International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Performance of Indigenous Species as Hedgerows: An Evaluation

Napoleon Taguiling

Ifugao State University, Nayon, Lamut, Ifugao, Philippines

Abstract: ***The study was conducted in search for indigenous species that can be used as hedgerow for alley cropping in upland farms. Indigenous species were screened using basic criteria and the best five species were evaluated in an experiment laid out in Randomized Complete Block Design for their performances in terms of survival, herbage production, controlling soil loss, and enhancing soil fertility. Survival of cuttings showed significant differences between the species evaluated. Cuttings of Tithonia diversifolia survived best at 95.25% followed by Baccaurea philippinensis and Grewia sp. at 70.64% and 68.88%, respectively. Tithonia hedgerow also produced the highest herbage at 232.9 kg followed by Baccaurea and Grewia species at 99.4 and 93.6 kg, respectively. Depth of soil losses was significantly lower under Tithonia (0.278 cm) followed by Baccaurea and Grewia species at 0.408 and 0.428 cm, respectively. Results further showed that after two years of continued application of hedgerow trimmings as fertilizer, there was significant improvement on Nitrogen, Organic matter, and Phosphorous contents of top soil but no significant improvement was found for Potassium and soil pH levels. Tithonia, Baccaurea and Grewia species exhibited high potential for hedgerows in that order. The actual impact of these species on crop yield needs however to be evaluated.***

Keywords: Hedgerows, Indigenous species, alley cropping, Tithonia

1. Introduction

One of the sustainable agricultural practices being promoted by the government is an alley cropping agroforestry system known as the Sloping Agricultural Land Technology (SALT). The technology uses hedgerows to minimize soil erosion and to restore soil fertility [1]. While this technology is widely accepted the Philippines, hedgerow species being promoted are purely exotic such as *Leuccaena leucocephala, Gliricidia sepium, Flamingia macrophylla* and *Desmodium rensonii*. The adoption and use of the introduced species however is limited by the availability of planting materials [2] and the psyllid pest of *Leucaena*.

On the other hand, "kaingin" system or slash and burn agriculture in small scale as a supplementary source of food and income is an old practice to the Ifugao farmers. The kaingin is usually maintained for three years and abandoned for fallow period and another clearing is made in the adjacent area. The short-lived productivity of slash and burn farms is due mainly to soil erosion and declining fertility of the soil exposed after clearing [3]. The use of hedgerows offers a promising potential to remedy the situation. There is however a need to identify and evaluate the performance of trees and shrubs within the locality that could be used as hedgerows so that problems on its availability and adaptation can be resolved at once. It was recommended that for future R&D activities, it might help to use the effectiveness of indigenous non-leguminous species rather than introduce new ones [4]. The use of indigenous species as hedgerow to conserve soil while enhancing farm productivity remains a challenge to sustainable upland farming advocates since it requires a long process of field evaluation through experimentation.

This paper presents the evaluation of five indigenous species with potential for hedgerows which can be used to stabilize upland sloping farms. Discussion is centered on survival, herbage production and the ability of the species to control soil erosion and improve soil fertility.

2. Methodology

2.1 Determination of Indigenous Species for Hedgerows

Fifty-seven key informants from the municipalities of Lamut and Kiangan, Ifugao knowledgeable with indigenous species were randomly selected from a list of farmers who availed training on alley cropping particularly on SALT. They were tapped to determine indigenous species that can be used as hedgerows based on the following basic criteria [5], [6], [7]: a) legume species or nitrogen-fixing, b) fast growing, c) withstand heavy pruning, e) sprouts readily and produce abundant herbage, e) easily propagated by seeds and/or cuttings, f) can grow in dense condition, h) non-prolific, and, i) cultural importance/use of the plant or plant parts.

2.2 Field Evaluation of Potential Indigenous Species for Hedgerows.

The study used experimental design following the Randomized Complete Block Design (RCBD) replicated three times. Each block contained six treatments including the control. The treatments were the identified indigenous species for hedgerows.

