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Effect of integrated nutrient management on biomass production and nutrients uptake in *Dendrocalamus strictus* (Roxb) Ness under nursery conditions

B SIVA KUMAR and AFAQ MAJID WANI*

Adhiparasakthi Agricultural and Horticultural College and Research Institute
GB Nagar, Kalavai, Vellore District 632506 Tamil Nadu
***School of Forestry and Environment**
Sam Higginbottom Institute of Agriculture, Technology and Sciences (formerly Allahabad Agricultural Institute) Deemed University, Allahabad 211007 UP
Email for correspondence: drsivakumar85@yahoo.com

ABSTRACT

An experiment was carried out to study the effect of integrated nutrient management on biomass production and nutrients uptake in *Dendrocalamus strictus* under nursery conditions. 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^{-1} 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^{-1} of soil respectively were evaluated with unfertilized soil (control). The results revealed that integration of 1.5 g N, 0.938 g P_2O_5 and 0.938 g K_2O kg^{-1} of soil supplemented with FYM (500 g), VAM (40 g) and *Azospirillum* (20 g) significantly enhanced the growth parameters viz shoot length, number of leaves, root length, collar diameter, dry matter, volume index and quality index of *D strictus* seedlings over control.

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

INTRODUCTION

Bamboo is a wonderful gift of nature. Bamboo species are giant, woody tree like grasses having a long history and widely used 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).

The plethora of 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 a tall arborescent grass belonging to the family Bambusae and a tribe of Poaceae (Gramineae) is 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.

D strictus is middle sized, densely tufted bamboo, often gregarious, sub-deciduous, culms attaining 8-16 m height and 2.5-8 cm diameter according to the locality. Young culms are pale blue-green, dull green or yellowish when old with 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

Effect of integrated nutrient management on biomass production and uptake of nutrients under nursery condition of *Dendrocalamus strictus* was studied. The experiment was laid out in Completely Randomized Design (CRD) (Snedecor and Cochran 1967) with five treatments and five replications at College of Forestry and Environment of Allahabad Agricultural Institute- Deemed University, Allahabad (25º 87' N Latitude, 81º 5' E Longitude, 78m above ms1, mean annual rainfall of 1100 mm). The soil used was non-calcareous, sandy loam, poor in nitrogen, rich in phosphorus and potassium and slightly alkaline in nature.

The polythene bags of size 25 x 20 cm were filled with two kg of soil. The bags were arranged in a Completely Randomized Design with five replications @ 100 polythene bags treatment^{-1} replication^{-1}. The seeds of *D strictus* were sown in mother bed size of 10 x 1 m. Healthy seedlings were transplanted uniformly @ one seedling bag^{-1} 30 DAS. The irrigation and plant protection measures were adopted as per recommendations. The soil mixture was in the ratio of 2:1:1 (soil: sand:FYM) used for polybags. The calculated quantity of bio fertilizers (VAM and *Azospirillum*) were added to the respective polybags as per the treatment schedule at transplanting. The inorganic fertilizers were added as aqueous solution to each polybag seven days after transplanting. 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 quality index were recorded at 60, 90 and 120 days after transplanting (DAT) @ fifty seedlings/treatment/replication.

RESULTS AND DISCUSSION

Effect of INM on biometrics at various stages of seedling growth

The various INM treatments significantly influenced the growth attributes viz shoot length, root length, collar diameter

Table 1. INM Treatment details

Treatment	Input (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* (20 g)

and number of leaves of *D strictus* seedlings compared to control.

Significantly the highest shoot length of 65.66 cm was obtained 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 (40g) and *Azospirillum* (20g) (T_4). At all the three stages of growth same treatment registered the highest shoot length (Table 2). This is understandable because *Azospirillum* is reported to be capable of fixing nitrogen at the rate of 0.7 kg N ha^{-1} day^{-1} and N is known to produce excess shoot growth at the expense of root growth (Cornett Zane 1982). Similar response to vegetative growth for N application has been reported by Malik (1987) in *Eucalyptus tereticornis* and obtained maximum height by applying 75 kg N ha^{-1} in *Bauhinia variegata* seedlings. Rohayat and Hendromono (1997) concluded that NPK application enhanced the shoot length of *Shorea pinanga* and *S leprosula*.

