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Influence of fertiliser and organic manures on the yield and quality of cassava (*Manihot esculenta* Crantz.)

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ABSTRACT
Field experiments were conducted to find out the effect of poultry manure on the yield and quality of cassava tubers at Veterinary College and Research Institute Farm, Namakkal during 2001 and 2002. The popular hybrid of cassava H 226 was tried as test crop. Two fertiliser levels viz., 100 per cent recommended NPK (60:60:150 kg ha^{-1}) and 75 per cent recommended NPK (45:45:112.5 kg ha^{-1}) were assigned to main plots. Six organic manurial treatments viz., FYM (25 t ha^{-1}), Poultry manure (10 t ha^{-1}), composted poultry manure (10 t ha^{-1}), FYM (12.5 t ha^{-1}) + poultry manure (5 t ha^{-1}), FYM (12.5 t ha^{-1}) + composted poultry manure (5 t ha^{-1}) along with control (no organic manure) were assigned to sub plots. The results indicated that 100 per cent recommended NPK had better yield than 75 per cent recommended NPK but could not bring out much improvement in the quality characters. But, all the quality characters such as peeled tuber yield, total and industrial starch content and sugar content were positively influenced by the application of organic manures especially composted poultry manure.

Key words : Poultry manure, Compost, Cassava, Yield, Quality.

INTRODUCTION

Among cassava growing countries, India ranks twelfth in area, but it is the seventh largest producer of cassava with a production capacity of 5.4 million tonnes from an area of 0.24 million hectares. However, India tops in productivity with 22.1 t ha^{-1} which is the highest for any country in the world (Chadha and Nayar, 1994)

Application of organic manures has various advantages like increasing soil physical properties, water holding capacity, organic carbon content apart from supplying good quality of nutrients. Poultry manure is rich organic manure since solid and liquid excreta are excreted together resulting in no urine loss. In fresh poultry excreta uric acid or urate is the most abundant nitrogen compound (40-70 per cent of total N) while urea and ammonium are present in small amounts (Krogdahl and Dahlsgard, 1981). The nutritional value of unprocessed poultry manure deteriorates rapidly. Hence, the immediate processing of poultry manure to prevent its rapid decomposition and save its nutrient properties is, thus essential.

Composting or the biological degradation of poultry manure produces a material with several advantages with respect to handling by reducing volume, mass of dry matter, doors, fly attraction and weed seed viability (Sweeten, 1980). Composting poultry manure under anaerobic conditions helps for greater recovery of final product and negligible loss of nutrients particularly nitrogen (Kirchmann and Witter, 1989).

Even though poultry manure contains more amount of nutrients than other manures, the research work on poultry manure is less, since poultry population is concentrated only in certain areas and hence the manure availability also. Moreover poultry manure containing more nutrients, if applied to the intercropping system, may even help to reduce the fertilizer levels to the main crop even without applying inorganic fertilizers to the intercrop. With these ideas in view, the present study was formulated.

MATERIALS AND METHODS

Field experiments were conducted to find out the effect of fertiliser levels and organic manures on the quality of cassava tubers at Veterinary College and Research Institute Farm, Namakkal during 2001 and 2002. The popular hybrid of cassava, H 226 was tried as test crop. Two N levels viz., 100 per cent recommended NPK (60:60:150 kg ha^{-1}) and 75 per cent recommended NPK (45:45:112.5 kg ha^{-1}) were assigned to main plots. Six organic manurial treatments viz., FYM (25 t ha^{-1}), Poultry manure (10 t ha^{-1}), composted poultry manure (10 t ha^{-1}), FYM (12.5 t ha^{-1}) + poultry manure (5 t ha^{-1}), FYM (12.5 t ha^{-1}) + composted poultry manure (5 t ha^{-1}) along with control (no organic manure) were assigned to sub plots. The treatments were fitted in split plot design replicated thrice.

Disease free setts of 20 cm length were prepared and planted at a spacing of 90 x 90 cm. Manures were applied as per treatments and thoroughly incorporated at the time of forming beds and channels

The entire dose of phosphorus, 50 per cent of recommended dose of nitrogen and 50 per cent of potassium were applied basally at the time of planting and the remaining 50 per cent of the recommended dose of nitrogen and potassium were top dressed in two equal splits at third and fifth month, respectively, as per the treatments.

After initial and life irrigation on third day, subsequent irrigations were given to the experimental field at an interval of ten days. Three hand weddings on 30th, 60th and 90th day after planting and an earthing up at 120 DAP was given commonly for all the plots irrespective of the treatments.

Composting of poultry manure was initiated using poultry manure and chopped sorghum straw. The bits of sorghum straw were mixed with poultry manure at the rate of 1:10 and packed in dug pits and closed with mud plaster.

