Effect of time and proportion of leaf harvest on pest, forage and root yields of sweetpotato (*Ipomoea batatas* L.) in the inland valley swamp and upland ecologies of Njala

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Abstract— *Dearth of knowledge exists regarding the leaf harvest intensity and frequency thresholds that support optimum forage and fresh storage root yields in Sierra Leone. A study was carried out to assess the effects of leaf harvesting time and proportion on Cylas puncticollis infestation, growth and yield of sweet potato in the inland valley swamp and upland ecologies of Njala. Treatment combinations comprised of two varieties ("Kabia" and "Gbanie"), four leaf harvest regimes: 0, 30 60 and 90 days after planting (DAP); and four-leaf harvest intensities (0, 25, 50 and 100%). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Data collected included Cylas puncticollis severity on vines and storage roots, root dimensions and numbers, fresh foliage and storage root yields. The results revealed that leaf harvesting twice at 25 and 50% contributed more to optimum forage and storage root yields and related attributes of sweet potatoes compared to other treatments. The present study suggests that good agronomic management of sweet potato that supports optimum forage and storage root yields should be selected to meet the dual purpose for which it is grown. These findings serve as good guide for incorporation of leaf harvesting time, proportion of leaf harvest in germplasm assessment and new population development objectives.*

Keywords— leaf harvest, regimes, intensities, root yield, pest, sweetpotato.

I. INTRODUCTION

Sweetpotato (*Ipomoea batatas* L) is a dicotyledonous root crop that belongs to the family Convolvulaceae that comprises about 50 genera and more than 1000 species. *Ipomoea batatas* is the only crop of major importance in the Convolvulaceae family [1]. The crop is native to Central and South America [2] and cultivated in over 100 countries of the world. Sweetpotato is extensively grown in tropical and subtropical regions particularly in Asia, Africa and the Pacific; with Asia and Africa continents accounting for 95% of total global production [3]. Sweetpotato is the fifteenth most important food security crop, and the third most important root and tuber crops, grown on 8.6 million hectares worldwide, with production and average yield of about 106 million tons and 12.2 t ha^{-1}, respectively [4]. China is the major producer of sweetpotato in the world, followed in order by Nigeria, Tanzania, Indonesia, Uganda, Ethiopia, Angola, India, the United States of America, Vietnam and Madagascar [4].

In Sierra Leone, the crop ranks as the second most important root and tuber crops after cassava, and is cultivated in all the provinces [5]. Both the leaves and roots of sweetpotato are consumed in Sierra Leone. Leaf harvesting from sweetpotato during its vegetative growth is common in most parts of the country. The harvested leaves are either used for vegetable or for fodder. Leaves harvested for livestock feed involves plucking the fully expanded mature leaves [6], whereas the immature leaves are used for human consumption. According to Kiozya *et al.* [7] leaf harvesting in sweetpotato reduces root yield by 43%. Moreover, Masumba [8] also noted that harvesting of a certain number of leaves from root crop reduces photosynthates thereby contributing to reduction in root yield.

Despite the dual-purpose potentiality of the leaves and roots of sweetpotato in contributing to food and nutrition security, no comprehensive study has been done on the effects of leaf harvest frequency and intensity on the growth and yield of sweetpotato. Even though earlier works by Kiozya *et al.* [7] suggests that leaf harvesting in sweet potato reduces root yield by 43%; and by Masumba [8] that increased leaf harvest intensity decreases photosynthate translocation to the roots thereby contributing to reduction in root yields, these are yet to be tested using different genotypes, ecologies and leaf harvest intensities and frequencies in Sierra Leone.

