1.2 Commercial plantation and Management

Effect of Organic Fertilizer Application on *Gigantochloa scortechinii* Wildings and its Biomass

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Abstract

Gigantochloa scortechinii Gamble is considered one of the most important commercial bamboos in Malaysia. A study to determine the effect of chicken dung fertilizer application on *G. scortechinii* seedlings including its biomass content and nutrient uptake was conducted at the nursery of the Faculty of Forestry, Universiti Putra Malaysia. Five treatments with various amounts of fertilizer of 0, 200, 250, 300 and 350 g/seedling were applied twice when the seedlings were one and three months old. A total of 45 seedlings were planted in polybags altogether. Parameters involved were culm height, green weight and dried weight of leaves, culms and roots, and nutrient uptake in the leaves. The biomass estimation for all the seedlings was done at 8 months; the seedlings were cut into three parts, i.e. leaves, culms and roots. The weighed parts were placed in the oven at 63°C for 72hr and later again weighed. Foliar samples for replicates 1, 3 and 5 for all treatments were determined for their macronutrient contents of N, P, K, Ca and Mg, using the Kjeldhal method for N and wet digestion method for P, K, Ca and Mg. Biomass content for root-shoot ratio showed significant difference between treatments for P at 0.05 level. Macronutrient contents of N, P, K and Ca in the foliar samples showed significant differences between treatments for at $P \leq 0.01$ level, while that of Mg showed significant differences at $P \leq 0.05$ level. It was found that fertilizer application at 350 g/seedlings was significant for the development of optimum biomass and nutrient contents in G. *scortechinii* seedlings.

Keywords : *Gigantochloa scortechinii* seedlings, chicken dung, parameters, biomass, nutrient uptake

Introduction

Bamboo is the only woody grass belonging to the Graminae family of the subfamily Bambusoideae. It is found in tropical, subtropical and temperate regions at latitudes from 40° S to 40° N and elevation up to 3,000 m above sea level. Most bamboos that originated in Asia can also be found in South America and Africa (Azmy 1991). According to Wong (1995), there are more than 59 species of bamboos and half are native to Malaysia, while the others are exotic. The common genera in Malaysia are *Bambusa*, *Dendrocalamus*, *Gigantochloa*, *Chusquea*, *Dinochloa*, *Melocanna*, *Phyllostachys*, *Racemobambos*, *Schizostachyum*, *Thyrsostachys* and *Yushania* (Azmy 2004).

Wong (1995) stated that bamboo can be found at the foothills and valleys of mountain ranges including the Main Range, from Pattani in Thailand to Malacca on the southwest coast, and in the highlands of Terengganu at the northeastern line of the Peninsula up to about 1,200 m. Its culms are produced into chopsticks, tooth-picks, bamboo skewers, joss-papers and basket (Azmy 1989, Wong 1989, Lim & Roslan 1992, Azmy *et al*. 1997).

Wild bamboo populations are found in forest gaps, especially in ex-logging areas and sometimes in patches on flatland and hill slopes (Ng & Mohd Noor 1980, Lokman *et al*. 1992, Azmy *et al*. 1997). Most forest bamboos are *G. scortechinii, S. grande, S. zollingerii D. pendulus,* and *G. ligulata* (Azmy 1991, Azmy & Abd Razak 1991). One of the most important species is *G. scortechinii*. *Gigantochloa scortechinii* occurs as a natural stand bamboo. It grows profusely in the forest throughout the whole of Malaysia. Due to the importance of this natural stand bamboo for the cottage industry and its potential for pulp and paper production (Jamaluddin *et al*. 1992), it is relevant to do a biomass study of *G. scortechinii* natural stand bamboo seedlings. Such a study was conducted at the Faculty of Forestry's nursery, examining the effect of organic fertilizer application.

