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Evaluation of Nutrient Uptake of Selected Cover Crops and Biochar on the Yield Advantage of Two Taro (*Colocasia esculenta*) Cultivars in Samoa

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Abstract

A study was conducted in three agro ecological zones of Samoa to compare the dry matter yields and nutrient uptake of selected tropical cover crops and biochar application on different Samoan inceptisols. Subsequent improvements in corm yield of the two taro cultivars, (Samoa 1 and Samoa 2), under these fallow systems were also determined. The split-plot arrangement with main plots as cover crops and subplots as the cultivars was used, with four replications. The evaluated cover crops included: a reference – grass fallow treatment (farmers practice), Mucuna pruriens, Erythrina subumbrans, Mucuna pruriens + 200 kg of NPK fertiliser (12-5-20), farmer's reference practice + 400 kg of NPK fertiliser (12-5-20), and biochar produced from coconut shells. The biomass samples were collected after the six month of fallow duration. Plant tissue analyses revealed that the nitrogen and the phosphorus contents of erythrina was higher than corresponding mucuna cover across all three sites. However, as a result of higher biomass production, Mucuna pruriens showed the highest nutrient accrual over the six month fallow duration. The general yield trend under different fallow practices across all the sites indicates that mucuna with modest supplementation of complete fertilisers can help maintain optimum taro yields. However, it appears that the yield responses of the taro crop to fallow treatments are site-specific.

Keywords: *Fallow; Cover crop; Nutrient uptake*

1. Introduction

Root and tuber crops are the major sources of dietary energy for many people in the Pacific island countries. In the Pacific Islands, taro has always been richly woven into the fabric of life (Guinto *et al.*, 2015). Intensification of production to meet food security and economic aspirations leads to the rapid soil degradation in the pacific islands. In various forms, intensification occurs widely across the Pacific Islands, not solely because of population pressure but also due to the ever increasing export demand for taro from the region. However, growers have not been introduced to more sustainable technologies to underpin this intensification (Maathuis and van Meer, 2003; Schipanski *et al.*, 2014). A sustainable crop production system must, therefore, adopt an ecological approach, using balanced nutrient inputs from inorganic, organic and biological sources (Wittwer *et al.*, 2017)**.**

Many studies recount how environments with great agricultural potentials and rich biodiversity have been degraded and have become unproductive due to unsustainable agricultural practices (Hartemink, 2003). Generally, soil degradation is evident from the rapid loss in soil fertility when forest vegetation is converted to farmlands and plantation agro-ecosystems. Restoration of soil quality for improvement of crop yields is thus a necessity which demands urgent measures such as soil erosion management, soil biodiversity improvement, implementation of soil restorative farming and cropping systems, and smart agricultural intensification which allows for significant gains to be made in terms of soil organic carbon storage, water use efficiency and biodiversity (Hartemink, 2003).

Cropping systems involve yearly sequences and special arrangements of crops, or fallow on a given area. Fallowing has been a valuable practice for exploring nutrient dynamics and overall assessment of fertilization (Shahid *et al*., 2016). The importance of cover crop and leguminous fallow in improving productivity of subsequent crops through soil mineral N contributions has been well documented (Fageria *et al.*, 2005; Baligar and Fageria, 2007; Gusti *et al.*, 2015; De Borja 2017). Interactions between cover crop choice and N regime have been found on winter wheat yields; confirming 'legume mix' approach tends to give positive yield responses (Stobart and Morris (2014). Soil quality improvements from incorporation of *Pueraria javanica* biomass encompassed increases in soil moisture content (40.25%), porosity (79.9%), organic C (1.95%), total N (0.09%), available-P (15.71 mg/kg), exchangeable K (2.07 mg/kg) and soil respiration (meC-CO_2/kg/day (Neiunna *et al.*, 2016).

Cover crops provide a variety of important agro-ecological services and improve the resilience of annual cropping systems, some of which includes soil organic carbon (SOC) sequestration (Olson *et al.*, 2010);

improved phosphorus availability (Dube *et al.*, 2014); crop nutritional benefits, suppression of plant parasitic nematodes (Abiodun *et al.*, 2016); as well as other bacterial pathogens (Neiunna *et al.*, 2016). Biochar incorporation lead increases in soil pH, total C, N, S, as well as exchangeable K, Ca, Mg and cation exchange capacity (CEC) have been observed (Carter *et al.*, 2013); while a decline in the exchangeable Na has been reported in the same study.

