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Influence of Organic Manures on the Nutrient Uptake and Soil Fertility of Cassava (*Manihot esculenta* Crantz.) Intercropping Systems

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Abstract: Field experiments were conducted to find out the effect of intercropping and organic manures on the nutrient uptake and soil fertility of cassava intercropping systems at Veterinary College and Research Institute Farm, Namakkal during 2001 and 2002. The popular hybrid of cassava H 226 was tried as test crop. Three intercropping systems viz., sole cassava, cassava + maize (var. African tall) and cassava + cowpea (var. CO 5) were assigned to main plots. Six organic manorial 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 study revealed that sole cassava had higher uptake of all nutrients (N, P and K) followed by cassava intercropped with cowpea. Among the organic manures, composted poultry manure either alone or with FYM had higher uptake. The depletion of soil nutrients was lesser in sole cassava followed by cassava intercropped with cowpea. Among the organic manures, composted poultry manure recorded higher soil nutrients. The N balance in the systems showed a lesser depletion of soil N due to cowpea intercropping and a higher depletion of soil N due to maize intercropping. Among organic manures, composted poultry manure depleted the soil nutrients, the least.

Key words: Cassava, intercropping, poultry manure, nutrient uptake, N balance

Introduction

Intercropping in cassava is a widely followed practice in the humid and sub-humid tropics. In Latin America and Africa, cassava is most commonly associated with an early maturing grain crop such as maize or legumes. Cassava, a long season, wide spaced crop is slow in its initial growth and development and therefore, intercropping a short duration crop may increase the biological efficiency as a whole. Normally, green covers are planted with cassava for a variety of purposes such as cultural weed control, fertility and moisture conservation and forage production (Leihner, 1980).

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 tones 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% of total N) while urea and ammonium are present in small amounts (Krogdahl and Dahlsgard, 1981).

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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, odors, 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).

Intercropping in Cassava helps to reduce soil erosion, leaching nutrient, depletion of fertility and check the growth of weeds than pure crop of cassava. The use of legumes as ground cover with cassava besides providing protection against runoff and erosion, also enhance grain yields in succeeding crops due to nutritional contributions from their residues. With these ideas in view, the present study was formulated.

Materials and Methods

Field experiments were conducted to find out the effect of intercropping and organic manures on the nutrient uptake and soil fertility of Cassava intercropping systems at Veterinary College and Research Institute Farm, Namakkal during 2001 and 2002. The popular hybrid of cassava, H 226 was tried as test crop. Three intercropping systems viz., sole cassava, cassava+maize (var. African tall) and cassava + cowpea (var. CO 5) were assigned to main plots. Six organic manorial 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.

Two rows of intercrops were sown in between the rows of main crop as additive intercropping series. Nutrients were applied only to the main crop. Disease free sets of 20 cm length were prepared and planted at a spacing of 90×90 cm. Seeds of fodder maize and cowpea were dibbled in lines at a spacing of 30×20 cm accommodating two rows of intercrops between the rows of cassava. Manures were applied as per treatments and thoroughly incorporated at the time of forming beds and channels.

A fertilizer dose of 60:60:150 NPK kg ha^{-1} was uniformly applied to all the plots. The entire dose of phosphorus, 50% of recommended dose of nitrogen and 50% of K were applied basally at the time of planting and the remaining 50% 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. Fertilizers were applied only to the main crop. After initial and life irrigation on third day, subsequent irrigations were given to the experimental field at an interval of ten days. Three hand weeding 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. 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
pH (1:2 soil water extract)	7.60	6.40	7.10
C: N ratio	20.80	11.80	16.90

Table 2: Details of analytical methods

	Name of estimation	Author(s)	Methodology
I.	Plant analysis		
	Nitrogen	Humphries (1956)	Kjeldhal method
	Phosphorus	Jackson (1973)	Colorimetric estimation
	Potassium	Jackson (1973)	Flame photometric method
II	Soil analysis		
	Available N	Subbaiah and Asija (1956)	Alkaline permanganate method
	Available P	Olsen *et al.* (1954)	Colorimetry
	Available K	Stanford and English (1949)	Neutral normal ammonium acetate and flame photometry

