Print : ISSN 0970-7662

Journal of Tree Sciences
online available at www.ists.in

Volume 33 No.1 June, 2014

Effect of Planting Techniques of Offsets on Growth and Development of *Bambusa vulgaris*

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ABSTRACT

An experiment was conducted at Orissa University of Agriculture and Technology, Bhubaneswar, India to study the effect of planting technique of offsets on growth and development of *Bambusa vulgaris.* It was laid out in Factorial RBD consisting of 12 treatment combinations (4 sized offsets × 3 sized pits). Offset sizes were : Offsets with 1, 2, 3 and 4 internodes while pit sizes were: 15 cm × 15 cm × 60 cm, 30 cm × 30 cm × 60 cm and 45 cm × 45 cm × 60 cm. The plants under different treatments were evaluated consecutively for four years. Offset with 3-4 internodes was found optimum. Pit with 45cm x 45cm x 60 cm^3 and 30x30x60 cm^3 volume were at par with each other but better than 15x15x60 cm^3. The pit of 30x30x60 cm^3 was found to be optimum for planting the offset of *B. vulgaris.* It can be concluded that the suitable planting technique of *B. vulgaris* is with 3 internoded offsets in 30x30x60 cm^3 pits for enhanced growth and yield.

Key words:
Bambusa vulgaris, offset size, pit size, planting technique

INTRODUCTION

The planting of offset is a general practice among villagers for raising bamboo plantations. It is one of the important methods of raising *Bambusa vulgaris* Schrader ex Wendland plantations in villages because this species does not produce viable seed (Koshy and Jee 2001; Bhol 2006; Kaushal et al. 2011; Gulabrao et al. 2012). *B. vulgaris* which is known as Commom bamboo is an important cultivated bamboo species of the world and is the only one bamboo found commonly in whole tropical and south subtropical areas of the world, so is called the Pan tropical bamboo. In India it is often grown in homesteads in north-east and peninsular regions. It is raised by vegetative means like offsets, culm cuttings, branch cuttings, rhizomes and micropropagated plants. The standardization of planting technique with different offset and pit sizes is an important aspect of evaluation for success of bamboo plantation. Use of offset as planting material (Sharma and Singh 1990; Anon. 1992a; 2004; Tewari 1992; Quingyi 1995) and different sizes of pits for bamboo plantation (Anon.1992b; Vatsala 2003; Pandalai 2006) has been reported. As offset is a bulky material, standardization of its size is essential and similarly, the pit size decides the volume of soil working. In this study an attempt was made to evaluate the effect of planting technique of offsets on growth and development of *B. vulgaris.*

MATERIALS AND METHODS

The experiment was conducted at Orissa University of Agriculture and Technology, Bhubaneswar, India. The climate is warm and

humid with short mild winter. The average rainfall is about 1500 mm with 113 rainy days in a year. The rainfall is received from south-west monsoon and 85% is received between June and September. The land was plane and soil was poor in fertility status. The levels of available nitrogen, phosphorus and potassium were low. It was laid out in Factorial RBD consisting of 12 treatment combinations (4 sized offsets × 3 sized pits) replicated thrice. Offset sizes evaluated were with 1(O_1), 2 (O_2), 3 (O_3) and 4 (O_4) internodes while pits of 15 cm × 15 cm × 60 cm (P_1), 30 cm × 30 cm × 60 cm (P_2) and 45 cm × 45 cm × 60 cm (P_3) sizes were evaluated. The offsets were carefully excavated from the base of 18 month old culms at the onset of monsoon. Immediately after collection, offseets were soaked in water for 24 hours followed by treating rhizome portion in 0.15% Bavistin solution for 20 minutes. After this pre-treatment offsets were transplanted at 5m x 5m spacing putting the root/rhizome portions inside the soil as those were in the parent clump. A total of 180 offsets (15 offsets per treatment) were planted. While planting, in each pit 5 kg FYM, 25 gram P (156 gram single super phosphate) and 20 gram phorate granules were added and mixed with pit soil. NPK was applied @ 50: 25: 25 g in first year, 100: 50: 50 g in second year, 150: 75: 75 g in third year and 250: 125: 125 g in fourth year per clump which was found optimum from other trials because clump size increases with age. The plants under different treatments were evaluated consecutively for four years.