Shifting cultivation with short fallow periods is an important form of land use system in the pacific island countries (Maathuis and van Meer, 2003). A quantitative evaluation of cover crops can provide the foundation for improvement in selecting organic practices to achieve taro's maximum yield potential under such systems. The use of biochar in agriculture has been well documented elsewhere in the world (Yang *et al.*, 2017); however, its use in pacific agriculture has been obscure. Thus, this study reports an investigation into the biomass production and nutrient uptake of selected green manure cover crops and biochar application and evaluate their effect on fresh taro yields of two improved (leaf blight resistant) cultivars.

2. Materials and Methods

2.1. Study Area

This experiment was conducted at three different sites in Samoa (15-17^{o} S and 171-173^{o} W). The location experiences a humid tropical climate with an annual rainfall varying from 2,000 to 5,000 mm with a strong seasonality of distribution. The months from April to October are the driest times of the year. The average annual air temperature range is 20–33^{o}C.

2.2. Description of the trial

Two leaf blight resistant taro cultivars (*Samoa 1* and *Samoa 2*) were grown under six fallow practices (Table 1) after a fallow duration of six months over three sites in 2014: Salani, Upolu, a high rainfall site (4,959 mm); Safaatoa, Upolu, receiving a comparatively lower annual rainfall (3,418 mm) and Siufaga, Savaii, (3,989 mm). The experimental design employed was a split plot arrangement in four randomised blocks with the six fallow practices randomly assigned as the main plots and the two cultivars as the sub plots.

2.3. Physico chemical characterization of the three sites

All the three sites were characterized for selected soil physical, chemical and fertility indices for the top 0-15 cm of the soil (Table 2).

2.4. Biochar preparation and characterization

The process of slow pyrolysis was used in the production of biochar, in which large biomass (coconut shell) particles was heated slowly in the absence of oxygen at an elevated pressure in a fixed metallic drum at a temperature of approximately 400^{o}C. The physico chemical characteristics of the biochar produced is given in Table 3 below.

2.5. Plant culture and management

After six month of fallow duration, vegetation under all the systems was sprayed with a systemic herbicide. Eight plants of each of the two cultivars of taro were planted using uniform size suckers in each of the net split plots within each fallow treatment at a spacing of 1m x 1m. After five and ten weeks of planting, the NPK treatments were applied as two split applications. Hilling and weeding was carried out across all plots.

2.6. Data collection

2.6.1. Dry matter yield and nutrient uptake of cover crops

Destructive sampling using 0.5m x 0.5m quadrats was employed to determine the total dry matter yields (t/ha) of all the cover crop vegetation. Samples of fully developed young leaves were collected at six months of age (before herbicide spraying) and were oven dried to a constant weight at 65^{o}C for determination of their dry matter yield, nutrient concentration and nutrient uptake. Nitrogen, phosphorus and potassium were determined after Kjeldahl digestion method for plant samples as described by Blakemore *et al.* (1987) and Daly *et al.* (1984). Determination of N was done by steam distillation, P by molybdovanadophosphoric acid (IBSNAT, 1987), and K, Ca, Mg, Zn, Fe, Mn, and Cu by atomic absorption spectrophotometry (Chapman and Prat, 1961; Prasad and Spiers, 1978). Nutrient contents were calculated as the product of dry matter content and tissue nutrient concentration. Nutrient uptake was calculated by multiplying the percentage nutrient content by the dry matter yields, expressed as kg/ha.

2.6.2. Harvesting and yield of the taro crop

The taro crop was harvested at 8 months of age, the corms washed clean and air dried before weighing (Guinto *et al.*, 2015). The yields of the two cultivars of taro grown under the different fallow practices over the 3 sites were ascertained and expressed as t/ha of fresh corm weight.

2.7. Statistical analysis

The biomass and nutritional composition data were analysed using ANOVA for randomised complete block design. The yield data from all the three sites was subjected to a nested classification analysis of variance for unbalanced designs, where blocks were nested into locations; the six fallow practices were nested into blocks and the two cultivars were nested into fallows (Table 5). Mean comparisons were carried out using least significant differences (LSD). All the data analyses were carried out using the Genstat statistical software package (VSN International Ltd., 2011).

Table 1. The fallow treatments applied to the soils at the three sites.