Materials and Methods

The study at the Faculty of Forestry's nursery, Universiti Putra Malaysia, Serdang, Malaysia, examine the effect of chicken dung fertilizer (in the form of granules) application on the biomass content and nutrient uptake of *G. scortechinii* wildings. The study was designed using 5 treatments and 9 replicates for 45 seedlings altogether planted in polybags. The various rates of fertilization were 0 (T1), 200 (T2), 250 (T3), 300 (T4) and 350 (T5) g/seedling, applied twice when the seedlings were one and three months old. Parameters used in this study were culm height, green weight and dried weight of leaves, culms and roots, and of nutrient uptake in the leaves. The biomass estimation was done on the seedlings at 8 months old. All the wildings were cleaned and cut into three parts i.e. leaves, culms and roots. The weighed parts were placed into the oven at 63°C for 72hr. Later, all the oven-dried samples were weighed. Foliar samples for replicates 1, 3 and 5 for all treatments were tested for their macronutrient contents of N, P, K, Ca and Mg. In this study, the Kjeldhal method for N and the wet digestion method for P, K, Ca and Mg were applied (Blamire, 2003). In order to raise the temperature and at the same time promote the oxidation of organic matter, sodium sulphate was added together with catalyst (selenium). Total nitrogen contents for each leaves, culms and roots were then determined by the distillation method using HCl solution for titration. The plant materials (foliar) were digested by acid oxidation in a closed pressurized Teflon vessel in a microwave oven. The combination of microwave heating and acid digestion under pressure in the Teflon vessel provided fast heating, reducing the digestion time and allowing contamination control. The samples digested were then analysed on Inductive Couple Plasma (ICP) for elemental analyses. The moisture and nutrient contents of each part of *G. scortechinii* seedlings were recorded.

Results and discussion

Biomass content

Foliar biomass

Analysis of variance showed that there was no significant difference between all treatments for foliar biomass (Table 1).

Table 1: ANOVA for the effects of treatments on measured parameters

Variable	DF	Mean square	F - value
Foliar biomass	4	69.644	0.974^{ns}
Culm biomass	4	291.105	1.608^{ns}
Root biomass	4	813.654	3.497**
Root-shoot ratio biomass	4	0.140	2.916**
Total dry weight	4	2844.856	2.304*
Culm height	4	219.755	0.714^{ns}

Note: * = significant at $p \leq 0.1$
** = significant at $p \leq 0.05$
*** = significant at $p \leq 0.01$

The application of 300 g/seedling of chicken dung fertilizer gave the highest foliar biomass content (17.13 g), followed by 350 g/seedling (16.43 g). The unfertilized seedlings (0 g/seedling) recorded the lowest foliar biomass content which was 11.36 g and this was a small difference from the values given by the seedlings fertilized at 200 and 250 g/seedling of chicken dung fertilizer applications which were 12.01 g and 11.85 g respectively (Figure 1).

In Table 2, there were no significant differences in the mean biomass content and culm height of *G. scortechinii* seedlings between the five treatments.

Table 2: Mean of all parameters' for biomass contents of *G. scortechinii* seedlings

Treatment	Biomass content					Culms height (cm)
	Leaves (g) *(1)*	Culms (g) *(2)*	Root (g) *(3)*	Root-shoot ratio *(3)/(1+2)*	Total (g) *(1)+(2)+(3)*	
T1	11.36^{a}	16.97^{a}	13.99^{a}	0.49^{ab}	42.32^{a}	54.8^{a}
T2	12.01^{a}	17.16^{a}	13.43^{a}	0.46^{a}	42.61^{a}	66.6^{a}
T3	11.85^{a}	16.61^{a}	15.88^{a}	0.56^{a}	44.34^{a}	52.4^{a}
T4	17.13^{a}	27.80^{a}	28.84^{b}	0.64^{ab}	73.76^{a}	54.0^{a}
T5	16.43^{a}	26.74^{a}	33.95^{b}	0.79^{b}	77.13^{a}	63.2^{a}

Note: By using Duncan Multiple Range Test (DMRT), means with the same alphabets in columns are not significantly different at the 0.05 probability level.

Culm Biomass

Analysis of variance showed no significant difference between all treatments for culm biomass at 0.05 significance level (Table 1 and 2).

The usage of 300 g/seedling of chicken dung fertilizer produced the highest culm biomass content (27.80g), followed by 350 g/seedling (26.74 g). However, the applications of 0, 200 and 250 g/seedling of chicken dung fertilizer showed small differences among the biomass values of 16.97 g, 17.16 g and 16.61 g (Figure 1).

Root Biomass

Analysis of variance showed significant difference in root biomass at 0.05 significance level between treatments (Tables 1 and 2).

The usage of 350 g/seedling of chicken dung fertilizer showed the highest root biomass content (33.95 g), followed by the usage of 300 g/seedling (28.84 g). However, the usages of 0 , 200 and 250 g/seedling of chicken dung fertilizer recorded almost similar values of 13.99 g, 13.43 g and 15.88 g respectively (Figure 1). The applications of 300 and 350 g/seedling of chicken dung fertilizer gave a significant difference at 0.05 level compared with 0 , 200 and 250 g/seedling of chicken dung fertilizer (Table 2).