RESULTS AND DISCUSSION

Total number of culms production per clump was significantly influenced by various offset sizes, pit sizes and their interactions (Table 1). In first year, highest number of culms were found in O_4 (offset with 4 internodes) with 1.6 number of culms while minimum number in case of O_1 and O_2 (1.0 each). Further, offsets planted in P_3 (pit size 45 cm x 45 cm x 60 cm) recorded maximum number of culms (1.3) which was at par with P_2 (pit size 30 cm x 30 cm x 60 cm) and minimum in P_1. Regarding interaction of O x P, maximum number of culms (1.7) were produced under O_4P_2 / O_4P_3 and minimum under O_1P_1, O_1P_2, O_1P_3, O_2P_1, O_2P_2, O_2P_3 and O_3P_1. In 2nd year, also total number of culms increased with increase of offset size and pit size. However, pit P_2 and P_3 resulted alike. Among the O x P interactions, O_4P_2 and O_4P_3 performed remarkably better (5.30 and 5.40, respectively). O_1P_1 performed least with 2.8 numbers of culms per clump.

In 3rd year, similar trend was noticed as in 2nd year. However, total number of culm produced was 8.5 – 12.2 under offsets irrespective of pit size and 9.9 – 10.8 under pit sizes irrespective of offset sizes. In different interactions of O x P, the total number of culm produced was 8.0 – 12.5. O_4P_3 produced maximum number of culms, which was at par with O_4P_2. Further O_4P_2 was at par with O_3P_3.In 4th year, the higher size offsets continued to have considerably more number of culms. The range of total culm production under offsets was 14.9 – 20.3 irrespective of pit size. In case of pits it was 17.1 – 18.3 irrespective of offset size and parity was noted between P_2 and P_3. With regard to interactions, the total number of culms varied from 14.34 to 20.72. O_4P_3, O_4P_2 and O_3P_3 which are at par with each other, produced comparatively higher number of culms per clump by the end of 4th year of plantation. Further, O_3P_2 (19.5) performed same as O_4P_2 and O_3P_3 towards 4th year.

It was evident from the above observations that offset having 4 internodes planted in P_2 (30 cm x 30 cm x 60 cm) or P_3 (45 cm x 45 cm x 60 cm) pit produced significantly higher number of culms. However, 3-noded offsets planted in P_2 or P_3 performed equally well towards 4th year of the crop.

The recruitment of new culms was strongly influenced by different planting techniques of offset (Table 2). The offset sizes, pit sizes and their combinations exerted significantly differential effects with regard to new culm recruitment. In first year, higher size offsets recruited more number of culms (1.6 under O_4). With regard to pit size, maximum numbers of culms were produced when planted on pits having size 30 cm x 30 cm x 60 cm and 45 cm x 45 cm x 60 cm. The interactions with highest number of culms recorded were O_4P_2 and O_4P_3 (1.7 each) and lowest under O_1P_1, O_1P_2, O_1P_3, O_2P_1, O_2P_2, O_2P_3 and O_3P_1 (1.0 each).Similar trend of observations were also recorded during 2nd year

Table **1:** Effect of planting technique of offsets of *B. vulgaris* on total number of culm per clump

st Year					2nd Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	1.0	1.0	1.0	1.0	2.8	3.2	3.3	3.1
O_2	1.0	1.0	1.0	1.0	3.5	3.9	4.0	3.8
O_3	1.0	1.3	1.4	1.2	4.1	4.8	5.0	4.6
O_4	1.3	1.7	1.7	1.6	4.7	5.3	5.4	5.1
Mean	1.0	1.3	1.3		3.8	4.3	4.4	
O, SE(m) ± = 0.018, $CD_{(0.05)}$ = 0.054					O, SE(m) ± = 0.053, $CD_{(0.05)}$ = 0.155			
P, SE(m) ± = 0.016, $CD_{(0.05)}$ = 0.047					P, SE(m) ± = 0.046, $CD_{(0.05)}$ = 0.135			
O ´ P, SE(m) ± = 0.032, $CD_{(0.05)}$ = 0.093					O ´ P, SE(m) ± = 0.093, $CD_{(0.05)}$ = 0.273			
3rd Year					4th Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	8.0	8.7	8.8	8.5	14.3	15.1	15.4	14.9
O_2	9.3	9.9	10.1	9.8	16.2	17.0	17.2	16.8
O_3	10.5	11.7	11.9	11.4	18.0	19.5	19.8	19.1
O_4	11.7	12.4	12.5	12.2	19.7	20.5	20.7	20.3
Mean	9.9	10.7	10.8		17.1	18.0	18.3	
O, SE(m) ± = 0.110 $CD_{(0.05)}$ = 0.322					O, SE(m) ± = 0.217 $CD_{(0.05)}$ = 0.636			
P, SE(m) ± = 0.096 $CD_{(0.05)}$ = 0.281					P, SE(m) ± = 0.188 $CD_{(0.05)}$ = 0.551			
O ´ P, SE(m) ± = 0.191 $CD_{(0.05)}$ = 0.560					O ´ P, SE(m) ± = 0.376 $CD_{(0.05)}$ = 1.102			

