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Influence of green manure and different organic sources of nutrients on yield and soil chemical properties of rice (*Oryza sativa* L.) grown under lowland condition

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2008-09 on clay loamy soil at wet land under long term organic manurial trial, TNAU, Coimbatore, to study the effect of green manure and different sources of organic manures on yield and soil chemical properties of rice. Green manure incorporation *in situ* + application of poultry manure on N equivalent basis recorded significantly higher grain and straw yield (4844 and 7746 kg ha^{-1}, respectively) compared to other treatments. Green manure incorporation along with poultry manure application resulted in higher soil available N, P and increased K uptake. Higher N and P uptake and increased soil available K was recorded with green manuring and poultry manure application. Incorporation of green manure *in situ*, vermicompost and poultry manure decreased the soil EC, pH and increased the organic carbon content of soil compared to all other combination of treatments.

Key words : Rice, Organics, Green manure, Organic carbon and poultry manure

INTRODUCTION

Rice is a major staple food crop grown in Asia. An estimated 24% of the increase in Asian rice production from 1965 to 1980 was attributed to use of fertilizer, mainly N (Barker *et al.,* 1985). Despite past gains in rice production through fertilizer, recent observations of stagnant or declining yields under continuous rice growing with high levels of N fertilizer have raised concerns about the long-term sustainability impacts of monoculture rice receiving high inputs of N fertilizer. Continuous stagnation of water under the rice system may increase alkalinity of the soil and application of green manures and organic sources to the rice is one of the best and cheaper alternatives against the use of fertilizers in rice system. Heavy and imbalanced use of chemical fertilizers has led to think about the use of organic manures in intensively growing areas for sustainable production system. Judicious use of organic manures and their scientific management is important to sustain the land and to achieve production potential of crops. The addition of chemical fertilizers like nitrogen to the plant leads to nitrate leaching and caused an infant disease like methamoglobinaemia (WHO, 1998). Hence, the expectation that organic farming by reverting to the use of green manures and other sources of organics can bring sustainability in agriculture with eco-friendly environment. It must be stressed that the value of FYM, vermicompost, poultry manure and green manure in soil improvement is due to there nutrient content, besides helping in the improvement of soil structure and water holding capacity of soil (Kale and Bano,1986 and Srivastava, 1998). Recent studies have revealed that rice crop needs more nitrogen than the present recommended dose *i.e.,* 120 kg per ha (Modgal *et al.,* 1995). India has a vast potential to supply nitrogen (11.08 m t) through organic manures *viz.,* FYM, poultry manure, green manures etc. as against total nitrogen consumption of 8.84 m t by crops (Jabhakar, 1992). To increase the productivity and to meet the heavy demand for food of the growing population, it is necessary to recycle available resources and wastes. Nambiar and Ghosh (1994) have shown that neither organic sources nor mineral fertilizers alone can achieve sustainability in crop production. Organic farming helps to improve the physical, chemical and biological properties of soil and maintains the ecological balance as well as productivity of life supporting systems for the future generations (Raj Gopal and Sree Ramulu, 1999). In view of this, the present investigation was carried out to know the effect of green manure and different organic sources of manures on yield and soil chemical properties of rice.

MATERIALS AND METHODS

A field investigation was conducted during *Rabi* season of 2008-09 in clay loam (*Verti sol*) soil in wet lands of Central Farm Unit, Tamil Nadu Agricultural University, Coimbatore, under permanent layout of long term organic manurial trial. The pH of the soil was 8.68, EC 0.44 dS m^{-1}, available N (225 kg ha^{-1}), available P_2O_5 (35 kg ha^{-1}), available K_2O (465 kg ha^{-1}) and organic carbon (0.50%). The experiment was laid out in a split plot design assigning green manure incorporation to main plots *viz.,* G_0: Without green manure incorporation, G_1: With green manure incorporation and manures applications to sub plots *viz*., M_1: No manure (Control), M_2: FYM,

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Table 1 : Nitrogen content, quantity of manures applied and methodology followed in the experiment

1. Manure analysis

Manures	N content (%)	Quantity applied (t ha^{-1})	Method
FYM	0.50	15.0	Alkaline permanganate
Poultry manure	2.14	3.5	method, Subbiah and Asija
Vermicompost	1.74	4.3	(1956)

2. Analysis of chemical properties

Particulars	Method	Author
pH	1:2.5 soil water suspension	Jackson (1973)
EC	Conductivity bridge	Jackson (1973)
Organic carbon (%)	Chromic acid wet digestion	Walkey and Black (1934)
Available N (kg ha^{-1})	Alkaline permanganate	Subbiah and Asija (1956)
Available P (kg ha^{-1})	0.5M Sodium bicarbonate colorimetric method	Olsen *et al*. (1954)
Available K (kg ha^{-1})	Flame photometer	Stanford and English (1949)

3. Plant analysis

Particulars	Method	Author
Total nitrogen	Kjeldahl method	Humphries (1956)
Total phosphorus	Triacid digestion –colorimetric estimation	Jackson (1973)
Total potassium	Triacid digestion – flame photometric method	Jackson (1973)

M_3: Poultry manure and M_4: Vermicompost with three replications. Medium duration rice variety Improved White Ponni (135-140 days) was chosen for the experiment.

