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Influence of planting material, plant population and organic manures on yield of East Indian galangal (*Kaempferia galanga*), soil physico-chemical and biological properties

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ABSTRACT

Results of the field experiment conducted at Kasaragod revealed that FYM and vermicompost application alone decreased the bulk density, improved soil porosity, organic carbon, pH and maximum water holding capacity (MWHC) to a greater extent, whereas composted coir pith had its effect on these characters to lesser extent, except MWHC. The microbial population and dehydrogenase activity were also higher under FYM and VC treatments compared to CCP treatments, whereas under NPK alone and control there was no change in physico-chemical properties but the microbial count and their activity declined. Among organic manures, FYM + NPK combination recorded significantly higher yield components and fresh rhizome yield (6.2 t/ha) compared to FYM, VC, CCP and NPK applied alone. Fresh rhizome yield under mother rhizome was significantly higher compared to finger rhizome.

Key words : Galangal, Organic manures, Plant population, Soil properties, Intercrop, Coconut

Sustainability in agriculture with respect to maintenance of soil fertility and stabilized crop production is the main concern in the present situation. Ever-increasing cost of energy would be an important constraint for increased use of chemical fertilizers in crop production. Use of organic manures to meet the nutrient requirement of crop would be an inevitable practice in years to come for sustainable agriculture since organic manures generally improve the soil physical, chemical and biological properties along with conserving and improving the moisture holding capacity of soil and thus results in enhanced crop productivity along with maintaining the quality of crop produce.

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Farmyard manure (FYM) is the commonly used organic manure but its availability is becoming scarce. In recent days vermicompost (VC) and composted coir pith (CCP) are the alternate organic manures being popularized. Organically grown products is in demand at present due to health consciousness. This is particularly true in medicinal plants, wherein, whole product is used in ayurvedic preparations. East Indian galangal (*Kaempferia galanga* L.) or commonly called as *kacholam* is an important medicinal-cum-aromatic plant.

The research work on the effect of VC and CCP on growth of East Indian galangal and soil properties is meagre. Hence a field experiment was conducted to study the effect of different agronomic practices on yield of East Indian galangal and soil properties when grown as an intercrop in coconut garden.

MATERIALS AND METHODS

The field experiment was conducted during wet (monsoon) seasons of 1995-96 and 1996-97 at the Central Plantation Crops Research Institute, Kasaragod, Kerala, which is situated at 12°30 'N latitude and 75°00 'E longitude at an elevation of 10.7 m above mean sea- level. The average annual rainfall received in the area is 3,401 mm, the maximum temperature ranges between 28.8°C and 32.4°C and minimum temperature varying between 19.4°C and 24.2°C. The soil of the experimental site was red sandy loam. The bulk density of the soil in 0-25 cm and 25-50 cm depths were 1.55 and 1.45 g/cc and the porosity of the soil was 41.5 to 45.3%, respectively. The soil was slightly acidic (pH 5.0 to 5.2) with an electrical conductivity of 0.04 dS/m at 25°C. The soil was low in available N, K and high in available P. The organic carbon content of the soil was low (0.21% at 0-25 cm depth and 0.18% at 25-50 cm depth) with the CEC of 3.5 C mol (p+)/kg soil. The nutrient contents of organic manures used in the experiment are FYM : N 1.2%, P 0.4% and K 0.8%, composted coir pith : N 1.0%, P 0.06 % and K 1.2%; and vermicompost : N 1.4%, P 0.45% and K 0.5%. The organic manures were applied 21 days before planting and mixed well.

The field experiment was laid out in a split-plot design with 3 replications on East Indian galangal crop intrcropped in coconut garden. Types of planting material and populaltion levels formed the main plot treatments, viz., mother rhizome with 333,000 population/ha (20 cm × 15 cm) (S_1P_1) and 500,000 population/ha (20 cm × 10 cm) (S_1P_2) and finger rhizome with 333,000 population/ha (S_2P_1) and 500,000 population/ha (S_2P_2). Organic manures like farmyard manure at the rate of 24 t/ha (F_1); and 32 t/ha (F_2); composted coir pith (CCP) 29 t/ha (F_3); and 39 t/ha (F_4); vermicompost (VC) 21 t/ha (F_5); and 28 t/ha (F_6); FYM (20 t/ha) + NPK (50 : 50 : 50 kg/ha) (F_7); NPK alone (50 : 50 : 50 kg/ha) (F_8); and control (F_9) formed the subplot treatments. The gross plot area for each subplot was 2.0 m × 1.8 m. The same treatments were superimposed in the same plot during the second year.

