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Integrated nutrient management in *Dendrocalamus strictus* (Roxb) Ness for quality seedling production

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ABSTRACT

An experiment was laid out for quality seedling production of *Dendrocalamus strictus* (Roxb) Ness in nursery at three levels of integrated nutrient management (INM) combinations viz N, P_2O_5 and K_2O (2.0, 1.25, 1.25; 1.5, 0.938, 0.938; 1.0, 0.625, 0.625 g kg^{-2} of soil) applied as urea, single super phosphate and muriate of potash along with FYM (500 g) and biofertilizers viz VAM and *Azospirillum* each @ 40, 20 g kg^{-2} of soil respectively and compared with unfertilized control. The results revealed that integration of 1.5 g N, 0.938 g of P_2O_5 and 0.938 g of K_2O kg^{-2} of soil supplemented with FYM (500 g), VAM (40 g) and *Azospirillum* (20 g) significantly enhanced the growth parameters viz shoot length and number of leaves, root length, collar diameter, dry matter, volume index and quality index of *D strictus* seedlings over control.

Keywords: Bio-fertilizers; VAM; FYM; *Azospirillum; Dendrocalamus strictus*

INTRODUCTION

Bamboo is a wonderful gift of nature. Bamboo species are giant, woody tree like grasses, have a long history and are widely used as renewable bioresource. The rage of uses of bamboo for humans is remarkable with an estimated annual use of 12 kg of bamboo produce per capita in Asia (Recht and Wetterwald 1988). Besides some minor uses such as leaves for medical purposes (Zhang 1997), fresh edible shoots and culms for timber or a raw material for pulping are the major products from bamboo. While supplying products of immediate use for humans bamboo also serves multiple ecological functions such as soil and water conservation and erosion control (Fu and Banik 1995). Due to its great potential for rapid biomass production (Pearson et al 1994) bamboo is a significant net sink of global CO_2 (Jones et al 1992). Although wasteland tracts in south and southern Asia are covered with bamboo and area planted to bamboo is increasing in China by 51,000 ha/year (Li and Xu 1997) there is rising concern about acute scarcity of bamboo products in the future (Hsiung 1988). In India it is projected that at the current level of bamboo productivity for paper industry and with the growing demand for paper an additional 30-60 million ha of land would be required by 2015 (AdKoli 1991).

The plethora of its uses in the human economy has led to the coinage of a variety of names for this superb species. The Vietnamese call it 'my brother', the Chinese 'Friend of the people' and in India it is widely known as 'Green gold' or 'Poorman's timber'. Bamboo is a tall arborescent grass belonging to the family Bambusae, a tribe of Poaceae (Gramineae) indigenously found in all the continents except Europe. It is reported that over 75 genera and 1250 species of bamboos occur in the world whereas 43 species belonging to 14 genera are found in Africa.

Dendrocalamus strictus is middle sized, densely tufted bamboo often gregarious, sub-deciduous and culms attaining 8-16 m height 2.5-8 cm diameter according to the locality. Young culms are pale blue-green, dull green or yellowish when old, nodes somewhat swollen, basal nodes often rooting, lower nodes often with branches, internodes 30-45 cm long and thick walled. Culms are almost solid in dry areas and hollow with thick walls in moist areas.

MATERIAL AND METHODS

Nursery studies were carried out on production of quality seedling through integrated nutrient management of *D strictus*. The experiment was laid out in Completely Randomized Design (CRD) as suggested by Snedecor and Cochran (1967) with five treatments and five replications at College of Forestry and Environment, Allahabad Agricultural Institute, Deemed University, Allahabad (25º 87' N latitude, 81º 5' E longitude, 78m above ms1, mean annual rainfall of 1100 mm). In the present experiment seed management techniques and INM were taken.

