J. Bamboo and Rattan, Vol.5, Nos. 1&2, pp. 15-27 (2006)

Site conditions and growth characteristics of plantation-grown palasan canes (*Calamus merrillii* Becc.)

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Abstract: Different site characteristics, namely soil properties, elevation, and exposure to sunlight influencing the growth rate were evaluated in 15 palasan (*Calamus merrillii*) plantations located all over the Philippines. Growth rate was highly affected by soil pH, organic matter, nitrogen, potassium and phosphorus contents. Site elevation, exposure to sunlight and topography also gave a direct impact on cane production. Based on the regression coefficient, the influence of site parameters follows the trend: elevation > exposure to sunlight > soil properties. These parameters should be first considered in the selection process of future plantation sites to achieve optimum cane production.

Key words: Calamus merrillii, soil characteristics, elevation, sunlight, growth rate, cane production.

INTRODUCTION

The rattan furniture industry in the Philippines is in the brink of closure because the supply of raw materials from natural forests has dwindled tremendously over the years (Tesoro, 2002). This has been brought about by several factors (Dransfield, 2002). As a result, a number of rattan species are already threatened and some are by now endangered (Walter and Gillett, 1998). To salvage this multimillion dollar industry, rattan plantations were established in the early 1980s all over the country through grants and loans (DENR, 1998).

Establishment of rattan plantation is the only way to provide renewable supply of raw material to the industry. However, it is faced with a number of uncertainties pertaining to the growth habit of plantation-grown rattan and the quality of the cane produced that will ultimately influence its economic feasibility. In view of this, a number of studies have already been conducted on growing rattan along with rubber trees and oil palms (Mohd Ali and Barizan, 2002), or cacao and coffee (Siebert, 2000).

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To solve the possible shortage of planting stocks, clones and container seedlings have also been tested (Chang-lin *et al.*, 2003). The environmental factors affecting the growth of the plants were more or less defined (Bonal, 1997). Most of these experiments were carried out *in situ*; thus, information on the actual field conditions and how these might influence cane production is minimal or even lacking. Knowledge on this is crucial because it will clearly define the best site for optimum cane production.

The present study was carried out to record the prevailing site conditions of different rattan plantations especially that of palasan canes (*Calamus merrillii* Becc.) in the Philippines and to evaluate their effect on growth and development of canes.

MATERIALS AND METHODS

Location of plantations

Fifteen palasan (*C. merrillii*) plantations from different sites all over the Philippines were visited (Table 1). These plantations differ in their age and size and were established either by the Department of Natural Resources (DENR) or by the Philippine National Oil Company- Energy Development Corporation (PNOC-EDC). Natural stands of palasan canes situated in the Makiling Forest Reserve managed by the University of the Philippines, Los Baños were taken as control. From these sites, two rattan plants were selected randomly for observations.

Soil analyses

Approximately 200 g of soil was collected from each site directly from the root zone and brought to the College of Agriculture, University of the Philippines, Los Baños for soil analyses. The soil characters evaluated include soil pH, organic matter content (OM), nitrogen (N), potassium (K), and phosphorus (P) contents.

Elevation

The elevation of each of the sites was measured using an altimeter. Mean of two measurements per site was used for the evaluation.

Exposure to sunlight

Before extracting the cane, digital images of the canopy exactly where the rattan plant was growing were taken. Standard image evaluation using the latest digital imagery techniques (J Image software) was used to assess the amount of sunlight the plant utilized for its growth and development. Mean of two measurements was used for the analysis.

Growth characteristics

After site characterization, the canes were cut down from the basal part (just above the ground) and the total length was determined. For every metre, internode length and internode diameter were measured. From these, mean internode length and internode diameter were determined.

Growth rate per year

Rattan undergoes the rosette stage which lasts for 3 to 5 years. However, there is no exact way of knowing how long the plant has undergone such a stage. To standardize this, it was assumed that the plant would produce cane right after the first year of establishment. Therefore, growth rate per year was obtained by simply dividing the total length of the cane with cane age.

Statistical analysis

Variability between cane in terms of both internodal length and diameter was determined using the Kruskal-Wallis Test (Zöfel, 1992) at 5 per cent significance level. This non-parametric test was used because the sample sizes were different from one another. It was also uncertain whether the individual data follow a normal distribution pattern, so the assumptions for a one-way analysis of variance (ANOVA) were not met and could not be tested. To describe within cane differences, standard deviation from the mean was considered. Finally, regression analysis was performed to evaluate the possible influence of site characteristics, namely soil, elevation, *etc*., on the growth and development of the cane.