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To maintain optimum moisture, water was sprinkled before it is being packed and left under anaerobic conditions for 75 days as suggested by Sims *et al.* (1992) for composting poultry manure and poultry carcasses. The chemical analysis of the manures is furnished in Table 1.

Table 1 : Chemical analysis of FYM and poultry manure

Particulars	FYM	Poultry manure	Composted poultry manure
N content (%)	0.55	2.20	1.92
P content (%)	0.48	1.41	1.35
K content (%)	0.90	1.52	1.55
p H (1:2 soil water extract)	7.60	6.40	7.10
C: N ratio	20.8	11.8	16.9

Starch content was estimated by the procedure suggested by McCready *et al*. (1950). The hydrocyanin content in tuber and rind was estimated by the method described by Indira and Sinha (1969) and expressed as µg g^{-1}. Industrial starch content was estimated by the method described by Krochmal and Kilbride (1966). Industrial starch yield was calculated by multiplying the industrial starch content with peeled tuber yield and expressed as t ha^{-1} on fresh weight of peeled tuber. The total sugars, non-reducing sugars and reducing sugars were estimated by the methods described by Somogyi (1957).

RESULTS AND DISCUSSION

Fresh tuber yield

In cassava cultivation, the fresh tuber is the ultimate product that decides the benefit. Any practice that improves the yield would enhance returns and this is well known. In this study, various treatments imposed had their own influence on the tuber yield with varying magnitudes. Among the fertilizer levels, 100 per cent NPK recorded higher yield than 75 per cent NPK (Table 2). The reduction in fertilizer dose might have caused a depression in the growth parameters in the early stage as evidenced in this study, which in turn might have reflected in the ultimate yield. Saraswat and Chettiar (1976) obtained yield increase due to higher N up to 150 kg ha^{-1}. Ramanujam and Indira (1987) reported increased yield of cassava due to application of K up to 200 kg K_2O ha^{-1}.

On comparing the data on yield due to the organic manures, it was clearly evident that all the treatments that received organic manures recorded higher tuber yield than no organic manure control suggesting the importance of organic manures. Higher tuber yield due to organic manures could be attributed to favourable changes in soil, which might have resulted in loose and friable soil condition and enabled better tuber formation. Moreover, positive influence of these treatments might be due to slow and steady availability of nutrients throughout the crop growth period from organic manures. Pillai *et al*. (1987) reported the beneficial effect of FYM at 12.5 t ha^{-1} in enhancing the yield of cassava tuber.

Adequate biomass production, better nutrient uptake and improvement in yield parameters might have resulted in higher tuber yield consequent to application of composted poultry manure either alone or in combination with FYM followed by poultry manure in conjunction with FYM. Enrichment of soil N and P in available form by the addition of composted poultry manure might be responsible for good performance by CPM besides their higher NPK content compared to FYM. Jayanthi (1995) reported similar result of higher yield of rice due to composted and recycled poultry manure. Increased castor seed yields due to the application of 10 t ha^{-1} of poultry manure was reported by Ugbaja (1996) and increased egg plant yields up to 15 t ha^{-1} of poultry manure was reported by Opara and Asiegbu (1996). Ponsica *et al***.** (1983) observed a higher efficiency of poultry manure than cattle manure in increasing the yield of Maize. Even though poultry manure had higher N than composted poultry manure, it did not record higher yield over composted poultry manure. The immediate mineralisation of N after application, at the stage, the plant had not even sprouted and the resultant loss of N by ammonia volatilisation might be the reason for the relatively lesser yield recorded under poultry manure. In the present investigation, in part I incubation studies, the available N of the soil incubated with poultry manure increased markedly on 15th day and reduced suddenly on 30th day and slowly thereafter. Wolf *et al***.** (1988) reported that 37 per cent of N in poultry manure was volatilised in 11 days after application, which might reduce the availability of N for plant uptake and this is concomitant to this result. Another ostensible reason might be the narrower C: N ratio of poultry manure. Low C: N ratio might have favoured aerobic fermentation in the field resulting in loss of Co_2 and ammonia, thus reducing the nutrients especially N for plant uptake. Similar result was also reported by Simpson (1986).

Regarding fertilizer levels and organic manure interaction, the treatment combination F_1M_4 registered the highest yield (36.21 t ha^{-1}). The immediate supply of nutrients due to the addition of inorganic fertilizers and the slow and continuous supply of nutrients due to the addition of composted poultry manure either alone or with FYM might be the reason for increased yields in the treatments mentioned. It is noteworthy that composted poultry manure with 75 per cent NPK registered higher yields than the combination of 100 per cent NPK in conjunction with FYM 25 t ha^{-1}, or poultry manure 10 t ha^{-1}, indicating the potentiality of CPM to supply nutrients, even if inorganic fertilizers were reduced by 25 per cent, owing to its higher content of NPK than other organic manures. Similar finding was also reported by Savithri *et al*. (1991) in sorghum.