The identification of dual-purpose leaf harvest frequency and intensity with optimum economic forage and fresh root yields contributes to increasing food and feed production and productivity that meet the demands of various actors in the sweetpotato value chain. The identification of the leaf harvest frequency and intensity with optimum economic forage and fresh storage root yields also facilitate ready availability of planting materials, food and feeds, thereby contributing to increased food production and productivity. Thus, the main aim of the study was to investigate the effects of leaf harvesting time and proportion on *Cylas puncticollis* infestation, forage yield, fresh storage root yield and related attributes of sweetpotato grown in the inland valley swamp and upland ecologies of Njala. The specific objectives were to: (i) assess the effect of leaf harvest intensity and frequency on *Cylas puncticollis* infestation in sweetpotato; (ii) assess varietal response to leaf harvest intensity and frequency in sweetpotato; (iii) determine the effect of leaf harvest frequency and intensity on the forage yield of sweetpotato; and (iv) determine the effect of leaf harvest frequency and intensity on fresh storage root yield of sweetpotato.

II. MATERIALS AND METHODS

2.1 Trial site description

A field trial was conducted at the at the inland valley swamp (IVS) and the upland of Njala during the third cropping season (dry season) of 2019 under irrigated conditions for the inland valley swamp and rain fed for the upland. Njala is situated at an elevation of 54 m above sea level on 8°06′N latitude and 12°06′W longitude. The most dominant vegetation at Njala is grassland, comprising mainly of *Andropogon gayanus* (gamba grass). Njala has two distinct seasons, like other parts of the country, including the rainy season, which starts from April to November, while the dry season lasts between December and March. The dry season trial was irrigated every other day to field capacity till establishment at 2 months after planting using watering cans. The mean monthly air temperature of Njala ranged from 23.4°C to 34.9°C, and the mean monthly relative humidity was 69.9% for the dry season trial; whereas the rainy season, the mean monthly air temperature ranged from 20.4°C to 33.8°C, and the mean monthly relative humidity was 83.9% (SLARI Weather Station, 2019). The average annual rainfall was about 2500 mm.

The soils of the experimental sites are slightly acidic and moderate in available plant nutrients. The soils from trial sites are well to moderately well-drained and low in plant nutrients [9].

2.2 Experimental design, treatments and management

The experimental site was manually brushed and cleared. The ridges were prepared using digging hoe, large clods were pulverized using garden hoe prior to planting. The experiment was laid out in a randomized complete block design with three replications. A total of 20 treatment combinations used in the experiment is shown in Table 1. The varieties used were "Gbanie" (V 1) and "Kabia" (V 2).

Healthy vine tip cuttings 30 cm long were used as planting materials, and planted in a slantwise orientation. Planting was done lowland ecology on the 7th of February 2019 on ridges at a plant spacing of 0.30 m × 1 m giving a plant density of 33,333 plants ha^{-1}; and the second planting was done at the upland ecology on the 29th May 2019 with the same plant spacing and density. Weeding and earthing up to cover the exposed roots were done monthly, for both planting seasons. No fertilizer and pesticides were applied in both seasons.

2.3 Data collection

A total of six parameters were collected including two above ground (vine diameter, and fresh leaf yield) and above ground (tuber length, tuber diameter, number of tubers per plant and fresh storage root yield) traits. The root diameter was measured from the middle portion of the fresh storage roots. Both the root diameter and root length were measured using the vernier caliper.

At harvest, storage roots were counted and weighed using the weighing balance. Big, medium and small storage roots were randomly selected for diameter and length measurements. Harvesting at the lowland and upland ecologies was done at 120 DAP.

TABLE 1
TREATMENT COMBINATIONS FOR SWEETPOTATO TRIAL

Variety	Leaf harvest regime	Leaf harvest proportion	Treatment combination
Gbanie	R0	P0	V1 P0R0
	R1,3	P25	V1 P25R1,3
	R2,3	P25	V1 P25R2,3
	R1,3	P50	V1 P50R1,3
	R2,3	P50	V1 P50R2,3
	R1,3	P100	V1 P100R1,3
	R2,3	P100	V1 P100R2,3
	R1,2,3	P25	V1 P25R1,2,3
	R1,2,3	P50	V1 P50R1,2,3
	R1,2,3	P100	V1 P100R1,2,3
Kabia	R0	P0	V2 P0R0
	R1,3	P25	V2 P25R1,3
	R2,3	P25	V2 P25R2,3
	R1,3	P50	V2 P50R1,3
	R2,3	P50	V2 P50R2,3
	R1,3	P100	V2 P100R1,3
	R2,3	P100	V2 P100R2,3
	R1,2,3	P25	V2 P25R1,2,3
	R1,2,3	P50	V2 P50R1,2,3
	R1,2,3	P100	V2 P100R1,2,3