Root- Shoot Ratio Biomass

Analysis of variance showed significant differences in root shoot ratio at 0.05 significance level between treatments (Tables 1 and 2).

In Figure 2 the ratios of biomass between roots and shoots did not attain the value of one. The highest root-shoot ratio was given by treatment 350 g/seedling of chicken dung fertilizer (0.79) and the lowest value was given by treatment 200 g/seedling of chicken dung fertilizer (0.46). Figure 2 also shows a decrease in root-shoot ratio by the usage of 200 g/seedling chicken dung fertilizer compared with the usage of 0 g/seedling and increases by the usages of 250 g/seedling, 300 g/seedling and 350 g/seedling chicken dung fertilizer.

The usage of 350 g/seedling of chicken dung fertilizer showed significant difference compared with those of 0, 200, 250 and 300 g/seedling of chicken dung fertilizer at 0.05 significance level (Table 2). However, there was no significant difference found between the usages of 200 and 250 g/seedling of chicken dung fertilizer and between the usage of to 0 and 300 g/seedling of chicken dung fertilizer at 0.05 levels. The application of 350 g/seedling of chicken dung fertilizer gave the highest root-shoot ratio with significant difference at 0.05 level (Table 2).

Total Biomass

From the analysis of variance, there were no significant differences between all treatments for total biomass at 0.05 significance level. This was also true for the culm height (Table 2).

Biomass percentage composition of *G. scortechinii* seedlings according to their parts

Figure 3 shows an increment in the composition of roots but a decline in the culm and foliar compositions with the increment of dosage of chicken dung fertilizer. The composition increment of roots between the usages of 350 g/seedling and to 0 g/seedling was 10.9%, while the declines of culm and foliar composition between the usages of 350 g/seedling and 0 g/seedling were 5.4% and 5.5% respectively (Figure 3)

Nutrient Uptake

Nitrogen (N)

Analysis of variance showed high significant differences in nitrogen, phosphorus, potassium and calcium contents at 0.01 significance levels between treatments (Table 3).

Table 3: Effects of treatments on nutrient contents

Variables	DF	Mean Square	F value
Nitrogen (N)	4	0.302	1678.741***
Phosphorus (P)	4	0.001	11.969***
Potassium (K)	4	0.063	1345.857***
Calcium (Ca)	4	0.002	51.083***
Magnesium (Mg)	4	0.000	4.864**

Note: * = significant at $p \leq 0.1$

** = significant at $p \leq 0.05$

*** = significant at $p \leq 0.01$

The usage of 200 g/seedling of chicken dung fertilizer gave the highest N content (2.20%), followed by the usage of 250 g/seedling (1.84%) while the control (0 g/seedling) showed the lowest nitrogen content (1.35%) (Table 4 and Figure 4).

Phosphorus (P)

Analysis of variance showed high significant differences in phosphorus content at 0.01 significance level between treatments (Table 4).

Application of 250 g/seedling of chicken dung fertilizer gave the highest P content (0.29%), followed by the usage of 350 g/seedling (0.28%) while the usages of 0 g/seedling, 200 g/seedling and 300 g/seedling of chicken dung fertilizer recorded the lowest nitrogen content (0.25% each) as shown in Table 4 and Figure 5.

Table 4: Nutrient uptakes of *G. scortechinii* seedlings based on Duncan's values.

Treatment	Nutrient Uptake (%)				
	N	**P**	**K**	**Ca**	**Mg**
T1	1.35[a]	0.25[a]	1.26[a]	0.35[a]	0.18[a]
T2	2.20[d]	0.25[a]	1.41[c]	0.34[a]	0.19[ab]
T3	1.84[c]	0.29[b]	1.62[d]	0.34[a]	0.18[a]
T4	1.60[b]	0.25[a]	1.27[a]	0.40[c]	0.17[a]
T5	1.62[b]	0.28[b]	1.39[b]	0.38[b]	0.20[b]

Note: By using Duncan Multiple Range Test (DMRT), means with the same alphabet in columns are not significantly different at the 0.05 probability level.

Potassium (K)

Analysis of variance showed high significant differences in potassium content at 0.01 significance level between treatments (Table 4).

The usage of 250 g/seedling of chicken dung fertilizer gave the highest K content (1.62%), followed by the usage of 200 g/seedling (1.41%). The control (0 g/seedling) showed the lowest phosphorus content (1.26%) in (Figure 6). Significant differences in phosphorus content were shown by 200, 250 and 350 g/seedling of chicken dung fertilizer applications (Table 4).