Table 2: Effect of planting technique of offsets of *B. vulgaris* on number of new culms recruited per clump

1st Year					2nd Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	1.0	1.0	1.0	1.0	1.8	2.2	2.3	2.1
O_2	1.0	1.0	1.0	1.0	2.5	2.9	3.0	2.8
O_3	1.0	1.3	1.4	1.2	3.1	3.5	3.6	3.4
O_4	1.3	1.7	1.7	1.6	3.4	3.6	3.7	3.5
Mean	1.1	1.3	1.3		2.7	3.0	3.1	
O, SE(m) ± = 0.018, $CD_{(0.05)}$ = 0.054					O, SE(m) ± = 0.049, $CD_{(0.05)}$ = 0.144			
P, SE(m) ± = 0.016, $CD_{(0.05)}$ = 0.047					P, SE(m) ± = 0.042, $CD_{(0.05)}$ = 0.123			
O ´ P, SE(m) ± = 0.032, $CD_{(0.05)}$ = 0.093					O ´ P, SE(m) ± = 0.085, $CD_{(0.05)}$ = 0.249			
3rd Year					4th Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	5.2	5.5	5.5	5.4	6.3	6.5	6.6	6.4
O_2	5.8	6.0	6.1	6.0	6.9	7.0	7.1	7.0
O_3	6.4	6.9	6.9	6.7	7.6	7.9	8.0	7.8
O_4	7.0	7.1	7.1	7.1	8.0	8.1	8.1	8.1
Mean	6.1	6.4	6.4		7.2	7.4	7.4	
O, SE(m) ± = 0.096, $CD_{(0.05)}$ = 0.281					O, SE(m) ± = 0.095, $CD_{(0.05)}$ = 0.278			
P, SE(m) ± = 0.083, $CD_{(0.05)}$ = 0.243					P, SE(m) ± = - $CD_{(0.05)}$ = NS			
O ´ P, SE(m) ± = 0.165, $CD_{(0.05)}$ = 0.483					O ´ P, SE(m) ± = 0.165, $CD_{(0.05)}$ = 0.483			

under offset sizes and pit sizes. Under different offset sizes the range of new recruitment was 2.1 – 3.5 and under pit sizes it was 2.7 – 3.1 numbers of culms per clump. The performance of P_2 and P_3 was statistically alike. Among the P x S interactions, O_3P_2, O_3P_3, O_4P_1, O_4P_2 and O_4P_3 recruited higher number of culms over others. O_1P_1 recruited lowest number of culms (1.8) per clump. However, in the following year, variation in culm recruitment was observed under different treatments. Irrespective of pit size maximum number of culms (7.1) was recruited under O_4 while minimum (5.4) under O_1. Regarding pit sizes, irrespective of offset size P_3 was recorded with maximum recruits (6.4) which was at par with P_2 (6.4) while P_1 had lowest (6.1). New culm recruitment under interactions O_3P_2, O_3P_3, O_4P_1, O_4P_2 and O_4P_3 were statistically alike but significantly higher over others. The O_1 offsets planted in different pit sizes performed least.