RESULTS AND DISCUSSION

Site descriptions

Location and area

Table 1 provides the age, location and total area as well as the agencies managing the plantations. The plantations were normally established in secondary forest or logged-over areas, where dipterocarps and almaciga trees used to thrive. In some areas, they were intercropped with *Acacia mangium* or *A. auriculiformis.* DENR established its plantations primarily for research purpose to study on the growth and development of canes, while PNOC-EDC used the plantations for forest protection. Employing local communities in the establishment and maintenance of plantations enabled the company to divert the attention of upland dwellers from “slash and burn farming”. This strategy helped to protect their geothermal plants.

Table 1. Description of the different rattan plantations

Sample code	Age during collection (yrs)	Location	Area (ha)	Managed by
Nat	Unknown	Los Baños, Laguna	Unknown	UPLB[1]
QP2-84	20	Pagbilao, Quezon	4	DENR[2]
LP2-86	18	Daraga, Legaspi	4	DENR
TP-89	15	Ormoc, Leyte	150	PNOC-EDC[3]
LP1-90	14	Daraga, Legaspi	4	DENR
NP-93	11	Southern Negros	25	PNOC-EDC
MLP-93	11	Ormoc, Leyte	40	PNOC-EDC
NP-93P*	11	Southern Negros	20	PNOC-EDC
QP1-94	10	Pagbilao, Quezon	4	DENR
AKP-94	10	Ormoc, Leyte	25	PNOC-EDC
MP-94	10	Southern Negros	30	PNOC-EDC
MP-96	8	Southern Negros	60	PNOC-EDC
MP-96P*	8	Southern Negros	60	PNOC-EDC
PNOC-97	7	Sorsogon	2	PNOC-EDC
NP-97	7	Southern Negros	30	PNOC-EDC
NP-2000*	4	Southern Negros	20	PNOC-EDC

* Samples are still in their rosette stage or have yet to produce cane.
1: University of the Philippines Los Baños. 2: Department of Environment and Natural Resources.
3: Philippine National Oil Company-Energy Development Corporation.

Table 2. Soil analyses of the different sites

Sample code	pH	Organic matter (%)	Nitrogen (%)	Phosphorus (ppm)	Potassium (cmol (+) /kg)
Nat	7.30	8.37	0.16	18.00	2.60
QP2-84	5.10	5.01	0.26	0.75	1.05
LP2-86	6.00	7.24	0.30	20.80	3.46
TP-89	5.90	7.57	0.33	18.90	1.84
LP1-90	5.90	4.53	0.30	27.70	3.36
NP-93	5.20	16.98	0.62	10.20	0.34
MLP-93	4.50	10.26	0.37	5.50	0.43
NP-93P*	4.70	31.97	0.87	13.60	0.34
QP1-94	4.90	3.25	0.15	1.70	2.09
AKP-94	4.50	3.72	0.17	0.70	2.05
MP-94	5.50	4.79	0.25	1.10	0.45
MP-96	5.00	7.32	0.45	3.20	0.82
MP-96P*	5.70	6.47	0.29	23.50	1.91
PNOC-97	5.20	8.58	0.35	0.56	0.60
NP-97	5.30	7.91	0.43	31.20	1.90
NP-2000*	4.40	32.33	0.97	19.70	1.06

* Samples are still in their rosette stage or have yet to produce cane.

Table 3. Amount of sunlight exposure and topographical description of the sites

Sample code	Sunlight (%)	Elevation (m asl)	Topography
Nat	22.00	620	Slightly slopy
QP2-84	21.00	500	Slightly slopy
LP2-86	72.91	10	Flat
TP-89	83.34	220	Flat
LP1-90	83.90	10	Flat
NP-93	42.43	980	Valley
MLP-93	63.74	660	Slightly slopy
NP-93P*	20.00	1000	Steep
QP1-94	20.00	480	Slightly slopy
AKP-94	53.75	520	Slightly slopy
MP-94	22.79	460	Slightly slopy
MP-96	90.28	460	Relatively flat
MP-96P*	18.00	980	Steep
PNOC-97	50.58	480	Slightly sloppy
NP-97	32.67	800	Flat
NP-2000*	18.00	1000	Steep

* Samples are still in the grass stage or have yet to produce cane.