Calcium (Ca)

Analysis of variance showed significant differences in calcium content at 0.05 significance level between treatments (Table 4).

The application of 300 g/seedling of chicken dung fertilizer gave the highest Ca content (0.40%) followed by the usage of 350 g/seedling (0.38%) (Figure 7) and Table 4.

Magnesium (Mg)

Analysis of variance showed significant differences in magnesium content at 0.05 significance level between treatments (Table 4).

The usage of 350 g/seedling of chicken dung fertilizer gave the highest Mg content (0.20%), followed by the usage of 200 g/seedling (0.19%). The usage of 300 g/seedling recorded the lowest magnesium content which was 0.17% (Figure 8).

Conclusion

From the experiment, *Gigantochloa scortechinii* seedlings responded well to the application of various rates of chicken dung fertilizer. Generally the higher the rate of application of organic fertilizer, the better was the response. This was true for the *G. scortechinii* seedlings tested at Faculty of Forestry's nursery, University Putra Malaysia. All the bamboo plant parts showed increments in their weight within the eight - month period.

The root part showed the largest increment in the root biomass compared with the other parts. Based on this, bamboo can be a good soil stabilizer because of its fast growth and advantage due to the large accumulation of root biomass for clump establishment. It is an added advantage in soil erosion control purposes and could be useful in erosion-prone areas.

For bamboo plantation establishment, application of fertilizers is needed to produce good quality bamboo shoots and culms and also in large quantity for commercial supply to the bamboo industries.

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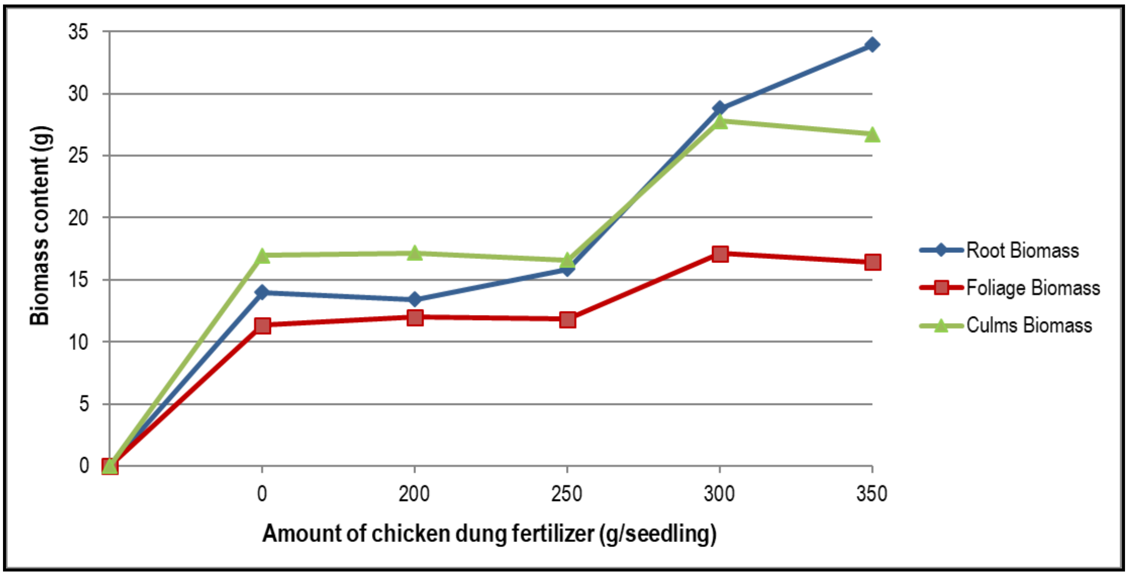