The whole plant samples collected to record the dry weight were ground into fine powder in Wiley mill and used to find out the nutrient contents at harvest as per standard procedures given in the Table 2. The contents were multiplied with their respective dry matter to calculate the N, P and K uptake and expressed in kg ha^{-1}. The initial composite soil sample collected up to a depth of 30 cm and post harvest samples collected from each plot up to 30 cm depth were air dried under shade, powdered and sieved with a 2 mm sieve and analyzed for chemical properties.

Nitrogen balance in the intercropping system was calculated by computing soil available N in the intercropping system for different treatments as per the procedure suggested by Sadanandan and Mahapatra (1973).

Results and Discussion

Nutrient Uptake by Cassava

Sole cassava recorded the highest NPK uptake followed by cassava intercropped with cowpea, which had comparable uptake with sole cassava (Table 3 and 4). This might be ascribed to the leguminous nature and complementary effect of fodder cowpea on cassava. The N fixed by cowpea might have been taken up by cassava and the complementary effect of cowpea might have boosted the uptake of nutrients from the soils. Similar observation under cassava + groundnut was reported by Prabhakar and Nair (1984) and is concomitant to this finding. The lower uptake of nutrients in cassava intercropped with maize indicated the competitiveness of maize.

The results from the present study also indicated that by and large, application of organic manures registered fairly higher uptake of NPK that might be due to greater availability of nutrients. Added organic manures not only acted as a source of nutrients but also had influenced their availability. Cumulative effect of these treatments seemed to be adequate supplier of nutrients slowly and steadily throughout the crop growth. Sabanyangam (1982) observed increase in the uptake of N and P due to application of FYM at 25 t ha^{-1} in groundnut.

Higher uptake of nutrients in composted poultry manure either alone or with FYM might be due to increased availability of nutrients. Increase in available N due to application of poultry manure and FYM was reported by Rayar (1984). Reddy *et al.* (1980) reported that application of poultry manure decreased the adsorption capacity and increased the soluble P and P desorption and this lend support to the higher uptake of P in poultry manure treatments in this study. Application of poultry manure

Table 3: Effect of intercropping and organic manures on the nutrient uptake (kg ha^{-1}) of Cassava intercropping system, 2001

	N				P				K			
Treatment	Cassava	Maize	Cowpea	Total	Cassava	Maize	Cowpea	Total	Cassava	Maize	Cowpea	Total
I_1 Sole cassava	202.7	-	-	202.7	25.95	-	-	25.95	199.0	-	-	199.0
I_2 Cassava + maize	186.2	20.87	-	206.9	23.29	3.00	-	26.29	180.0	16.32	-	196.3
I_3 Cassava + cowpea	200.2	-	28.50	228.7	25.03	-	2.93	27.96	193.6	-	8.16	201.8
SE_d	1.8	-	-	-	0.24	-	-	-	2.1	-	-	-
CD (p = 0.05)	3.9	-	-	-	0.53	-	-	-	4.6	-	-	-
M_1 control	136.0	16.24	20.63	-	17.66	2.26	2.13	-	131.9	13.25	6.07	-
M_2 FYM (25 t ha^{-1})	198.7	19.82	27.34	-	24.75	2.74	2.77	-	188.8	15.32	7.84	-
M_3 PM (10 t ha^{-1}),	199.2	20.17	28.50	-	24.84	2.87	2.89	-	191.0	15.71	8.17	-
M_4 CPM (10 t ha^{-1}),	224.2	24.17	32.78	-	28.48	3.54	3.37	-	220.6	18.81	9.13	-
M_5 FYM (12.5 t ha^{-1}) + PM (5 t ha^{-1})	207.0	21.03	29.59	-	25.92	3.07	3.07	-	202.5	16.34	8.54	-
M_6 FYM (12.5 t ha^{-1}) + CPM (5 t ha^{-1})	213.0	23.78	32.16	-	26.91	3.49	3.33	-	210.3	18.49	9.20	-
SE_d	2.7	0.35	0.51	-	0.34	0.05	0.05	-	2.5	0.28	0.14	-
CD (p = 0.05)	5.5	0.90	1.32	-	0.68	0.13	0.12	-	5.0	0.71	0.35	-