The R1,2 combinations were not included due to limited planting material and space; R0,1,2,3= leaf harvest regime at 0, 30, 60 and 90 days after planting

2.4 Statistical analysis

The data collected were analyzed using analysis of variance (ANOVA). The data obtained were analyzed using the Genstat statistical package [10] and differences between treatment means were compared using the Least Significant Difference (LSD).

III. RESULTS

3.1 Effects of ecology, leaf harvest frequency and proportion on severity of Cylas puncticollis infestation on vines and roots of sweetpotato

The infestations of *Cylas puncticollis* on vines and roots varied significantly (p<0.001) for the lowland and upland ecologies used in the study (Table 2). However, the infestations of *C. puncticollis* were non-significant for treatments (p=0.847) and ecology × treatment interaction (p=0.341) for *C. puncticollis* on vines. Similarly, the infestations of *C. puncticollis* on fresh storage roots were non-significant among treatments (p=0.981) and ecology × treatment interactions (p=0.178). The pest pressure on the vines and fresh storage roots was mild for all treatments during the rainy season cultivation in the upland ecology compared to the dry season treatments in the lowland ecology which had low attack of the pest for most treatment combinations.

3.2 Effects of ecology, leaf harvest frequency and proportion on leaf yield of sweetpotato

The leaf yields varied significantly (p=0.013) at the lowland and upland ecologies. There were also significant differences (p<0.001) among treatments and ecology × treatment interaction for sweetpotato leaf yield per hectare. Leaf foliage harvest at 100% harvest intensity at 30, 60 and 90 DAP intervals (treatment V1P100R1,2,3) exhibited the highest leaf yield (26.30 t ha^{-1}) in the upland, whereas leaf harvest at 100% harvest intensity at 30 days after planting (treatment VIP25R1) was among treatments that produced the lowest leaf yield (1.11 t ha^{-1}) at both ecologies (Table 3).

TABLE 2
EFFECTS OF *CYLAS PUNCTICOLLIS* SEVERITY ON VINES AND ROOTS OF SWEETPOTATO

	***Cylas puncticollis* severity on vines**		***Cylas puncticollis* severity on roots**	
Treatment	**Lowland**	**Upland**	**Lowland**	**Upland**
V1P0R0	2.4	1.7	1.7	1.7
V1P100R1,2,3	2.7	1.3	2.2	1.3
V1P100R1,3	2.8	1.3	1.7	1.3
V1P100R2,3	2.8	1.5	1.8	1.6
V1P25R1,2,3	2.8	1.3	2.2	1.3
V1P25R1,3	2.9	1.1	2.3	1.1
V1P25R2,3	2.4	1.1	2.0	1.1
V1P50R1,2,3	2.7	1.4	1.5	1.3
V1P50R1,3	2.7	1.7	1.4	1.7
V1P50R2,3	2.6	1.4	1.5	1.4
V2P0R0	2.5	1.5	1.7	1.4
V2P100R1,2,3	2.8	1.0	2.4	1.0
V2P100R1,3	2.6	1.1	2.0	1.1
V2P100R2,3	2.8	1.2	2.1	1.2
V2P25R1,2,3	2.9	1.2	2.3	1.2
V2P25R1,3	2.5	1.3	1.7	1.3
V2P25R2,3	2.9	1.3	1.7	1.3
V2P50R1,2,3	2.9	1.2	1.7	1.2
V2P50R1,3	2.6	1.1	1.9	1.1
V2P50R2,3	2.7	1.1	1.8	1.1
Mean	**2.7**	**1.3**	**1.9**	**1.3**
Grand mean	2.0		1.6	
LSD0.05=E	0.13***		0.16***	
LSD0.05=T	.40^{ns}		0.52^{ns}	
LSD0.05=E×T	0.56^{ns}		0.73^{ns}	
CV(%)	17.3		28.3	

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 at p<0.05, ***=significant at p<0.001

At 30 DAP, treatments V1P100R1,2,3 and V2P100R1,2,3 in both lowland and upland ecologies had significantly (p<0.001) higher leaf yield than the remaining treatments except V1P100R1,3 and V2P100R1,3 (Table 3). The ecology and ecology × treatment were non-significant for leaf yield measured at 30 DAP sampling regime.