The experiment was conducted in a moderately sloping area (12^0 or 26.7% slope) at the Ifugao State College of Agriculture and Forestry (*ISCAF*) now Ifugao State University, Nayon, Lamut, Ifugao. An area of 3,375 m^2 was cleared from its grass vegetations followed by the establishment of contour lines with an average distance between contours of 6 meters. Experimental plots were then established measuring 9 meters following the contours. Cuttings of the 5 indigenous species were used as planting materials planted following the contour 6-8 cm apart in double rows 30 cm between rows. To facilitate comparison,

one plot without hedgerow was used as control. Between hedgerows, mung beans (*Vigna radiata (L.)* R. Wilczek) was planted during rainy season without plowing the area and employing only hand-weeding.

Data gathered include percentage survival of cuttings, fresh weight of herbage, soil loss measured using the modified profile meter, and soil nutrients limited to percent organic matter, Nitrogen, Phosphorous, Potassium and soil pH, analyzed at the Bureau of Soils, Department of Agriculture. Nutrient content of herbage of the indigenous species were analyzed at the Analytical Services Laboratory, Institute of Plant Breeding UPLB Los Baños, Laguna. Data were analyzed using means and percentage, analysis of variance, and Duncan Multiple Range Tests.

3. Results and Discussion

Indigenous species identified with high potential for hedgerows based on known criteria include Wild sunflower (*Tithonia diversifolia*), Himbabao (*Allaeanthus luzonicus* (Blanco) F.-Vill), Baloi-boi (*Baccaurea philippinensis* Merr.), Alim (*Mallotus multiglandulosis* (Rein. ex Blume) Hurus.), and *Grewia sp*. locally known as "Baguh." Dapdap (*Erythrina orientalis* (L.) Murr.) and four other native legume species were dropped as treatment because they grow very slowly and have zero or very low survival when propagated through cuttings. The nutrient contents of the herbage of the five species are shown in Table 1.

Table 1: Leaf meal analysis of potential indigenous species for hedgerows

Species	*Nitrogen mg/100g*	*P mg/100g*	*K mg/100g*	*Ca mg/100g*	*Mg mg/100g*
Mallotus sp.	24.57	95	171	244	54.40
Grewia sp.	21.00	108	115	182	61.47
Baccaurea sp.	20.28	157	152	180	64.61
Allaeanthus sp.	18.50	126	96	351	86.29
Tithonia sp.	24.20	95	160	181	56.06

Notes: Values are average of two replications
Nitrogen analyzed by Kjeldahl method
Potassium analyzed by Flame Photometry
Phosphorous analyzed by Colorimetry
Calcium and magnesium analyzed by Titrametry

3.1 Survival

The indigenous species tested for hedgerows differ significantly in terms of survival (Table 2). Among the five indigenous species studied, *Tithonia sp.* or Wild sunflower had the highest field survival at 95.25%, compared to *Baccaurea* sp., *Grewia* sp., *Allaeanthus sp.*, and *Mallotus sp.* at 70.47%, 68.88%, 39.69%, and 34.32%, respectively. The finding implies that the need for replanting is very minimal when Wild Sunflower is used as hedgerow. It also implies that slightly less than one-third is to be replanted when *Baccaurea sp.* and *Grewia sp*. are used as hedgerows compare to more than 60% when *Allaeanthus sp.* and *Mallotus sp.* are used.

Table 2: Mean survival and mean herbage production of cuttings of indigenous species tested as hedgerows.

Treatments	*Mean Survival (%)*	*Mean Herbage Production(Kg)*
Grewia sp.	68.88^{bc}	93.6^{bc}
Mallotus multiglandulosis	34.32^{d}	25.9^{d}
Baccaurea philippinensis	70.64^{bc}	99.4^{bc}
Allaeanthus luzonicus	39.70^{d}	36.7^{d}
Tithonia diversifolia	95.25^{a}	232.9^{a}
Effect of Treatments (F Computed)	654.63 **	1092.90 **
Blocking Effect (F Computed)	3.44 ns	4.45 ns
Coefficient of Variation (% CV)	2.8%	4.6 %

Means with the same letter subscripts are not significant at 5% level of probability
** significant at 1% level
ns Not significant

3.2 Herbage Production

Table 2 further shows the herbage production of species used as hedgerows. The hedgerows were pruned to 0.75 meters every time hedgerow reaches a height of 1.5-1.75 meters. Fresh weight of herbage production differs significantly among the five species evaluated. *Tithonia sp.* yielded the highest average fresh weight of herbage at 232.9 kg/trim and was significantly higher than the other treatments.

