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EVALUATION OF BIOMASS AND SOME CHEMICAL PROPERTIES OF *Dendrocalamus strictus* GROWN UNDER SEWAGE WATER

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ABSTRACT

Evaluation of biomass and some physical and chemical properties of *Dendrocalamus stricus* 6-year-old (Barkley *et al)* grown under sewage water in Sarabuim Ismailia Governorate were conducted during the season of 2009. It is shown from data that, plants where cut has weight of 3.622 kg then weight decreased to 1.203 kg after 100days from cutting. Also culm diameter decreased from 2.446 cm to 2.075 cm after 80 days from cutting. It is observed that NPK differed from group to other, the group C (culm diameter more than 4 cm) has the highest content of nitrogen while, P and K are less than the group which their plants culm less than 0.4 cm. Wood extracts, cellulose and lignin are increased with increasing plant culm diameter. So the group C (culm diameter more than 4 cm) has the largest amount of cellulose, lignin and fiber length (77.437%, 81.197% and 1.85 mm), respectively. Also group C (culm diameter more than 4 cm) has the largest content of heavy metal (Ni, Cd and Pb) 121.83, 8.160 and 50.773 mg/100 g., respectively. Branches number and their weight increased from group A (culm diameter less than 3 cm) to group C (culm diameter more than 4 cm) (culm diameter is above 4 cm) and group B (culm diameter 3- 4 cm) in between.

Keywords: *Dendrocalamus strictus* , lignin, cellulose, fiber length, specific gravity, culm and heavy metals.

INTRODUCTION

Dendrocalamus strictus is commonly recognized as Calcutta bamboo (Farrelly 1984), it is also known as male bamboo (Tewari 1992), and solid bamboo (Anon 1972 and Anon 1992). Calcutta bamboo is the most widely used bamboo in India (Kumar and Dobriyal 1992), especially in the paper industry. It is also used in housing construction, basket making, mats, furniture, agricultural implements, and tools handles. It is the most common species of bamboo sighted in the Indian forest and available in every state in India (Limaye 1952). Bamboo is a very promising alternative raw material for the manufacture of structural composite products. It is economical, renewable, and abundant throughout the world. There are about 60–70 genera and over 1,200–1,500 species of bamboo in the world (Wang and Shen 1987). About half of these species grow in Asia, most of them within the Indo-Burmese region (Grosser and Liese 1971). Bamboo is quite adaptable. Many bamboo species have been introduced and strive in new places. Calcutta bamboo was introduced to the United States and can be found in Southern California, Florida, and Puerto Rico (Farrelly 1984). This species also found in Malaysia, Burma, Bangladesh, and Thailand, it flourishes in places with an annual rainfall between 75 and 500 mm, in a maximum shade temperature as low as -5◦C, and up to 47◦C. It can grow in all types of soils, with good drainage characteristics, except water-logged soil such as pure clay or clay mixed with lime. Sandy soil or well-drained soil, or comparatively low rainfall, are the factors, which enable Calcutta bamboo to occupy even flat ground. It is said to be the most drought resistant species of bamboo (Tewari 1992). Bamboo (*Dendrocalamus stricuts* Roxb. is native to India. This specie is one of the two most important bamboos in India. It is found suitable for reclamation of ravine land. It is extensively used as raw material in paper mills and also for variety of purposes such as construction, agricultural implements, musical instruments, furniture etc. young shoots are commonly used as food. Decoction of leaves and nodes and siliceous matter is used in the traditional medicine.

This species occupies 53 % of total bamboo area in India. This is one of the predominant species of bamboo in Ultra Pradesh and Western Ghats. Widely distributed in India in semi dry and dry zone along plains and hilly tracts usually up to an altitude of 1000 m, also commonly cultivated throughout the plains and foot hills. *D. strictus* is widely adaptable to temperature as low as -5◦c and as high as 45◦c. this species is mainly found in drier open deciduous forests in hill slopes, ravines and alluvial plains. Yield and chemical analysis of hemicellulose and holocellulose is also reported by (Rita and Singh 1982) special absorbance of cellulose 0.354, lignin 0.296 (Sekar and Balasubramanian – personal communication).