At 60 DAP, treatment V2P100R2,3 (11.1 t ha^{-1}) significantly (p<0.001) had the highest leaf yield followed by treatments V1P100R1,2,3 (5.57 t ha^{-1}) and V2P100R1,2,3 (6.27 t ha^{-1}) in the lowland (Table 4). However, in the upland, the highest leaf yielders were treatments V1P100R1,2,3 (11.85 t ha^{-1}) and V2P100R2,3 (10.74 t ha^{-1}). The ecology and ecology × treatment was non-significant for leaf yield measured at 30 DAP sampling regime. At 90 DAP, treatments V1P100R1,2,3 (11.48 t ha^{-1}) and V1P100R2,3 (11.48 t ha^{-1}) significantly (p<0.001) exhibited the highest leaf yield in the lowland (Table 5). For the upland ecology, treatment V2P100R2,3 (10.73 t ha^{-1}) significantly (p<0.001) produced the highest leaf yield. The ecology and ecology × treatment interactions were significant (p<0.001) for leaf yield measured at 30 DAP sampling regime.

TABLE 3
EFFECT OF ECOLOGY AND TREATMENT COMBINATIONS OF VARIETY, LEAF HARVEST FREQUENCY AND PROPORTION ON FRESH LEAF YIELDS (t ha^{-1}) OF SWEETPOTATO AT 30 DAYS AFTER PLANTING

	Leaf yield (t ha^{-1}) at 30DAP	
Treatment	**Lowland**	**Upland**
V1P0R0	-	-
V1P100R1,2,3	2.93	2.96
V1P100R1,3	2.57	2.59
V1P25R1,2,3	1.10	1.11
V1P25R1,3	1.10	1.11
V1P50R1,2,3	1.83	1.85
V1P50R1,3	1.83	1.85
V2P0R0	-	-
V2P100R1,2,3	2.93	2.96
V2P100R1,3	2.57	2.59
V2P25R1,2,3	1.10	1.11
V2P25R1,3	1.10	1.11
V2P50R1,2,3	1.83	1.85
V2P50R1,3	1.83	1.85
Mean	1.62	1.64
Grand mean	1.63	
LSD0.05=E	0.21^{ns}	
LSD0.05=T	0.55^{***}	
LSD0.05=E×T	0.78^{ns}	
CV(%)	29.2	

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, *=significant at p<0.05, ***=significant at p<0.001

TABLE 4
EFFECT OF ECOLOGY AND TREATMENT COMBINATIONS OF VARIETY, LEAF HARVEST FREQUENCY AND PROPORTION ON FRESH LEAF YIELDS (t ha^{-1}) OF SWEETPOTATO AT 60 DAYS AFTER PLANTING

	Leaf yield (t ha^{-1}) at 60 DAP	
Treatment	**Lowland**	**Upland**
V1P0R0	-	-
V1P100R1,2,3	5.57	11.85
V1P100R1,3	4.83	6.67
V1P25R1,2,3	1.47	1.11
V1P25R1,3	1.83	1.11
V1P50R1,2,3	2.20	1.85
V1P50R1,3	5.53	2.96
V2P0R0	-	-
V2P100R1,2,3	6.27	6.67
V2P100R1,3	11.1	10.74
V2P25R1,2,3	1.47	1.11
V2P25R1,3	1.83	1.48
V2P50R1,2,3	2.57	1.85
V2P50R1,3	4.43	2.22
Mean	**3.51**	**3.54**
Grand mean	3.53	
LSD0.05=E	0.90^{ns}	
LSD0.05=T	2.39^{***}	
LSD0.05=E×T	3.38^{ns}	
CV(%)	58.5	

