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Effect of Planting Alignment and Cutting Size on Propagation of *Bambusa vulgaris*

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ABSTRACT

Bambusa vulgaris is an important cultivated bamboo species of the world. It is propagated by vegetative methods because it does not produce viable seeds. Among various vegetative methods of propagation, propagation by culm cutting is a suitable method. To find out the effect of planting alignment and cutting size on propagation of this species, an experiment was carried out at Orissa University of Agriculture and Technology, Bhubaneswar, India. It included three planting alignments (horizontal, slanting and vertical) in combination with three sizes (1, 2 and 3 noded) of culm cuttings planted in nursery in April. The treatments were evaluated 3 months after planting. It was observed that horizontal planting of culm cuttings was significantly better over planting in slanting as well as vertical irrespective of size. Similarly planting of 1 or 2 noded cuttings horizontally was the best method over others. More than 1-noded culm cuttings should be planted horizontally, not slantingly or vertically because the later methods not only reduce quality of plant but also number of rooted plants

Keywords:

Bamboo, alignment, biomass, internodes

INTRODUCTION

Bambusa vulgaris Schrader ex Wendland is one of the most commonly cultivated bamboos of the world. It is the only one bamboo found in whole tropical and south subtropical areas of the world, so is called the Pan tropical bamboo. Because of its wide presence its English name is “Common Bamboo”. This is an important bamoo species in coastal regions used for various purposes. This is one of the five quick growing bamboo species preferred for raising plantations in India (Kulkarni and Seth 1968). It establishes quickly and assumes luxuriant growth (Waheed Khan 1972). It is a cultivated bamboo species in India and free from transit permit. It is used for multifarious purposes. This species does not produce viable seeds, hence is propagated by vegetative means (John and Nadgauda 1997; Koshy and Jee 2001 and Bhol 2006; Kaushal et al. 2011; Gulabrao et al. 2012). It is propagated by culm cuttings, offsets, branch cuttings, rhizomes and tissue cultured plants. Among these, propagation by culm cutting is a suitable method. To know the suitable planting alignment as well as cutting size and to produce maximum number of plant propagules through culm cutting of *B. vulgaris*, the present investigation was carried out.

MATERIALS AND METHODS

The experiment was carried out at Orissa University of Agriculture and Technology, Bhubaneswar, India involving 9 treatment combinations (3 planting alignments × 3 cutting sizes) in Factorial RBD with 3 replications. The planting alignments were horizontal planting (P_1), planting in slanting i.e. 45^0 (P_2), vertical planting (P_3). However, the cutting sizes were 1 noded cutting (S_1), 2 noded cutting (S_2) and 3 noded cutting (S_3) (Photo 1-5). The cuttings were collected from about 1½ year old culms of *B. vulgaris* in the first week of April and planted in nursery. The cuttings, excepting 1 noded, planted horizontally were filled with water in culm cavity making hole of 2 cm × 1 cm size in internodal position and then covered with 2-3 cm soil layer. In the cuttings planted slantingly and vertically the lower most node was one inch below the ground level. Further, while watering, always the upper most internodal cavity was filled with water from the top. Regular watering was done in the nursery beds. Partial shade, allowing about 60% light, was provided over the nursery beds. The treatments were evaluated 3 months after planting. The observations were recorded on sprouting period, survival per cent, number of shoots per node, height of dominating shoot, collar diameter of dominating shoot, shoot biomass per node, number of roots per node, length of dominating root, root biomass per node, total biomass per node of cutting and quality index of plant. The quality index of plant was calculated by the formula derived by Ritchi (1984).

RESULTS AND DISCUSSION

The effect of three types of planting alignments and three sizes of culm cuttings on different growth and quality parameters of *B. vulgaris* are presented in Table 1 – 4. The data regarding sprouting period of culm cuttings reveal no significant variation among the planting alignments, sizes of culm cuttings as well as interactions of P x S (Table 1). The range of sprouting period was 11 – 13 days.

The various treatments have exerted differential effects with respect to survival percent of culm cuttings (Table 1). The horizontal planting (P_1) achieved significantly higher survival percent (98.89%) over others and the vertical planting (P_3) achieved the lowest survival of 81.11 percent irrespective of cutting sizes. The different cutting sizes also reflected variation irrespective of planting alignment. The 1-noded cuttings (S_1) and 2-noded cuttings (S_2) recorded significantly more survival percent (93.33% and 90.00%, respectively) over 3-noded cuttings (S_3). The S_1 and S_2 cuttings performed at par. With regard to interaction of P x S, the survival percent was considerably different. The P_1S_1, P_1S_2 and P_1S_3 which were statistically alike performed remarkably better over other combinations. The P_3S_3 survived least (73.33%) among the combinations.