The hemicellulose of bamboo is similar to hemicellulose of hardwoods. The sugar composition of hemicellulose consists of xylose, arabinose and glucose, glucurnic acid is also present in small amounts with xylose as the main constituent. The nodal portion has lower holocellulose content but pentosan lignin and ash are higher compared to internodal region (Maheswari and Satpathy 1988). Studies on the effect of pH on prehydrolysis of *D. stricuts* indicates that pulp yield decrease at higher pH.

It propagated by different methods like set planting rhizome planting, rooting of culm cuttings and tissue culture are used one-year-old culms which cut through with a slanting cut about 90 or 120 cm from the ground and the rihizomes which they are attached are dug up with roots intact and cut off to a length sufficient include a well developed bud.

The investigation was done to evaluate this kind of bamboo and spreading it around Nasr lake at southern valley as well as in new valley special at low altitude regions.

MATERIALS AND METHODS

Concerning Bamboo solid (*Dendrocalamus stricuts* Roxb 6-year-old with planting distance of 5x5 m was evaluated which planted in Sarabium area, Ismailia Governorate (Barkley *et al* 2005*)*. The plants irrigated by swage water. Three Gores holes were taken off to Culm determine Culm length, branches, No. leaves and diameter at the base as well as diameter in the lower third of the Culm, culms was also weighed and measured diameters day after day for 10 days and then took the weight and diameters of culms once every 10 days so get optimal drying and after the period to make sure it will be very air drying and proven weight at 100 days. Soil was analyzed as chemical and physical

Estimate the content of chemical nitrogen, phosphorus, potassium and heavy metals (lead - cadmium - Nickel). Cellulose, lignin and hemicellulose each of the culm and leaves was determined as amount of density and the fiber length in the culms. Three random holes were cut, each hole contain 31 plants divided to three groups, the first plants (10 culms) where the culm diameter is less than 3 cm, second (10 culms) is 3-4 cm for culm diameter and the last one (11 culms) more than 4 cm for
culm diameter, the following measurements were estimated:

1- Culm length (meter).
2- Culm diameter at the base (cm), 1/3 and at 2/3 of culm length, whereas the diameter also estimated at interval (each one for two days, then at 20 days till 100 days) till completely air drying .
3- Branches numbers were counted.
4- culm weight at interval time (kg) (each one for two days, then at 20 days till 100 days) was estimated till air draying, by storing bamboo vertically in the shade for fully air draying according to (Sharma, 1988) .
5- Wood extract of plant was done according to (Kouris, 1993) and then (cellulose according to the method derived by (Browning 1967) , hemicelluloses by Rozmarin and Simionescu 1973 and lignin according to Klason 1923) the content of cellulose, hemicellulose and lignin can be determined by analysis of NDF (Neutral Detergent Fiber), ADF (acid detergent fiber) used to estimate the total lignocellulosic materials

   ADL (acid detergent fiber can be determined as follows:

$$\mathbf{ADL=\frac{L x100}{S}}$$

   L= Loss upon inition after 72.5 H_2SO_4 treatment
   S= Overn dry weight of sample.
   Holocellulose= cellulose + hemicellulose.
   Wholecellulose were determined by adding both of cellulose and hemicellulose. (Philips and Hayman, 1970)

6- Specific gravity ,by American Standard Test Methods (1989) P.A. fiber length according to Franklin (1946), Nitrogen content (gm/100 gm D, wt) was determined in the digested solution by the modified microkjeldahl method as described by Plummer,(1971) . Phosphorous content (gm/100 g D, wt) was determined colorimetrically according to the method of Jackson (1958). Potassium content (gm/100 g D, wt) was determined against a standard using flame – photometer (Piper, 1950).and the heavy metal were determined by using Atomic Absorption Spectrophotometer, Pye unican SP 1900. According to Brandifeld and Spincer,(1965).
7- Soil chemical and physical was analyzed, soil extracted was used to determine the soluble cations and anions which described by (Champan and Pratt, 1961)

8- Statistical analysis of this experiment was complete randomized design and the mean values were compared by New LSD as the methods reported by Snedecor and Cochran (1982).