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, ns=non-significant, *=significant at p<0.05, ***=significant at p<0.001, V1= "Gbanie", V2="Kabia"

TABLE 5
EFFECT OF ECOLOGY AND TREATMENT COMBINATIONS OF VARIETY, LEAF HARVEST FREQUENCY AND PROPORTION ON FRESH LEAF YIELDS (t ha^{-1}) OF SWEETPOTATO AT 90 DAYS AFTER PLANTING

	Leaf yield (t ha^{-1}) at 90 DAP	
Treatment	**Lowland**	**Upland**
V1P0R0	-	-
V1P100R1,2,3	11.48	4.07
V1P100R1,3	7.41	4.80
V1P25R1,2,3	11.48	3.33
V1P25R1,3	3.33	2.57
V1P50R1,2,3	2.96	3.33
V1P50R1,3	1.85	5.17
V2P0R0	6.30	1.47
V2P100R1,2,3	5.19	4.83
V2P100R1,3	3.70	4.43
V2P25R1,2,3	-	-
V2P25R1,3	10	4.8
V2P50R1,2,3	7.04	9.27
V2P50R1,3	9.63	10.73
Mean	2.22	2.2
Grand mean	2.22	
LSD0.05=E	2.59	
LSD0.05=T	6.30	
LSD0.05=E×T	2.96	
CV(%)	4.07	

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, ***=significant at p<0.001

3.3 Effects of ecology, leaf harvest frequency and proportion on root yield of sweetpotato

Fresh storage root yields differed significantly ($p<0.001$) among treatments, but non-significantly varied for ecology ($p=0.092$) and ecology × treatment interaction ($p=0.118$) (Table 6). "Gbanie" (14.89 t ha^{-1}), "Kabia" (10.44 t ha^{-1}) defoliated twice at 25% leaf harvest intensity at 30 and 90 DAP (i.e. treatments V1P25R1,3 and V2P25R1,3, respectively); and "Kabia" (12.45 t ha^{-1}) defoliated twice at 50% leaf harvest intensity at 60 and 90 DAP (i.e. treatment V2P50R2,3) had similar fresh root yields as the non-leaf harvested plots in the lowland ecology. For the upland ecology, "Gbanie" (11.33 t ha^{-1}) and "Kabia" (15.33 t ha^{-1}) defoliated twice at 25% leaf harvest intensity at 30 and 90 DAP (i.e. treatments V1P25R1,3 and V2P25R1,3, respectively); and "Gbanie" (11.33 t ha^{-1}) defoliated twice at 50% leaf harvest intensity at 60 and 90 DAP (i.e. treatment V1P50R2,3) had similar fresh root yields as the non-leaf harvested plots.

3.4 Effects of ecology, leaf harvest frequency and proportion on root yield attributes of sweetpotato

The fresh storage root length and width significantly ($p<0.001$) varied among treatments studied, but did not vary for ecology × treatment interactions of both traits. Three treatments (V2P50R2,3; V1P100R1,3 and V1P25R1,3) with storage root length ranging from 10.56 – 13.46 cm were similar to those of the non-leaf harvested plots in the lowland ecology (Table 6). For the upland ecology, "Gbanie" with no leaf defoliation (i.e. treatment V1P0R0) significantly produced the longest roots.

For storage root diameter, five treatments (V2P25R2,3; V2P50R2,3; V2P25R1,3; V1P50R1,3; and V1P25R1,3) with storage root diameter ranging from 6.68 – 8.84 cm had similar root diameters compared to the non-leaf harvested plots in the lowland ecology (Table 6). Treatments V1P25R2,3 (7.00 cm) and V2P25R1,3 (7.53 cm) had similar root diameters as the non-leaf harvested plots in the upland ecology. The fresh storage root number per plant significantly varied among ecology ($p<0.001$), treatments ($p<0.001$), and ecology × treatment interaction ($p=0.024$). Treatment V1P100R1,2,3 (2.55) had similar numbers of storage roots as the control plots in the lowland ecology. For the upland ecology, seven treatments (V2P50R2,3; V2P50R1,3; V2P25R1,3; V2P100R1,3; V1P50R2,3; V1P25R1,3; and V1P25R1,2,3) with number of storage roots ranging from 2.20 – 3.10 produced similar numbers of storage roots compared to the non-leaf harvested control plots (Table 6).