Different planting techniques exerted considerable variation with regard to new culm recruitment during fourth year also. A comparison of mean values at offset level, irrespective of pit size, reflected significant variation. The O_4 and O_3 offsets put statistically similar number of new culms which was significantly higher over others. The effect of pit size, irrespective of offset size, was not found significant. Regarding interaction O_4P_3 reflected maximum (7.4) which was at par with O_4P_2, O_4P_1, O_3P_3 and O_3P_2. Lowest numbers of culms were under O_1P_1 (6.3), which were statistically alike as O_1P_2 and O_1P_3. These observations clearly indicate that 3 - 4 internodes offsets planted in P_2 (30 cm x 30 cm x 60 cm) or P_3 (45 cm x 45 cm x 60 cm) produced maximum culm.

The height of dominating culms under various planting techniques of offsets varied prominently (Table 3) under offset sizes, pit sizes and their interactions from first to fourth year of the plantation. After first year it was observed that the mean height under offsets increased with increasing offset size. The O_4 registered a maximum height of 3.61 m whereas O_1 registered 2.36 m. The increase of pit size also improved height, however, P_2 and P_3 was at par. Among the interactions, O_4P_2 and O_4P_3 were observed with significantly higher height while, O_1P_1 had lowest (2.15 m). Similar trend was also observed after second year. The height varied from 4.17 m to 5.40 m under different offset sizes and 4.65 m to 4.94 m under different pit sizes. Treatment combinations O_4P_1, O_4P_2 and O_4P_3 recorded significantly higher height over all combinations of O_1 and O_2 while, O_1P_1 recorded the least (4.00 m). After third year, the comparison of offset mean values irrespective of pit size shows a significant variation in height among offsets. Higher sized offsets put more height. However, pit size did not significantly influenced height growth. The interaction of offset size and pit size reflected differential effect on height growth. The height growth under O_3 and O_4 offsets in each pit size was significantly higher over the others. The height growth of O_3P_2, O_3P_3, O_4P_1, O_4P_2 and O_4P_3 was statistically at par with each other while, O_1P_1 was recorded with lowest height (6.04 m). After fourth year, the variation in height growth was reduced under different treatments in comparison to previous years. It ranged from 8.31 to 9.15 m under different offset sizes irrespective of pit size. The height increased with pit size; however, the height growth of O_4 remained at par with O_3. Further, parity was observed between O_3 and O_2 as well as O_2 and O_1. In case of pit size, no significant variation was observed in height growth. Combinations O_4P_1, O_4P_2, O_4P_3 which were statistically at par with each others had significantly higher height growth over O_1P_1. Similarly, O_4P_2 and O_4P_3 put differential growth over O_1P_2. The height growth in all other combinations remained statistically at par.

The dbh growth of dominating culm from first to fourth year of *B. vulgaris* is given in Table 4. After first year, differential growth of dbh was observed under offset sizes and offset with 4 internodes (O_4) acquired significantly higher growth (2.44cm) followed by O_3, O_2 and O_1 (1.33cm). Similarly P_3 (45cm x 45cmx 60cm) recorded maximum which was at par with P_2 (30cm x 30cm x 60cm) pit. The interaction of offset size and pit size had resulted into significantly higher dbh under O_4P_2, O_4P_3 while, lowest under O_1P_1 (1.31cm). Differential dbh growth was also observed after second year under different offset sizes. The O_4 offsets had significantly higher dbh (3.27 cm) followed by O_3, O_2 and O_1 the least. The

Table 3: Effect of planting technique of offsets on height growth of dominating culm (m)

1st Year					2nd Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	2.15	2.40	2.52	2.36	4.00	4.20	4.30	4.17
O_2	2.83	3.07	3.12	3.01	4.50	4.70	4.80	4.67
O_3	3.23	3.42	3.44	3.36	4.90	5.10	5.12	5.04
O_4	3.44	3.66	3.72	3.61	5.20	5.45	5.55	5.40
Mean	2.91	3.14	3.20		4.65	4.86	4.94	
O, SE(m) ± = 0.049, CD $_{(0.05)}$ = 0.144					O, SE(m) ± = 0.076, CD $_{(0.05)}$ = 0.223			
P, SE(m) ± = 0.042, CD $_{(0.05)}$ = 0.123					P, SE(m) ± = 0.066, CD $_{(0.05)}$ = 0.196			
O ´ P, SE(m) ± = 0.085, CD $_{(0.05)}$ = 0.249					O ´ P, SE(m) ± = 0.131, CD $_{(0.05)}$ = 0.384			
3rd Year					4th Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	6.04	6.12	6.16	6.11	8.20	8.32	8.40	8.31
O_2	6.44	6.62	6.66	6.57	8.54	8.66	8.74	8.65
O_3	6.92	7.04	7.05	7.00	8.84	8.90	8.94	8.89
O_4	7.20	7.30	7.32	7.27	9.04	9.16	9.24	9.15
Mean	6.65	6.77	6.80		8.65	8.76	8.83	
O, SE(m) ± = 0.083, CD $_{(0.05)}$ = 0.243					O, SE(m) ± = 0.157, CD $_{(0.05)}$ = 0.460			
P, SE(m) ± = - CD $_{(0.05)}$ = NS					P, SE(m) ± = - CD $_{(0.05)}$ = NS			
O ´ P, SE(m) ± = 0.145, CD $_{(0.05)}$ = 0.425					O ´ P, SE(m) ± = 0.273, CD $_{(0.05)}$ = 0.801			