The next highest herbage production was recorded from *Baccaurea* sp. with an average production of 99.4 kg followed by *Grewia* sp. with an average production of 93.6 kg. Herbage production between *Baccaurea* and *Grewia* were not significantly different from each other. *Mallotus* and *Allaeanthus* yielded only an average of 25.9 and 36.7 kg, respectively per trim. The result implies that more herbage that can be used as organic fertilizer can be gathered from wild sunflower followed by *Baccaurea* and *Grewia* species.

3.3 Effect of Hedgerows on Soil Loss

Soil loss measured two tears after hedgerow establishment every after major rain event is summarized in Table 3. Analysis on depth of soil loss revealed significant differences between treatments every reading. On the overall average, depth of Soil loss was significantly lower (0.278) under *Tithonia* compared to the other treatments. This means that soil loss is minimized more effectively by Wild sunflower which can be explained by the ability of the species to grow in high density and the application or more herbage from the species, thereby reducing more effectively the velocity of surface run-off and the impact of raindrops [8].

The second lowest depth of soil loss was observed under *Baccaurea* sp. and *Grewia sp*. treatment at 0.408 and 0.428 cm, respectively. This could be attributed to the fact that herbage production of *Baccaurea* and *Grewia sp*. have substantially increased after two year from establishment. Depth of soil loss was highest (0.888 cm) under *Mallotus* hedgerow treatment and was at par with *Allaeanthus* and control treatments, implying that *Mallotus* and *Allaeanthus*

species do not effectively control soil erosion when used as hedgerow.

Table 3: Average depth of soil loss (cm) under each treatment measured every after major rain event 2 years after establishment of hedgerows.

Treatments	Mean Depth of Soil Loss (cm)				Overall
	1st Reading	2nd Reading	3rd Reading	4th Reading	Mean (cm)
Control	0.90 ab	0.78 ab	0.88 a	0.90 ab	0.860a
Grewia sp.	0.52 bc	0.47 bc	0.38 cd	0.52 bc	0.428b
Mallotus multiglandulosis	1.11a	0.99 a	0.77 ab	1.11a	0.888a
Baccaurea philippinensis	0.47 bc	0.42 bc	0.39 cd	0.47 bc	0.408b
Allaeanthus luzonicus	1.07 a	1.09 a	0.67 bc	1.07 a	0.865a
Tithonia diversifolia	0.35 c	0.29 c	0.25 d	0.35 c	0.278c
Effect of Trmt. ($F_{computed}$)	5.54**	7.51**	9.39**	3.109*	6.19**
Blocking Effect ($F_{computed}$)	2.21ns	1.59 ns	1.37 ns	1.11 ns	2.15 ns
CV (%)	51.8%	54.9%	46%	61.9%	41.9%

Means with the same letter are not significantly different at 5% (DMRT)
** *Significant at 1% level of significance*
ns *Not significant*

3.4 Effects of Hedgerow Trimmings on Soil Nutrients

Table 4 summarizes the change in soil nutrient content under the different species tested as hedgerows. Data readily shows that in all the treatments, there was improvement on the amount of soil organic matter, Nitrogen, Phosphorous, Potassium, and soil pH after continued application of hedgerow trimmings as organic fertilizer, except in the control treatment where there was a decrease in Phosphorus, Potassium and pH contents. The increase in these important nutrients is due to the amount of contribution of prunings coupled with its slow rate of decomposition, which reduces nutrient loss through leaching [4].

