Der Tropenlandwirt, Beiträge zur tropischen Landwirtschaft und Veterinärmedizin,
100. Jahrgang, Oktober 99, S. 133 - 146.

Interactions between Leguminous Hedgerows and a Sweet Potato Intercrop in Papua New Guinea

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1 Introduction

The annual intercrop in most hedgerow intercropping trials has been maize - a cereal likely to benefit from increased inputs from nitrogen-rich leaf mulches - and most of such studies have been located in areas suited to maize growing. Experimentally, these systems have demonstrated that crop yields can be sustainable over numerous cropping cycles, albeit it at moderate levels, but with little or no external input other than mulching with clippings from the hedges. However, there has been much critical review attributed to unpopularity with resource poor farmers and doubts about its biological sustainability (Sanchez, 1995; Ong 1996). Nevertheless, it has been demonstrated that crops benefit from association with hedges under some circumstances (Edje *et al.*, 1993; Haggar, Beer, 1993; Peden *et al.*, 1993), although examples of this are out-numbered by reports of detrimental effects of hedges upon intercrops.

In the Pacific Islands, tuber crops are the principal carbohydrate staples and the effects of leguminous hedgerows upon these have received much less attention. In the case of taro (*Colocasia esculenta* L. Schott) in Western Samoa, Rosecrance *et al.* (1992b) found no advantage in association with hedges, compared with no-hedge controls. Similar results with sweet potato (*Ipomoea batatas* (L) Lam.) were obtained in Sierra Leone on degraded ultisol soils of *p*H 4.5. Hedges of *Leucaena leucocephala*, notorious for poor performance on acidic soils (Szott *et al.* 1991), had a depressive effect upon intercrop yields, compared with no-hedge controls (Karim *et al.*, 1991). Tuber yield was significantly lower in sweet potato rows immediately adjacent to hedges, compared with rows 1.5 m distant.

Long term experiments in Papua New Guinea established that in the absence of additional nutrient input, on the same site as the experiment described in this paper, sweet potato declined in successive seasons along a negative exponential curve (Newton, Jamieson, 1968; Bourke, 1977, 1984).

In the experiment described in this paper, sweet potato was used as an intercrop in association with nine species of leguminous shrubs, in order to:

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- test a wide range of leguminous shrubs and trees under hedgerow management in a humid, equatorial climate;
- determine to what extent mulches from these species could maintain yields of sweet potatoes on the local soils;
- understand some of the underlying causes of crop yield variations.

2 Materials and Methods

2.1 Site characteristics

This study was conducted at the Lowlands Agricultural Experiment Station, East New Britain Province, Papua New Guinea (4°S 120°E, 20 m altitude), on sandy loam soils of recent volcanic ash origin, classified as a vitrandept. The climate is humid equatorial, with mean annual rainfall of 2,700 mm. A drier period sometimes occurs between September and November, but is rarely sufficiently intense to constrain the growth of annual crops. Annual means of daily temperature maxima and minima are respectively approximately 31 °C and 22 °C. There is little variation in either parameter from month to month.

2.2 Establishment

Ten leguminous shrub treatments (Table 1) were established before it was decided to use sweet potato as an intercrop. One shrub treatment was incorrectly planted with the wrong species, so was removed before sweet potato was planted and regarded as a no-hedge control treatment.

Table 1: Treatments applied in hedgerow intercropping experiment.

Acacia angustissima (Mill.) Kuntze
Cajanus cajan (L.) Millsp.
Calliandra calothyrsus Meissn.
Calliandra houstoniana (Mill.) Standl.
Gliricidia sepium (Jacq.) Walp.
Leucaena diversifolia (Schlecht) Benth.
Leucaena leucocephala K636 (Lam.) de Wit
Leucaena macrophylla Benth.
Ormocarpum orientale (Spreng.) Merr.
Control (no hedge).

Each treatment consisted of a single 6 m row of 13 shrubs 50 cm apart. Alleys between hedges were 6 m wide, as measured from the base of each hedge, and aligned north-west to south-east. With the exception of *Gliricidia sepium* and *Ormocarpum orientale*, which were established as 1 m long stakes, hedges were planted as seedlings raised in polythene bags in a nursery. Seedlings were trimmed to 1 m in height at planting (19 to 26 February 1991).