Table 4: Effect of intercropping and organic manures on the nutrient uptake (kg ha^{-1}) of Cassava intercropping system, 2002

	N				P				K			
Treatment	Cassava	Maize	Cowpea	Total	Cassava	Maize	Cowpea	Total	Cassava	Maize	Cowpea	Total
I_1 Sole cassava	197.0	-	-	197.0	24.62	-	-	24.62	192.7	-	-	192.7
I_2 Cassava + maize	181.2	23.65	-	204.9	22.03	3.38	-	25.41	174.5	18.39	-	192.9
I_3 Cassava + cowpea	193.7	-	31.33	225.0	22.88	-	3.26	26.14	187.6	-	9.17	196.8
SE_d	1.5	-	-	-	0.23	-	-	-	1.9	-	-	-
CD (p = 0.05)	3.3	-	-	-	0.51	-	-	-	4.1	-	-	-
M_1 control	120.6	16.95	23.07	-	15.14	2.45	2.46	-	115.8	13.97	6.90	-
M_2 FYM (25 t ha^{-1})	193.4	23.51	31.31	-	23.15	3.22	3.22	-	181.2	18.18	9.11	-
M_3 PM (10 t ha^{-1}),	195.4	23.87	30.88	-	23.72	3.41	3.19	-	190.7	18.54	9.15	-
M_4 CPM (10 t ha^{-1}),	221.6	27.53	36.14	-	27.07	3.97	3.76	-	218.4	21.31	10.51	-
M_5 FYM (12.5 t ha^{-1}) +PM (5 t ha^{-1})	203.4	24.27	33.40	-	24.67	3.80	3.47	-	196.7	18.92	9.70	-
M_6 FYM (12.5 t ha^{-1}) + CPM (5 t ha^{-1})	209.1	25.73	33.14	-	25.31	3.74	3.46	-	204.8	19.39	9.64	-
SE_d	2.7	0.39	0.53	-	0.32	0.08	0.05	-	2.5	0.32	0.15	-
CD (p = 0.05)	5.4	1.02	1.35	-	0.63	0.20	0.14	-	5.1	0.82	0.40	-

and PM + FYM was found to increase the P availability in soil and subsequently the nutrient uptake in maize (Sharma and Saxena, 1990). Similarly, Iyengar *et al*. (1984) reported higher build up of P concentration in leaf sample of banana due to application of poultry manure. Madhumita Das *et al*. (1991) reported an increase in the exchangeable K due to application of PM up to 24th day after incubation in an incubation study. An increase in N, P, K, Fe, Mn and Cu content of faba beans due to application of poultry manure in comparison with FYM, as reported by Faiyard *et al*. (1991) also lend support to the results obtained in the present investigation.

Even though the N content of PM is higher than CPM, it did not record higher uptake than CPM. This probably might be due to loss of nutrients due to mineralization and volatilization of N. Wolf *et al*. (1988) found that 37% of total N in surface applied poultry manure volatilized in 11 days. Volatilization losses might have significantly reduced the amount of N available for plant uptake.