The number of shoots produced per node of culm cutting under various treatments exhibited differential results. The mean number of shoots under P_1 (2.83) was significantly higher over P_2 (2.53) and P_3 (2.43). It decreased from P_1 to P_3 and remained at par under P_2 and P_3. With regard to size of cuttings, the mean number of shoots per node was prominently higher under S_1 (2.87) over S_2 and S_3. It decreased with increase of cutting size and showed parity under S_2 and S_3. The interaction of planting alignment and size of cutting also exhibited significant variation in number of shoot production. P_1S_1 and P_1S_2 produced maximum number of shoots (2.90) which were at par with P_1S_3, P_2S_1 and P_3S_1 (2.80 each), whereas P_3S_3 produced minimum number of shoots (2.20).

The height of dominating shoot differed significantly under various planting alignments, cutting sizes and their interactions (Table 1). Comparison of mean values shows that cuttings under horizontal planting (P_1) revealed significantly maximum height (129.53 cm) over other two methods while cuttings under other two methods remained statistically at par. In respect of 1-noded cuttings (S_1) recorded significantly maximum height (127.40 cm) where as the 3-noded cuttings recorded minimum height of 117.50cm. Among interactions, P_1S_1 resulted maximum height (134.2 cm) which was statistically at par with P_1S_2 (130.0 cm). However, P_3S_3 registered the minimum height (111.3 cm).

The collar diameter of dominating shoot was significantly influenced by different planting alignments as well as cutting sizes (Table 2). P_1 plants attained maximum diameter (0.693 cm) and parity was observed between P_2 and P_3. Among cuttings S_1 put maximum diameter growth (0.68 cm) which was prominently higher over S_2 (0.66

Photo 1. Plants of 1-noded culm cuttings planted slantingly

Plate 2. Plants of 1-noded culm cuttings planted vertically

Photo 3. Plants of 2-noded culm cuttings planted horizontally

Photo 4. Plants of 2-noded culm cuttings planted slantingly

Photo 5. Plants of 3-noded culm cuttings planted vertically

Table 1: Effect of different planting alignments and size of culm cuttings on sprouting period, survival per cent, number shoots and height growth of *B. vulgaris*

	Sprouting period of culm cuttings (days)				Survival (%)				No. of shoots / node				Height of dominating shoot (cm)			
Planting alignment/ Size of cutting	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	11.00	12.00	13.00	12.00	96.67	93.33	90.00	93.30	2.90	2.80	2.80	2.87	134.20	125.60	122.40	127.40
S_2	11.00	12.00	13.00	12.00	100.00	90.00	80.00	90.00	2.90	2.40	2.30	2.50	130.00	120.40	117.10	122.50
S_3	11.00	12.00	13.00	12.00	100.00	83.33	73.33	85.53	2.80	2.30	2.20	2.43	124.40	115.70	111.30	117.13
Mean	11.00	12.00	13.00		98.89	88.88	81.11		2.83	2.53	2.43		129.53	120.56	116.93	
For P		$CD_{(0.05)}$ = NS			For P		$CD_{(0.05)}$ = 3.74		For P,		$CD_{(0.05)}$ = 0.14		For P		$CD_{(0.05)}$ = 2.88	
For S		$CD_{(0.05)}$ = NS			For S		$CD_{(0.05)}$ =3.74		For S		$CD_{(0.05)}$ = 0.14		For S		$CD_{(0.05)}$ = 2.88	
For P'S		$CD_{(0.05)}$ = NS			For P'S		$CD_{(0.05)}$ = 6.47		For P'S		$CD_{(0.05)}$ = 0.24		For P'S		$CD_{(0.05)}$ = 5.10	

Table 2: Effect of different planting alignments and size of culm cuttings on collar diameter, shoot biomass, number of roots and root length of *B. vulgaris.*