The experiment conformed to a randomised complete block design with ten treatments and twelve replications, sweet potatoes being planted on either side of each hedge, and with it, forming one treatment unit. Sweet potato variety K9 was used, this being the standard variety for experiments at the Lowland Agricultural Experimental Station. The sweet potato was planted as cuttings on five ridges 6m long and 1 m apart, raised in the alleys between each hedge. There were two cycles in sweet potato two cropping, initiated with planting in July 1991 and January 1992, respectively.

In the first cropping season, four cuttings were planted per planting position, at 1 m intervals within each row. In the second season, three cuttings were planted per position, and an interval of 50cm was used, to increase the rate of ground cover and aid weed suppression. Experience with sweet potatoes indicates that this change in planting pattern will not have materially influenced areal yields. The central ridge, equidistant between hedges hence being influenced by two different treatments, was excluded from evaluation. The harvested area of sweet potato for each treatment unit was 16 m^2. Within this, ridges were categorized according to proximity to hedges as outer or inner rows and data from them recorded separately. The central 4 m section of each ridge only was evaluated, and 1 m at either end of each ridge was not harvested to avoid edge effects.

2.3 Management and recording

While the experiment was in progress hedges were pruned to a height of 1 m and a width of 50 cm on three occasions: August - September 1991, January - February, 1992 and May 1992. Clippings from the 4 m central portion of each hedge (corresponding to the 4 m long net plots of sweet potato) were separated into wood (twigs and branches of diameter > 5 mm) and foliage (including shoots < 5 mm), and weighed. Sub-samples of foliage were taken for oven drying and chemical analysis. Foliage was then returned to each plot as mulch placed between the rows of sweet potato growing on either side of the associated hedge.

Sweet potatoes were harvested in November 1991 and June 1992. Vines (foliage) and tubers from each 4 m row length were weighed fresh, and sub-samples taken for oven drying. After weighing vines were killed by sun-drying to prevent resprouting and then incorporated in preparation for the next cropping cycle.

On 22 March 1991, after planting of hedges but before planting of sweet potato, soil samples from all treatments were taken and bulked, from three different replications. A second set of soil samples were taken on 13 January 1992, just prior to the start of the second pruning and application of mulch, but after incorporation of sweet potato vines. To reduce the cost of analysis, only four treatments from each were sampled (*Acacia angustissima*, *G sepium*, *L macrophylla* and control), representing hedges with good, average and poor performance, from three replications. Soil samples were analysed at the National Agricultural Chemistry Laboratory, Port Moresby.

3 Results and Discussion

3.1 Soils

The values for soil parameters (Table 2) were very similar to those reported from the same site by Bourke (1977). Between 22 March 1991 and 13 January 1992, available phosphorus rose, but all cations, base saturation and organic matter decreased, suggesting that nutrients were being removed from the soil by either or both hedges and the sweet potato crop. The sampling programme did not allow any effects to be attributed to particular treatments.

Table 2: Results of soil analysis from experimental site

Test	**22 March 1991**		**13 January 1992**	
pH (1:5 soil:distilled water)	6.1	(0.03)	6.2	(0.02)
P mg/kg (Olsen)	3.3	(0.33)	10.3	(0.27)
Extractable cations meq/100g (ammonium acetate pH 7)				
Ca^{2+}	12.9	(0.18)	10.0	(0.31)
Mg^{2+}	2.27	(0.09)	1.83	(0.07)
K^{+}	1.90	(0.08)	1.20	(0.04)
Na^{+}	0.14	(0.01)	0.06	(0.003)
Sum of cations	17.2		13.1	
CEC (ammonium acetate pH 7)	19.9	(0.17)	20.2	(0.48)
Base Saturation %	86.0	(0.58)	65.2	(1.68)
C % (Walkley-Black)	5.49	(0.047)	4.30	(0.147)
N % (Kjeldahl)	0.54	(0.02)	0.39	(0.01)
C/N	10.3	(0.33)	11.2	(0.30)
P retention % (Saunders)	75.3	not analysed		

Standards error of mean in parenthesis. 22 March 1991 sampled from all treatments 13 January 1992 sampled from *Acacia angustissima, Gliricidia sepium, Leucaena macrophylla* and control treatments.