TABLE 6
EFFECT OF ECOLOGY AND TREAT COMBINATIONS OF VARIETY, LEAF HARVEST FREQUENCY AND PROPORTION ON FRESH ROOT YIELD AND ATTRIBUTES (t ha^{-1}) OF SWEETPOTATO

	Root length (cm)		Root width (cm)		Root no per plant		Root yield (t ha^{-1})	
Treatment	**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**
V1P100R1,2,3	10.11	6.63	5.43	4.23	2.55	1.80	8.89	4.43
V1P100R1,3	11.77	6.60	6.43	3.80	2.00	1.33	9.11	3.57
V1P100R2,3	7.45	8.27	4.52	6.00	1.00	1.90	4.45	7.77
V1P25R1,2,3	8.36	9.43	4.86	5.83	1.22	2.80	3.33	10.67
V1P25R1,3	13.46	10.37	8.84	6.80	1.67	2.23	14.89	11.33
V1P25R2,3	8.10	9.57	5.56	7.00	1.33	1.90	6.22	10.00
V1P50R1,2,3	9.59	9.27	5.76	5.80	1.55	1.90	4.45	7.33
V1P50R1,3	9.47	7.57	7.37	6.03	1.45	1.87	8.67	7.57
V1P50R2,3	10.07	7.40	6.28	5.10	1.89	3.00	6.45	12.23
V2P0R0	10.30	11.20	8.13	**8.57**	2.89	**2.77**	**14.22**	**15.33**
V2P100R1,2,3	8.28	7.80	4.52	4.47	1.11	2.10	4.44	5.33
V2P100R1,3	8.30	7.70	6.46	4.87	1.22	2.47	4.22	5.13
V2P100R2,3	7.71	8.60	5.45	5.93	1.33	1.87	4.22	8.63
V2P25R1,2,3	8.05	8.37	4.77	5.70	1.00	1.67	3.55	6.47
V2P25R1,3	9.73	9.77	7.85	7.53	1.66	3.10	10.44	15.33
V2P25R2,3	8.28	7.73	6.68	5.60	1.00	2.23	2.44	8.23
V2P50R1,2,3	8.73	8.63	5.79	5.40	1.22	2.10	7.33	6.67
V2P50R1,3	7.43	7.13	4.95	4.63	1.55	2.23	4.22	5.80
V2P50R2,3	10.56	8.40	7.10	4.37	1.55	2.20	12.45	6.00
Mean	**9.41**	**8.70**	**6.22**	**5.77**	**1.58**	**2.19**	**7.39**	**8.61**
Grand mean	9.06		5.99		1.88		8.00	
$LSD_{0.05}$=E	0.71^{*}		0.54^{ns}		0.20^{***}		1.43^{ns}	
$LSD_{0.05}$=T	2.23^{***}		1.70^{***}		0.64^{***}		4.52^{***}	
$LSD_{0.05}$=E×T	3.15^{ns}		2.41^{ns}		0.90^{*}		6.39^{ns}	
CV(%)	21.4		13.3		29.4		15.3	

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, *=significant at p<0.05, ***=significant at p<0.001

IV. DISCUSSION

Cylas puncticollis infestation on the vines and fresh storage roots was mild for all treatments during the rainy season cultivation in the upland ecology relative to the dry season cultivation in the lowland ecology which exhibited low attack of the pest for most treatment combinations. Findings indicated that ecology and time of cultivation of sweetpotatoes contribute more to *Cylas puncticollis* infestation on vines and roots of sweetpotatoes rather than the combined effects of putative varieties, leaf harvest frequency and intensity.