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) (T_4) at all the three stages recorded the highest root length over other levels of integrated nutrient treatments. The higher availability of P in the root zone by higher dose of P_2O_5 than its lower levels might have contributed for better P availability favouring vigorous root growth. The higher dose of P_2O_5 coupled with mineralization/solubilization of insoluble P by VAM might have contributed for better P availability favouring the root growth (Table 2). These findings are in accordance with Deswal et al (2000) who reported that the combination of N and P at 40, 20 mg $seedling^{-1}$ respectively resulted in increased shoot length, root length and number of branches on one year old *Acacia nilotica* seedlings. The favourable effect of VAM on root length was also reported by Saravanan (1991) in *Acacia mellifera* and A *farnesiana*.

The collar diameter increased by 83 per cent over control (T_1) when the seedlings were applied with FYM (500 g), VAM (40 g) and *Azospirillum* (20 g) in combination with 1.5 g N, 0.938 g of P_2O_5

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

and 0.938 g of K_2O kg^{-2} of soil (T_4). The above treatments paved the way for higher build up of both available N and P and also facilitated the enhanced uptake of nutrients (Table 3). These findings are in accordance with Gangoo et al (1997) who reported that the combination of N and K boosted the diameter of *Populus deltoides* seedlings. Singh (2001) reported that fertilizer (NPK) application significantly increased the collar diameter, height, shoot biomass and nutrient uptake by *Populus deltoides* seedlings in nursery. Same results were reported by George (1997) in teak (*Tectona grandis*) and Singh and Banerjee (1999) in *Albizia procera* seedlings.

Maximum number of leaves were obtained when the seedlings were applied with 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) (T_4) accounting for 147 per cent increase over control at 120 DAT. The above treatments enjoyed a better nutrient environment with optimal doses of NPK supplemented with *Azospirillum* and VAM that enhanced the availability of N to the plants that in turn produced maximum number of leaves (Table 3). The present findings are in line with those of Saravanan (2000) who reported that application of 13.5 kg of N, 36 kg of P_2O_5 and 27 kg of K_2O ha^{-1} along with FYM and *Azospirillum* increased the shoot length and number of leaves in *Azadirachta indica*. In the present investigations the root dry weight was significantly increased by the association of biofertilizers with organic and inorganic fertilizers. Hence the bioinoculant treated bamboo seedlings with its significantly higher root weight with well developed root system could establish well in even harsh conditions.

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

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

Application of FYM (500 g), VAM (40 g) and *Azospirillum* (20 g) in combination with 1.5 g N, 0.938 g of P_2O_5 and 0.938 g of K_2O kg^{-2} of soil increased the shoot dry matter, root dry matter and total dry matter production to the tune of 140, 112 and 126 per cent respectively proving more beneficial nature of combined effect of inorganic and biological sources of nutrients in enhancing the dry matter production (Table 4). Nitrogen is the key element for increasing the dry matter production and obviously the N availability in the soil has unique importance. The above findings of this study corroborate with the results of George (1997) who reported that the application of *Azospirillum* along with NPK produced higher dry matter production of *Tectona grandis*. Similar results were obtained by Tiwari and Saxena (2003) in *Dalbergia sissoo* and Prasad et al (1998) in *Albizia procera* and *Ougeinia dalbergioides*. Singh and Banerjee (1999) reported that the combination of NPK @ 150-50-50 of N, P_2O_5 and K_2O kg ha^{-1} produced higher biomass when compared to their lower levels in *Albizia procera* seedlings.

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

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) (T_4) recorded higher value in the quality parameters viz root/shoot ratio, volume index and quality index among the treatments at 120 DAT (Table 5). This might be due to enhanced uptake of phosphorus by mineralizing the soil phosphorus (Cooper 1979). It is well established that root colonization by vesicular-arbuscular mycorrhizal fungi helps in host plant growth and nutrition (Mosse

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	1.927	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

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

1973). The VAM symbiosis is known to promote acquisition of mineral nutrients especially by host plant (Bolan 1991). These findings are in agreement with the results reported by Gangoo et al (1997) in *Populus deltoides* seedlings and by Garg (2000) in *Prosopis juliflora*. The good seedlings are the result of better quality index. This enhanced response could also be ascribed to the influence of bioinoculants on uptake and plant growth which has been well documented by various scientists (Rangarajan and Narayanan 1990, Karthikayan and Pandiyarajan 1995, Sekar et al 1995)

CONCLUSION

The above findings based on nutrient management studies suggest that 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) gives maximum growth and biomass production in *D strictus*.

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