Fallow treatment	Treatment description
Farmer's practice	Natural grass vegetation with the biomass decomposed as mulch.
Mucuna	*Mucuna pruriens* propagated by seeds planted at 1m x 1m spacing. The entire biomass decomposed as mulch.
Erythrina	Erythrina subumbrans propagated by cuttings of 1m in length and planted at a spacing of 1m x1m. Biomass and residues decomposed as mulch.
Mucuna + 200 kg/ha NPK	*Mucuna pruriens* plus NPK (12-5-20) applied to the taro crop at a rate of 200 kg/ha in two split applications at 5 and 10 weeks after planting.
Farmer's practice + 400 kg/ha NPK	Natural grass vegetation plus NPK (12-5-20) applied to the taro crop at a rate of 400 kg/ ha in two split applications at 5 and 10 weeks after planting.
Biochar	Biochar produced from coconut shells incorporated at the beginning of the six month fallow period, at a rate of 15 t/ha. Vegetation during the fallow was incorporated.

Table 2. Selected physical and chemical characteristics of the soils at pre-experiment period.

Soil property	Procedure followed	Salani	Safaatoa	Siufaga
pH H_2O (1:5)	Daly *et. al* (1984)	5.5	5.6	5.98
EC (dS/m)	Daly *et. al* (1984)	0.12	0.22	0.45
Sand (%)	Daly *et. al* (1984)	43	40	57
Silt (%)	Daly *et. al* (1984)	24	24	22
Clay (%)	Daly *et. al* (1984)	33	36	21
Organic carbon (%)	Walkley and Black (1934)	2.99	4.63	6.33
Total N (%)	IBSNAT (1987)	0.28	0.43	0.60
Olsen Available P, (mg kg^{-1})	IBSNAT (1987)	3.20	2.85	5.38
Exchangeable Ca ($cmol_c$ kg-1)	Blakemore *et al.* (1987)	9.01	2.74	6.99
Exchangeable Mg ($cmol_c$ kg-1)	Blakemore *et al.* (1987)	0.68	1.07	5.02
Exchangeable K ($cmol_c$ kg-1)	Blakemore *et al.* (1987)	0.28	0.32	0.27
Exchangeable Na ($cmol_c$ kg-1)	Blakemore *et al.* (1987)	0.11	0.12	0.12
CEC (pH 7) ($cmol_c$ kg^{-1})	Blakemore *et al.* (1987)	20.83	19.23	26.19
DTPA Extractable Fe (mg/kg)	Blakemore *et al.* (1987)	47.59	38.97	80.67
DTPA Extractable Mn (mg/kg)	Blakemore *et al.* (1987)	21.07	49.46	52.30
DTPA Extractable Cu (mg/kg)	Blakemore *et al.* (1987)	3.76	2.45	8.17
DTPA Extractable Zn (mg/kg)	Blakemore *et al.* (1987)	0.85	2.86	6.04

3. Results and Discussion

3.1. Cover crop dry matter yields and nutrient uptake over the three sites

The dry matter yields (t/ha) of all the fallow cover crops together with their nutrient uptake is given in Table 4. The dry matter yield of the mucuna cover crop significantly out yielded all the other fallow cover crops across all the three sites. This can be ascribed to the inherent growth characteristic of the mucuna cover as well as its ability to fix atmospheric nitrogen biologically. Goh and Chin (2007), and Ngome *et al.* (2011), concluded that mucuna fallow crop fixed 70% of atmospheric N through biological symbiosis while the remaining was thought to have been taken up from the soil. However, Chikowo *et al.* (2004) stated that mucuna fallow fixed up to 96% of nitrogen, while Sanginga *et al.* (2001) concluded that approximately 91% of the total N was fixed by mucuna cover crop. All these findings indicate a predominant contribution of cover crops towards total soil N through biological N fixation. This fixed N directly influences agricultural productivity by providing N that can be accumulated in the corms and tubers of root crops. This is particularly important for the pacific region since most production systems are characterized by low input of chemical fertilisers.

The nutrient concentration analyses of the cover crop revealed significant differences between fallow crops across all the sites. Plant tissue analyses revealed that the nitrogen and the phosphorus content of erythrina was significantly higher than the mucuna cover across all three sites. However, since the biomass production of erythrina was much lower, total uptake of N and P was significantly much lower than the mucuna cover (Table 2). Since, the nutrient uptake of mucuna across all the sites were very high (196-700 kg N/ha), it is rational to assume that at taro harvesting time (eight months after spraying the fallow crop), almost all the N contained in the mucuna biomass has been mineralised. This can be attributed to the low C:N ratio of 11:1 for mucuna. Comparable findings were reported by Ibewiro *et al.* (2000) and Ruhlemann and Schmidtke (2016) showing that mucuna decomposition can be quite fast, losing 60% of its biomass within the first 28 days of decomposition while releasing up to 174 kg N/ha during that time period. The C:N ratios for erythrina, grass and biochar were 20:1, 25:1 and 70:1, respectively. These comparatively higher C:N ratios coupled with significantly lower biomass production than mucuna can be linked to the much lower N inputs under these fallow systems.