Figure 1: Foliar, culm and root biomass of *G. scortechinii* seedlings

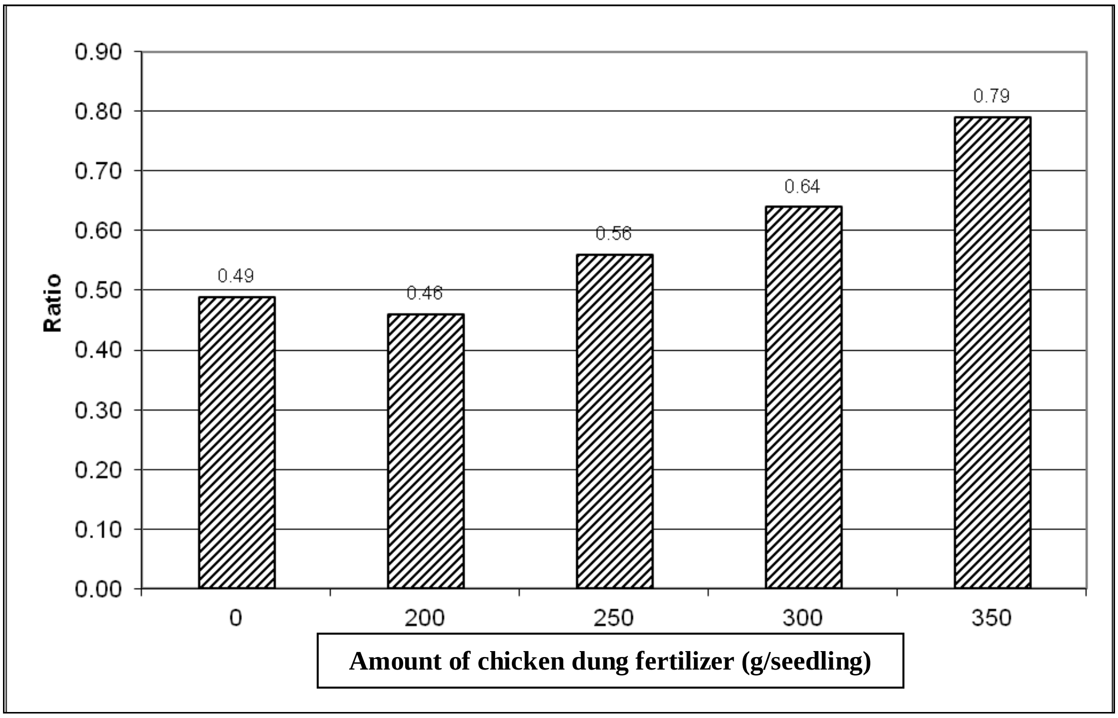

Figure 2: Root-shoot ratio biomass of *G. scortechinii* seedling

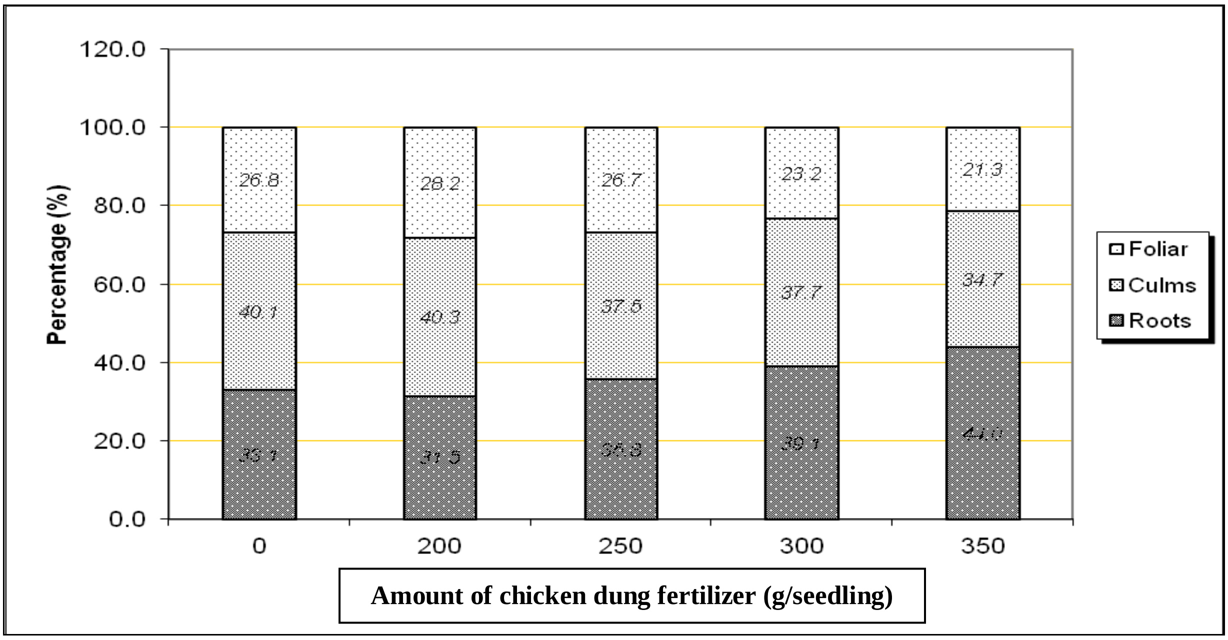

Figure 3: Biomass percentage compositions of *G. scortechinii* seedlings according to their part