RESULTS AND DISCUSSION

Crop yield

Fresh rhizome yield under mother rhizome, during both the seasons, was significantly higher compared to finger rhizome (Table 1). The pooled data also

Table 1. Yield components and yield (t/ha) of East Indian galangal as influenced by different treatments

Treatmet	No. of rhizomes/plant			Vol.of rhizomes (ml/plant)			Fresh rhizome yield (t/ha)		
	A	B	C	A	B	C	A	B	C
Planting material									
S_1 Mother rhizome	7.3	8.0	7.6	22.0	21.9	22.0	4.7	5.1	4.9
S_2 Finger rhizome	7.2	7.7	7.5	21.2	21.1	21.2	4.6	5.0	4.8
CD (P = 0.05)	0.04	0.05	0.04	0.22	0.46	0.29	0.10	0.07	0.08
Plant population									
P_1 333 '000/ha	7.0	7.6	7.3	21.4	21.6	21.5	4.5	4.9	4.7
P_2 500 '000/ha	7.0	7.6	7.3	21.4	21.7	21.5	4.8	5.2	5.0
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Organic manure and level									
F_1 FYM : 24 t/ha	8.5	9.3	8.9	26.0	26.5	26.2	5.3	5.7	5.5
F_2 FYM : 32 t/ha	8.6	9.3	8.9	26.0	26.0	26.0	5.3	5.7	5.5
F_3 CCP : 29 t/ha	5.1	5.1	5.1	17.2	17.2	17.2	3.5	4.1	3.8
F_4 CCP : 39 t/ha	5.3	5.8	5.6	16.7	16.7	16.7	3.6	4.1	3.9
F_5 VC : 21 t/ha	8.6	9.3	8.9	25.0	27.0	26.0	5.3	5.7	5.5
F_6 VC : 28 t/ha	8.6	9.3	8.9	26.2	26.2	26.2	5.3	5.7	5.5
F_7 FYM (20 t/ha) + NPK (50 : 50 : 50 kg/ha)	8.8	9.5	9.1	26.0	26.0	26.0	6.0	6.3	6.2
F_8 NPK (50 : 50 : 50 kg/ha)	7.6	8.6	8.1	26.0	26.0	26.0	4.9	5.2	5.1
F_9 Control	4.2	4.2	4.2	13.5	13.5	13.5	2.7	3.1	2.9
CD (P = 0.05)	0.07	0.08	0.07	0.38	0.88	0.54	0.11	0.09	0.08

A : 1995, B : 1996-97, C : Pooled, NS : Non-significant

followed the same trend. The fresh rhizome yield was significantly higher at 500,000/ha population level. Fresh rhizome yield obtained was significantly superior under FYM + NPK compared to other treatments. FYM and VC at both the levels also recorded significantly higher yield compared to CCP at both the levels, NPK alone and control. The NPK alone recorded significantly higher yield compared to CCP at both the levels. The per cent reduction in yield under different organic manure treatments compared to FYM + NPK was 12% with FYM and VC at both the levels, 38.7% with F_3, 37.1% with F_4, 17.7% with NPK alone and 53.2% with control.

Soil physical properties

Soil physical properties like bulk density, porosity and MWHC did not vary significantly due to types of planting material or plant population levels. The bulk density was decreased to 1.380 g/cc in FYM @ 32 t/ha from the initial value of 1.55 g/cc (Table

2), whereas in CCP treated plots the decrease was to the lesser extent (1.470 to 1.471 g/cc during 1996-97). There was no change in the bulk density under NPK alone and control plots. Correspondingly the porosity of the soil also increased to 47.86% under FYM @ 32 t/ha during 1996-97 from the initial value of 41.40%, whereas the increase was up to 44.42 to 44.73% under CCP-treated plots. There was no variation in the porosity of the soil under NPK alone and control treatments. The water holding capacity of the soil was increased under all the organic manure treatments, whereas there was no change in MWHC values under NPK alone and control treatments. The WHC increased up to 33.2% from the initial values of 22.8% under organic manure treatments.