The polythene bags of size 25x20 cm were filled with two kg of soil. The bags were arranged in a CRD with five replications @ 100 polythene bags treatment^{-1} replication^{-1}. The seeds of *D strictus* were sown in mother bed of size of 10x1 m. Healthy seedlings were transplanted uniformly @ one seedling bag^{-1} at 30 days after sowing (DAS). The irrigation and plant protection measures were given as per recommendations. The soil mixture was 2:1:1 (soil:sand:FYM) used for poly bags. The calculated quantity of biofertilizers (VAM and *Azospirillum*) were added to the respective poly bags as per the treatment schedule at transplanting. The inorganic fertilizers were added as aqueous solution to each poly bag seven days after transplanting (DAT). The experiment and treatment details are furnished in Table 1. The biometric observations viz shoot length (cm), root length (cm), collar diameter (cm), number of leaves, shoot dry weight (g), root dry weight (g), total dry matter production (g), root/shoot ratio, volume index and

Table 1. INM treatment details

Treatment	Particulars (kg^{-2} soil of pot mixture)
T_1	Control
T_2	2 g N, 1.25 g P_2O_5 and 1.25 g K_2O alone
T_3	2 g N, 1.25 g P_2O_5 and 1.25 g K_2O+FYM (500 g)+VAM (40 g)+*Azospirillum* (20 g)
T_4	1.5 g N, 0.938 P_2O_5 and 0.938 K_2O+FYM (500 g)+VAM (40 g)+*Azospirillum* (20 g)
T_5	1 g N, 0.625 P_2O_5 and 0.625 K_2O+FYM (500 g)+VAM (40 g)+*Azospirillum*

quality index were recorded at 60, 90 and 120 DAT @ three seedlings/treatment/replication.

RESULTS AND DISCUSSION

Effect of integrated nutrient management (INM) on seedling quality

The shoot length of *D strictus* seedlings significantly varied at all the three stages and the highest shoot length of 65.67 cm was recorded with the application of 1.5 g N, 0.938 g of P_2O_5 and 0.938 g of K_2O kg^{-2} of soil along with FYM (500 g), VAM (40 g) and *Azospirillum* (20 g) in T_4 at 120 DAT followed by 54.41 cm with the application of 2 g of N, 1.25 g of P_2O_5 and 1.25 g of K_2O kg^{-2} soil supplemented with FYM (500 g), VAM (40 g) and *Azospirillum* (20 g) in T_3 (Table 2). The lowest shoot length of 28.83 cm was observed in control at 120 DAT. All the treatments followed the same trend at 60 and 90 DAT and the different levels of treatments registered a significant effect on root length of *D strictus*. T_4 was rated to be the best as it recorded the highest root length of 29.55, 51.33 and 64.61 cm at 60, 90 and 120 DAT respectively. The lowest root length of 32.25 cm was observed in control at 120 DAT. Collar diameter exhibited a significant variation among the stages and treatments. T_4 also recorded the highest collar diameter of 2.97 cm followed by T_5 with the value of 2.08 cm. The lowest collar diameter of 0.84 cm was observed in control at 60 DAT. The number of leaves ranged from 13.3 to 29.11, 17.3 to 36.1 and 24.7 to 45.1 at 60, 90 and 120 DAT respectively. T_4 ranked first at 60, 90 and 120 DAT recording 29.1, 36.1 and 45.1 number of leaves respectively. Control recorded the lowest number of leaves at all the stages with 13.3, 17.3 and 24.7 number of leaves at 60, 90 and 120 DAT (Table 3).

Effect of INM on dry matter production at various stages of seedling growth

Shoot dry weight in all the treatments had a profound influence in enhancing the shoot dry matter while control recorded the least value of 0.977, 1.472 and 1.939 g seedling^{-1} respectively at 60,

Table 2. Effect of INM on shoot length (cm) and root length (cm) of *D strictus* seedlings

Treatment	Shoot length (cm)			Root length (cm)		
	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT
T_1	16.15	21.66	28,83	19.41	25.47	32.25
T_2	19.45	26.13	37.07	22.77	33.53	36.01
T_3	20.72	28.81	54.41	26.37	40.69	53.25
T_4	25.81	31.73	65.67	29.55	51.33	64.61
T_5	18.93	28.23	45.73	13.25	36.65	46.15
SEd	0.68	0.71	0.65	0.82	1.26	1.24
$CD_{0.05}$	1.41	1.53	1.33	1.71	2.63	2.58

Table 3. Effect of INM treatments on collar diameter (cm) and number of leaves of *D strictus* seedlings

Treatment	Collar diameter (cm)			Number of leaves		
	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT
T_1	0.84	1.05	1.21	13.3	17.3	24.7
T_2	1.16	1.46	1.93	18.1	27.3	32.1
T_3	1.55	1.81	2.21	24.3	28.5	36.7
T_4	2.06	2.26	2.97	29.1	36.1	45.1
T_5	1.39	1.61	2.08	20.3	23.9	33.5
SEd	0.04	0.05	0.06	1.08	1.05	1.17
$CD_{0.05}$	0.09	0.09	0.12	2.27	2.16	2.36