	Collar diameter of dominating shoot (cm)				Shoot biomass/ node (g)				No. of roots/node				Length of dominating root (cm)			
Planting alignment/ Size of cutting	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	0.71	0.68	0.66	0.68	30.92	29.00	28.24	29.88	15.70	14.90	14.40	15.17	36.10	33.80	33.00	34.30
S_2	0.70	0.65	0.63	0.66	30.00	26.84	26.02	27.20	15.30	13.10	12.80	12.87	35.00	32.40	31.50	32.97
S_3	0.67	0.62	0.60	0.63	28.72	25.76	24.72	26.33	14.50	10.60	10.50	12.57	33.50	31.20	30.00	31.57
Mean	0.69	0.65	0.63		29.39	27.62	26.40		15.00	13.73	11.87		34.87	32.47	31.50	
For P		$CD_{(0.05)}$ = 0.02			For P		$CD_{(0.05)}$ =1.54		For P		$CD_{(0.05)}$ = 0.86		For P		$CD_{(0.05)}$ =1.48	
For S		$CD_{(0.05)}$ = 0.02			For S		$CD_{(0.05)}$ =1.54		For S		$CD_{(0.05)}$ = 0.86		For S		$CD_{(0.05)}$ =1.48	
For P'S		$CD_{(0.05)}$ =0.03			ForP´S		$CD_{(0.05)}$ =2.677		For P'S		$CD_{(0.05)}$ = 1.48		For P'S		$CD_{(0.05)}$ =2.56	

Table 3: Effect of different planting alignments and size of culm cuttings on root biomass and total biomass of *B. vulgaris.*

Planting alignment/ Size of cutting	Root biomass/ node (gm)				Total biomass/ node (gm)			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
S_1	5.22	4.82	4.70	5.00	36.14	33.82	32.94	34.88
S_2	5.00	4.02	3.92	5.19	35.00	30.86	29.94	31.39
S_3	4.78	3.72	3.54	4.05	33.50	29.48	28.26	30.38
Mean	4.91	4.31	4.01		34.30	31.93	30.41	
	For P		CD (0.05)= 0.30		For P		CD (0.05)= 1.38	
	For S		CD (0.05)= 0.30		For S		CD (0.05)= 1.38	
	For P´S		CD (0.05)= 0.51		For P´S		CD (0.05)= 2.40	

Table 4: Effect of different planting alignments and size of culm cuttings on Quality index of *B. vulgaris.*

Planting alignment/ Size of cutting	Quality Index of plant			
	P_1	P_2	P_3	Mean
S_1	0.185	0.177	0.172	0.181
S_2	0.183	0.161	0.156	0.163
S_3	0.175	0.152	0.147	0.158
Mean	0.178	0.167	0.158	
For P, SE(m) ± = 0.003			CD (0.05)= 0.009	
For S, SE(m) ± = 0.003			CD (0.05)= 0.009	
ForP ´ S,SE(m) ± = 0.005			CD (0.05)= 0.015	

cm) and S_3 (0.63 cm). The diameter growth of shoots ranged 0.60 – 0.71 cm in the P x S combinations. P_1S_1 and P_1S_2 registered significantly higher diameter over other combinations while P_3S_3 produced minimum diameter (0.60cm).

The shoot biomass per node varied considerably under different planting alignments and cutting sizes (Table 2). P_1 produced highest shoot biomass of 29.39 gm per node irrespective of cutting size which was significantly higher over P_2 and P_3. Similar trend was observed in case of cutting sizes where S_1 put the maximum shoot biomass of (29.88 gm) per node. The shoot biomass also varied significantly among treatment combinations. P_1S_1, P_1S_2 and P_2S_1 produced considerably higher biomass. P_3S_3, P_2S_3, P_3S_3 and

P_2S_2 generated comparatively lower biomass.

The number of roots produced per node differed significantly under various planting alignments, cutting sizes as well as under interactions of P x S. The number of roots per node was significantly highest (15.00) under P_1 followed by P_2 and P_3 irrespective of size. Irrespective of planting alignment S_1 recorded maximum number of roots (15.17) which was significantly higher over S_2 and S_3. The values of S_2 and S_3 remained statistically at par. In respect of interactions, P_1S_1 produced maximum number of roots (15.7) which was found to be at par with P_1S_2, P_2S_1, P_1S_3 and P_3S_1. However, minimum numbers of roots were produced under P_3S_3, P_2S_3 and P_3S_2.