3.2 Performance of hedgerows

There is an extensive literature concerning the use of *L leucocephala, L diversifolia, Calliandra calothyrsus, Cajanus cajan* (pigeon pea) and *G sepium* in alley cropping and similar agroforestry systems (e.g. Baggio, Heuveldop, 1984; Blair et al., 1990; Karim, Savill, 1991). There has been little reported on the use of *A angustissima, Calliandra houstoniana, L macrophylla* or *O orientale* in cropping systems. *A* *angustissima* originates from central America. The potential of this as a fodder species has been described by Ahn *et al.* (1989) and Maasdorp, Gutteridge (1986), and its use in agroforestry systems was recently reviewed by PREECE, BROOK (1999). *Calliandra houstoniana* is described by McVaugh (1987), and *O orientale* by Verdcourt (1979). The latter was the only shrub included that was indigenous to the locality of the experiment.

At the first pruning event (Table 3) *A angustissima* produced the greatest foliage yields. In later harvests the mass of foliage obtained from the two *Calliandra* spp., although less, did not differ significantly from *A angustissima*. A particular advantage of *Calliandra houstoniana* compared with *A angustissima* is its more compact form which results in less shading of any intercrop. The ratio of foliage to wood was greatest in this species (Table 3). *Cajanus cajan* responded poorly to the hedgerow pruning regime applied, and several specimens in each hedge failed to resprout after pruning. Rosecrance et al. (1992a) described similar experiences with this species, although Böhringer *et al.* (1994) did not report any death of *Cajanus cajan* when repeatedly pruned in trials in Hawaii, USA. In the experiment described here, when entries were ranked, the comparative performance of *G sepium* improved with successive harvests. The three *Leucaena* spp. and *O orientale* entries were all low yielding, although all four regrew readily after pruning.

Outputs from pruning consist of wood and foliage. Wood production indicates potential usefulness of shrubs for fuelwood provision. In terms of wood production, *A angustissima* was the most productive, followed by *Calliandra calothyrsus* then *G sepium* (Table 3). There was a positive correlation between harvested hedge foliage mass and woody biomass. Thus, the structure to support foliage would have extended further over the intercrop, resulting in shading.

Perhaps of greater importance than the biomass of mulch applied is the content of nutrients potentially available for the intercrop (Table 4). Besides their mineral requirements for growth, when crops are harvested, significant quantities of inorganic elements are removed from the field. In the higher yielding treatments of this experiment, total tuber fresh weight in the first cropping cycle was 18 t ha^{-1} equivalent. A crop of sweet potato producing 18 t ha^{-1} of fresh tubers is reported to remove from 72 to 79, 9 to 18 and 97 to 126 kg ha^{-1} of N, P and K, respectively (SANCHEZ, 1976; REHM, ESPIG, 1991:47).

All hedgerow species provided N in quantities in excess of intercrop requirements. It has been reported that excessive application of N inhibits tuber production in sweet potato and enhances foliage growth (GODFREY-SAM-AGGREY, 1976; BOURKE, 1977; HAHN, HOZYO, 1984). Estimation of the availability of P mulches is complicated by the tendency for volcanic ash soils to fix this nutrient. Sweet potato, in common with many tuber crops, has a high requirement for K. Potassium is required for effective activity of the enzyme starch synthetase in the tubers (HAHN, HOZYO, 1984). Fertilizer trials in the south Pacific region have shown a consistent tuber yield response by sweet potato to applied K fertilizer (Golliffer, 1972; Bourke, 1977). *G sepium* in particular displayed the potential to supply sufficient inputs of K for the sweet potato crop (Table 4). Comparisons of nutrient content of foliage with other published worked show that the levels of N, P and K in *G. sepium* were slightly higher than those obtained by Garrity *et al.* (1994) and Miah *et al.* (1996).

