

**INFLUENCE OF ORGANIC MANURES ON YIELD OF ARROWROOT,
SOIL PHYSICO-CHEMICAL AND BIOLOGICAL PROPERTIES
WHEN GROWN AS INTERCROP IN COCONUT GARDEN**

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ABSTRACT

A field experiment was conducted to study the effect of organic manures on certain physico-chemical and biological properties of soil and crop yield of arrowroot when grown as intercrop in coconut garden. Organic manures like, FYM and vermicompost (VC) application alone and FYM+NPK application decreased the bulk density, improved soil porosity and maximum water holding capacity (MWHC) to a greater extent, whereas composted coir pith (CCP) had its effect on these characters in lesser extent except MWHC. Organic carbon and pH of the soil was increased to a greater extent under FYM and VC treated plots compared to CCP. There was no change in above physico-chemical properties under NPK alone and control treatments. The microbial population and dehydrogenase activity was also higher under FYM and VC treatments compared to CCP treatments, whereas under NPK alone and control there was decrease in the microbial count and their activity. Among organic manures, FYM+NPK combination recorded significantly higher yield components and fresh rhizome yield (17.1 t/ha) compared to FYM, VC, CCP and NPK applied alone.

Key words : Coconut, arrowroot, organic manures, soil properties, yield.

In present day alarming situation of degradation and loss of soil and declining crop yields, sustainability in agriculture with respect to maintenance of soil fertility and stabilised crop production year after year is the main concern. Ever-increasing cost of energy would be an important constraint for increased use of chemical fertilisers in crop production

coupled with its deleterious effect on soil environment. Use of organic manures to meet the nutrient requirement of crop would be an inevitable practice in years to come for sustainable agriculture. In recent days vermicompost (VC) and composted coir pith (CCP) are the alternate organic manures being popularised. Importance of organically grown products is in demand at present due to health consciousness. The research work on the effect of VC and CCP on soil properties and crop growth is meagre. Hence, a field experiment was conducted

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to study the effect of organic manures on crop yield of arrowroot when grown as intercrop in coconut garden and soil properties.

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.

The field experiment was laid out in a split plot design with three replications. Sizes of planting material and plant population levels formed main plot viz., 15-20 g with 111 thousands population ha^{-1} (S_1P_1), and 166 thousands population ha^{-1} (S_1P_2), 25-30 g with 111 thousands population ha^{-1} (S_2P_1) and 166 thousands population ha^{-1} (S_2P_2). Organic manures like farm yard manure (FYM) : 26 t ha^{-1} (F_1), FYM : 34 t ha^{-1} (F_2), Composted coir pith (CCP) : 32 t ha^{-1} (F_3) CCP : 42 t ha^{-1} (F_4), Vermicompost (VC) : 22 t ha^{-1} (F_5), VC : 30 t ha^{-1} (F_6), FYM (20 t ha^{-1}) + NPK (75:50:50 kg ha^{-1}) (F_7), NPK alone (75:50:50 kg ha^{-1}) (F_8) and Control (F_9) formed the subplot treatments. The same treatments were superimposed in the same plot during second year. Soil bulk density was determined by following the standard procedure given by Dastane (1967) and maximum water holding capacity as given by Keen and Reczkowski (1921) at top 0-25 cm depth. Soil chemical properties were determined by following the procedure given by Jackson (1973), and biological properties were measured by adopting standard procedures as given by Pramer and Schmidt (1964) and Casida *et al.* (1964).

RESULTS AND DISCUSSION

Crop yield

The yield components did not differ significantly due to 15-20 g and 25-30 g sizes of planting material. The yield also did not differ significantly due to sizes of planting material (12.5 t/ha each). The yield attributes were superior under 111 thousands population ha^{-1} compared to 166 thousands population ha^{-1} . Among organic manures, FYM+NPK, FYM and VC at both the levels had significantly higher yield attributes resulting in significantly higher fresh rhizome yield compared to CCP at both the levels and NPK alone. The yield components like number of rhizomes were more under FYM, VC and FYM+NPK treatments (9.4 to 11.0) compared to NPK alone (8.0), CCP at both the levels (3.3 to 3.5) and control (2.7). Among organic manures, FYM+NPK combination recorded significantly higher fresh rhizome yield (16.9 and 17.3 t/ha during 1995-96 and 1996-97, respectively) compared to other treatments. Reduction in the yield with FYM at both the levels applied alone was 16.4 and 17.9 per cent, with VC at both the levels applied alone was 12.9 and 14.0 per cent, with CCP at both the levels was 41.5 and 42.7 per cent, with NPK alone was 26.9 per cent and with control was 63.7 per cent compared to FYM+NPK treatment.