Soil characteristics

Results of the soil analyses are presented in Table 2. Plantation soils were observed to be acidic (pH 4.40-6.0) as compared to a more neutral soil of the natural stand (pH 7.3). Organic matter and nitrogen content were highest in NP-2000 and NP-93 and was lowest at QP1-94. Phosphorus content on the other hand, ranged from 0.56 to 31.20 ppm, while potassium ranged from 0.34 to 3.46 cmol (+) /kg. This indirectly shows the large variability in the soil characteristics among sites. It is also interesting to note that in the two NP sites, where organic matter and nitrogen content were highest, the plants were yet to produce cane, though they were already 4 and 11 years old, respectively.

Topography

Table 3 presents the topographical description of the different sites. Elevation ranged from 10 to 1000 m asl. Highest elevation was observed in NP-93P and NP-2000, while the lowest was in both LP samples. In terms of topography, it ranged from flat to slightly undulating to relatively steep.

Exposure to sunlight

The amount of sunlight that the cane can use for its growth and development ranged from 18 per cent to as high as 90 per cent (Table 3). Therefore, in some sites, the cane is exposed to sunlight for almost the entire day while in others it is limiting.

Growth characteristics

Total length of the cane

Total cane production in different sites is depicted in Figure 1. Cane length varied significantly between samples. Canes from Southern Negros (NP-93) were the shortest with only 3 m, while canes from Daraga, Legaspi (LP1-90) were the longest with 53 m. It is also worth noting that the cane derived from the natural forest (Nat) only gave an average total length of 23 m which is much shorter than those collected from Daraga, Legaspi (LP1-90 and LP2-86), and from Ormoc, Leyte (TP-89 and MLP93). This would imply that in some sites, plantation-grown rattans could produce more

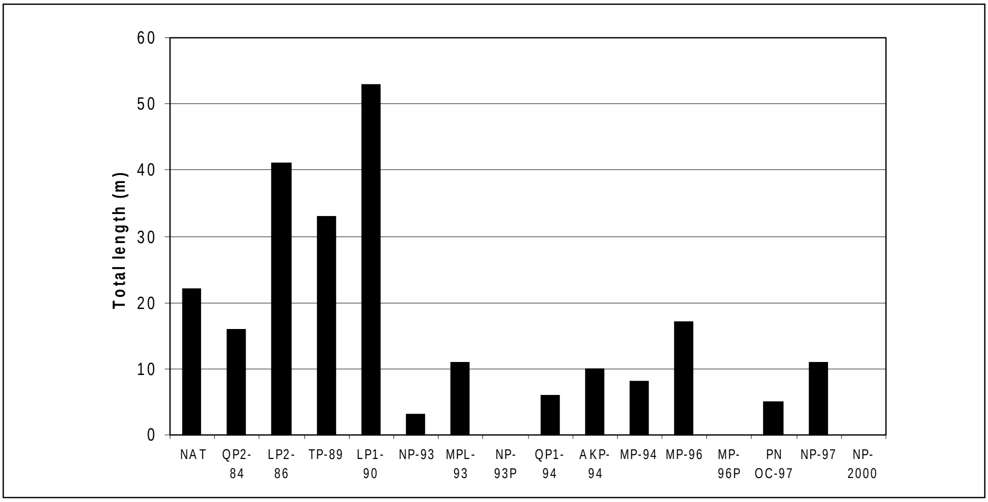


Figure 1. Total cane production in different sites.