Nutrient Uptake by Intercrops

Among the organic manure treatments, the highest NPK uptake was associated with composted poultry manure. However, it was comparable with CPM + FYM and PM + FYM. Added organic manures not only acted as a source of nutrients but also increased the availability leading to higher uptake of nutrients (Table 3 and 4). The beneficial effect of organic manures in increasing the available N content was reported by Grewal *et al*. (1981). The increased availability of K due to application of FYM was also reported by Sandhu and Meelu (1974). Increase in the availability of N (Rayar, 1984), P (Ravikumar and Krishnamoorthy, 1983) and K (Madhumita Das *et al*., 1991a) due to application of poultry manure corroborated the present findings. Similarly, Faiyard *et al*. (1991) reported increase in N, P, K contents in faba beans due to application of poultry manure in comparison with FYM.

Total Nutrient Uptake by the Intercropping Systems

Cassava intercropped with cowpea recorded the highest total uptake of nutrients than the other systems followed by cassava intercropped with maize. Sole cassava recorded lesser total nutrients (Table 3 and 4). Cumulative effect of uptake by the intercrops along with cassava in the respective systems might be the reason for such a higher uptake.

Post Harvest Soil Nutrients

The reduction in soil available nutrients compared to initial status, particularly N and K in all the treatments might be due to the higher crop uptake than the quantity of nutrients applied (Table 5).

Cassava intercropped with cowpea had higher available soil nutrients and this might be due to the leguminous nature and complementary effect of cowpea fodder. The N fixed by cowpea might have been taken up by cassava resulting in optimum uptake of soil nutrients especially N, without depleting the soil nutrients. Further, the organic acids produced by the residue of legumes during decomposition might have accelerated the liberation of nutrients especially available P in the soil. The beneficial effects of legumes in cassava legume intercropping by nutritional contributions from their residues were reported by Swaify *et al*. (1988). Thamburaj (1991) reported that the NPK content of the soil was improved due to raising of legumes in cassava.

The low available NPK recorded in cassava + maize combinations might be due to the competitive nature of maize for various nutrients. This is in conformity with the findings of Olasantan *et al*. (1995) who reported that the soil fertility especially N was lower in cassava + maize intercropping than in cassava grown alone.

The available N, P and K in the post harvest soil were higher in treatments that received CPM either alone or with FYM followed by PM + FYM, PM and FYM. All the organic manorial treatments registered higher available N, P and K than no manuring. The application of organic manure increased soil available N (Venkateswara Rao, 1985), soil available P (Yadav *et al*., 1991) whereas available NPK declined in no organic manured plot (Rajendra Prasad and Goswami, 1992). These results corroborate with the findings of the present study.

The higher NPK of the post harvest soil due to poultry manure might be due to its higher nutrients content. A significant increase in the nutrient content of the soil after the harvest of sorghum due to the application of 6.25 t ha^{-1} of coir pith based poultry litter was reported by Savithri *et al*. (1991). Gupta *et al*. (1988) also concluded that the residual effect of organic manures after the harvest of wheat was in the order of poultry manure + FYM followed by PM, FYM and no organic manure which lend support to this present finding.

Table 5: Effect of intercropping and organic manures on the post harvest soil nutrient status NPK (kg ha^{-1})

	2001			2002		
Treatments	N	P	K	N	P	K
I_1 Sole cassava	209.3	14.20	225.9	204.8	13.2	228.0
I_2 Cassava + maize	201.0	13.00	219.4	195.5	12.1	223.8
I_3 Cassava + cowpea	208.7	14.10	224.2	199.5	13.1	228.8
SE_d	1.9	0.20	2.1	3.9	0.1	2.1
CD (p = 0.05)	4.3	0.30	4.6	NS	0.3	4.7
M_1 control	172.4	8.80	186.3	163.9	7.90	195.3
M_2 FYM (25 t ha^{-1})	205.5	14.00	221.6	203.9	12.9	227.7
M_3 PM (10 t ha^{-1}),	213.0	14.80	229.7	208.0	14.0	233.4
M_4 CPM (10 t ha^{-1}),	218.7	15.20	236.6	213.2	14.2	237.3
M_5 FYM (12.5 t ha^{-1}) + PM (5 t ha^{-1})	213.3	14.80	231.1	209.9	13.9	232.1
M_6 FYM (12.5 t ha^{-1}) + CPM (5 t ha^{-1})	215.3	15.20	233.6	200.7	14.0	235.6
SE_d	2.8	0.20	3.0	6.8	0.2	3.1
CD (p = 0.05)	5.6	0.40	6.1	13.5	0.4	6.2
Initial Soil Nutrient	225.0	16.00	248.0	216.0	18.5	256.0