90 and 120 DAT all other treatments proving to be better than control. The shoot dry matter was higher with the application of T_4 recording 3.165, 3.917 and 4.660 g seedling^{-1} respectively at 60, 90 and 120 DAT (Table 4). For root dry weight among the treatments the performance of T_4 was the best at all the stages by recording the highest root dry matter value of 2.731, 3.286 and 3.955 g seedling^{-1} for 60, 90 and 120 DAT respectively and T_3 with the value of 3.352 g seedling^{-1} at 120 DAT. The control recorded the lowest root dry matter of 1.866 g seedling^{-1} at 120 DAT (Table 4).

There was a significant difference in total dry matter production of *D strictus* seedlings as affected by the treatments at all stages of observation. T_4 recorded higher value of 8.617 g seedling^{-1} at 120 DAT which was followed by T_3 recording 7.132 g seedling^{-1} g. The control remained to be inferior to all other treatments by recording 1.927, 2.884 and 3.807 g seedling^{-1} at 60, 90 and 120 DAT respectively. The individual application of inorganic fertilizers proved its superiority over control but could not stand before any of the integrated nutrient management treatments (Table 4).

Effect of INM on quality parameters at various stages of seedling growth

The root/shoot ratio was significantly influenced by the treatments at all the stages. T_4 recorded significantly higher value of 1.983 at 120 DAT which was on par with T_3 which recorded 1.978 at 120 DAT (Table 5). The volume index of *D strictus* seedlings significantly varied

Table 4. Effect of INM treatments on root dry weight, shoot dry weight and total dry matter of *D strictus* seedlings

Treatment	Shoot dry weight (g seedling^{-1})			Root dry weight (g seedling^{-1})			Total dry weight (g seedling^{-1})		
	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT
T_1	0.977	1.472	1.939	0.950	1.412	1.866	1.972	2.884	3.807
T_2	2.131	2.755	2.961	1.990	2.613	2.695	4.122	5.368	5.658
T_3	2.724	3.169	3.777	2.439	2.833	3.352	5.164	5.002	7.132
T_4	3.165	3.917	4.660	2.731	3.286	3.955	5.879	7.203	8.617
T_5	2.305	2.985	3.380	2.121	2.832	3.060	4.428	5.819	6.442
SEd	0.072	0.077	0.081	0.084	0.071	0.112	0.151	0.141	0.181
$CD_{0.05}$	0.150	0.160	0.170	0.176	0.148	0.234	0.315	0.295	0.397

at all the three stages and the highest volume index of 1950 was recorded with the application of T_4 at 120 DAT. This was closely followed by T_3 which recorded the volume index value of 1202 at 120 DAT. Control remained poorer in all the treatments at all the three stages with volume index of 136, 227 and 336 at 60, 90 and 120 DAT respectively (Table 5). Quality index supplementation of T_4 favorably influenced the quality index than other treatments at all stages by recording quality index of 2.543 at 120 DAT. T_3 was rated next best with quality index of 2.987.

Table 5. Effect of INM treatments on root /shoot ratio, volume index and quality index of *D. strictus* seedlings

Treatment	Root:shoot ratio			Volume index			Quality index		
	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT	60 DAT	90 DAT	120 DAT
T_1	1.202	1.176	1.119	136	227	336	0.653	0.929	1.113
T_2	1.171	1.283	1.971	224	381	715	1.500	1.888	1.874
T_3	1.273	1.412	1.978	319	521	1202	2.104	2.214	2.987
T_4	1.145	1.618	1.983	529	717	1950	2.446	3.775	2.543
T_5	1.700	1.298	1.009	261	455	951	1.808	2.073	2.950
SEd	0.023	0.017	0.026	14.9	26.4	47.1	0.089	0.054	0.071
$CD_{0.05}$	0.047	0.036	0.055	31.0	55.1	98.2	0.186	0.113	0.148

The control registered the lowest quality index at all the three stages (Table 5).

CONCLUSION

Considering the above findings, T_4 (1.5 g N, 0.938 P_2O_5 and 0.938 K_2O+FYM (500 g)+VAM (40 g)+*Azospirillum* (20 g) has given maximum growth and biomass production and uptake of nutrients under nursery condition.

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