Table 3: Dry weight of foliage and wood matter removed at each pruning event (kg per metre length of hedge)

Species	**Pruning Event**	**Foliage**	**Wood**
Acacia angustissima	1	2.32	2.21
	2	4.08	6.14
	3	2.18	1.78
Cajanus cajan	1	1.82	1.18
	2	2.51	2.39
	3	1.51	0.55
Calliandra calothyrsus	1	1.43	1.08
	2	3.96	4.12
	3	1.51	0.74
Calliandra houstoniana	1	2.05	1.06
	2	3.30	2.68
	3	1.48	0.48
Gliricidia sepium	1	0.95	0.83
	2	2.62	3.91
	3	1.31	0.67
Leucaena diversifolia	1	0.70	0.38
	2	1.23	1.22
	3	0.52	0.28
L. leucocephala K636	1	0.69	0.49
	2	1.12	1.08
	3	0.60	0.41
L. macrophylla	1	0.93	0.61
	2	1.67	1.78
	3	0.91	0.71
Ormocarpum orientale	1	0.25	0.17
	2	0.80	0.52
	3	0.31	0.08
Standard errors of differences*	1	0.08	0.08
	2	0.24	0.60
	3	0.08	0.06

*F-tests on foliage and wood dry weight (kg m^{-1} hedge): $p < 0.001$ in all cases

Timing of pruning: 1 = August - September 1991

2 = January - February 1992

3 = April- May 1992

Table 4: Quantities of mineral nutrients potentially available from shrub leaf mulch applied to sweet potato crops

Species	**Pruning event**	**Leaf mineral element content (% on dry matter basis)**			**Nutrients potentially available from applied mulch (kg ha^{-1})**		
		N	**P**	**K**	**N**	**P**	**K**
Acacia angustissima	1	3.75	0.18	0.86	217	10.4	50
	2	3.41	0.19	0.97	348	19.4	99
	3				186	10.4	53
Cajanus cajan	1	2.76	0.19	0.95	125	8.6	43
	2	2.96	0.18	1.01	186	11.3	63
	3				67	4.1	23
Calliandra calothyrsus	1	3.47	0.16	0.64	124	5.7	23
	2	3.31	0.17	0.58	327	16.8	57
	3				125	6.4	22
Calliandra houstoniana	1	2.59	0.13	0.91	133	6.6	47
	2	3.04	0.14	1.05	252	11.6	87
	3				113	5.2	39
Gliricidia sepium	1	3.45	0.20	2.38	82	4.7	56
	2	4.25	0.24	2.22	279	15.7	146
	3				139	7.9	73
Leucaena diversifolia	1	3.32	0.19	1.83	58	3.3	33
	2	4.33	0.18	1.75	134	5.6	54
	3				57	2.4	23
L. leucocephala K636	1	4.09	0.19	1.74	71	3.3	30
	2	4.87	0.22	2.30	135	6.1	64
	3				73	3.3	34
L. macrophylla	1	3.12	0.20	2.12	73	4.6	49
	2	3.90	0.20	2.13	162	8.3	89
	3				89	4.6	49
Ormocarpum orientale	1	3.43	0.20	2.30	21	1.2	14
	2	4.02	0.26	2.35	81	5.3	48
	3				31	2.0	18
Standard errors of difference[1]	1	No statistical test			6.78	0.37	2.75
	2	No statistical test[2]			10.6	0.56	4.13
	3	No samples taken[3]			7.06	0.39	2.55

Timing of pruning: 1 = August - September 1991
2 = January - February 1992
3 = April - May 1992

[1] F-tests on nutrients potentially available (nutrient content multiplied by dry mass of foliage per pruning event) from applied mulch: $p < 0.01$ in all cases

[2] Samples for foliar analysis bulked up for each shrub species

[3] No chemical analysis was conducted on foliage from 3rd pruning event

3.3 *Effects on sweet potato intercrop*

In the first cropping cycle, hedgerow treatment had highly significant effects upon sweet potato growth (Table 5). *A angustissima* hedges resulted in the lowest tuber, vine and total crop mass. Greatest tuber, vine and crop masses were produced by the *L diversifolia, G sepium* and *O orientale* treatments, respectively.

In the second season, in all but one treatment tuber mass declined while vine mass increased, compared with the first season. This seasonal effect was highly significant for both parameters (Table 5). However, total crop biomass was not significantly different between seasons, although harvest index was reduced, with loss in tuber mass being matched by increase in vine mass. Only with *A angustissima* did tuber yields increase slightly in the second season, and this could be explained on the basis of decreased shading of sweet potato as a consequence of reduced intervals between pruning events. In the second cropping cycle, the control plots produced the greatest tuber yields, although when means were separated using Duncan's Multiple Range Test, control plot tuber yields were significantly different only from the *Calliandra calothyrsus* treatment, which gave the lowest yields. Application of mulch greatly enhanced vine growth, possibly in response to provision of N in quantity, but this would not explain why control plots, to which no mulch was added, also displayed increased vine production and a reduced harvest index.