Table 6: Effect of intercropping and organic manures on nitrogen balance in the intercropping systems, 2001

Treatment	Initial soil status (A)	Added nutrient (B)	Uptake by cassava	Uptake by intercrop	Total crop uptake (C)	Expected balance (D)	Actual status (E)	Apparent gain (E-D)/ loss (D-E)	Actual gain (E-A) loss (A-E)
$I_1 M_1$	225	60	146.4	0.0	146.4	138.6	180.6	42.0	-44.4
$I_1 M_2$	225	60	210.4	0.0	210.4	74.6	214.2	139.6	-10.8
$I_1 M_3$	225	60	216.8	0.0	216.8	68.2	219.1	150.9	-5.9
$I_1 M_4$	225	60	236.7	0.0	236.7	48.3	225.3	177.0	0.3
$I_1 M_5$	225	60	218.1	0.0	218.1	66.9	217.6	150.7	-7.4
$I_1 M_6$	225	60	216.8	0.0	216.8	68.2	220.4	152.2	-4.6
$I_2 M_1$	225	60	131.4	16.3	147.7	137.3	167.8	30.5	-57.2
$I_2 M_2$	225	60	194.3	20.1	214.4	70.6	204.6	134.0	-20.4
$I_2 M_3$	225	60	193.3	20.4	213.7	71.3	210.8	139.5	-14.2
$I_2 M_4$	225	60	219.1	24.3	243.4	41.6	214.6	173.0	-10.4
$I_2 M_5$	225	60	203.4	21.2	224.6	60.4	209.4	149.0	-15.6
$I_2 M_6$	225	60	208.6	24.1	232.7	52.3	211.6	159.3	-13.4
$I_3 M_1$	225	60	141.9	20.9	162.8	122.2	176.8	54.6	-48.2
$I_3 M_2$	225	60	212.9	27.7	240.6	44.4	212.4	168.0	-12.6
$I_3 M_3$	225	60	205.7	28.7	234.4	50.6	220.6	170.0	-4.4
$I_3 M_4$	225	60	225.5	32.9	258.4	26.6	228.4	201.8	3.4
$I_3 M_5$	225	60	212.1	29.7	241.8	43.2	219.8	176.6.0	-5.2
$I_3 M_6$	225	60	226.1	32.2	258.4	26.6	221.6	195	-3.4

N Budgeting

The negative balance evidenced in the present study indicated that the N uptake by the crops exceeded the quantity of N applied. Intercropping in cassava and organic manures exerted influence on the soil fertility and N balance and showed a considerable depletion of soil available N due to intercropping maize (Table 6 and 7).

The higher negative N balance recorded in cassava intercropped with maize might be due to the depletion of soil N by exhausting maize crop. Similar result of N depletion by maize was reported by Olasantan *et al*. (1995) in cassava-maize intercropping system.

Cassava intercropped with cowpea did not deplete the soil as much as that of cassava intercropped with maize and this might be due to the atmospheric N fixed by cowpea in the earlier stages, which could have met at least a part of the N requirement of cassava. Intercropping legumes in cassava helped to reduce the depletion of soil N as reported by many workers (Prabhakar and Pillai, 1984; Thamburaj, 1991) is concomitant to this finding.