The length of dominating root was significantly influenced by the planting alignment as well as cutting sizes (Table 2). P_1 reflected significantly higher length of roots (34.87 cm) over P_2 (32.47 cm) and P_3 (31.50 cm). With regard to cutting size S_1 (34.30 cm) produced larger roots over S_3, however, S_1 – S_2 and S_2 – S_3 showed parity. The P x S combinations also had influential effect on root length. P_1S_1 registered considerably higher length roots over P_3S_3, P_3S_2, P_2S_3, P_2S_2 and P_3S_1. The values of P_1S_2, P_1S_3 and P_2S_1 were at par with P_1S_1.

The root biomass of propagated plants differed significantly due to different planting alignments, cutting sizes and their interactions (Table 3). Planting alignment P_1 produced highest biomass of 4.91 gm which was significantly more than P_2 and P_3 irrespective of size of cuttings. Similar trend was observed in case of size irrespective of planting alignment. S_1 recorded maximum root biomass (5.00 gm) and S_3 registered the minimum biomass (4.05 gm). P_1S_1, P_1S_2, P_2S_1 and P_1S_3 which showed parity produced maximum root biomass than others.

The total biomass of plant per node of cutting also varied significantly under different treatments Table 3). Irrespective of cutting size, P_1 put maximum total biomass (34.30 gm) followed by P_2 (31.93 gm) and P_3 (30.41 gm). In case of cutting size irrespective of planting alignment, S_1 produced considerably higher biomass (34.8 gm) over S_2 and S_3. The performance of S_2 and S_3 was statistically at par.

The quality index of plant was significantly differentiated under various planting alignments, cutting sizes as well as under their interactions (Table 4). Irrespective of cutting sizes, the quality index was prominently higher under planting alignment P_1 (0.178) followed by P_2 (0.167) and P_3 (0.158). With regard to cutting size irrespective of planting alignment, S_1 registered remarkably higher quality index (0.181) while S_2 and S_3 were at par with each other. Among interactions (P x S), P_1S_1 (0.185) and P_1S_2 (0.183) performed better. The interactions P_1S_1, P_1S_2, P_1S_3, P_2S_1, P_3S_1 and P_2S_2 were found to be statistically alike and rest exerted comparatively lower quality index.

Results of the planting alignment, size of culm cutting and their interaction was found to be statistically significant among different treatments with regard to diffeent growth and quality parameters. In respect of planting alignment, horizontal alignment was significantly higher than slanting as well as vertical alignment. However, the latter two were at par with each other in all parameters excepting the survival percent. The survival per cent in vertical alignment was significantly less than the slanting alignment.

Zhang *et al*. (1997) and Othman and Nor (1993) have reported advantages of horizontal methods of planting in different bamboo species including *B. vulgaris* with respect to culm production and survival percent. Jayasree Gopalkrishnan (1989) has also found higher rooting in culm cuttings of *B. vulgaris* planted horizontally than planted vertically. The result of the present investigation is in line with the findings of above workers. In horizontal method of planting all the nodes are buried inside the soil and have access to soil moisture and nutrients for development of propagules from each node in comparison to other methods of planting. In slanting and vertical planting of cuttings more portion of the cuttings gets exposed to outside the soil and prone to get dried by transpiration.

As regards to size of culm cutting, one noded culm cutting was found to be significantly superior than two and three noded culm cuttings which were at par with each other. The performance of one noded culm cuttings was found to be better than two and three noded culm cuttings because of no competition and more access to water and nutrients through both the empty sides of culm cutting. The findings are in conformity of Sharma and Kaushal (1985) who have reported that March propagation of one noded cutting was the best for bamboo. Barnes *et al*. (1999) have also reported significantly higher performance of one noded cuttings than two noded cuttings in case of *B. oldhamii, Gigantochloa atter* and *Dendrocalamus asper*.

Interaction of planting alignment with size of cutting was also found to be significant with regard to growth and quality parameters. Horizontal planting alignment with 1 or 2 noded cutting as well as slanting alignment with 1 noded cutting were the best combination for propagation of *B. vulgaris*.

CONCLUSION

It was observed that horizontal planting of culm cuttings was significantly better over planting in slanting as well as vertical irrespective of size. Similarly planting of 1 or 2 noded cuttings horizontally was the best method over others. More than 1-noded culm cutting should be planted horizontally, not slantingly or vertically because the later methods not only reduce quality of plant but also number of rooted plants.

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