To examine variation in tuber and vine mass, a number of variables (mass of foliage, N, P, K applied as mulch), from the perennial component were regressed using sweet potato mass as the response variable. For tubers, data did not fit the models well, but did indicate factors having statistically significant effects upon yield.

The two best fit models for tuber yield from the second cropping cycle were:

$$\text{Tuber yield} = 0.401 - 0.0301\,L_2 + 0.0081\,K_2\ (r^2 = 32.7\%);$$

$$\text{Tuber yield} = 0.405 - 0.059\,L_3 + 0.0145\,K_3\ (r^2 = 31.0\%);$$

where L = hedgerow leaf dry weight and K = quantity of K applied in mulch, and subscripts refer to the second and third pruning events.

These models suggest that hedgerow foliage mass had a negative effect on tuber yield, presumably due to shading. Sweet potato is not tolerant of shade, reported shade effects being reduction of tuber and vine mass (MARTIN, 1985; ROBERTS-NKRUMAH *et al.* 1986. Conversely, applied K tended to increase yield. There were significant differences between shrub species both in the content of K in foliage and in the quantity of K potentially available in applied mulches (Table 4). In particular, *G sepium* had both a high content of K in foliage and in total quantity applied in mulch. This quantity was significantly greater than for any other treatment in the second and third pruning events.

Table 5: Oven dry mass of tubers and vines at final harvests, cropping cycles 1 and 2 (g/m²)

Treatment	**Tuber mass**			**Vine mass**			**Total crop mass**			**Harvest Index**		
	Inner rows	**Outer rows**	**Mean**	**Inner rows**	**Outer rows**	**Mean**	**Inner rows**	**Outer rows**	**Mean**	**Inner rows**	**Outer rows**	**Mean**
November 1991												
Acacia angustissima	248	518	383	227	320	273	475	838	657	0.53	0.62	0.59
Cajanus cajan	364	469	416	357	295	326	721	764	742	0.52	0.62	0.57
Calliandra calothyrsus	395	520	458	412	359	386	808	879	843	0.49	0.59	0.54
Calliandra houstoniana	438	549	494	372	365	369	811	915	863	0.54	0.60	0.57
Gliricidia sepium	532	577	555	484	370	427	1016	947	982	0.53	0.61	0.57
Leucaena diversifolia	585	686	636	426	350	388	1011	1037	1024	0.58	0.66	0.62
L. leucocephala K636	549	578	564	439	332	385	988	910	949	0.56	0.64	0.60
L. macrophylla	516	604	560	397	368	383	913	972	943	0.56	0.62	0.59
Ormocarpum orientale	690	580	635	477	309	393	1167	889	1028	0.59	0.65	0.62
Control (no hedge)	586	616	601	455	362	409	1041	979	1010	0.56	0.63	0.60
Treatment mean	490	570	530	405	343	374	895	913	904	0.55	0.62	0.59
Treatment effect F test p=	0.00	0.046	0.00	0.00	0.372	0.001	0.00	0.135	0.00	0.004	0.028	0.007
Treatment s.e.d.. (d.f. = 99)	51.2	60.3	46.3	42.9	n.s.	32.8	81.9	n.s.	68.8	0.024	0.021	0.021
Covariate (row) effect F test p=			0.00			0.00			0.528			0.00
June 1992												
Acacia angustissima	416	362	389	448	421	434	864	783	824	0.49	0.48	0.48
Cajanus cajan	394	362	378	578	503	540	972	865	919	0.41	0.43	0.42
Calliandra calothyrsus	336	272	304	605	486	545	940	757	849	0.39	0.37	0.38
Calliandra houstoniana	453	422	438	459	446	453	912	868	890	0.50	0.49	0.49
Gliricidia sepium	449	400	424	613	555	584	1062	955	1008	0.43	0.43	0.43
Leucaena diversifolia	438	364	401	480	445	463	918	810	864	0.49	0.45	0.47
***L. leucocephala* K636**	451	449	450	521	499	510	972	947	960	0.48	0.49	0.49
L. macrophylla	477	365	421	420	460	440	897	826	862	0.53	0.46	0.49
Ormocarpum orientale	453	406	430	540	464	502	993	870	932	0.48	0.47	0.47
Control (no hedge)	542	377	460	651	475	563	1193	852	1023	0.45	0.45	0.45
Treatment mean	441	378	409	532	475	503	972	853	913	0.46	0.45	0.46
Treatment effect F test *p*=	0.091	0.011	0.036	0.001	0.171	0.007	0.01	0.017	0.016	0.019	0.037	0.017
Treatment s.e.d. (d.f. = 99)	n.s.	42.2	44.0	61.1	n.s.	46.1	84.0	58.4	61.7	0.039	0.035	0.034
Covariate (row) effect F test *p*=			0.00			0.001			0.00			0.223
Season effect F test *p*=	0.01	0.00	0.00	0.00	0.00	0.00	0.011	0.017	0.71	0.00	0.00	0.00
Treatment x season s.e.d. (d.f. = 209)	60.0	54.1	80.2	66.8	48.3	52.3	95.5	78.7	n.s.	40.4	34.6	35.4