Organic Matter (OM). OM is well known to have beneficial effects on soil physical and chemical properties. Between treatments, the amount of organic matter was significantly different after the application of hedgerow prunings. Soil under wild sunflower treatments was found to have the most organic matter (5.50 %), followed by *Allaeanthus* (4.50 %), *Baccaurea* (4.33 %), *Mallotus* (4.33 %), *Grewia* sp. (4 %) and control (3%). Soil organic matter improvement can be caused by direct effect of the application of hedgerow trimmings [9], [10], and the increase in OM content could be attributed to the addition of large quantities of pruned material biomass [11]. The differences in the volume of herbage produced by the species that was used as soil organic fertilizer could account for the significant differences in the amount of organic matter between species. Variation on the effect of hedgerow prunings on soil properties is due to the kind of hedgerow species use and management as this influenced the quantity and quality of prunings [7].

Total Nitrogen. Highest total Nitrogen content (0.89) was found in *Tithonia* hedgerow followed by *Baccaurea* (0.73), *Grewia* (0.59), *Mallotus* (0.42), *Allaeanthus* (0.35) and the lowest content (0.18) was in control treatment. Total N content in *Tithonia* plots were significantly higher than the rest of the treatments. This could be attributed to the effect of greater volume of prunings of *Tithonia* and the greater amount of Nitrogen content of its biomass. Increased Nitrogen content of the surface soil as a result of application of prunings [7]. The very limited increase in Nitrogen content under control treatment can be explained by the fact that no herbage was applied and the slight increase might be due to the effect of the mung beans crop raised between the hedgerows.

Phosphorous content. The results of the experiment showed significantly differences on the level of available phosphorous (P_2O_5) between the treatments. Highest phosphorous level was observed under Baccaurea hedgerow (39.67) followed by Tithonia (37.67) and Grewia (32.33). The soil phosphorous content under the above species were not significantly different from each other. While there was an increase on phosphorous levels under all hedgerow species used, there was a reduction on the phosphorous level under the control treatment. The findings in this study are in agreement with that of [11].

Potassium and pH contents. On the levels of soil Potassium and soil pH, the effect of treatments was found to be insignificant. It could be noted however that there was an increase in Potassium content by about 15 to 24% and pH level by about 5-8% in all the hedgerow treatments. The control treatment showed decreased Potassium content by 13% and pH level by 3.4%.

Table 4. Level of soil nutrients before and after application of hedgerow trimmings as organic fertilizer for 2 years

Treatments	% N		% O.M.		P_2O_5 (ppm)		K_2O (ppm)		pH	
	Before	After	Before	After	Before	After	Before	After	Before	After
Control	0.12	0.18 ^{c}	2.83	3.00 ^{b}	18.67	11.00 ^{c}	396.00	343.33	5.9	5.7
Grewia sp.	0.14	0.59 ^{ab}	3.1	4.3 ^{ab}	16.67	32.33 ^{ab}	391.33	451.67	5.65	6.14
Mallotus sp.	0.13	0.42 ^{b}	3.27	4.23 ^{ab}	18	26.67 ^{b}	380.33	439.67	6.15	6.45
Baccaurea sp.	0.15	0.73 ^{a}	3.23	4.73 ^{a}	19	39.67 ^{a}	376.67	448.33	5.83	6.26
Allaeanthus sp.	0.12	0.35 ^{b}	3.13	4.1 ^{ab}	17.67	27.33 ^{b}	352.67	422.33	5.90	6.24
Tithonia sp.	0.13	0.89 ^{a}	3.16	5.70 ^{a}	18.33	37.67 ^{a}	356.00	442.67	5.86	6.38
Effect of Treatment (F computed)	6.21 **		4.92 **		16.11 **		1.92 ^{ns}		1.74 ^{ns}	
Blocking Effect (Fcomputed)	5.24 **		1.71 ^{ns}		6.94 **		0.71 ^{ns}		0.45 ^{ns}	
CV (%)	18.67%		22.04%		24.15%		21.98%		6.21%	

Note: Means with the same letter are not significantly different at 5% (DMRT)
** *Significant at 1% level of significance*
* *Significant at 5% level of significance*
^{ns} *Not Significant*

4. Conclusions

Tithonia diversifolia survived best as hedgerow followed by *Baccaurea philippinensis* and *Grewia sp.*

Tithonia diversifolia also produced significantly higher herbage than the other species studied. *Baccaurea philippinensis* and *Grewia sp*. produce considerable amount of herbage after two years from establishment.