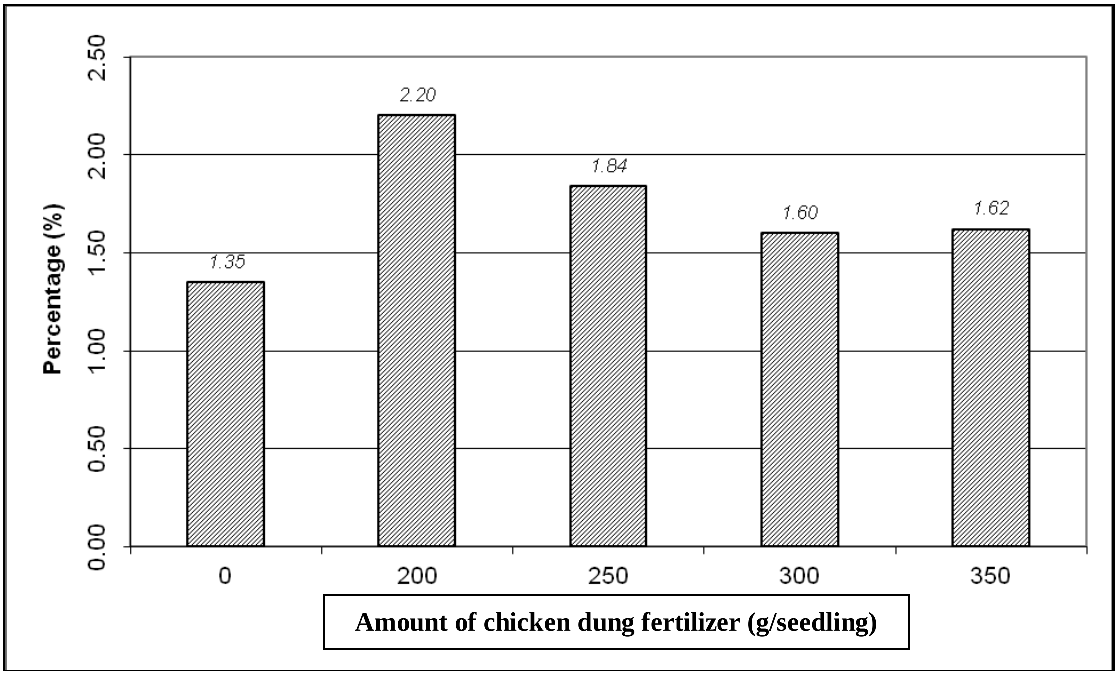

Figure 4: Nitrogen contents (%) in foliar parts of *G. scortechinii* seedlings

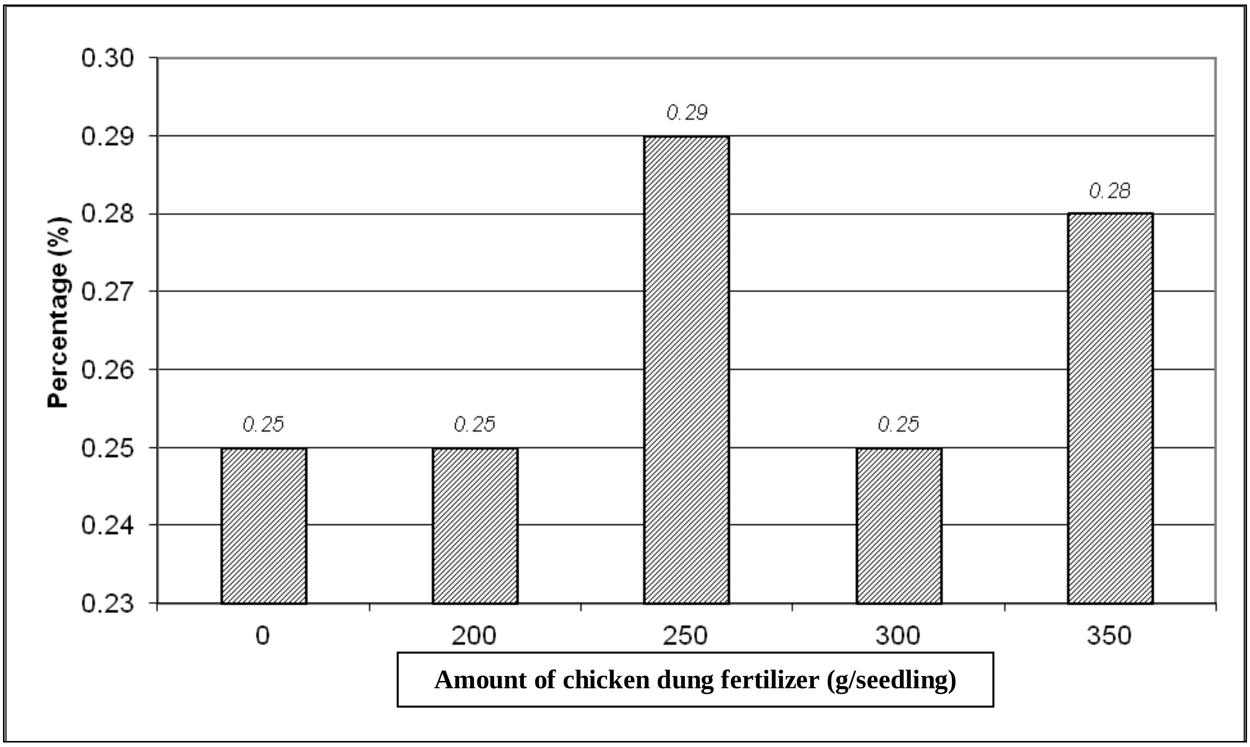

Figure 5: Phosphorus contents in foliar parts of *G. scortechinii* seedlings.