Table 4: Effect of planting technique of offsets of *B. vulgaris* on DBH growth of dominating culm (cm)

1st Year					2nd Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	1.23	1.34	1.42	1.33	2.22	2.38	2.42	2.34
O_2	1.81	1.96	2.03	1.93	2.60	2.80	2.84	2.75
O_3	2.08	2.26	2.28	2.20	2.94	3.10	3.12	3.05
O_4	2.32	2.48	2.52	2.44	3.14	3.30	3.36	3.27
Mean	1.86	2.01	2.06		2.72	2.90	2.93	
O, SE(m) ± = 0.030, CD $_{(0.05)}$ = 0.088					O, SE(m) ± = 0.046, CD $_{(0.05)}$ = 0.135			
P, SE(m) ± = 0.026, CD $_{(0.05)}$ = 0.076					P, SE(m) ± = 0.040, CD $_{(0.05)}$ = 0.117			
O ´ P, SE(m) ± = 0.053, CD $_{(0.05)}$ = 0.155					O ´ P, SE(m) ± = 0.081, CD $_{(0.05)}$ = 0.237			
3rd Year					4th Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	3.28	3.44	3.52	3.41	4.36	4.45	4.46	4.42
O_2	3.66	3.70	3.76	3.71	4.52	4.66	4.68	4.62
O_3	3.90	4.00	4.02	3.97	4.82	4.90	4.93	4.88
O_4	4.10	4.24	4.26	4.20	5.03	5.14	5.16	5.11
Mean	3.73	3.84	3.89		4.68	4.79	4.81	
O, SE(m) ± = 0.064, CD $_{(0.05)}$ = 0.188					O, SE(m) ± = 0.067, CD $_{(0.05)}$ = 0.196			
P, SE(m) ± = - CD $_{(0.05)}$ = NS					P, SE(m) ± = - CD $_{(0.05)}$ = NS			
O ´ P, SE(m) ± = 0.112, CD $_{(0.05)}$ = 0.328					O ´ P, SE(m) ± = 0.116, CD $_{(0.05)}$ = 0.340			

Table 5: Effect of planting technique of offsets of *B. vulgaris* on number of internodes in dominating culm

1st Year					2nd Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	12.78	14.26	14.98	14.00	21.40	22.47	23.00	22.29
O_2	16.82	18.25	18.54	17.87	24.08	25.15	25.68	24.97
O_3	19.20	20.33	20.45	19.99	26.22	27.28	27.39	26.96
O_4	20.44	21.75	22.10	21.43	27.82	29.16	29.69	28.89
Mean	17.31	18.65	19.11		24.88	26.01	26.44	
For O, SE(m) ± = 0.309, CD $_{(0.05)}$ = 0.906					For O, SE(m) ± = 0.442, CD $_{(0.05)}$ = 1.296			
For P, SE(m) ± = 0.268, CD $_{(0.05)}$ = 0.786					For P, SE(m) ± = 0.383, CD $_{(0.05)}$ = 1.123			
For O ´ P, SE(m) ± = 0.536, CD $_{(0.05)}$ = 1.572					For O ´ P, SE(m) ± = 0.766, CD $_{(0.05)}$ = 2.246			
3rd Year					4th Year			
Pit size/ Offset size	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
O_1	30.41	30.82	31.02	30.75	40.05	40.64	41.03	40.57
O_2	32.43	33.34	33.54	33.10	41.72	42.30	42.70	42.24
O_3	34.85	35.45	35.50	35.27	43.18	43.47	43.67	43.44
O_4	36.26	36.76	36.86	36.63	44.16	44.74	45.13	44.68
Mean	33.49	34.09	34.23		42.28	42.79	43.13	
For O, SE(m) ± = 0.603, CD $_{(0.05)}$ = 1.768					For O, SE(m) ± = 0.681, CD $_{(0.05)}$ = 1.997			
For P, SE(m) ± = - CD $_{(0.05)}$ = NS					For P, SE(m) ± = - CD $_{(0.05)}$ = NS			
For O ´ P, SE(m) ± = 1.045, CD $_{(0.05)}$ = 3.065					For O ´ P, SE(m) ± = 0.181, CD $_{(0.05)}$ = 3.463			

