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POST HARVEST MANURING IN BAMBOO (BAMBUSA BAMBOS) PLANTATION

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ABSTRACT

A study was carried out in an eight year old *Bambusa bambos* plantation at Puthoor(10°29' N, 76° 17'30" E) in Peechi Range of Thrissur Forest Division during 1994-1996 to assess the growth of bamboo in response to manrinng after harvesting mature culms. Various quantities of cow dung (15, 30 and 45kg/clump), paddy husk (10, 20 and 30 kg/clump) and N:P:K mature (100:50:150. 200: 100:300 and 300: 150:450 g/clump) were applied to each clump in May 1995 in completely randomised block design after harvesting the mature culms in January 1995. The response in terms of height and girth of culms, number of new culms per clump and clump girth were assessed in January 1996.

Manuring improved the growth of *Bambusa bambos* in plantation, and application of cow dung gave excellent growth in terms of height and girth of culms as well as total culm production. It was seen that cow dung (45 kg/ clump) could bring about the greatest increase in culm height (31%)and culm girth (86%)over the control. Number of new culms produced was most influenced by application of 300 g N + 150 g P + 450 g K which could bring about an increase of 67 percent as compared with control. The above levels of cow dung and N:P:K mixture could cause 10 percent increase in circumference of clumps also when compared with the value of previous year. There was no significant difference between the highest levels of cow dung and N:P:K mixture in influencing any of the growth attribute studied.

Key words : *Bambusa bambos*. manuring. growth

1. INTRODUCTION

Bamboo, due to its peculiarities in growth, structure and properties, has diverse end uses. Bamboo culms are used for making handicrafts. blinds, chopsticks. fish traps, poultry cages. mats, baskets, farming implements, walls, fences, scaffolding, bridges and rafts while its tender shoots are relished as a delicacy (Alam, 1991: Bennet. 1988: Gupta and Gularia. 1982: Liese. 1987: Sharma. 198'7: Sharma, 1988; Thammincha. 1990).Industrial use of bamboo for producing good quality paper came later but the demand by this sector is not meagre. In Kerala. bamboo was present in most of the forest areas and in the absence of accurate data the supply from the natural forests was overestimated. This has led to an ever widening gap between demand and supply of this important natural resource. The present scenario calls for extensive planting of bamboo in all suitable lands as well as increasing the productivity of the existing plantations to meet the combined demand by the traditional and industrial sectors. Bamboo *(Bambusa bambos)* has thus been under-planted in teak *(Tectona grandis)* plantations in several parts of the State by the Kerala Forest Department. The Kerala Forest Research Institute too has spared no efforts in popularising bamboo cultivation among the farmers (Chandrashekara *et. al.*. 199'7)and also in conducting fertilizer trials to enhance productivity (Thomas, 1990). Fertilizer trials in *Bambusa bambos* were started in 1987 as part of a multidisciplinary project, 'Silviculture, management and utilization of bamboo resources of Kerala'. In this espcriment, one year old bamboo seedlings were planted at Nilambur and trials with different levels of nitrogen, phosphorus and potassium carried out in the conventional factorial randomised block design. The plants were destructively sampled at the end of 30 months and biomass of culm. branch, rhizome and root determined separately. It was found that appreciable increase in growth and dry matter yield could be obtained with fertilizer application. The present project, 'Postharvest manuring in *Bambusa bambos* plantation', was taken up in 1994 as a follow up of the previous work to see whether similar response could be obtained in older bamboo. It was also intended to compare the effect of a fertilizer mixture containing nitrogen, phosphorus and potassium with that of cow- dung and paddy husk that are locally available and environmentally friendly materials.