RESULTS AND DISCUSSION

Data in Table (2) indicated that culm diameter significantly decreased after 6 and 8 days as compared to the first day or at fresh states. While the other differences were insignificant.

On the other hand culm diameter significantly increased as an ascending order as the arranged group A (culm diameter is less than 3 cm), b and c. As for the interaction, data indicated that culm diameter of group C (culm diameter is more than 4 cm) at all days of drying significantly increased as compared to all interaction.

Table (2): Culm diameter of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3-4 cm)	Group C (culm diam. > 4 cm)	Mean
1st day	2.526	3.603	4.736	3.622
After 2 days	2.5oo	3.463	4.543	3.502
After 4 days	2.436	3.360	4.393	3.396
After 6 days	2.336	3.100	4.326	3.324
After 8 days	2.260	3.233	4.226	3.240
Mean	2.412	3.394	4.445	

L.S.D. at 5 % for Treat,= 0.143 / Sub.= 0.184 / Treat x sub= 0.319

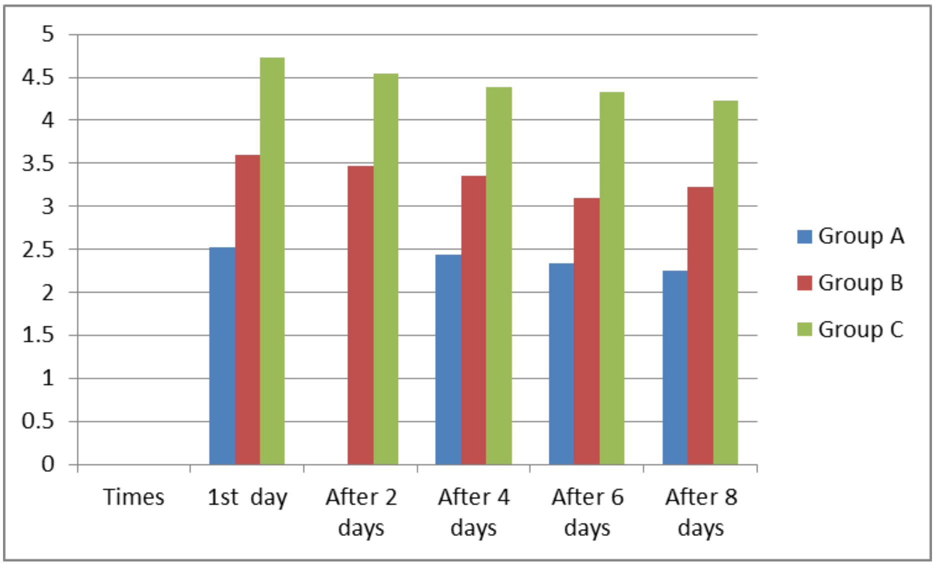

Fig. (1): Culm diameter at base of three groups of *D. strictus* at different times

Table (3) showed that culm diameter significantly decreased after 2, 4, 6 and 8 days as compared to the first day or at fresh states. Insignificant difference between plants at each whole under investigation was observed at fresh state. Group C (culm diameter more than 4 cm) and group B (culm diameter 3- 4 cm) at 1/3 of Culm length did not achieve any significant differences, while the differences in group A (culm diameter less than 3 cm) were significant.

Table (3): Culm diameter at 1/3 Culm length of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3- 4 cm)	Group C (culm diam. > 4 cm)	Mean
1st day	2.000	2.466	2.873	2.446
After 2 days	1.853	2.350	2.756	2.320
After 4 days	1.768	2.250	2.673	2.230
After 6 days	1.650	2.216	2.622	2.163
After 8 days	1.550	2.126	2.550	2.075
Mean	1.764	2.282	2.695	

L.S.D. at 5 % for Treat,= 0.547 / Sub.= 0.070 / Treat x sub= 0,122

Data in Table (4) indicated that culm diameter at 2/3 of Culm length significantly decreased after 6 and 8 days as compared to the first day or at fresh states.