n.s. = not significant s.e.d. = standard error of difference

For vines from the second cropping cycle, better fit models were obtained:

Vine yield = $0.419 - 0.337\,L_2 + 0.0416\,N_2$ ($r^2 = 64.9\%$);

Vine yield = $0.415 - 0.572\,L_3 + 0.0715\,N_3$ ($r^2 = 64.6\%$);

where N is quantity of N applied in mulch from the second and third pruning events (indicated by subscripts). It appeared that foliage mass had a depressant effect upon vine production (presumably via shading), but N supplied in mulch counteracted this by increasing vine yield.

Analysis of covariance, using distance of rows from the hedge base as the covariate, was used to determine the overall effect of proximity of rows to the hedges. In the first cropping cycle, outer rows produced significantly greater tuber mass than inner rows (Table 5), whilst for vine mass the reverse was the case. Proximity to hedges also affected partitioning of assimilates, harvest index being greater in outer rows. However, row position had no significant effect on total crop mass.

It has often been observed that crop yields decline in proximity to hedges (Karim et al., 1991; Rosecrance et al., 1992a), but this phenomenon is by no means universal. Edje et al. (1993) found that *Phaseolus vulgaris* yields were highest in rows closest to hedges of *L leucocephala*. The experiment described here provides another instance of this. In the second cropping cycle, inner rows produced greater tuber yields than outer rows, the reverse of the case in the first season (Table 5), and also greater vine mass. Thus, total crop mass was much greater in inner rows compared with outer rows, but row position had no effect upon harvest index. In some treatments, inner row tuber mass increased in the second compared with the first cropping cycle. In the case of *A angustissima*, the shrub producing greatest foliage yields (Table 3), this difference reached statistical significance. As mulch was applied evenly to both inner and outer rows, this effect might rather reflect hedge fine root dieback as a pruning response beneath rows closest to hedges. Following pruning, leguminous shrubs shed fine roots and nodules (Fownes, Anderson, 1991; Akinnifesi et al., 1995), and these contribute to mineralizable soil organic matter pools. Haggar, Beer (1993) showed that the species of the perennial component affected intercrop response. Maize growth was suppressed next to *Erythrina poeppigiana* hedges, but not next to *G sepium* hedges. In the experiment described here, the greatest difference between inner and outer rows was in the zero-mulch controls, and is circumstantial evidence that mineralization of organic matter from roots remaining after hedgerow removal in June 1991 (see *Establishment*) arrested declining yields in inner rows, particularly in the absence of shade.

Intervals between pruning were reduced in cropping cycle two, to every 11 weeks. This allowed more light to reach the sweet potato crop, which may have been crucial in reducing hedgerow-crop competition in this season. In the second cropping cycle, total vine and tuber masses per treatment were both significantly negatively correlated with difference between outer and inner rows masses (r = -0.487 and -0.356, respectively). As vine and tuber masses increased, inner row mass increased relative to outer row mass. Sweet potato production was greatest when associated with hedge species that produced least foliage, suggesting that decreased levels of shade enhanced the hypothesised effect of fine root and nodule die-back following pruning.