2. MATERIALS AND METHODS

The study was conducted in a bamboo *(Bambusa bambos)* plantation raised as under plants in a teak plantation at Puthoor in Peechi Range, Thrissur Forest Division. The plantation was raised over an area of 70 hectare in 1986 with a spacing of 10 m x 10 m. Teak was final-felled in 1991 while bamboo was retained. The present investigation started in 1994 when the bamboo was 8 years old. The land is sloping with stones and pebbles on the surface: rock exposures are common. The soil, derived mostly from gneissic/charnockitic parent material, is a shallow to moderately deep and reddish brown to reddish yellow coloured lateritic soil poor in organic matter and nutrients. Growth of bamboo was not uniform because of heterogeneity of the experimental area. Considering this variation in growth of bamboo, the clumps were measured and grouped into small, medium and large categories and the treatments replicated accordingly. Characteristics of each clump were measured before applying the treatments. Harvesting of mature culms was carried out during January-February and manuring in May 1995. Each treatment was replicated thrice in all the three groups. The treatments included three levels each of cow-dung, paddy husk and fertilizer mixture. Urea was used as the source of nitrogen, single super phosphate as that of phosphorus and muriate of potash as the source of potassium. The manures were mixed well with the soil around the clumps during the premonsoon showers of May 1995.

Table 1. Details of manurial treatments

Treatments	Quantity of manure applied per clump				
	Cow dung	Paddy husk	N	P	K
	(kg)	(kg)	(<---g--->)		
T 1	15	-	-	-	-
T 2	30	-	-	-	-
T 3	45	-	-	-	-
T 4	-	10	-	-	-
T 5	-	20	-	-	-
T 6	-	30	-	-	-
T 7	-	-	100	50	150
T 8	-	-	200	100	300
T 9	-	-	300	150	450
T 0	0	0	0	0	0

Number- of new shoots produced in 1996 was noted and those survived taken into account as culm production. Height and girth of these culms as well as the girth of clumps were measured and increase in clump girth over the previous year calculated The data were summarised and analysed using Analysis of Variance and the comparative influence of treatments found out by ranking of treatments.

3. RESULTS

The influence of manuring on culm height. culm girth. culm production and increase in clump girth over the initial level are presented below in Tables 2 to 5 and is followed by a discussion on the subject.

CULM HEIGHT (m)

The effect of different manuring treatments on height of culms is prescnted in Table 2 below. All the treatments were distinctly different from the control in their effect on height growth of culms. The three groups of clumps were also significantly different from one another. Greatest influence in culm height was brought about by the third level of cow-dung which was closely followed by the third level of fertilizer mixture (NPK) and the second level of cow-dung. The third level of cow-dung which produced the tallest culms recorded an average height of 17. 11 m and the third level of NPK could produce an average height of 17. 05 m while the mean height obtained with the second level of cow- dung was 16. 39 m. These three treatments were significantly different from all the others. Treatments in the descending order of influence were T3, T9, T2. T6, T8. T5, T1. T7 and T4. The second level of cow dung, the third level of paddy husk and the second level of NPK were similar in their influence. Likewise, the treatments T6, T8 and T5 were not different. T5. T1 and T7 were similar and T1. T7 and T4 were also similar in their impact on height of bamboo culms.

Table 2. Culm height (m) obtained with different treatments

T2 = 16.39ab	T7 = 14.97de
Ts = 16.08bc	T4= 14.22e
T8 = 16.06bc	To = 13.03f

The treatment T3 which exerted the greatest influencc was found to incrcasc the mean height by 31. 31 percent over the control. The treatment T9 was almost similar to T3: it could increase the height of cuims by 30. 85 percent. The third treatment in the order of influence. T2. which mas slightly lesser than T3 and T9, could bnng about an increase of 25.78 percent in height of culms as compared with control. The second and third levels of cow-dung and paddy, husk were significantly different from their first levels. In the case of NPK mixture. all the three levels were significantly. different from one another.

CULM GIRTH

The effect of manuring on girth of culrns was similar to that of height of culms. The results are given in Table 3 below. The treatments were significantly different from the control in their effect on girth of culms. The groups were also found to differ significantly from one another. The highest mean girth of culms was 32. 37 cm obtained with the third level of cow-dung which was followed by 31. 68 cm obtained with the third level of fertilizer mixture. The third prominent treatment was the second level of cow-dung which produced a mean girth of 27. 68 cm. The highest doses of cow-dung and NPK mixture did not differ significantly, but the second level of cow-dung was different from the third levels of both cow-dung and NPK mixture. The treatments in the decreasing order of influence on culm girth were T3, T9, T2, T6, T8. T5, T4, T7 and T1. The treatments T6. T8. T5, T4 and T7 were similar and T4, T7 and Ti were also similar in their influence on girth of culms.