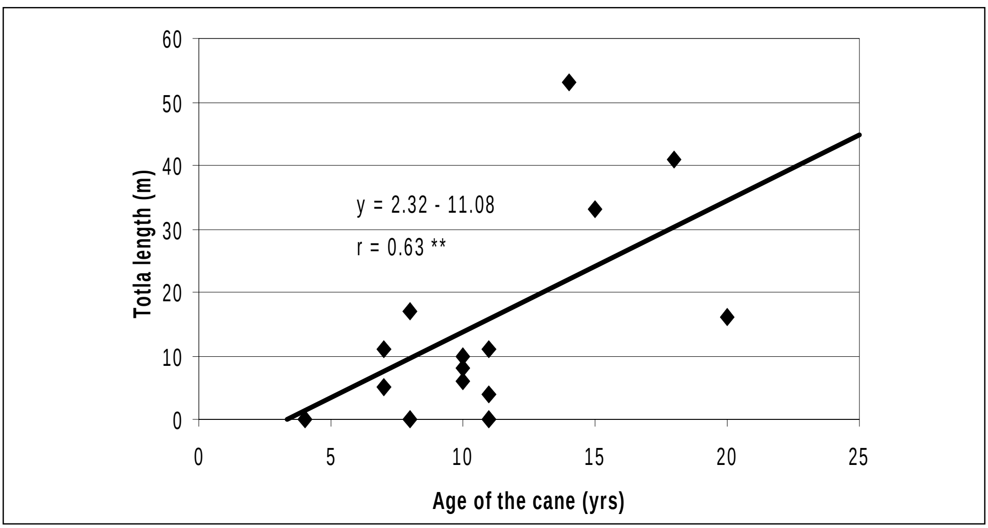


Figure 2. Influence of age of rattan plants on cane length.

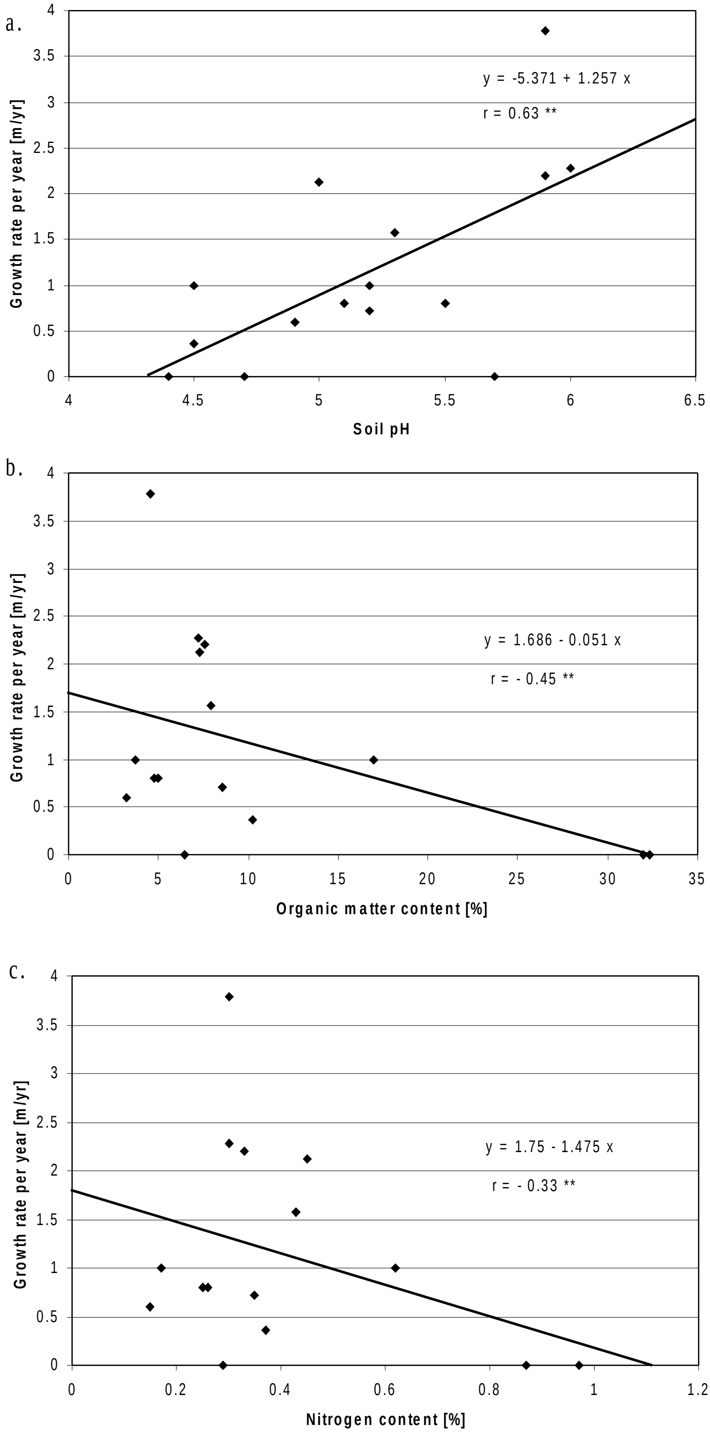


Figure 3. Influence of soil characteristics on the growth rate of the cane; a: soil pH *vs* growth rate; b: organic matter content *vs* growth rate; c: nitrogen content *vs* growth rate.

merchantable volume of canes than those collected from the wild. However, in some sites, the plant did not produce any cane even after 11 years of growth (NP-93P). Normally in the development of rattans, the first 3 to 5 years is termed as the rosette stage when the plant is still establishing itself and does not produce any cane (Tomlinson, 1990). This situation is alarming especially to the investors of the plantation.