DBH also varied under pit size. Pit size of 45cm x 45cm x 60cm (P_3) and 30cm x 30cm x 60cm (P_2) exerted significantly higher dbh than with pit size 15cm x 15cm x 60cm (P_1). O_4 offsets achieved significantly higher dbh with all pit sizes, O_1 offsets were recorded with smallest dbh among all pit sizes. After third year, it was observed that with increasing offset size the dbh also increased significantly and ranged from 3.41 to 4.20 cm. Influence of pit size on dbh was however non-significant. The dbh which ranged from 3.28 to 4.26 cm varied significantly among the interactions of offset size and pit size (OP). The combinations of O_4 with P_1, P_2, P_3 and O_3 with P_2 and P_3 were at par with each other but were significantly higher than combinations of O_1 with P_1, P_2 and P_3. Similar trend was observed after fourth year growth also. Thus for obtaining higher dbh, offsets with 3-4 internodes should be planted either pits with 30cm x 30cm x 60cm or 45cm x 45cm x 60cm volume.

There was significant variation in number of internodes of dominating culm under different treatments (Table 5). After one year of planting, offsets with 4 internodes grown to have 21.43 internodes which was significantly higher over others and showed a decreasing trend with decrease of size of offset. Similarly, the number of internodes increased as the pit size increased irrespective of offset size. Variation of internodes ranged from 12.78 to 22.10 cm under different combinations. Combinations O_4P_3 and O_4P_2 which were statistically at par with each other produced significantly higher number of internodes over others while, O_1P_1 produced the least. Similar trend was recorded throughout the subsequent years of observation. Thus to get best growth, offsets with 3-4 internodes must be planted in the pits either of 30cm x 30cm x 60cm or 45 cm x 45cm x 60cm dimensions.

Significant differences in growth and yield parameters were recorded in different offset sizes, pit sizes as well as with their combinations. The observations clearly indicated that 4-internoded offset was significantly superior to rest other offsets. However, in the 4th year, 3 and 4-internoded offsets were at par with each other but significantly superior than others. Thus 3-4 internoded offsets can be recommended as optimum size with *B.*

vulgaris plantation. Similar recommendation of 3-5 nodes offset for raising conventional bamboo plantation was also reported (Banik 1995). NMBA however had made general recommendation 2-node offsets for planting bamboo (Anon. 2004). In the present investigation 3-4 internoded offsets were found to suit to the rain fall, humidity and temperature of the coastal Orissa condition. It was learnt that the higher size offsets (7 and more internodes) usually taken by farmers is unnecessary. Similarly, low size (1-2 nodes) is also not desirable because of low food stock in the offset. Among different sizes of pits investigated 45cm x 45cm x 60cm and 30cm x 30cm x 60cm pit sizes were at par with each other and better than 15cm x 15cm x 60cm. The pit 30cm x 30cm x 60 cm could be considered best for *B. vulgaris* because it involved less soil working and less cost. Perhaps this much of soil working was sufficient for the growth of offsets. Beyond this volume of soil working, it was found unnecessary because as such the normal soil became loose in monsoon due to good rainfall in coastal Orissa. However, references in this regard are not available. Offsets with 3 or 4 internodes planted either in 30 cm x 30 cm x 60 cm or 45cm x 45cm x 60 cm had performed significantly well than other combinations. Hence, it can be concluded that offset with 3 internodes planted in 30cm x 30cm x 60 cm can be regarded as optimum combination for obtaining enhanced growth and yield of *B. vulgaris*.

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