollis* Infestation on Vines		Severity of *Cylas puncticollis* Infestation on Roots	
	Lowland	Upland	Lowland	Upland
V1P0R0	2.4	1.7	1.7	1.7
V1P100R1	2.4	1.4	1.9	1.4
V1P100R1,2,3	2.7	1.3	2.2	1.3
V1P100R2	2.8	1.2	2.0	1.2
V1P100R3	2.9	1.3	2.4	1.3
VIP25R1	2.8	1.5	2.2	1.5
V1P25R1,2,3	2.6	1.0	1.2	1.0
V1P25R2	2.8	1.3	2.2	1.3
V1P25R3	2.5	1.2	2.1	1.2
V1P50R1	2.9	1.1	2.0	1.1
V1P50R1,2,3	2.4	1.2	1.6	1.1
V1P50R2	2.7	1.4	1.5	1.3
V1P50R3	2.4	1.3	2.3	1.4
V2P0R0	2.8	1.5	1.9	1.5
V2P100R1	2.5	1.5	1.7	1.4
V2P100R1,2,3	2.5	1.3	2.2	1.3
V2P100R2	2.8	1.0	2.4	1.0
V2P100R3	2.8	1.0	2.1	1.0
V2P25R1	2.9	1.5	2.1	1.5
V2P25R1,2,3	2.6	1.3	2.1	1.3
V2P25R2	2.9	1.2	2.3	1.2
V2P25R3	2.5	1.3	2.3	1.3
V2P50R1	2.7	1.1	1.7	1.1
V2P50R1,2,3	2.5	1.1	1.9	1.1
V2P50R2	2.9	1.2	1.7	1.2
V2P50R3	2.5	1.3	2.0	1.3
Mean	2.7	1.3	2.0	1.3
Grand mean	2.0		1.6	
$LSD_{0.05}$ = E	0.11^{*}		0.15^{*}	
$LSD_{0.05}$ = T	0.41^{ns}		0.53^{ns}	
$LSD_{0.0 5}$= E × T	0.57^{ns}		0.75^{ns}	
CV (%)	18		28.2	

Notes: R: leaf harvest regime, 1, 2 and 3: 30, 60 and 90 days after planting, respectively; P0: 0% leaf harvest, P25: 25% leaf harvest, P50: 50% leaf harvest, P100: 100% leaf harvest, E: ecology, T: treatment, ns: non-significant, *P<0.05.

defoliated once at 30 DAP, with 25% defoliation at 90 DAP, 50% defoliation at 30 DAP, and 50% defoliation at 60 DAP, producing high fresh storage root yields in the lowland ecology. 25% defoliation of Gbanie and Kabia at 30, 60 and 90 DAP, as well as 25% defoliation of Kabia once at 30 and 60 DAP also had high storage root yields in the upland trial site. The results demonstrate that optimum storage root organ development depends on good agronomic management of frequency and intensity of leaf harvest, choice of variety for dual-purpose sweet potato production and site selection. These results are consistent with those obtained by Lebot[15], who reported that 50% defoliation of sweet potatoes promotes optimal leaf and root yields, but defoliation greater than 50% harvest intensity could reduce fresh root yields. The results are also consistent with those obtained by Kiozya et al.[8], who found decreased fresh storage root yields of 33, 25 and 15% in plots where sweet potato foliage were harvested at 45, 75 and 105 DAP respectively. The decrease in root yields was possibly due to the utilization of most of the photosynthates for foliage production at the expense of translocation of photosynthates into the storage root yields. This study agrees with the assertion that harvesting foliage with the view of creating a balance between yield and quality is a potent agronomic tool utilized in forage species[21].

Table 3. Effect of Ecology and Treatment Combinations of Variety, Leaf Harvest Frequency and Proportion on Total Fresh Leaf Yields (t ha^{-1}) of Sweet Potatoes

Treatment	Leaf Yield (t ha^{-1})	
	Lowland	Upland
V1P0R0	-	-
V1P100R1	2.59	2.59
V1P100R1,2,3	10.37	26.30
V1P100R2	5.93	11.11
V1P100R3	10.37	9.26
VIP25R1	1.11	1.11
V1P25R1,2,3	3.70	4.82
V1P25R2	3.33	1.11
V1P25R3	2.96	3.33
V1P50R1	1.85	1.85
V1P50R1,2,3	5.56	9.63
V1P50R2	5.19	1.85
V1P50R3	4.81	4.44
V2P0R0	-	-
V2P100R1	2.22	2.22
V2P100R1,2,3	14.07	19.63
V2P100R2	7.78	11.48
V2P100R3	11.11	10.00
V2P25R1	1.11	1.11
V2P25R1,2,3	4.07	3.70
V2P25R2	2.59	1.11
V2P25R3	2.59	2.22
V2P50R1	1.85	1.85
V2P50R1,2,3	7.04	10.00
V2P50R2	2.96	1.48
V2P50R3	4.44	4.82
Mean	4.60	5.65
Grand mean	5.13	
$LSD_{0.05}$ = E	0.82*	
$LSD_{0.05}$ = T	2.97*	
$LSD_{0.05}$ = E × T	4.20*	
CV (%)	14.3	

Notes: R: leaf harvest regime, 1, 2 and 3: 30, 60 and 90 days after planting, respectively; P0: 0% leaf harvest, P25:25% leaf harvest, P50: 50% leaf harvest, P100: 100% leaf harvest, E: ecology, T: treatment, -: no leaf harvest, **P*<0.05.