On the other hand, culm diameter significantly increased as an ascending order as the arranged group A (culm diameter less than 3 cm), b and c. As for the interaction data indicated that culm diameter of group C (culm diameter is more than 4 cm) at all days of drying significantly increased as compared to all interactions.

Table (4): Culm diameter at 2/3 Culm length of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3- 4 cm)	Group C (culm diam. > 4 cm)	Mean
1st day	1.350	1.563	1.803	1.572
After 2 days	1.263	1.470	1.736	1.490
After 4 days	1.186	1.423	1.700	1.436
After 6 days	1.500	1.420	1.653	1.407
After 8 days	1.076	1.393	1.600	1.356
Mean	1.205	1.454	1.698	

L.S.D. at 5 % for Treat,= 0.031 / Sub.= 0.040 / Treat x sub= 0.070

Data in Table (5) revealed that culm diameter significantly decreased after 6 and 8 days as compared to the first day or at fresh states.

On the other hand culm diameter significantly increased as an ascending order as the arranged group A (culm diameter less than 3 cm), b and c. As for the interaction data indicated that culm diameter of group C (culm diameter more than 4 cm) at all days of drying significantly increased as compared to all interaction, differences between all studied groups are insignificant.

Table (5): Culm diameter at base of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3-4 cm)	Group C (culm diam. > 4 cm)	Mean
1 day	2.526	3.603	4.736	3.622
20 days	2.173	3.126	4.170	3.156
40 days	2.153	3.080	4.093	3.108
60 days	2.116	3.030	4.016	3.054
80 days	2.083	3.013	3.993	3.030
100 days	2.076	3006	3.973	3.018
Mean	2.188	3.143	4.163	

L.S.D. at 5 % for Treat,= 0.146 / Sub.= 0.207 / Treat x sub= 0.358

Table (6): Culm diameter at 1/3 Culm length of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3-4 cm)	Group C (culm diam. > 4 cm)	Mean
1st day	2.000	2.446	2.873	2.446
20 days	1.513	2.080	2.563	2.052
40 days	1.463	2.043	2.450	1.985
60 days	1.406	1.996	2.396	1.933
80 days	1.356	1.983	2.343	1894
100 days	1.326	1.983	2.336	1.882
Mean	1.511	2.092	2.493	

L.S.D. at 5 % for Treat,= 0.518 / Sub.= 0.073 / Treat x sub= 0.126

Table (7): Culm diameter at 2/3 Culm length of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3- 4 cm)	Group C (culm diam. > 4 cm)	Mean
1st day	1.350	1.653	1.803	1.572
20 days	1.043	1.336	1.566	1.315
40 days	1.020	1.303	1.523	1.282
60 days	0,993	1.263	1.496	1.251
80 days	0.950	1.246	1.486	1.227
100 days	0.950	1.246	1.486	1.227
Mean	1.051	1.326	1.560	

L.S.D. at 5 % for Treat,= 0.043 / Sub.= 0.061 / Treat x sub= 0.107

On the other hand, the plant weight (culm and leaves) was decreased with advanced time as shown in Table (8), where the data revealed that weight at the time of cut was the highest at all groups then decreased the weight with continuous time. Differences between groups are significant.

Table (8): Culm weight of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3- 4 cm)	Group C (culm diam. > 4 cm)	Mean
1st day	0.710	2.116	3.696	2.174
After 2 days	0.583	1.880	3.403	1.955
After 4 days	0.516	1.740	3.100	1.785
After 6 days	0.473	1.603	2.893	1.656
After 8 days	0.416	1.546	2.763	1.575
Mean	0.540	1.777	3.171	

L.S.D. at 5 % for Treat,= 0.201 / Sub.= 0.259 / Treat x sub= 0.450

Table (9) show that culm weight significantly decreased after 6 nd 8 days as compared to the first day or at fresh states. Insignificant difference between plants at each whole under investigation was observed at fresh state. Differences were significant between all groups.