Table 3. Physico chemical characteristics of the biochar.

Property	Units	Methods used	Typical values
Sample homogenisation	mm	Crush and sieve method by Daly *et. al* (1984).	<2
Bulk Density	g/cm^3	Mass divided by volume by Daly *et. al* (1984).	0.28
Moisture content	g/g	Oven drying by Daly *et. al* (1984).	0.14
Specific surface	m^2/g	Carter *et al.* (1986) as modified by Cerato and Lutenegger (2002).	290
pH (20:1 solution:solid ratio)	pH	Calibrated pH electrode	10.2
Cation exchange capacity	µmol/g	Boehm (1994), Goertzen *et al.* (2010) and Oickle *et al.* (2010)	234
Maximum water holding capacity	g/g	Briggs and McLane, 1907; Briggs and Shantz, 1912	0.312
Wettability (surface tension)	mN/m	Roy and McGill (2002)	68.3
Total C content	g/g	Walkley and Black (1934)	80
Total N	%	Blakemore *et al.* (1987)	0.31
P	%	Blakemore *et al.* (1987)	0.19
K	%	Blakemore *et al.* (1987)	1.16
Ca	%	Blakemore *et al.* (1987)	0.41
Mg	%	Blakemore *et al.* (1987)	0.29
Fe	mg/kg	Blakemore *et al.* (1987)	4537
Mn	mg/kg	Blakemore *et al.* (1987)	6
Cu	mg/kg	Blakemore *et al.* (1987)	33
Zn	mg/kg	Blakemore *et al.* (1987)	61

Prominently, biochar supported vegetation resulted in higher uptake of K than all the fallow practices at the two biochar treated sites on the island of Upolu. Significant concentrations of Mg and the analysed micronutrients (Fe, Mn, Cu and Zn) were also observed for the biochar supported vegetation in the high rainfall zone only. For the Siufaga site, erythrina had the higher K content. Generally, nutrient uptake was significantly higher under mucuna fallow systems across all the sites (Salani and Safaatoa sites from the island of Upolu and Siufaga site from on the island of Savaii), owing to the higher biomass production, comparatively.

3.2. Fresh taro corm yields

The fresh taro corm yield data from the three sites showed highly significant ($P<0.001$) differences between sites, with the Salani site out yielding the other two sites (Table 5). This can partially be attributed to the relatively higher amount of annual rainfall received by the Salani site (4,959 mm) as opposed to the Safaatoa (3,418 mm) and Siufaga (3,989 mm) sites. In addition, inherent soil fertility may have had a large influence on these yield variations. Significant difference was also found ($P<0.05$) between the mean yields of two cultivars within the same fallow treatment, with cultivar *Samoa 2* out yielding cultivar *Samoa 1*. Fallows within a site were also highly significant ($P<0.05$) with regards to the mean corm yield of taro produced over the three sites (Table 5).

The six month cover crop fallow practice with mucuna together with modest application (200 kg/ha) of complete fertiliser (NPK 12-5-20) to the taro crop, that is a corresponding supplementation of 24 kg N/ha, 10 kg P/ha and 40 kg/K/ha, resulted in significantly higher ($P<0.001$) mean yields at the Salani site, out yielding all the fallow practices except for taro grown under the mucuna with no fertiliser supplementation. Grass fallow supplemented with 400 kg/ha of complete fertiliser, (that is, 48 kg N/ha, 20 kg P/ha and 80 kg/K/ha) and the biochar fallow treatments did not differ significantly from each other; however, they significantly out - yielded the grass fallow at the Salani site.

Table 4. Dry matter yields and nutrient uptake by the fallow crops over the three sites.