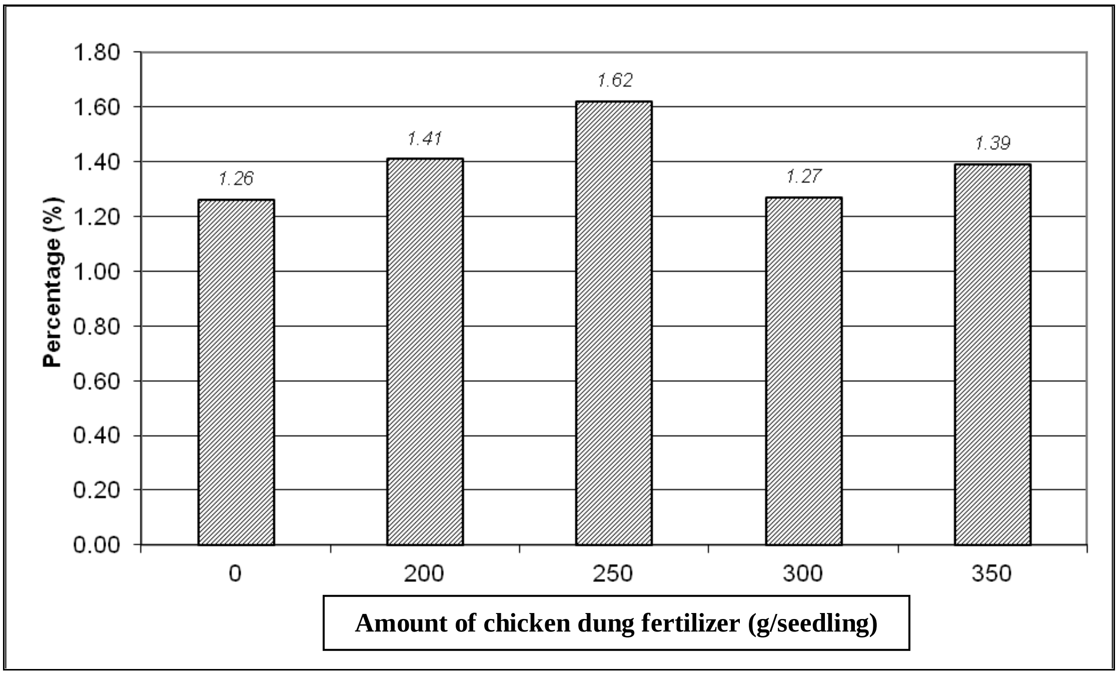

Figure 6: Potassium contents in foliar parts of *G. scortechinii* seedlings

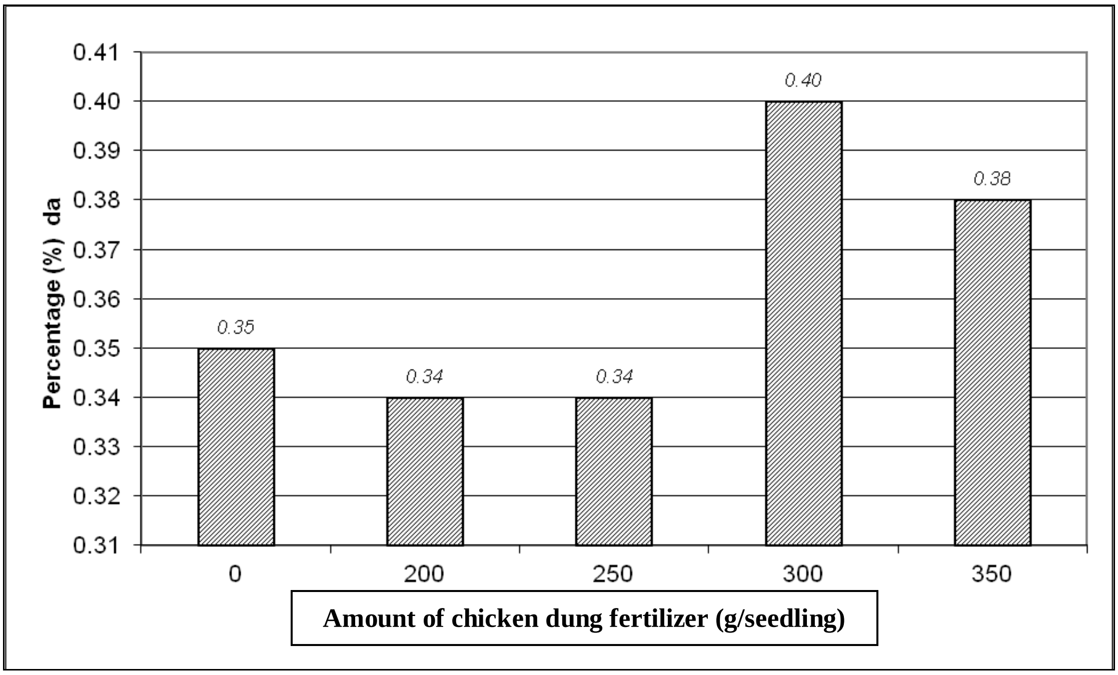