Table 3. Culm girth (cm) in different treatments

T3 = 32.37a	T5 = 25.99c
T9 = 31.68a	T4 = 25.39^{cd}
T2 = 27.68b	T7 = 25.36cd
T6 = 26.37c	T1 = 24.35d
T8 = 26.35c	To = 17.39e

Figures superscribed by the same letter do not differ significantly.

There was no significant difference between the three levels of paddy husk. The first and second levels of NPK mixture did not differ but all the levels of cow-dung were significantly different from one other. The biggest mean culm girth. 32. 37 cm, brought about by the third level of cow-dung was 86. 14 percent greater than the control (17. 39 cm) while mean culm girth obtained with the third level of NPK. mix-ure was 82. 17 percent more than the control.

NUMBER OF NEW CULMS

The influence of manuring on production of new culms is depicted in Table 4 below. The treatments as well as groups of clumps were found to differ significantly in the production of new culms. The second and third levels of NPK mixture as well as the third level of cow-dung produced maximum number of new culms (20) on an average. There was no significant difference between these treatments. All the three levels of cow-dung were significantly different from one another in their effect on production of new culms. In the case of paddy husk and fertilizer mixture treatments. the second and third levels were significantly different from the first level. All the treatments produced significant effect in culm production when compared with control. The increase in culm production by the treatments T9, T8 and T3 was found to be 67 percent when compared with control. The treatments in the decreasing order of influence were T9, T8. T3, T6. T5. T2. T7, T4 and T1. There was no significant difference between the treatments T9, T8 and T3; T8, T3 and T6: T6 and T5; T5, T2 and T7 as also T4 and T1.

Table 4. Number of new culms in different treatments

T9 = 20.11a	T2 = 17.67d
T8 = 19.78ab	T7= 17.56d
T3 = 19.67ab	T4= 16.00e
T6 = 18.78 bc	T1 = 15.56e
T5 = 18.11cd	To= 12.00f

Figures superscribed by the same letter do not differ significantly

CLUMP GIRTH INCREASE

Table 5 presents the effect of manuring on percentage increase of clump girth over the initial level. All the treatments were found to exert significant effect

in increasing the girth of clump. The groups of clumps also differed significantly in the matter of clump girth increase. Ranking of treatments in the order of decreasing influence followed the pattern T3, T9. T8, T7, T6,T4, T5. T2, T1 and it was also found that the first five. namely T3, T9, T8, T7 and T6 did not differ significantly. Similarly T9. T8, T7, T6 and T4 were similar. T8. T7, T6. T4. T5 and T2 were similar and T5, T2 and T1 were also similar in their effect on clump girth.

Table 5. Percentage increase in clump girth with manuring

T3 = 9.84 a	T4 = 9.02 bc
T9 = 9.80 ab	T5 = 6.77cd
T8 = 9.45 abc	T2 = 8.68cd
T7 = 9.17	T_1 = 8.16^{d}
T6 = 9.15 abc	To = 6.58e

Figures superscribed by the same letter do not differ significantly

Among the levels of cow-dung, the first and second levels showed minimum influence while the third was found to impart the greatest influence. Similarly the highest dosage of paddy husk was much different from the first two levels. All the levels of NPK mixture were found to exert very significant influence in increasing the clump girth. The increase in clump girth by the highest ranking treatment. T3. was 9. 84 percent while that of the control was 6. 58 percent when compared with the previous year measurement.

4. DISCUSSION

It can be observed from the results that all the treatments produced positive effect in the growth of bamboo. The highest dosages of cow-dung and NPK were able to make greatest influence in the number of new culms produced, their height and girth as well as increase in circumference of the clumps. The largest dosage of paddy husk also showed appreciable effect in culm emergence and clump girth increase.