Site	Fallow	Dry matter yield (t/ha)	Nutrient uptake Macronutrient (kg/ha)					Micronutrient (kg/ha)			
			N	P	K	Ca	Mg	Fe	Mn	Cu	Zn
Salani	Grass	8.21 *b**	78.77 *c*	12.31 *b*	105.02 *b*	25.44 *bc*	46.77 *b*	63.81 *b*	2.83 *b*	0.15 *b*	0.40 *b*
	Mucuna	22.11 *a*	486.31 *a*	35.37 *a*	305.05 *a*	170.21 *a*	75.16 *a*	140.45 *a*	5.18 *a*	0.57 *a*	0.73 *a*
	Erythrina	8.13 *b*	196.75 *b*	26.02 *a*	152.03 *b*	66.67 *b*	46.34 *b*	3.39 *c*	1.02 *c*	0.10 *b*	0.34 *b*
	Biochar	6.50 *b*	74.75 *c*	11.05 *b*	142.35 *b*	16.90 *c*	52.00 *b*	96.60 *b*	3.11 *b*	0.19 *b*	0.60 *ab*
	LSD (5%)	6.98	117.4	13.47	84.9	43.60	22.07	41.54	1.43	0.19	0.29
Safaatoa	Grass	7.62 *b*	89.95 *c*	14.48 *b*	83.09 *b*	50.31 *bc*	34.30 *b*	38.30 *b*	1.58 *b*	0.15 *b*	0.56 *a*
	Mucuna	17.85 *a*	408.65 *a*	30.34 *a*	215.92 *a*	219.49 *a*	71.38 *a*	127.13 *a*	4.34 *a*	0.51 *a*	0.65 *a*
	Erythrina	8.13 *b*	256.91 *b*	24.39 *ab*	98.37 *b*	113.82 *b*	49.59 *ab*	1.38 *b*	1.33 *b*	0.18 *b*	0.33 *b*
	Biochar	10.87 *b*	33.21 *c*	17.38 *ab*	230.34 *a*	42.37 *c*	28.25 *b*	30.84 *b*	1.77 *b*	0.22 *b*	0.40 *a*
	LSD (5%)	5.84	130.5	13.16	72.8	64.3	26.06	38.13	1.40	0.19	0.27
Siufaga	Grass	7.03 *b*	71.71 *b*	10.55 *b*	81.55 *b*	39.37 *b*	40.07 *b*	40.47 *b*	1.36 *b*	0.11 *b*	0.30 *b*
	Mucuna	35.92 *a*	700.49 *a*	122.14 *a*	506.51 *a*	370.00 *a*	140.10 *a*	60.44 *a*	5.07 *a*	0.94 *a*	1.19 *a*
	Erythrina	4.49 *c*	155.80 *b*	15.27 *b*	112.70 *b*	89.35 *b*	14.82 *c*	1.58 *c*	0.31 *b*	0.05 *b*	0.18 *b*
	LSD (5%)	11.55	241.0	41.10	169.9	106.4	54.82	26.80	1.79	0.22	0.4
LSD (5%) for between site comparison	Grass	3.32	32.70	5.89	45.09	17.25	19.16	21.29	0.85	0.06	0.17
	Mucuna	11.03	245.4	34.16	159.1	107.5	46.14	50.13	2.08	0.27	0.36
	Erythrina	2.04	66.8	6.57	46.14	34.66	8.50	0.62	0.22	0.03	0.08
	Biochar	7.35	25.77	16.69	86.9	31.90	20.79	34.26	0.05	0.24	0.46

* Column means, within a site, followed by the same letter are not significantly different from each other

Table 5. Mean corm yields (t/ha) of the two cultivars of taro grown under various fallow practices across the three sites.

Fallow		Site								
		Salani			Safaatoa			Siufaga		
		Samoa 1	Samoa 2	Fallow means	Samoa 1	Samoa 2	Fallow means	Samoa 1	Samoa 2	Fallow means
Grass		7.17	9.93	8.55 *c*	5.70	8.04	6.87 *c*	5.51	5.66	5.58 *d*
Mucuna		10.15	13.16	11.65 *ab*	6.14	9.09	7.62 *bc*	7.42	10.68	9.05 *ab*
Erythrina		9.58	9.87	9.73 *bc*	7.55	10.10	8.82 *ab*	6.25	6.77	6.51 *cd*
Mucuna + NPK		12.38	14.76	13.57 *a*	9.07	11.40	10.23 *a*	7.91	12.29	10.10 *a*
Grass + NPK		10.05	10.99	10.52 *bc*	9.19	10.45	9.82 *a*	7.90	7.27	7.59 *bc*
Biochar		8.98	11.93	10.46 *bc*	7.37	7.58	7.47 *bc*		-	
Cultivar means		9.72 *b*	11.77 *a*	10.75	7.50 *b*	9.44 *a*	8.47	7.00 *b*	8.54 *a*	7.77
FPr.	Fallow within site		0.011			0.006			<0.001	
	Cultivar within site		<0.001			0.002			<0.001	
	Fallow x Cultivar		0.428			0.703			0.002	
SED	Fallow within site		1.159			0.851			0.702	
	Cultivar within site		0.462			0.537			0.365	
	Fallow x Cultivar		1.132			1.315			0.815	
LSD (5%)	Fallow within site		2.470			1.813			1.529	
	Cultivar within site		0.971			1.128			0.777	
	Fallow x Cultivar		2.378			2.762			1.738	
	Between cultivars across all three sites = 1.5									
	Between Sites = 0.75									
	Site x Fallow x Cultivar = 2.6									