Decrease in BD, increase in porosity and better water conducting properties of the soil are mainly due to the action of gum compounds, polysaccharides and fulvic acid compounds of organic matter on the soil structure (Manickam, 1993). Water retention capacity of the soil gets more pronounced with high organic matter content, basically due to its qualitatively higher net negative charge and the dipolar nature of water molecules. Because of its sponge like structure, coir pith helps retain water and improve aeration. The MWHC of the soil was incrased to 33.2% in CCP @ 29 t/ha treated plots from the initial value of 22.8%. Increase in WHC of the soil due to coir pith application has been reported by Bhowmic and Debnath (1985). Maheswarappa *et al.* (1998) reported decrease in BD, increase in porosity and MWHC due to recycling FYM and poultry waste in coconut-based mixed farming system.

Soil chemical properties

In general, the OC and pH have not been influenced by types of planting material or plant population levels (Table 2). There was increase in the OC and pH of the soil under different treatments except NPK alone and control. Soil organic matter influences chemical functions by its ability to interact with metals, metal oxides, hydroxides and clay minerals to form metallo-organic compounds and acts as ion exchanger and store house of nutrients. Among organic manures, the OC content was increased to 0.380-0.381% under FYM and to 0.391% under VC treated plots compared to CCP treated plots (0.286 and 0.282%) and NPK alone (0.198%) during 1996-97 from the initial value of 0.21%. The OC observed under control plot and NPK alone decreased year after year marginally. Significant increase in OC content due to application of FYM over a long period of time has been reported in coconut based mixed farming (Bopaiah and Shetty, 1991).

Perceptible increase in pH was recorded with the application of FYM, VC and CCP (Table 2).There was no change in pH under NPK and control treatments at both the depths. Maheswarappa *et al.* (1998) reported increase in OC and pH of the soil due to recycling FYM and poultary waste in cononut-based mixed farming system.

Soil biological properties

The soil microbial population did not vary due to types of planting material or plant population levels. The fungal population was higher in FYM and VC treatments (Table 3), whereas NPK alone and control treatments had lower population. Actinomycetes

Table 2. Influence of different treatments on soil physico-chemical properties at 0—25 cm depth

Treatment	BD (g/cc)		Porosity (%)		MWHC (%)		OC (%)		PH	
	A	B	A	B	A	B	A	B	A	B
Planting material										
S_1 : Mother rhizome	1.440	1.440	45.70	45.72	30.15	30.16	0.320	0.331	5.70	5.72
S_2 : Finger rhizome	1.441	1.441	45.73	45.74	30.18	30.19	0.321	0.330	5.69	5.71
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Plant population										
P_1 : 333,000/ha	1.450	1.449	45.68	45.69	30.22	30.25	0.321	0.332	5.71	5.70
P_2 : 500,000/ha	1.449	1.448	45.70	45.70	30.25	30.28	0.320	0.333	5.70	5.70
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Organic manure and level										
F_1 : FYM : 24 t/ha	1.399	1.382	47.73	47.83	31.97	32.17	0.377	0.380	5.72	5.81
F_2 : FYM : 32 t/ha	1.398	1.380	47.74	47.86	32.10	32.20	0.379	0.381	5.78	5.82
F_3 : CCP : 29 t/ha	1.473	1.471	44.30	44.45	33.10	33.20	0.289	0.286	5.41	5.43
F_4 : CCP : 39 t/ha	1.471	1.470	44.50	44.78	33.00	33.10	0.288	0.282	5.40	5.40
F_5 : VC : 21 t/ha	1.398	1.380	47.70	47.75	32.30	32.41	0.385	0.390	5.73	5.80
F_6 : VC : 28 t/ha	1.399	1.381	47.67	47.80	32.51	32.58	0.386	0.391	5.78	5.82
F_7 FYM (20 t/ha) + NPK (50 : 50 : 50 kg/ha)	1.399	1.382	47.58	47.50	31.00	31.03	0.371	0.378	5.74	5.80
F_8 : NPK (50 : 50 : 50 kg/ha)	1.541	1.543	41.51	41.54	22.82	22.81	0.202	0.198	5.21	5.23
F_9 : Control	1.542	1.542	41.50	41.55	22.80	22.80	0.203	0.191	5.24	5.24
CD (P = 0.05)	0.004	0.004	0.08	0.09	0.28	0.24	0.005	0.004	0.06	0.06

A : 1995-96, B : 1996-97, NS : Non-significant

population did not show wide variation among organic manures, however FYM and VC showed higher population. Bacterial population was higher in all the organic manure treatments compared to NPK alone and control. Higher population under FYM and VC treatments attributed to increase in OC status of the soil. Increase in bacterial population to a greater extent than actinomycetes and fungi has been reported by Gaur *et al.* (1994). Bopaiah and Shetty (1991) reported the higher bacterial counts in the rhizospheres of coconut and napier grass, where FYM has been recycled. Tewari *et al.* (1989) reported the higher microbial population in earthwarm casts. The lower microbial population under NPK alone was mainly attributed to suppressive effect of chemical fertilizers on microbial activity. Organic amendments produce more microbial biomass than inorganic fertilisers because they increase the proportion of labile carbon and notrogen, directly stimulating the activity of the micro-organism.