The ranking of treatments according to effect showed that an almost similar pattern was followed in the case of height and girth of culms. It was not so in the case of culm production and clump girth. but the highest levels of cow-dung and NPK mixture were always the first two treatments registering greatest influence irrespective of the growth attribute studied. Cow-dung, though considered mainly to be a source of organic matter, was able to improve the growth of bamboo as effectively as or perhaps better than fertilizer mixture containing nitrogen, phosphorus and potassium.

Cow-dung is always considered to be a good manure though it contains very little of available nutrients. The indirect influence of cow-dung on soil properties and soil fauna as well as its growth promoting influence were studied by many workers. Cow-dung was found to increase growth and dry matter yield of pine (Gharib. 1971). maize (Olayinka and Adebayo, 1989). coconut (Liyanage *et al,* 1993) and trema (Faria and Davide, 1996). Reasons for such response can be direct as well as indirect. Cow- dung being hygroscopic, retains moisture and thus prevents pronounced fluctuations in moisture (Kadambi, 1951: Dunn *et al.* 1952). This helps in improving the availability of soil moisture for a longer period to the plant. It has been found to be hyper saline (Sushil Kumar *et al.* 1995) and on incubation increases soil pH (Olayinka and Adebayo, 1989). An increase in soil pH of the acidic soil under consideration increases the availability of nutrients. Cow-dung attracts various insects, micro arthropods and microbes. Fimicolous insects were reported to be associated with cow-dung by Flechtmann and Rodrigues (1995) while Nakamura (1976) reported the presence of acari, meso-stigmata, cryptostigmata. araneae, chilopoda, diplopoda. thripidae, pselaphidae. diptera, hemiptera, coleoptera and formicidae in pasture and forest plots supplied with cow-dung. Sushil Kumar *et al* [1995) also found that microbial load was high in fresh cow- dung undergoing decomposition. Fujita (1987) had even observed that manures made of livestock excreta was better than artificial fertilizer.

An increase in the number of soil fauna and its diversity improves the soil physical and chemical properties. Activity of organisms, small and big. aids in the creation of stable soil structure which in turn helps in improving both aeration and water holding capacity of the soil. Proper aeration and moisture will maintain the soil temperature also at optimum levels. The organisms also help in the breakdown of complex organic materials into simpler ones thus speeding up mineralisation and release of nutrients. On death and decay these organisms themselves enrich the soil by adding to the organic matter pool. It can thus be seen that addition of cow-dung not only improves the organic matter status of soil but helps indirectly in enhancing the soil health which is reflected in the growth of bamboo.

Fertilizer mixture containing N. P and K, the primary nutrients necessary for plant growth, has shown its significant effect in the growth of bamboo. Nitrogen is essential for the synthesis of amino acids, the building units of 'plant proteins. Proteins are the main constituent of protoplasm as well as nucleoproteins present in chromosomes. Nitrogen is a component of the chlorophyll pigments necessary for photosynthesis. It is also found in hormones and the respiration energy carrier, adenosine triphosphate. Phosphorus is an essential costituent of phytin, phospholipids and nucleic acids. It is stored as phytin in seeds. Phospholipids are involved in metabolism as well as selective permeability and ion transport. Nucleic acids form the genes of plants which determine hereditary characters. Phosphorus occurs in some of the enzymes and is the main constituent of adenosine triphosphate, the energy carrier essential for oxidising glucose to carbon dioxide and water. Potassium also plays an important part in metabolic processes. It is essential in certain enzymatically catalysed reactions involving adenosine phosphates, the energy carriers. Potassium is required in the coupling of certain amino acids to form peptides, thus suggesting that it is essential in protein synthesis also. Supply of these three most important nutrients in readily available forms has thus definitely helped in better growth and development of bamboo.

Bamboo contains higher amounts of silica as compared to most other plants both in its aerial and underground parts. The requirement of this element by the plant is thus high. Paddy husk was expected to improve the silica status of soil on decomposition and consequently help in easy availability of this element to bamboo. But such an effect could not be seen in the present experiment. The contribution of silica from the added paddy husk compared to the cumulative contribution from bamboo through litterfall and decomposition during the past years might have been negligible. Probably it will require more time for the breakdown and release of silica from the paddy husk. The positive effect that paddy husk has shown in the present study,

therefore. is thought to be due to the loosening of the soil around the clump by the presence of paddy husk coupled with the activity of ants which were attracted by the paddy husk because it contained small fragments of rice along with it. Loosening of soil encourages sprouting of culms and such was the result of the present study. Impact of paddy husk was seen mainly in production of new culms and consequent increase in clump girth.