This indicated that reasonable taro yields can be obtained under mucuna fallows with no supplementation as opposed to grass fallows with 400 kg/ha of complete fertiliser supplementation and biochar additions during fallow periods increases taro yields of the succeeding crop for the Salani site. This also shows that improved fallows are better than the traditional practice. The yield differences can be attributed to the possible P effect, as the native Olsen P values of the soils are well below the critical range (Table 2), making it the most limiting nutrient.

The fallow practice of mucuna only, mucuna together with modest application (200 kg/ha) of complete fertiliser (NPK 12-5-20) and grass fallow with 400 kg/ha complete fertiliser supplementation showed no statistical significance with regards to the mean yields of taro for the Safaatoa site. Taro yield obtained under erythrina and biochar treatments were not significant from the traditional grass fallow for the Safaatoa site. This denotes that maximum taro yields at this particular site are largely dictated by fertiliser inputs.

For the Siufaga site, mucuna with 200 kg/ha of NPK fertiliser supplementation did not significantly increase the taro yields as compared to mucuna with no supplementation. Mucuna with no supplementation did not significantly differ from grass fallow with 400 kg/ha complete fertiliser supplementation. This signifies that optimum taro yields are possible by switching from the traditional grass fallowing to mucuna fallows without any additional application of fertilisers.

The increased mean taro yields obtained under mucuna fallowing systems can be attributed to the greater biomass production and subsequently greater nutrient uptake and recycling by the vegetation cover. In addition, the phenomenon of biological fixation of atmospheric nitrogen by the legume cover crop can also be credited to the comparatively higher mean yields obtained under these fallows. These results are in agreement with the work of other authors involved with cover cropping trials including leguminous and non-leguminous cover crops (Clark *et al.*, 1994; Vaughn and Evanylo, 1998; Kuo and Jellum, 2002).

The general yield trend under different fallow practices across all the sites indicates that mucuna with modest supplementation with complete fertilisers can help maintain optimum yields of the taro crop. However, it appears that the yield responses of the taro crop to fallow treatments are site-specific. In Safaatoa, the yield increase relative to control was only 10%, indicating that other factors, such as inherent soil fertility, particularly low available P and low rainfall, may have contributed heavily towards the lower yield improvements. In Salani, it was 36% and in Siufaga it was 62%. Moreover, more yields can be obtained if a positive change to the traditional grass fallow is made by opting for the economically best site specific improved fallow alternative. Mucuna fallow systems appear to increase yields of Samoan taro soils that generally have medium levels of organic C and total N; however, are low in plant available P and exchangeable K. Sakala *et al.* (2003) reported significant increase in maize yields under short term mucuna fallow compared to natural fallow. Carsky *et al.* (1998) attributed the improved yield of the succeeding crop under mucuna fallow to increased soil moisture retention and improved fertility.

4. Conclusions

Analyses of all the cover crops for their nutrient concentrations and uptake showed that while generally the nutrient content of erythrina was significantly higher than that of Mucuna, the latter had higher nutrient accumulation over the six month fallow duration, owing to its comparatively higher biomass production over all the three sites. This was well reflected on the taro yields for Salani and Siufaga sites (high rainfall zones), where biomass production was comparatively higher. The yield of taro under mucuna with no supplementation of any fertiliser was not significantly different from taro grown under traditional grass with the crop being supplemented by the recommended rate of 400 kg/ha of complete fertiliser. This affirms that optimum taro yields can be obtained under mucuna fallow only without any additional inputs of chemical fertilisers. Comparable yields under biochar fallow can be attributed to the biochar fallow to enhance appreciable quantities of K uptake.

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