Soil physical and chemical properties

Soil physical and chemical properties did not vary significantly due to sizes of the planting material or plant population levels. Among organic manure treatments,

the decrease in bulk density was to the greater extent in FYM and VC treated plots (1.389 to 1.392 g cc⁻¹) compared to CCP treated plots (1.466 to 1.477 g cc⁻¹) from the initial value of 1.55 g cc⁻¹ (Table 1). Correspondingly the porosity of the soil also increased to the greater extent in FYM and VC treated plots compared to CCP treated plots. There was no variation in the bulk density and 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. Decrease in BD, increase in porosity and better water conducting properties of the soil is mainly due to the action of gum compounds, polysaccharides and fulvic acid compounds of organic matter on the soil structure (Manickam, 1993). Larson and Clapp (1984) also reported the structural changes due to addition of organic manures, through the changes in pore size both within and between the soil aggregates. Maheswarappa *et al.* (1998) reported decrease in bulk density, increase in porosity and MWHC of the soil under coconut based mixed farming system

Table 1. Influence of different treatments on soil physico-chemical properties in arrowroot

Treatments	BD (g cc ⁻¹)	Porosity (%)	MWHC (%)	OC (%)		pH	
				0-25 cm	25-50 cm	0-25 cm	25-50 cm
Sizes of planting material							
S ₁ : 15-20 g	1.440	45.60	30.11	0.325	0.179	5.66	5.24
S ₂ : 25-30 g	1.440	45.70	30.17	0.325	0.181	5.65	5.22
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
Plant population levels							
P ₁ : 111 Thousands ha ⁻¹	1.440	45.61	30.19	0.326	0.182	5.65	5.25
P ₂ : 166 Thousands ha ⁻¹	1.440	45.68	30.08	0.325	0.182	5.66	5.22
C.D. (5%)	NS	NS	NS	NS	NS	NS	NS
Organic manures & levels							
F ₁ : FYM : 26 t ha ⁻¹	1.391	47.76	31.77	0.378	0.202	5.73	5.29
F ₂ : FYM : 34 t ha ⁻¹	1.390	47.77	32.00	0.381	0.203	5.74	5.31
F ₃ : CCP : 32 t ha ⁻¹	1.477	44.36	33.08	0.290	0.164	5.43	5.14
F ₄ : CCP : 42 t ha ⁻¹	1.466	44.67	32.83	0.292	0.158	5.43	5.14
F ₅ : VC : 22 t ha ⁻¹	1.391	47.73	32.03	0.382	0.197	5.75	5.35
F ₆ : VC : 30 t ha ⁻¹	1.392	47.40	32.77	0.382	0.196	5.78	5.23
F ₇ : FYM (20 t/ha) + NPK (75:50:50 kg/ha)	1.389	47.47	31.02	0.382	0.203	5.58	5.21
F ₈ : NPK (75:50:50 kg/ha)	1.540	41.48	22.71	0.192	0.182	5.22	5.03
F ₉ : Control	1.537	41.46	23.22	0.185	0.137	5.24	5.04
C.D. (5%)	0.004	0.08	0.24	0.004	0.005	0.06	0.04

involving recycling of FYM. Water retention capacity of the soil gets more pronounced with high organic matter content, basically due to its qualitatively higher net negative charges and the dipolar nature of water molecules. Because of its sponge like structure, coir pith helps to retain water and improve aeration. Increase in WHC of the soil due to coir pith application has been reported by Bhowmic and Debnath (1985).

In general there was increase in the OC and pH of the soil under different organic manure treatments (Table 1). Soil organic matter influences chemical functions by its ability to interact with metals, metals 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 a greater extent at 0-25 cm depth under FYM and VC treated plots (0.378 to 0.382%) compared to CCP treated plots (0.290 to 0.292%) and NPK alone (0.192%). The OC observed under control plot and NPK alone decreased year after year marginally. Significant increase in OC content due to application of FYM has been well documented by many workers. Under coconut based mixed farming, Maheswarappa *et al.* (1998) and Bopaiah and Shetty (1991) reported the increase in OC content due to recycling of FYM over a long period of time. Application of worms casts found to increase the OC content of the soil (Tiwari *et al.*, 1989). Jagannathan *et al.* (1990) reported the increase in OC of the soil due to residual effect of coir pith waste application. There was increase in the pH under FYM and VC

treatments to a greater extent compared to CCP alone compared to initial pH of 5.21. There was no change in pH under NPK and control treatments at both the depths. Similar increase in soil pH due to application of cowdung and pongemia cake has been reported by Balasubramanian *et al.* (1972).