Internode length and internode diameter

Average internode length ranged from 18.47 to 36.39 cm, while average internode diameter was from 2.95 to 4.86 cm. Normally, internode length was shortest at the basal part and tends to increase along the length of the cane, while internode diameter was maximum at the base with a slight decrease along its length. With H-values of 63.55 and 155.71 for internode length and internode diameter, respectively, Kruskal-Wallis test showed a great deal of variation in both internode length and diameter between the canes coming from different sites. Nevertheless, when canes were compared to that of the control (natural stands), canes were of larger diameter and slightly shorter in internode lengths. Conversely, within cane variation was less distinct (Table 4) probably due to more stable cane characteristics observed at the middle portion of the cane.

Influence of rattan age on the total length of the cane

The variability in the amount of cane produced between sites is very apparent in Figure 1. Although it is apparent that the main reason for such discrepancies was related to differences in growing conditions between sites, it would be incorrect to rule out the possible influence of rattan age on the amount of cane produced. To verify this possibility,

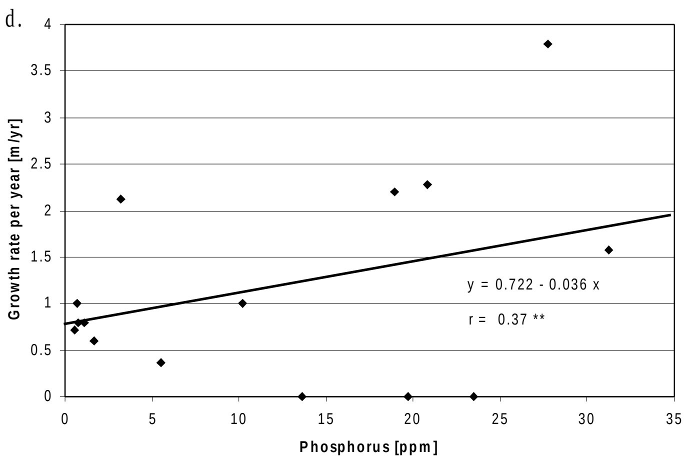
Table 4. Statistical results of internode length and diameter

Sample	Total	Internode length (cm)		Internode diameter (cm)	
code	length (m)	Average	SD	Average	SD
Nat	22	29.96	8.22	2.95	0.60
QP2-84	16	28.30	8.47	2.95	0.60
LP2-86	41	29.75	4.45	3.73	0.30
TP-89	33	24.30	6.75	4.86	0.55
LP1-90	53	25.73	4.85	3.92	0.59
NP-93	3	21.67	7.01	4.56	0.38
MLP-93	11	28.79	8.50	3.66	0.36
QP1-94	6	19.67	5.39	3.15	0.83
AKP-94	10	26.52	5.67	3.71	0.30
MP-94	8	28.09	10.96	3.57	0.29
MP-96	17	36.39	6.40	4.41	0.44
PNOC-97	5	18.47	8.52	3.41	0.52
NP-97	11	23.85	6.70	3.48	0.42

total cane length was correlated to age of rattan plant and as expected, the two were directly related (Fig. 2). Older plants are likely to produce longer canes, but this is not true for all the sites and in some cases, the older plant like NP-93 did not produce even a meter of cane, while the younger one like NP-97 produced 11m of cane. Since, total length is not reliable for comparing the growth characteristics of the rattans between different sites, growth rate per year was used instead.