The dehydrogenase activity (DHA) is the indicator of microbial activity in the soil. It was higher in the FYM (4.12-4.21 µg of TPF/g soil/hr), VC (4.24 to 4.31 µg of TPF/g soil/hr) treatments compared to other treatments. The CCP at both the levels, NPK

Table 3. Soil biological properties as influenced by different treatments

Treatment	Fungi population (X 10^4)		Actinomycetes (X 10^5)		Bacteria (X 10^5)		Dehydrogenase activity (µg TPF/g soil/hr)	
	A	B	A	B	A	B	A	B
Planting material								
S_1: Mother rhizome	8.6	9.2	13.9	13.9	13.2	13.3	3.06	3.75
S_2: Finger rhizome	8.3	9.3	13.8	13.9	13.4	13.6	3.01	3.70
Plant population								
P_1: 333 '000/na	8.3	9.1	14.1	14.1	13.6	13.7	3.08	3.76
P_2: 500 '000/ha	8.6	9.2	13.9	14.1	13.3	13.8	3.02	3.69
Organic manures and levels								
F_1: FYM : 24 t/ha	8.1	9.0	15.1	15.2	13.2	13.3	3.92	4.12
F_2: FYM : 32 t/ha	7.9	9.2	15.2	15.4	13.1	13.2	4.02	4.21
F_3: CCP : 29 t/ha	6.3	6.4	12.4	12.4	13.8	13.9	1.82	1.93
F_4: CCP : 39 t/ha	5.3	6.0	12.6	12.8	13.9	14.1	1.74	1.86
F_5: VC : 21 t/ha	8.4	8.9	14.3	14.8	13.8	13.9	4.15	4.24
F_6: VC : 28 t/ha	10.7	10.9	17.3	17.5	13.4	13.8	4.21	4.31
F_7: FYM (20 t/ha) + NPK (50 : 50 : 50 kg/ha)	8.0	9.0	17.6	17.7	13.2	13.8	3.89	4.03
F_8: NPK (50 : 50 : 50 kg/ha)	4.0	4.1	14.3	14.3	10.6	10.0	1.74	1.84
F_9: Control	5.0	5.1	13.4	13.6	9.7	9.8	1.35	1.38

A : 1995-96, B:1996-97, *Data statistically not analysed

alone showed vary less DHA during both the seasons. Increase in DHA due to FYM, VC application was mainly attributed to increase in OC content in turn which enhanced the microbial population. Bopaiah and Shetty (1991) also reported the increase in the activities of urease, dehydrogenase and phosphatase enzyme and microbial biomass in the cononut mixed farming where FYM has been recycled compared to control plot.

REFERENCES

Bhowmic, B.B. and Debnath, C.R. 1985. Coir fibre, Part. II. Potentiality of coir fibre products. *Indian Coconut Journal* **16** (3) : 7-10.

Bopaiah, B.M. and Shetty, H.S. 1991. Soil microflora and biological activities in rhizospheres and root regions of coconut based multistoreyed cropping and coconut monocropping systems. *Soil Biology and Biochemistry* **23** (1) : 89-94.

Gaur, A.C., Neelakantan, S. and Dargan, K.S. 1984. *Organic Manures*. ICAR, New Delhi.

Maheswarapa, H.P., Hegde, M.R., Dhanapal, R. and Biddappa, C.C. 1998. Mixed farming in coconut garden : Its impact on soil physical and chemical properties, coconut nutrition and yield. *Journal of Plantation Crops* **26** (2) : 139-143.

Manickam, T.S. 1993. Organics in soil fertility and productivity management. (*In*) Thampan, P.K. (ed.). *Organics in Soil Health and Crop Production*. pp. 87-104. Peekay Tree Crops Development. Foundation, Cochin, India.

Tiwari, S. C.,Tiwari, B. K. and Mishra, R.R. 1989. Microbial populations, enzyme activities and nitrogen, phophorus and potassium enrichment in earthworm casts and in the surrounding soil of a pineapple plantation. *Biology and Fertility of Soils* **8** : 178-182.