Table 2 : Effect of fertilizer levels and organic manures on the tuber yield (t ha^{-1}) of cassava

Treatment	2001			2002		
	100 % NPK	75 % NPK	Mean	100 % NPK	75 % NPK	Mean
Control	22.48	21.17	21.83	22.74	21.33	22.03
FYM (25 t ha^{-1}),	32.22	31.05	31.63	32.98	31.72	32.35
Poultry manure (10 t ha^{-1}),	32.52	31.79	32.16	33.16	31.80	32.48
Composted poultry manure (10 t ha^{-1})	35.23	34.12	34.67	36.21	34.66	35.44
FYM (12.5 t ha^{-1}) + poultry manure (5 t ha^{-1})	34.28	32.97	33.62	34.77	33.42	34.10
FYM (12.5 t ha^{-1}) + composted poultry manure (5 t ha^{-1})	34.72	33.57	34.15	35.62	34.22	34.92
Mean	31.91	30.78		32.58	31.19	
	SE_d	CD (P=0.05)		SE_d	CD (P=0.05)	
F	0.32	0.72		0.33	0.73	
M	0.03	0.07		0.03	0.07	
F x M	0.33	0.73		0.33	0.74	

Total and Industrial Starch content

The starch content of the tubers was not affected by fertiliser levels but was significantly affected by organic manures. Fertiliser levels did not influence the starch content of the tubers appreciably (Table 3). The fact that fertiliser levels did not affect starch content of cassava tubers as reported by Muthuswamy and Chiranjivi Rao (1979) might be the plausible reason for the least response of starch due to fertiliser levels.

In general, all the organic manurial treatments registered higher starch content with the values being highest with CPM either alone or with FYM. This might be due to the increased uptake of nutrient in these treatments especially P and K along with the uptake of micronutrients. Several investigators have discussed the beneficial effect of K for starch synthesis in tapioca (Obigbesan, 1977; Nair and Aiyer, 1986; Nair and Sadanandan, 1987). The effect of K in increasing starch content of the tuber was attributed to its role as a factor for a number of enzyme reactions in carbohydrate metabolism, particularly the polymerisation of glucose to starch. (Obigbesan, 1973 and Kumar *et al*., 1976). Abu Saleha (1992) observed an increase in total carbohydrate in Okra due to the application of 50 kg N through poultry manure along with 10 kg N as ammonium sulphate.

Industrial starch yield

The starch extracted from the fresh tuber by mere

Table 3 : Effect of fertilizer level and organic manures on the total starch content, industrial starch content and industrial starch yield of cassava

Treatments	2001			2002		
	Total starch (%)	Industrial starch (%)	Industrial starch yield (t ha^{-1})	Total starch (%)	Industrial starch (%)	Industrial starch yield (t ha^{-1})
100 % NPK	30.9	22.0	5.99	31.3	22.3	6.19
75 % NPK	30.6	21.9	5.74	31.3	22.3	5.92
SE_d	0.2	0.2	0.05	0.2	0.2	0.06
CD (P=0.05)	NS	NS	0.11	NS	NS	0.13
Control	28.5	21.0	3.92	29.2	21.8	4.09
FYM (25 t ha^{-1}),	30.9	21.8	5.94	31.3	22.3	6.15
Poultry manure (10 t ha^{-1}),	31.2	22.1	6.04	31.5	22.4	6.20
Composted poultry manure (10 t ha^{-1})	31.6	22.2	6.56	32.1	22.5	6.88
FYM (12.5 t ha^{-1}) + poultry manure (5 t ha^{-1}	31.2	22.2	6.29	31.7	22.4	6.50
FYM (12.5 t ha^{-1}) + composted poultry manure (5 t ha^{-1})	31.4	22.2	6.47	31.9	22.5	6.69
SE_d	0.4	0.3	0.10	0.4	0.2	0.10
CD (P=0.05)	0.8	0.6	0.20	0.9	0.4	0.20

pulping and agitation with water as is being practiced in starch industry is referred to as industrial starch. From an industrial point of view, the starch content of the fresh tuber and the yield of starch ha^{-1} are more important rather than the yield in terms of fresh tuber (Table 3).

Fertilizer levels could not bring out any change in the industrial starch content. However, all organic manurial treatments tried in this investigation recorded significantly higher industrial starch than control. The better soil conditions provided by organic manures and higher content of NPK and the better uptake of nutrients especially K in these treatments might have influenced the industrial starch content. Muthuswamy and Chiranjivi Rao (1979) reported increase in industrial starch due to increased application of K.