Table (9): Culm weight of three groups of *D. strictus* at different times

Groups / Times	Group A (culm diam. < 3 cm)	Group B (culm diam. 3- 4 cm)	Group C (culm diam. > 4 cm)	Mean
1st day	0.710	2.176	3.756	2.214
20 days	0.420	1.423	2.523	1.455
40 days	0.406	1.360	2.353	1.373
60 days	0.390	1,236	2.113	1.246
80 days	0.390	1.216	2.016	1.205
100 days	0.390	1.210	2.010	1.203
Mean	0.451	1.437	2.462	

L.S.D. at 5 % for Treat,= 0.150 / Sub.= 0.212 / Treat x sub= 0.3

Concerning physical properties Tables (10 &11) revealed physical properties where branches number is significant differed between group A with B and C. While non significant between B and C . While culm weight and dry weight are differed significant between all groups under investigation. Same trend was observed concerning weight of fresh and dry leaves. Culm height also is significant differed between each group under study. The differences are significant.

Table (10): Physical properties of three groups of *D. strictus* at different times

Groups	No. of brunch	Culm weight kg		Brunch weight kg		Leaves weight kg	
		fresh	Dry	fresh	Dry	Fresh	dry
Group A (culm diam. < 3 cm)	11.667	0.676	0.390	0.923	0.126	0.190	0.123
Group B (culm diam. 3- 4 cm)	17.333	2.116	1.210	0.656	0.336	0.280	0.170
Group C (culm diam. > 4 cm)	17.667	3.969	2.010	0923	0.480	0.410	0.263
L.S.D at 5%	1.153	0.769	0.451	0,215	0.143	0.098	0.045

Table (11): Physical properties of three groups of *D. strictus* at different times

Groups	Culm height m.	Diameter cm.		Diameter 1/3		Diameter 2/3	
		after cutting	after dry	after cutting	after dry	after cutting	after dry
Group A (culm diam.< 3cm)	3.153	2.530	2.076	2.000	1.326	1.350	0.950
Group B (culm diam.3- 4cm)	5.380	3.603	3.006	2.466	1.983	1.563	1.246
Group C (culm diam.> 4 cm)	6.576	4.736	3.973	2.873	2.336	1.803	1.486
L.S.D at 5%	0.418	0.417	0.488	0.277	0.219	0.058	0.125

Wood extract :-

Concerning the wood extract of all groups the Table (12) revealed that the highest values was observed at group (A) (culm diameter is less than 3 cm) following by group (B) and (C) these due to the diameter of each group whereas the smallest diameter at group (A).

On the other hand, same Table showed that cellulose and lignin was the highest at group (C) followed by the other two groups B and A. these results due to the diameter of each group, whereas the largest diameter was at group C (culm diameter is more than 4 cm) while the narrowest one at group A (culm diameter is less than 3 cm).

Table (12): Extracts, cellulose, hemicellulose and lignin, percentage of *D. strictus* at culm of three groups

Groups	extract	Cel	Hemi	Leg
Group A (culm diam. < 3 cm)	18.333	72.300	5.283	75.033
Group B (culm diam. 3- 4 cm)	14.333	76.530	4.710	79.477
Group C (culm diam. > 4 cm)	12.667	77.437	4.306	81.197
L.S.D at 5%	1.631	1.594	0.505	2.210

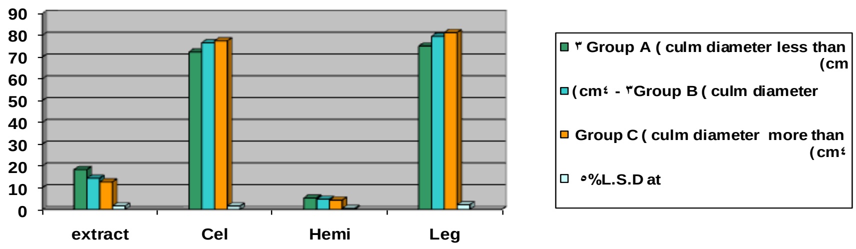

Fig. (2): Extract, cellulose, hemicellulose and lignin, percentage of *D. strictus* at culm of three groups.