Figure 7: Calcium contents in foliar parts of *G. scortechinii* seedlings

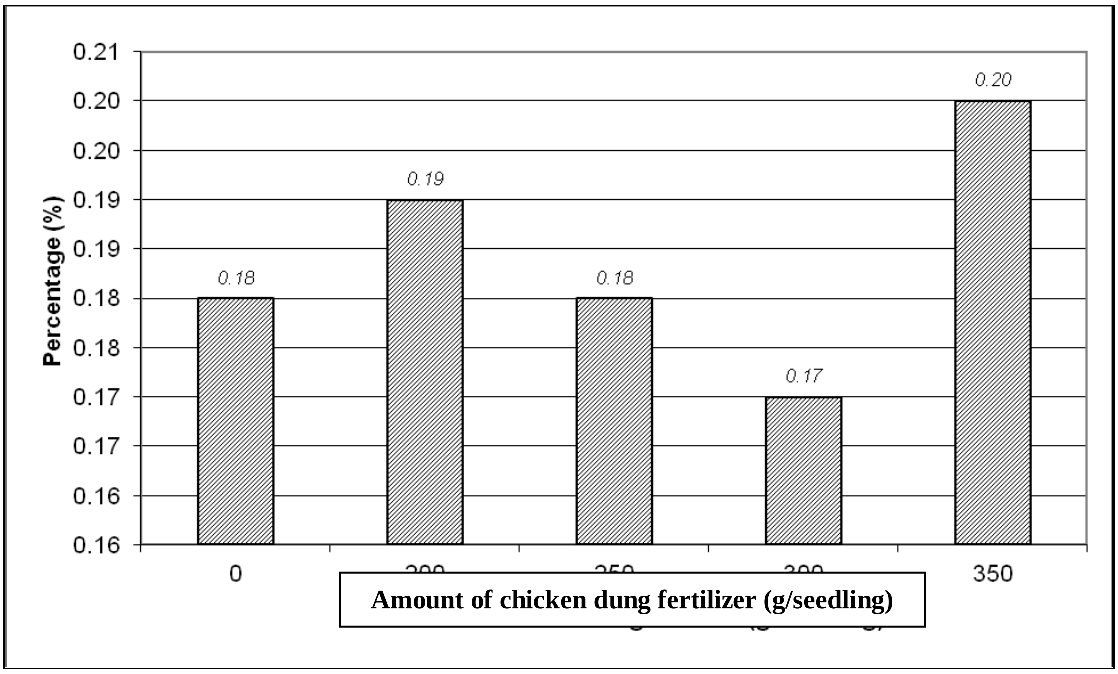

Figure 8: Magnesium contents in foliar parts of *G. scortechinii* see