Soil biological properties

Organic manures, greatly influenced the soil microbial population. The fungal population was higher in FYM and VC treatments (Table 2), whereas NPK alone and control treatments had lower population. Actinomycetes 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.* (1984). Tiwari *et al.* (1989) also reported the higher microbial populations in earthworm casts. Increase in the colonization of total microbes, N-fixers in the VC applied soil compared to control plot has been reported by Kale *et al.* (1992). Bopaiah and Shetty (1991) reported the higher bacterial counts in the rhizospheres of coconut and napier grass, where FYM has been recycled. The lower microbial population under NPK alone was mainly attributed to suppressive effect of chemical fertilisers on microbial activity. Organic amendments produce more microbial biomass than inorganic

Table 2. Soil biological properties as influenced by different treatments in arrowroot

Treatments	Fungi population (x 10 ⁴) g ⁻¹ soil		Actinomycetes population (x 10 ⁵) g ⁻¹ soil		Bacteria population (x 10 ⁵) g ⁻¹ soil		Dehydrogenase activity (µg TPF g ⁻¹ soil hr ⁻¹)	
	1995-96	1996-97	1995-96	1996-97	1995-96	1996-97	1995-96	1996-97
<i>Types of planting material</i>								
1 : 15-20 g	8.7	9.1	13.8	13.9	13.3	13.4	3.10	3.81
2 : 25-30 g	8.4	9.3	13.9	13.9	13.3	13.4	3.11	3.94
<i>Plant population levels</i>								
1 : 111 Thousands ha ⁻¹	8.6	9.2	14.0	14.0	13.6	13.8	3.21	3.91
2 : 166 Thousands ha ⁻¹	8.5	9.3	13.9	14.0	13.7	13.9	3.20	3.89
<i>Organic manures & levels</i>								
1 : FYM : 26 t ha ⁻¹	8.3	9.2	15.2	15.2	13.6	13.8	3.90	4.20
2 : FYM : 34 t ha ⁻¹	8.3	9.3	16.9	17.2	13.7	13.9	4.10	4.25
3 : CCP : 32 t ha ⁻¹	6.2	6.3	12.4	12.5	13.8	13.9	1.75	1.90
4 : CCP : 42 t ha ⁻¹	5.8	6.0	12.6	12.7	13.9	13.9	1.85	1.91
5 : VC : 22 t ha ⁻¹	8.5	8.9	13.3	13.4	13.8	14.0	4.20	4.31
6 : VC : 30 t ha ⁻¹	9.9	10.4	17.3	17.4	13.5	13.9	4.25	4.35
7 : FYM (20 t/ha) + NPK 75:50:50 kg/ha	8.1	9.0	17.0	17.2	13.4	13.8	3.81	4.01
8 : NPK (75:50:50 kg/ha)	4.1	4.1	14.2	14.2	11.5	10.8	1.71	1.80
9 : Control	4.8	4.9	13.4	13.5	9.8	9.9	1.30	1.32

ertilisers because they increase the proportion of labile carbon and nitrogen, directly stimulating the activity of the microorganisms. The dehydrogenase activity (DHA) is the indicator of microbial activity in the soil. During 1995-96 and 1996-97, it was higher in the FYM (3.90 to 4.25 mg of TPF g⁻¹ soil hr⁻¹), VC (4.20 to 4.35 mg of TPF g⁻¹ soil hr⁻¹) treatments compared to other treatments. CCP at both the levels, NPK alone showed very 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. Galstyan and Avnudzhyan (1970) reported the positive correlation between DHA with the contents of minerals, organic matter and the number of adsorbed microorganisms. Bopaiah and Shetty (1991) also reported the increase in the activities of urease, dehydrogenase and phosphatase enzyme and microbial biomass in the coconut mixed farming where FYM has been recycled compared to control plot.

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