This result is in accordance with the result of Jolly *et al.* (2000) who found that cellulose increased with advanced age of plants. Same trend was observed concerning hemicellulose where group A (culm diameter is less than 3 cm) achieved the highest values for hemicellulose This is naturally because the hemicellulose always higher when cellulose is little and the opposite are truly correct.

These results are in accordance with the findings of Khullarl *et al*. (2008) who found that cellulose was 90.1, hemicellulose was 8.9 and lignin was 0.4 . also in

Table (13) indicated that fiber length was significantly differed between all groups and group C has the longest fiber followed by group B and group A.

accordance with the finding of (Chu and Yao 1964) who found the species ranged from 1.7 to 3.19 mm (average 2.52 mm) .Though the average fiber length is situated between the coniferous average 3 - 4 mm) and broadleaved woods (average 1.4 mm), it appears mostly to approximate the coniferous woods.

Table (13) indicated that specific gravity, was significantly differed between all groups and group A(culm diameter is less than 3 cm) has the highest values (76.452) of specific gravity, followed by group B (culm diameter 3- 4 cm) and group C (culm diameter is more than 4 cm). Accordance with the finding of (Chu and Yao 1964) who found the determination of basic density should be considered on one way for assessing wood quality for pulping .Although the increase in yield has been associated with increase in density, however .Some species with lower basic density usually give pulp higher overall strength.

Table (13): Specific. gravity. and fiber length of *D. strictus* at culm of three Groups.

Groups	Spec. grav.	Fiber length
Group A (culm diam. < 3 cm)	76.452	1.486
Group B (culm diam. 3- 4 cm)	72.077	1.676
Group C (culm diam. > 4 cm)	68.604	1.850
L.S.D at 5%	2.940	0.028

Chemical analysis :-

Table (14) showed that nitrogen at each culm and leaves for each group is different, group A (culm diameter is less than 3 cm) had the lowest values concerning the culms (1.685 mg/100 g) while group B (culm diameter 3- 4 cm) had the largest amount of nitrogen (2.881 mg/100 g) while the amount of nitrogen in leaves increased with groups where group A (culm diameter less than 3 cm) had the lowest amount then group B (culm diameter 3- 4 cm) followed by group C (culm diameter is more than 4 cm) (2.119 mg/100 g). Concerning phosphorus data showed that the highest amount was achieved at group A (culm diameter less than 3 cm) then decreased with group B (culm diameter 3- 4 cm) then group C (culm diameter more than 4 cm). for each culm and leaf. Potassium content differed between groups for each culm and leaves, where group B (culm diameter 3- 4 cm) achieved the lowest amount of potassium (0.843 and 0.789) for culm and leaves respectively.

Table (14): N.P.K percentage of *D. strictus* at culm and leaves of three groups.

Groups	N %		P %		K %	
	Culm	**Leaves**	**Culm**	**Leaves**	**Culm**	**Leaves**
Group A (culm diam. < 3 cm)	1.685	1.518	0.466	0.459	0.950	0.910
Group B (culm diam. 3- 4 cm)	2.881	1.813	0.436	0.370	0.834	0.789
Group C (culm diam. > 4 cm)	1.799	2.119	0.407	0.301	0,939	0.935
L.S.D at 5%	0.389	0.418	0.038	0.031	0.182	0.143

Heavy metals were recorded at Table (15) revealed that all nickel, cadmium and lead were differed in groups under investigation, whereas the amount of all above heavy metals in each culm and leaves were the highest in group C (culm diameter more than 4 cm) while the lowest amount was observed at group A (culm diameter less than 3 cm). the differences are significant.

These results may due to the diameter of each group where the group A (culm diameter less than 3 cm) has the narrowest diameter while the group C (culm diameter is more than 4 cm) has the largest diameter.

Table (15): Some heavy metals mg/100g of *D. strictus* at culm and leaves of three groups.