Influence of soil properties on the growth rate of the cane

Figure 3 shows how pH, organic matter, nitrogen, phosphorus and potassium contents of the soil affected the growth rate of the cane. Soil pH showed a significant influence on growth rate. When pH approached the neutral, growth rate was enhanced. This supports the report of PCARRD (1991) that the pH for optimum growth to be from 5 to almost neutral. Soil pH is one of the most important soil properties that influences



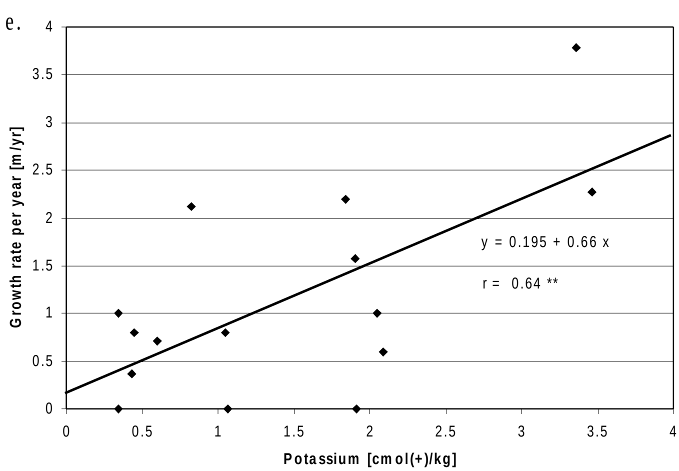


Figure 3. Influence of soil characteristics on the growth rate of the cane; d: phosphorus content *vs* growth rate; e: potassium content *vs* growth rate.

the availability of soil nutrients (Sparks, 1999). In the pH range of 6-6.5, nutrients are more readily available to the plant and soil microbial flora is favoured, thereby improving the growth and development of the plant.

Organic matter is important for plant growth because it provides valuable nutrients to the soil as well as prevents them from leaching out. It is interesting to note that the highest OM content was observed in NP-93P and NP-2000 where cane production was zero. Its abundance in the soil could mean that it has not been fully degraded yet to its utilizable form. However, this is not the case because as observed, nitrogen concentration was also high in both sites. It is possible that the OM was just newly converted to N during the time of observation and being retained in the upper-most layer of the soil reduced its availability to the plant. Therefore, even though there was abundance of OM, it did not enhance the growth of the rattan.

Phosphorus content, though moderately related, was similar to potassium in positively affecting the growth rate of the rattan. Like nitrogen, phosphorus and potassium are essential in the process of photosynthesis, and their availability will have a direct effect on growth. One major weakness of this evaluation, however, is that it failed to account for the changes in soil properties over time. It would have been better if there was information on soil characteristics during plantation establishment which would have served as baseline data with which the current results could have been compared. Nevertheless, this result clearly shows the intertwining influence of the different soil constituents on rattan growth rate.

Elevation and topography

Although rattans are observed to survive at varying elevations and even as high as 3000 m asl (PROSEA, 1994), their growth rate under such conditions is still uncertain. Figure 4 shows that growth was inversely affected by elevation. As elevation approaches 1000 m asl, cane length decreased. This is very apparent in the field especially in Nasue, Southern Negros where the plantations are from 800 to 1000 m asl. Eleven-year-old rattan (NP-93P 1000 m asl) was dwarfed and did not develop even a meter of cane, while in the same site but with slightly lower elevation (NP-93 980 m asl), 3 m of cane was produced. Nevertheless, this is still far lower than the growth rate of rattans grown at lower elevations. It seems that high elevation tends to prolong the rosette stage. Instead of 3 to 5 years, it is delayed up to 11 years or more. Site with very low elevation is more preferred. Samples collected in Daraga, Albay planted at 10 m asl gave a total merchantable length of 53 m after 14 years. Assuming that the rosette stage was just 3 years, thus, the 53 m long stem was produced for 11 years at an average rate of 4.82 m/year. This is far greater than the recorded growth rate of 0.7 m/year reported by Cadiz (1987) for plantations. It is therefore recommended that rattan plantations, especially that of *C. merrillii* be established in sites with elevations lower than 800 m asl.