Harvesting of leaves during growth, however, reduces the supply of photosynthates needed for the developmental phase of plants leading to an eventual reduction in root yields[22]. The findings therefore suggest that sweet potatoes grown for both foliage and root yields should not be subjected to high leaf harvest intensities and frequencies.

5 CONCLUSION

This study established that variety, leaf harvest frequency, and intensity affect fresh foliage yield, storage root yield, and related yield traits of sweet potatoes cultivated in the upland and IVS lowland ecologies of Njala, findings that can be exploited for the dual-purpose cultivation of the crop. *C. puncticollis* infestation was higher in sweet potatoes grown during the dry season in the IVS ecology than in those cultivated in the upland ecology during the wet season. The present study established that leaf harvesting at 25 and 50% supports optimization of foliage and storage root yields and related attributes of sweet potatoes, and can be exploited for the genetic improvement and agronomic benefits of the crop. This study is relevant for the conservation, management, and maintenance of sweet potatoes for genetic improvement to

Table 4. Effect of Ecology and Treatment Combinations of Variety, Leaf Harvest Frequency and Proportion on Fresh Root Yield (t ha^{-1}) and Attributes of Sweet Potatoes

Treatment	Root Length (cm)		Root Width (cm)		Root No. Per plant		Root Yield (t ha^{-1})	
	Lowland	Upland	Lowland	Upland	Lowland	Upland	Lowland	Upland
V1P0R0	12.51	13.63	7.63	7.73	2.33	2.33	13.78	14.43
V1P100R1	13.13	7.13	8.18	5.40	1.33	1.67	12.00	8.67
V1P100R1,2,3	10.11	8.67	5.43	4.10	2.55	2.37	8.89	4.67
V1P100R2	11.25	7.83	7.69	6.17	1.44	2.43	8.45	11.13
V1P100R3	10.32	8.50	5.67	4.40	1.78	2.33	6.00	7.10
VIP25R1	11.53	10.70	7.28	7.07	2.33	2.47	14.00	13.30
V1P25R1,2,3	8.36	9.70	4.86	6.50	1.22	2.57	3.33	12.87
V1P25R2	11.81	11.53	7.29	7.63	1.56	2.00	16.44	12.90
V1P25R3	11.90	9.37	6.76	5.67	1.67	2.20	10.45	8.67
V1P50R1	10.76	10.23	8.28	6.80	1.55	2.23	14.22	10.20
V1P50R1,2,3	9.59	9.27	5.76	5.80	1.55	1.90	4.45	7.33
V1P50R2	10.59	9.77	7.34	7.07	1.78	2.23	11.11	10.00
V1P50R3	10.85	8.47	7.20	5.83	1.78	2.23	9.55	9.77
V2P0R0	10.30	11.20	8.13	8.57	2.89	2.77	14.22	15.33
V2P100R1	10.60	7.43	7.90	5.37	1.11	1.67	9.11	4.90
V2P100R1,2,3	8.28	5.97	4.52	3.27	1.11	1.87	4.44	3.57
V2P100R2	7.81	7.80	5.51	6.17	1.11	2.23	3.78	10.00
V2P100R3	9.50	7.73	5.48	4.83	1.11	1.90	3.11	4.23
V2P25R1	9.38	9.60	5.52	7.33	1.33	2.23	6.55	10.43
V2P25R1,2,3	8.05	8.93	4.77	6.30	1.00	2.33	3.55	10.90
V2P25R2	9.84	9.43	7.11	6.70	1.89	2.67	9.33	11.13
V2P25R3	9.46	9.07	7.54	6.40	1.22	2.00	7.55	9.10
V2P50R1	10.03	9.00	5.86	5.67	1.45	2.23	8.22	8.00
V2P50R1,2,3	8.73	8.63	5.79	5.40	1.22	2.10	6.67	6.67
V2P50R2	8.90	9.03	5.88	6.57	1.33	2.77	5.55	10.23
V2P50R3	9.87	7.70	6.92	4.67	1.33	2.53	8.22	9.80
Mean	10.13	9.09	6.55	6.05	1.58	2.24	8.58	9.44
Grand mean	9.61		6.30		1.91		9.01	
$LSD_{0.05}$ = E	0.60^{*}		0.44^{*}		0.20^{*}		1.71^{ns}	
$LSD_{0.05}$ = T	2.16^{*}		1.59^{*}		0.71^{*}		6.15^{*}	
$LSD_{0.05}$ = E × T	3.06^{ns}		2.25^{ns}		1.01^{ns}		8.69^{ns}	
CV (%)	19.7		22		32.7		21.8	

Notes: R: leaf harvest regime, 1, 2 and 3: 30, 60 and 90 days after planting, respectively; P0: 0% leaf harvest, P25: 25% leaf harvest, P50: 50% leaf harvest, P100: 100% leaf harvest, E: ecology, T: treatment, ns: non-significant, -: no leaf harvest, *P<0.05.

support both foliage and food production for ruminants and humans respectively.

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Conflicts of Interest
The authors declared no conflict of interest.

Author Contribution
Norman PE, Kroma S, and Bogba C designed the experiment. Norman PE, Kroma S, and Kassoh FA supervised the work. Norman PE performed the data analysis. Norman PE, Bogba C and Kroma S drafted the manuscript. All the authors contributed to writing the article, read and approved its submission.

Abbreviation List
C. puncticollis, *Cylas puncticollis*
DAP, Days after planting

IVS, Inland valley swamp

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