The higher yield of industrial starch by 100 per cent NPK was mainly due to the increased tuber yield recorded at that level of N. Obigbesan and Fayemi (1976) have observed increased starch yield due to N. Muthuswamy and Chiranjivi Rao (1979) reported increased industrial starch yield due to K fertilization.

Among the organic manures, higher industrial starch yield recorded by CPM either alone or with FYM followed by PM + FYM was due to the increased yield of tubers and higher industrial starch content recorded in these treatments. In the present study, one kg of starch was obtained for every 5.35 kg of fresh tapioca tuber. This is in accordance with the findings of Muthuswamy and Chiranjivi Rao (1979) who obtained one kg of starch for every six kg of fresh tapioca tuber in cultivated hybrid H 165. The higher recovery recorded in this investigation might be due to high starch content of the variety H 226 used in this study.

Hydrocyanin content

Fertiliser levels did not affect the HCN content of tuber and rind. Even though 100 per cent NPK registered higher HCN content, the difference did not reach the level of significance (Table 4).

Among the organic manures, all the treatments registered higher HCN content than no organic manure control and the highest HCN content was associated with FYM application. The higher uptake of N by these treatments might be the reason for the increased HCN content. According to Bala Nambissan (1994), basal application of cow dung increased the cyanide level in tubers. Nitrogen uptake stimulated the formation of nitrogenous products such as protein and cynogenic glucosides. Increase in HCN content of tubers and consequent poor quality had already been reported by Nair (1982).

Sugar content

Fertiliser levels did not affect the sugar content of cassava viz., reducing sugar, non-reducing sugar and total sugar. However, organic manures significantly influenced the sugar content (Table 4).

All the manurial treatments registered significantly higher content than no organic manure control and were comparable among them, with the highest content registered under application of poultry manure alone. The higher sugar content recorded by the manurial treatments might be due to better soil physical conditions which could

Table 4 : Fertiliser levels and organic manures on the hydrocyanin ($\mu g\ g^{-1}$) and sugar content (%) of Cassava.

Treatment	2001					2002				
	Hydro cyanin (tuber)	Hydro cyanin (rind)	Reducing sugar	Non-reducing sugar	Total sugar	Hydro cyanin (tuber)	Hydro cyanin (rind)	Reducing sugar	Non-reducing sugar	Total sugar
100 % NPK	16.82	140.1	0.70	1.96	2.66	16.48	134.2	0.71	2.01	2.72
75 % NPK	16.74	139.2	0.70	1.94	2.62	16.29	133.1	0.72	1.98	2.71
SE_d	0.13	1.0	0.01	0.01	0.02	0.12	1.0	0.01	0.02	0.02
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	15.87	135.3	0.66	1.74	2.40	15.21	130.2	0.67	1.79	2.46
FYM (25 t ha^{-1}),	17.48	142.2	0.70	1.87	2.57	17.26	136.2	0.69	1.98	2.67
Poultry manure (10 t ha^{-1}),	16.53	138.2	0.71	1.90	2.61	15.96	132.5	0.74	1.97	2.73
Composted poultry manure (10 t ha^{-1})	16.97	139.9	0.72	2.11	2.83	16.39	133.4	0.76	2.08	2.84
FYM (12.5 t ha^{-1}) + poultry manure (5 t ha^{-1}	16.79	141.2	0.70	2.01	2.71	16.90	135.4	0.70	2.07	2.77
FYM (12.5 t ha^{-1}) + composted poultry manure (5 t ha^{-1})	17.06	141.3	0.70	2.05	2.75	16.60	134.3	0.71	2.09	2.80
SE_d	0.23	1.9	0.01	0.03	0.03	0.22	1.8	0.01	0.03	0.04
CD (P=0.05)	0.46	3.8	0.02	0.05	0.05	0.44	3.7	0.02	0.05	0.07

have helped in nutrient absorption as reported by Ayyasamy (1994) who observed an increase in total sugar content by the application of coir waste at 10 t ha^{-1} and FYM 12.5 t ha^{-1}. The results of Pimpini *et al*. (1992) who had reported higher total and extractable sucrose in sugar beat by application of 4 t ha^{-1} of poultry manure also lend support to this finding. The results indicated that 100 per cent recommended NPK (60:60:150 kg ha^{-1}) had better yield than 75 per cent (45:45:112.5 kg ha^{-1}) recommended NPK but could not bring out much improvement in the quality characters. But all the quality characters such as peeled tuber yield, total and industrial starch content and sugar content were positively influenced by the application of organic manures especially composted poultry manure.

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