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Efficacy of microbial inoculants and organic fertilizer for establishing large cardamom (*Amomum subulatum* Roxb.) sucker nursery

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Abstract

An experiment was conducted to evaluate the effectiveness of various microbial inoculants on large cardamom suckers. The study demonstrated the beneficial effect of microbial inoculants, *viz*., *Azospirillum, Pseudomonas fluorescens, Trichoderma harzianum,* phosphate solubilizing bacteria (PSB) and Arbuscular Mycorrhizal Fungi (AMF) on plant growth. Application of farm yard manure (FYM) + *Azospirillum* + *P. fluorescens* + *T. harzianum* + AMF recorded significantly higher number of tillers and plant height as compared to other treatments. Hence, using the above microbial inoculants may facilitate better establishment and growth for planting material in the nursey.

Keywords: *Amomum subulatum*, growth, large cardamom, microbial inoculants, nurser

Large cardamom (*Amomum subulatum* Roxb.) in the sub-Himalayan tract of Sikkim and Darjeeling district of Paschim Banga generally receives less or no bio-input for its growth and development. However, the use of microbial inoculants and organic fertilizer is imperative for better crop stand and health. The idea of controlling and manipulating the soil microflora through the use of microbial inoculants, organic fertilizers and cultural practices to create a more favourable soil microbiological environment and activity for optimum production and protection of various crops is well established (Singh & Jamaluddin 2010; Marathe *et al*. 2011; Parr *et al*. 2011). Arbuscular Mycorrhizal Fungi (AMF) and Plant Growth Promoting Rhizobacteria (PGPR) have been proved significant in reducing the use of organic fertilizers (Parr *et al.* 2011). AMF provide the access to nutrients like N, P and K which are often limited in some soils (Marathe *et al.* 2011). Use of microbial inoculants on plant growth and soil nutrient management is promising since large cardamom is grown organically by tradition (Saju *et al*. 2010). Hence, an experiment was undertaken to study the

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efficiency of microbial inoculants and organic fertilizer on cardamom suckers.

The experiment was carried out in Indian Cardamom Research Institute Research Farm at Kabi (1650 m MSL), North Sikkim during 2009–11. The treatment consisted of $T_{1:}$ Control (Farmers' Practice); $T_{2:}$ FYM alone (500 g plant^{-1}); $T_{3:}$ T_2 + *Azospirillum* (10 g) + *Pseudomonas* (10 mL) + *Trichoderma* (10 g) + PSB (10 g); $T_{4:}$ T_2 + T_3 + AMF (10 g). Experiment was conducted in RBD with five replications. Number of plants per plot was 16. Suckers of the high yielding variety ICRI Sikkim 1 were used. A sucker (planting unit) consisted of one mature tiller having 1-2 young tillers or vegetative buds. Commercially available formulation of *Azospirillum* was used. AMF and Phosphate solubilising bacteria (PSB) were obtained from The Energy Research Institute, New Delhi. *Azospirillum* was a formulation in lignite, PSB in talc and AMF in sand. *Pseudomonas fluorescens* Migula (PF) and *Trichoderma harzianum* Rifai (TH) were obtained from Indian Cardamom Research Institute, Myladumpara, Kerala. PF was grown in King's B broth and TH on broken maize grains. Planting was done in trenches on newly prepared terraces of 2 feet width 1 feet depth filled with top soil on sloppy land. The suckers were planted in line along the trench at a distance of 2 feet during June 2009.

The microbial inoculants were applied at the time of planting. The application of treatments was repeated in August 2009 followed by June and August 2010. Survival (%), growth parameters (number of tillers, height of tallest tiller and number of leaves tallest tiller^{-1}) and microbial population of soil were carried out in 2009–10 and 2010–11 before application, after first application and after second application. Growth parameters were analysed by ANOVA. Number of colony forming units of microbial inoculants was transformed to log values prior to analysis by ANOVA.

The data on growth parameters obtained after second application in 2010–11 were considered to assess the treatment effects. Total number of tillers was significantly high in T_4 (10.9) followed by T_2 (10.4). Number of vegetative buds was on par with each other among various treatments. Tiller height was significantly high in T_4 (90 cm) followed by T_2 (86.5 cm) and T_3 (81.3 cm) as compared to control. There was no significant difference in the number of leaves of tallest tiller among the treatments (Table 1). *Azospirilum* could not be retrieved during 2009–10. Similarly, before application in 2010–11, there was no colony forming units of *Azospirillum* in soil. However, after first and second application *Azospirillum* could be retrieved from the respective treatments. Population of *P. fluorescens* and *T. harzianum* could be retrieved from soil even before first application and this showed that the colonies survived from the previous year. Even though no PSB was applied during 2010, colonies were retrieved from soil and this also showed that the population did survive in the second year (Table 2). However, AMF could not be retrieved from soil or roots.

Large cardamom is a slow growing plant especially during the initial years of planting (Gupta & Upadhyaya 1995; Saju *et al.* 2010). The ratio of tiller formation was 1:10.9 in the case of T_4 which was the maximum. The main purpose of sucker nursery is to generate planting materials for new field planting and area expansion. Providing planting units in the ratio of 1:10.9 obtained in T_4 after two years was promising. Considering the high number of tillers formed, it was inferred that the use of microbial inoculants and organic fertilizer enhanced the growth of plants in the nursery.