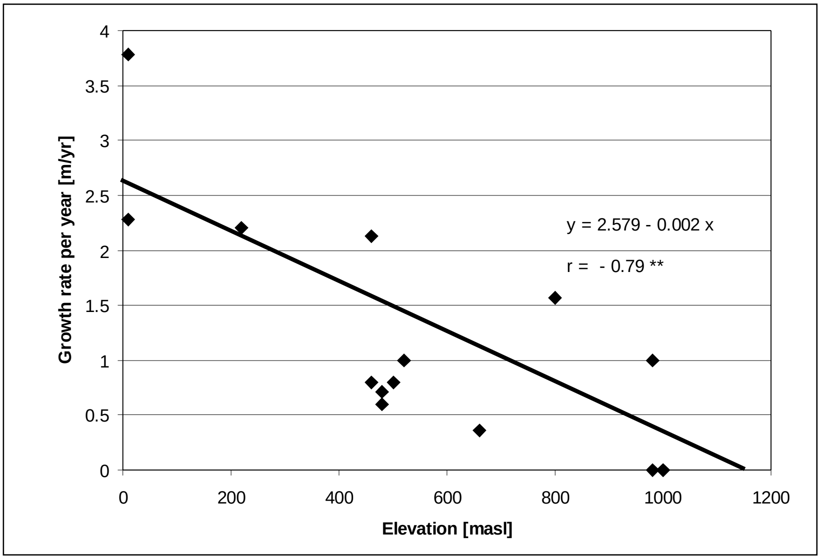


Figure 4. Influence of elevation on the growth rate of the cane.

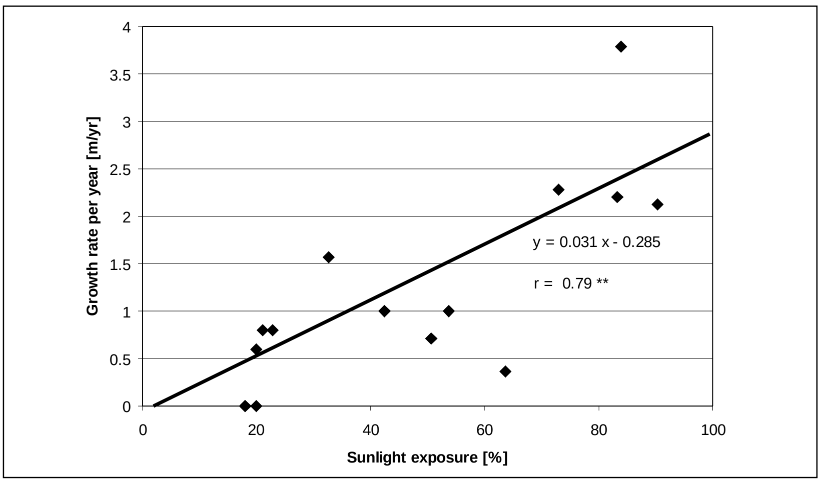


Figure 5. Influence of amount of sunlight exposure on the growth rate of the cane.

It was observed that the plant prefers relatively flat areas. Besides having a low elevation, sites in Daraga, Albay were flat. This facilitates conservation of nutrients due to lower surface run-off during rain. In steep areas, on the other hand, the nutrient-rich top soil could easily be washed away by surface run-off, reducing the ability of the soil to support plant life.

Exposure to sunlight

Sunlight enhances stem elongation in rattans (Manokaran, 1985). Dela Cruz (1987) noted that palasan seedling grows better under 25 per cent, 50 per cent and 75 per cent than 100 per cent exposure. Results obtained in this study support this claim (Fig. 5). However, these values could not account for the changes in canopy cover from the establishment stage of the plantation till the time of observation. Canopy cover could change in an instant due to typhoons/storms and thus, it is uncertain whether it remained the same from beginning till the time of observation. We could only presume that these changes in vegetative cover were very minimal for this evaluation to be acceptable. But apparently, *C. merrillii* needs more sunlight for better growth.

CONCLUSION

Cane development in *C. merrillii* varied between sites and was highly affected by the growing conditions in the area. Nevertheless, it is important to note that in some areas, plantation canes were better in terms of total length and internode diameter than from the natural forest. Growth rate was obviously dependent not only on one site parameter but on the intertwining relationship of all other related characters. Ranking each character on the basis of their regression coefficient as well as their permanence on the site, it was observed that it follows the trend: elevation > sunlight exposure > soil properties. These parameters should be considered in selecting sites for future plantation establishment.

ACKNOWLEDGEMENTS

This study was funded by the International Foundation for Science under Research Grant No. D/3499-1. The author also acknowledges C. Dapla and W. Palaypayon of the Deparment of Environment and Natural Resources; A. de Jesus, E. del Rosario and M.Paje of the Philippine National Oil Company-Energy Development Corporation, for providing the much needed rattan samples.

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