Groups	Ne		Cd		Pb	
	Culm	**Leaves**	**Culm**	**Leaves**	**Culm**	**Leaves**
Group A (culm diam. < 3 cm)	111.09	100.97	4.893	10.420	30.368	60.787
Group B (culm diam. 3- 4 cm)	114.05	116.00	6.816	12.673	38.570	76.480
Group C (culm diam. > 4 cm)	127.83	120.00	8.160	14.753	50.773	88.427
L.S.D at 5%	2.061	4.414	0.402	1.056	2.707	2.135

Conclusion

Average yield of holocellulose at culms 80.16%, the hole gave yield of 38.11 kg of culms. Number of holes per fedan is 168 at space 5x5 m and feddan gave about 5132.65 kg of holocellulose.

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تقييم الكتلة الحيوية وبعض الصفات الكيماوية للبامبو النامي تحت ظروف الري بمياه الصرف الصحي.

منى مصطفى عباس، مها فاروق محمد إسماعيل و هاله مصطفي كمال
قسم بحوث الأشجار الخشبية- معهد بحوث البساتين- مركز البحوث الزراعية بالجيزة

تم تقييم البامبو المصمت -عمر ٦ سنوات- المزروع على ماء الصرف الصحي بغابة الصرف الصحي بمنطقة سرا بيوم بالإسماعيلية في موسم ٢٠٠٩

قسمت أعواد الجور إلى ثلاث مجموعات حسب القطر عند القاعدة من صفر لأقل من ٣ سم والمجموعة الثانية من ٣-٤ سم والمجموعة الثالثة أكبر من ٤ سم وأظهرت النتائج أن النباتات عند قطعها كانت بوزن ٣ كجم ووصل بعد ١٠٠ يوم إلى حوالي ا كجم كذلك نقص قطر العود نقصا معنويا ليصل إلى حوالي ٢ سم بعد ٨٠ يوم من القطع واختلف محتوى النبات من العناصر المعدنية فتجد أن المجموعة الثالثة كانت بها اعلي كمية من النتروجين وكميات اقل من البوتاسيوم والفسفور مقارنة بالمجموعة الثانية والأولى وارتفعت نسبة السليولوز واللحنين في المجموعة الأولى أما عن العناصر الثقيلة فوجد أن كل من النيكل والكاديوم والرصاص ارتفعت في المجموعة الثالثة عن المجموعتين الأولى والثانية ولوحظ أن غدد الأفرع ووزنها اختلف من مجموعة لأخرى وكان اعلي ما يمكن في المجموعة الثالثة

الخلاصة :متوسط نسبة الهليوسيليلوز في السيقان هي:- ٨٠,١٦ %
متوسط أنتاج الجورة من السيقان الجافة هي:- ٣٨,١١ كجم
عدد الجور للفدان ١٦٨ جوره على مسافة زراعة ٥ x ٥
متوسط أنتاج الفدان من السيقان الجافة عند عمر ٦ سنوات ٦٤٠٢,٤٨ كجم
متوسط أنتاج الفدان من الهليوسيليلوز ٥١٣٢,٦٥ كجم

قام بتحكيم البحث

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Table (1) : Soil analysis of forestry in Sarabium site where *Dendrocalamus strictus* was grown.

Soil Depth (cm)	pH	EC mmho/cm	Cat ions (meq/L)				Anions (meq/L)				Elements (mg/Kg)								
			Ca^{++}	Mg^{+}	Na^{+}	K^{+}	$Co_3^{=}$	Hco_3^{-}	$C1^{-}$	$So_4^{=}$	Fe	Mn	Zn	Cu	Co	Ni	Pb	Cr	Cd
0 - 20	7.26	3.04	9.85	4.58	16.07	0.60	—	2.20	16.04	12.86	7.20	2.19	0.18	0.17	0.18	0.12	1.71	0.20	0.26
20-40	7.40	2.51	8.70	2.75	13.45	0.55	—	2.40	12.10	10.95	6.15	2.16	0.20	0.19	0.17	0.13	1.28	0.19	0.21
40 -70	7.65	1.96	7.63	2.10	10.00	0.47	—	2.30	9.75	8.10	7.35	2.00	0.15	0.16	0.11	0.12	1.15	0.16	0.31