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Table 1. Effect of microbial inoculants and organic manure in sucker nursery of large cardamom

Treatment	2009–10				2010–11					
	Survival (%)	Total number of tillers	Height of tallest tiller (cm)	No. of leaves tallest tiller^{-1}	No. of mature tillers	No. of young tillers	Total number of tillers	No. of veg. buds	Height of tallest tiller (cm)	No. of leaves tallest tiller^{-1}
Before application										
T_1 Control (Farmers' Practice)	100	1.7	46.7	7.0	1.4	3.9	5.3	2.4	64.4	6.0
T_2 FYM alone	100	1.8	56.5	6.7	1.2	4.6	5.8	2.3	69.5	6.4
T_3 FYM + AZO + PF + TH + PSB	100	1.9	53.6	6.8	1.2	3.1	4.2	2.0	67.4	5.6
T_4 FYM + AZO + PF + TH + AMF	100	1.8	53.7	6.3	1.3	4.2	5.5	2.5	71.9	5.7
CD (P<0.05)	0	0.5	8.1	0.7	0.2	1.3	1.3	0.4	10.3	1.2
Two months after first application										
T_1 Control (Farmers' Practice)	100	2.0	46.4	6.9	3.4	6.8	9.1	2.6	74.2	8.6
T_2 FYM alone	100	2.0	56.8	6.7	3.2	6.3	9.6	2.0	83.9	9.4
T_3 FYM + AZO + PF + TH + PSB	100	2.1	53.6	6.8	3.6	3.9	7.5	3.7	78.6	9.2
T_4 FYM + AZO + PF + TH + AMF	100	2.0	53.7	6.3	3.3	5.0	8.3	2.9	87.9	8.8
CD (P<0.05)	0	0.5	8.4	0.9	1.8	1.8	1.2	1.5	9.1	0.7
Two months after second application										
T_1 Control (Farmers' Practice)	100	2.0	47.3	6.8	4.7	4.8	9.5	3.7	75.9	9.7
T_2 FYM alone	100	2.1	59.5	7.0	5.4	5.0	10.4	4.2	86.5	9.8
T_3 FYM + AZO + PF + TH + PSB	100	2.0	55.5	6.6	4.3	4.8	9.1	4.2	81.3	9.9
T_4 FYM + AZO + PF + TH + AMF	100	2.1	54.4	6.6	5.5	5.4	10.9	4.3	90.0	9.8
CD (P<0.05)	0	0.5	6.9	0.7	1.7	1.8	1.8	1.0	15.4	1.0

FYM=Farm Yard Manure; AZO=*Azospirillum*; PF=*Pseudomonas fluorescens*; TH=*Trichoderma harzianum*; PSB=Phosphorus Solubilizing Bacteria; AMF=Arbuscular Mycorrhizal Fungi

Table 2. Population of microbial inoculants in the soil of sucker nursery of large cardamom

Treatment	2009–10					2010–11				
	log colony forming units					log colony forming units				
	AZO	PF	TH	PSB	AMF	AZO	PF	TH	PSB	AMF
Before application										
T_1 Control (Farmers' Practice)	0	5.2304	4.4771	3.8260	0	0	5.2304	2.4771	2.4771	0
T_2 FYM alone	0	5.6334	6.0681	5.3010	0	0	5.6334	4.0413	3.2304	0
T_3 FYM + AZO + PF + TH + PSB	0	5.5185	5.6989	4.3222	0	0	5.5185	3.6989	3.5051	0
T_4 FYM + AZO + PF + TH + AMF	0	5.5682	5.8450	5.2304	0	0	5.5682	3.8450	3.8450	0
CD (P<0.05)		2.72	2.47	3.11			0.024	0.586	0.266	
Two months after first application										
T_1 Control (Farmers' Practice)	0	5.6989	5.4771	6.3010	0	0	5.6989	5.4771	2.0000	0
T_2 FYM alone	0	5.5682	6.0791	5.6989	0	0	5.5682	6.0791	2.3010	0
T_3 FYM + AZO + PF + TH + PSB	0	5.7923	6.1846	5.3010	0	4.8450	5.7923	6.1846	3.2787	0
T_4 FYM + AZO + PF + TH + AMF	0	5.0791	6.8305	5.4771	0	5.0791	6.0791	6.8305	3.6020	0
CD (P<0.05)		2.93	0.40	3.81		0.356	0.211	0.338	0.178	
Two months after second application										
T_1 Control (Farmers' Practice)	0	5.7993	5.6334	6.2944	0	0	5.7993	5.6334	2.4771	0
T_2 FYM alone	0	5.7993	6.1038	5.7781	0	0	5.7993	6.1038	2.3010	0
T_3 FYM + AZO + PF + TH + PSB	0	5.6334	6.2479	5.5682	0	5.0413	5.6334	6.2479	3.3424	0
T_4 FYM + AZO + PF + TH + AMF	0	5.0791	5.9395	6.3483	0	5.2304	6.0791	5.9395	3.6434	0
CD (P<0.05)		0.51	0.29	0.57		0.096	0.030	0.134	0.147	

FYM=Farm Yard Manure; AZO=*Azospirillum*; PF=*Pseudomonas fluorescens*; TH=*Trichoderma harzianum*; PSB=Phosphorus Solubilizing Bacteria; AMF=Arbuscular Mycorrhizal Fungi and is presented as number of spores $100g^{-1}$ soil

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