Table 7: Effect of intercropping and organic manures on the nitrogen balance in the intercropping systems, 2002

Treatment	Initial soil status (A)	Added nutrient (B)	Uptake by cassava	Uptake by intercrop	Total crop uptake (C)	Expected balance (D)	Actual status (E)	Apparent gain (E-D)/ loss (D-E)	Actual gain (E-A) loss (A-E)
$I_1 M_1$	216	60	129.5	0.0	129.5	146.5	172.8	26.3	-43.2
$I_1 M_2$	216	60	204.9	0.0	204.9	71.1	208.4	137.3	-7.6
$I_1 M_3$	216	60	207.0	0.0	207.0	69.0	211.3	142.3	-4.7
$I_1 M_4$	216	60	232.8	0.0	232.8	43.2	218.6	175.4	2.6
$I_1 M_5$	216	60	212.4	0.0	212.4	63.6	214.3	150.7	-1.7
$I_1 M_6$	216	60	217.6	0.0	217.6	58.4	216.1	157.7	0.1
$I_2 M_1$	216	60	113.9	17.2	131.1	144.9	157.2	12.3	-58.8
$I_2 M_2$	216	60	188.4	23.9	212.3	63.7	201.3	137.6	-14.7
$I_2 M_3$	216	60	190.4	24.4	214.8	61.2	206.2	145.0	-9.8
$I_2 M_4$	216	60	219.5	28.6	248.1	27.9	208.2	180.3	-7.8
$I_2 M_5$	216	60	200.2	24.4	224.6	51.4	206.2	154.8	-9.8
$I_2 M_6$	216	60	203.7	26.4	230.1	45.9	207.1	161.2	-8.9
$I_3 M_1$	216	60	127.2	23.2	150.4	125.6	169.6	44.0	-46.4
$I_3 M_2$	216	60	200.8	31.0	231.8	44.2	207.4	163.2	-8.6
$I_3 M_3$	216	60	203.9	31.3	235.2	40.8	210.1	169.3	-5.9
$I_3 M_4$	216	60	216.0	36.9	252.9	23.1	217.3	194.2	1.3
$I_3 M_5$	216	60	206.2	34.2	240.4	35.6	213.1	177.5	-2.9
$I_3 M_6$	216	60	214.0	33.3	247.3	28.7	215.4	186.7	-0.6

In general, application of organic manures resulted in very low depletion of the soil N. Application of CPM registered positive N balance in sole cassava and cassava intercropped with cowpea. Slow decomposition of organic manure especially CPM led to steady N release to meet the requirement of cassava crop at critical stages. Even after the completion of growing period, mineralization of N could be continued and added to the soil pool (Bouldin, 1988). This might have helped in maintaining the soil available N, in spite of depletion by the cassava crop. This was well pronounced with the application of CPM.

The positive balance in the treatment combination in cassava + cowpea coupled with 10 t ha^{-1} CPM might be due to the cumulative effect of atmospheric N fixed by cowpea and the slow release and mineralization of N from CPM and in treatment combination sole cassava applied with 100% recommended NPK and 10 t ha^{-1} of CPM might be due to the absence of intercrop competition and the slow and higher release of N from CPM.

Nutrient balance studied earlier by Kundu and Pillai (1992) and Modgal *et al*. (1995) revealed that there was increasingly positive balance of NPK with the application of organic manures coupled with high levels of recommended NPK in different rice based cropping systems and this lend support to the present result.

The present study revealed that sole cassava did record higher uptake of all nutrients (N, P and K) followed by cassava intercropped with cowpea. Among the organic manorial treatments, composted poultry manure either alone or with FYM had higher uptake. The depletion of soil nutrients was lesser in sole cassava followed by cassava intercropped with cowpea. Among the organic manures, composted poultry manure, either alone or with FYM had recorded higher soil nutrients. The N balance in the systems showed a higher depletion of soil N due to maize intercropping. Among the organic manures, composted poultry manure either alone or with FYM depleted the soil nutrients, the least.

In general, the crop uptake exceeded the quantity of fertilizers applied. The treatment combinations involving either sole cassava or cassava intercropped with cowpea applied with composted poultry manure recorded a slight positive N balance.

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