Foliage yield of sweetpotato increased with leaf harvest frequency and intensity to varying degrees. Complete defoliation at 60- and 90-days increased foliage yield of both varieties at the two agro-ecologies indicating that two critical leaf harvest regimes of a putative variety good economic returns to producers targeting both foliage and root yields. Moreover, harvesting thrice mostly produced higher yields at different ecologies suggesting the dependence of foliage yield on the variety, frequency of leaf harvesting and proportion of leaf harvest. Findings concur with those obtained by Kiozya [7] who opined that leaf harvesting frequencies exhibited higher foliage yields than the non-leaf harvest plots. The results are in concurrence with Olorunnisomo [11] who reported that foliage yield increased with delayed leaf harvesting. The results also partly agree with Lebot [12] who noted that leaves can be harvested thrice or four times per growing season at 50% defoliation and 20 days interval. In this study, some treatments with 50% leaf harvest done twice or thrice also produced reasonable yields. The slight variances might be due to different genotypes and environments where the studies were conducted.

In this study, higher storage root yields were obtained in the plots with foliage harvested twice at 30 and 90 days after planting and leaf harvest intensities of 25% in the lowland and upland ecologies. Delayed harvesting of foliage twice of "Kabia" at 60 and 90 days after planting and leaf harvest intensities of 50% resulted in higher storage root yield in the upland ecology. The results generally indicated that comparably high fresh storage root yields are obtainable in lower leaf harvest intensities of 25% and 50% dependent upon the leaf harvest sampling interval, genotype and ecology. These findings agree with Lebot [12] who opined that sweetpotato defoliation of 50% promotes optimal leaf and root yields of the crop, since greater defoliation could reduce fresh storage root yields. Findings are also supported by Kiozya *et al.* [7] who noted that foliage harvest at 45, 75 and 105 days after planting decreased fresh storage root yields by 33, 25 and 15%, respectively. The reduction is probably attributable to translocation of most of the photosynthates to foliage production at the expense of storage root yields. These results suggest that cultivation of sweetpotatoes for forage and storage root yields require selection of desired variety, leaf harvest proportion and intensity.

Leaf harvesting affected fresh storage roots dimensions of sweetpotatoes to varying degree. High root length and diameter were obtained in treatments with foliage harvested twice at 30 and 90 days after planting and leaf harvest intensities of 25% in the lowland and upland ecologies. Delayed harvesting of foliage twice of "Kabia" at 60 and 90 days after planting and leaf harvest intensities of 50% resulted in high storage root dimension compared to treatments harvested at 30, 60 and 90 days after plant in the upland ecology indicating that frequent harvesting of leaves reduces storage root dimensions depending on variety and ecology [13] (Brazilian Archives of Biology and Technology, 2006). Findings in this study concur with those of Villordon *et al.* [14] who noted that radial diameter of storage roots is among main components of production and fresh storage root yields of sweetpotatoes. These results are also consistent with the suggestion by Kathabwalika *et al.* [15] that cultivars with similar storage root length and wide variations in diameters account for differences in root yields. Moreover, findings of the present study are in concurrence with the suggestion that root yield per plant is a function of number of roots per plant, root length, and root diameter [16, 17].

V. CONCLUSION

The current study demonstrated that good agronomic management including choice of appropriate ecology, variety and leaf harvest frequencies and intensities depending on the desired produce, can contribute to optimizing forage and fresh root yields of sweetpotato. Where both forage and fresh root yields are desired, leaf harvesting should be kept at 25 and 50%. Sweetpotato foliage tends to be rejuvenated thereby producing more leaves for subsequent harvests. Dual purpose sweetpotato varieties can be conserved and genetically improved to support both forage production for ruminant animals throughout the year and food for humans. The ecology and time of cultivation of sweetpotatoes contributed more to *Cylas puncticollis* infestation on vines and roots of sweetpotatoes than putative varieties, leaf harvest frequency and intensity treatment combinations assessed. Findings of the present study demonstrated the incorporation of leaf harvesting time, proportion of leaf harvest in germplasm assessment and new population development objectives for dual purpose sweetpotato varieties utilized by various end users.

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