Tithonia diversifolia minimize soil loss more effectively than the other species studied. *Baccaurea philippinensis* and *Grewia sp*. become significantly effective over control in minimizing soil loss only after two year from establishment.

The continued application of trimmings from the species improves significantly the amount of Nitrogen, organic matter, and Phosphorous content of the upper soil layer.

5. Recommendation

While the use of *Tithonia diversifolia* as contour hedgerow in alley cropping demonstrated high potential as hedgerow species in this study, it needs further study on the percentage contribution of its herbage to soil fertility improvement and its effect on yield of some specific agricultural crops. Considering the slower decomposition of herbage of *Baccaurea philippinensis* and *Grewia sp*., the species also deserve further studies in relation to soil nutrient balance and leaching

References

[1] W.A. Laquihon, "Some Key Determinants of SALT Adoption in the Philippines. Viewpoints of Farmer Cooperators." In: *Social Forestry in Asia: Factors that Influence Program Implementation* (eds. N.T. Vergara and R.A Fernandez). SEARCA, Los Baños, Laguna. pp 79-116, 1989.

[2] J.N.M. Garcia, R.V. Gerrits, R.A. Cramb, G.C. Saguiguit, J.J. Conchada, R.T. Yao, A.S. Perez, R.G. Bernardo, "Soil Conservation in an Upland Farming System in South Cotabato: A Case Study." SEARCA–UQ Upland Research Project. Survey Report No. 7. SEARCA, Los Baños, Laguna. 1997.

[3] R. Lal, Agroforestry systems and soil surface management of a tropical alfisol: 2. Water runoff soil erosion and nutrient loss. *Agroforestry Systems*8, 97-111. 1989

[4] A.B. Exconde, "Potential hedgerow species for alley cropping systems in Philippine upland farms," Ecosystems Research and Development Bureau, College, Laguna, Philippines, 1999. [Online]. Available: www.vetiver.com/TVN_IVC2/CP-5-7.PDF. [Accessed October 28, 2009].

[5] R.V. Dalmacio, "Evaluation of Species Adaptability for Agroforestry Systems," in Agroforestry Course. CEC UPLB, Laguna, Philippines, 1987.

[6] R. C. Serrano, Alternative species other than ipil-ipil for agroforestry. The PCARRD Monitor. XVI (3) pp. 1-10), 1988.

[7] B.T. Kang, R.C. Gutteridge, "Overstory #172 - Alley Cropping (Hedgerow Intercropping)," May 28, 2006. . [Online]. Available: http://www.agroforestry.net/ the-overstory/100-overstory-172-alley-cropping-hedgerow-intercropping. [Accessed December, 2009].

[8] M.A. McDonald, P.A. Stevens, J.R. Healey, "Contour hedgerows of *Calliandra calothyrsus* Meissn. for soil and water conservation in the Blue Mountains of Jamaica," 2001. [Online]. Available: http://tucson.ars.ag.gov/isco/isco10/ Sustaining TheGlobalFarm/P247-McDonald.pdf. [Accessed January 25, 2008].

[9] J.N.M. Garcia, R.V. Gerrits, R.A. Cramb, G.C. Saguiguit, "Characteristics and Implementation of Soil Conservation Technologies in the Case Study Sites." in Soil Conservation Technologies for Smallholder Farming Systems in the Philippine Uplands: A Socioeconomic Evaluation, R.A. Cramb (ed.). ACIAR Monograph no. 78. ACIAR Canberra. pp 52-71. 2000

[10] A. Young, 1990. Agroforestry for soil conservation. CAB International. Wallingford, UK, 1990.

[11] Z. A. Firoz, K. M. Nasiruddin, M. F. Mondal, "Effect of Different Hedgerow Species and Nitrogen Level on the Soil Properties and Yield of Okra *(Abelmoschus Esculentus L.* Moench)," March 2012. [Online]. Available: www.banglajol.info/index.php/ BJAR /article/ download/ 11190/8174. [Accessed August 20, 2014].