Thus it was seen that manuring in 8 year old bamboo *(Bambusa bambos)* plantation could improve its growth to a great esrent. Height of culms registered an increase of 31 percent by the best treatment T3 (45kg cow-dung per clump) as compared with control. Similarly, girth of culms also was found to be significantly improved by the treatment: the biggest increase was brought about again by T3 to the tune of 86 percent over control. Number of' new culms produced also increased by the treatments: the biggest increase of 67 percent was caused by the treatment T9 (300g N + 150g P + 450g K). Increase in clump girth was also noticed with manuring. There was 9.84 percent increase in circumference of clumps by the top ranking treatments, T3 and T9 both while the control plots showed an increase of 6.58 percent over the previous year.

Manuring has shown its positive influence in bamboo growth, but the effect was not as pronounced as was the case with younger plantations. In younger plantations, manifold increase in growth was reported by many workers (Adamson *et al,* 1978: Kinhal, 1985; Lakshmana. 1990: Maoyi *et al,* 1990: Patil *et al,* 1980: Patil and Patil, 1990: Qiu and Maoyi, 1987; Suwannapinunt and Thaintsa. 1990: Thomas, 1991; Uchimura. 1980). This shows that *Bambusa bambos* responds well to manuring in young stage. but as the plant matures, the response to manuring is less. This can be because the bamboo plant through its extensive root system is capable of absorbing its requirement from the surrounding soil. Litterfall and decomposition and consequent cycling of nutrients also increases as the plant matures reaching an equilibrium state in course of time. Still, the results of the study shows that manuring is good even in older plantations after harvesting and cow-dung is as good as fertilizer mixture containing nitrogen, phosphorus and potassium. Cow-dung has to be added in greater quantity compared to the fertilizer mixture but the contribution it makes towards improving the soil health definitely outweighs the inconvenience in handling and economy.

5. CONCLUSIONS

It could be concluded from the present study that manuring 8 year old *Bambusa bambos* plantation after harvesting mature culms was effective in improving its growth. Among the manures applied, the third level of cow-dung (45 kg per clump) was found to influence the height and girth of culms most while greater number of new culms was produced by the third level of N:P:K (150 g : 300 g : 450 g) mixture. These two treatments were similar in their effect on improving the girth of clumps.

Cow-dung at the rate of 45 kg per clump could bring about 31 percent increase in height of culms and 86 percent increase in girth of culms. Fertilizer mixture containing 150 g N, 300 g P and 450 g K registered an increase of 67 percent in the number of new culms produced. The above mentioned levels of cow-dung and N:P:K mixture separately could cause an appreciable increase of 9. 8 percent in the circumference of clumps also over the initial level.

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APPENDICES

Appendix 1. Analysis of Variance-Culm Height

Sources	SS	DF	MSS	F
Treatment	131.751	9	14.639	18.16**
Group	55.303	2	27.651	34.297**
Kesidu al	62.886	78	0.806	
Total	249.940	89	2.808	

** *Significant* at *P* =.01

Appendix 2. Analysis of Variance- Culm Girth

Sources	SS	DF	MSS	F
Treatment	1374.572	9	152.730	93.905**
Group	272.400	2	136.200	83.742**
Residual	126.862	78	1.626	
Total	1773.834	89		

** *Significant at P=.01*

Appendix 3. Analysis of Variance - Number of New Culms

Sorces	SS	DF	MSS	F
Treatment	495.122	9	55.014	46.318**
Group	230.689	2	115.344	97.112”
Residual	92.644	78	1.188	
Total	818.456	89		

** *Significant at P= .01*

Appendix 4. Analysis of Variance - Clump Girth Increase

Sources	SS	DF	MSS	F
Treatment	72.976	9	8.108	14.039**
Group	14.653	2	7.326	12.685**
Residual	45.051	78	0.578	
Total	132.680	89		

** *Significant at P =*