This work indicates that when growing sweet potato in association with a perennial component, a species with high levels of K in the foliage should be selected, and that pruning cycles should be timed to minimise shading of the intercrop. It also provided evidence that it might be possible to sustain sweet potato tuber yields in association with frequently pruned hedges.

4 Summary

Sweet potato is a staple crop in many areas of the South Pacific, but little has been reported on its potential in multistrata systems. In this experiment it was grown as an intercrop between nine different species of leguminous hedgerows, plus a control with no hedge. The aim was to determine whether addition of foliar mulch to sweet potato could compensate for the competitive effects of shrubs, whether such mulch applications could halt the decline in yields successive crops, and to test the performance of a range of lesser utilized shrubs alongside better known species. Hedge species varied greatly in performance, *Acacia angustissima*, *Calliandra calothyrsus* and *Calliandra houstoniana* producing greatest quantities of foliage when pruned, which was then applied to the sweet potato intercrop. Sweet potato biomass did not differ between the two seasons described, but in the second crop tuber yields declined while vine production increased. Regression analysis showed that tuber and vine mass decreased as hedge foliage offtake increased, but also that quantity of potassium applied in mulch increased tuber mass, and quantity of nitrogen applied increased vine mass. In the second cropping cycle, tuber mass in rows closest to hedges increased relative to outer rows. It is hypothesised that this effect was due to the fertilizing effect fine root and nodule dieback following pruning in rows closest to the hedges, in combination with a shortened hedge pruning cycle.

Interaktionen zwischen Hecken aus Leguminosen und der Süßkartoffel als Zwischenfrucht in Neuguinea

Zusammenfassung

Obwohl die Süßkartoffel in vielen Gebieten des Süd-Pazifiks als Hauptertragsfrucht angebaut wird, liegen Kenntnisse über ihre Wirkungspotentiale in multi-strata Systemen nur sehr begrenzt vor. In der hier vorgestellten Untersuchung wurde die Süßkartoffel zwischen neun verschiedenen Arten von leguminosen Hecken sowie auf einer

Kontrollfläche ohne Hecke angebaut. Die zu untersuchenden Fragen waren, ob zusätzliche Mengen an Blattmulch die Konkurrenzwirkung mit den Heckenpflanzen für die Süßkartoffel kompensieren können, und ob solche Mulchmaßnahmen den Ertragsrückgang in der Fruchtfolge aufhalten kann. Schließlich wurde der Einfluss von einer Reihe von weniger häufig verwendeten Strauchgewächsen gemeinsam mit den üblichen Arten getestet. Die Unterschiede in der Blattproduktion zwischen den verschiedenen Arten der Heckensträucher waren sehr groß. *Acacia angustissima, Calliandra calothyrsus* und *Calliandra houstoniana* zeigten die höchste Blattproduktion nach dem Rückschnitt, der dann als Mulch auf die Fläche mit der dazwischen angebauten Süßkartoffel aufgebracht worden war. In den beiden beschriebenen Jahreszeiten blieb die Menge der Biomasse der Süßkartoffel unverändert. In der zweiten Fruchtfolge allerdings verringerte sich die Menge der Knöllchen, während die Produktion des Krautes anstieg. Eine Regressionsanalyse zeigte, dass die Knollen- und Krautbiomasse mit zunehmendem Wachstum der Hecken abnahm. Die Analyse zeigte aber auch, dass die Menge an Kalium, die mit dem Mulch zugeführt wurde, die Menge der Knollen erhöhte und mit der Menge an zugeführtem Stickstoff die Blattmasse erhöht war. In dem zweiten Anbauzyklus zeigte sich, dass die Menge an Knollen in den Reihen, die in geringer Entfernung von den Hecken verliefen, höher war als in den weiter entfernten Reihen. Es wird die Hypothese aufgestellt, dass dieses Ergebnis auf die Düngewirkung von abgestorbenen Feinwurzeln und Knöllchen nach dem Heckenschnitt in den Reihen nahe der Hecke in Kombination mit dem verkürzten Zeiträumen zwischen den Heckenschnitten zurückzuführen ist.

5 Acknowledgements

The author wishes to acknowledge the able technical assistance of Jeff Binifa at the Lowlands Agricultural Experiment Station, and Dr John Hall in Bangor for his perceptive comments on this paper whilst in preparation.

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