Nutrient compositions of the organic manures were analyzed and applied on nitrogen equivalent basis except green manure as recommended for the variety 'Improved White Ponni' (75 kg N ha^{-1}) which is presented in Table 1. *Daincha* was incorporated prior to transplanting after 48 DAS. Rice was transplanted after 28 DAS from the separate organically grown nursery. Various observations were recorded during active tillering (AT), panicle initiation (PI), flowering (F) and at harvest (H) stages. The methodology followed during the experiment was presented in the Table 1.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been presented under following heads :

Grain and straw yield:

Combined application of green manure along with poultry manure recorded increased grain and straw yields (4844 and 7746 kg ha^{-1}) than the other combination of treatments *i.e.,* yield increased by 14.5 per cent over green manure alone, 16.7 per cent over poultry manure alone and 125 per cent over control. This may be due to increased growth attributes like DMP and yield attributes like panicle length, total number of grains, more number of filled grains, comparatively lower sterility per cent. Shukla *et al.* (2001) reported higher growth and yield due to addition of poultry manure + green manure. The data related to grain and straw yields is presented in Table 2.

Nutrient availability:

Higher total available N and P was noticed with the incorporation of green manure + poultry manure compared to other treatments. Higher total available K was found with the incorporation of green manure and poultry manure application than without green manure and control, respectively through out the cropping season. The slow and steady N releasing nature of green manure as well as fast mineralization of poultry manure might have made availability of nutrients throughout the cropping season resulted in higher availability. Similarly, result was obtained by Shukla *et al.* (2001). The data are depicted in Table 3.

Organic carbon:

There was slight improvement in the organic carbon content (0.59 %) compared to initial (0.53 %) due to incorporation of green manure. This improvement in the organic carbon content might be due to contribution of organic manure since from longer period. In rice soil ecosystem green manure building up of organic carbon in soil has been reported by Swarup (1986), Somani (1987), Sharma and Mittra (1988) and Gurung and Sherchan (1996). Green manure contains two fractions of which, one undergoes faster decomposition and release of N for current crop, while other does so at slower rate. Enhanced carbon has been attributed to the later fraction (Bouldin,

Table 2 : Grain and straw yield (kg ha^{-1}) by the crop as influenced by different organic sources of nutrients with and without green manure incorporation

Manures application (M)	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
	Green manuring (G)					
	G_0	G_1	Mean	G_0	G_1	Mean
M_1	2150	3317	2734	3433	5305	4369
M_2	2650	3975	3313	4237	6359	5298
M_3	3453	4844	4148	5522	7746	6634
M_4	3333	4774	4053	5329	7638	6484
Mean	2897	4227		4630	6762	
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
G	73.6	316.5		68.0	292.7	
M	45.6	99.4		65.7	143.1	
G at M	92.4	325.7		105.4	322.8	
M at G	64.5	140.5		92.9	202.4	

Table 3 : Available N and P (kg ha^{-1}) in the soil at different growth stages of rice as influenced by different organic sources of nutrients with and without green manure incorporation

Manures application (M)	Available N (kg ha^{-1})						Available P (kg ha^{-1})					
	Green manuring (G)											
	Active tillering			At harvest			Active tillering			At harvest		
	G_0	G_1	Mean	G_0	G_1	Mean	G_0	G_1	Mean	G_0	G_1	Mean
M_1	216.7	253.7	235.2	195.7	249.2	222.4	16.60	20.37	18.48	12.00	20.30	16.15
M_2	248.7	246.3	247.5	248.6	223.2	235.9	19.50	21.21	20.36	21.20	20.10	20.65
M_3	268.4	284.3	276.4	263.5	291.3	277.4	19.80	21.53	20.67	22.00	21.90	21.95
M_4	261.7	281.8	271.7	257.3	291.0	274.2	19.14	20.96	20.05	19.70	21.30	20.50
Mean	248.9	266.5		241.3	263.7		18.76	21.02		18.73	20.90	
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
G	4.03	17.38		4.05	17.42		0.40	1.71		0.26	1.12	
M	5.47	11.91		7.51	16.35		0.31	0.67		0.63	1.37	
G at M	7.82	21.47		10.05	25.38		0.55	1.81		0.81	1.95	
M at G	7.73	16.84		10.62	23.13		0.44	0.95		0.88	1.93	

Table 4 : Soil chemical properties of the soil at different growth stages of rice as influenced by different organic sources of nutrients with and without green manure incorporation

Treatments	Available K (kg ha^{-1})		Organic carbon (%)		pH	
	Active tillering	At harvest	Active tillering	At harvest	Active tillering	At harvest
			Green manuring (G)			
G_0	527.6	512.8	0.48	0.53	8.39	8.30
G_1	565.0	554.4	0.53	0.59	8.40	8.13
S.E.±	7.68	9.32	0.01	0.01	0.02	0.01
C.D. (P=0.05)	33.06	40.13	0.03	0.05	NS	0.07
			Manures application (M)			
M_1	511.1	497.9	0.47	0.48	8.39	8.23
M_2	553.5	539.9	0.50	0.58	8.37	8.19
M_3	570.8	560.3	0.51	0.60	8.39	8.21
M_4	549.8	536.6	0.55	0.58	8.45	8.25
S.E.±	15.95	15.00	0.01	0.02	0.04	0.08
C.D. (P=0.05)	34.75	32.70	0.02	0.05	NS	NS

1988).

Application of vermicompost recorded the highest values of organic carbon content during active tillering and panicle initiation stages (0.55 and 0.58 %, respectively) than the poultry manure and at flowering and at harvest stages poultry manure recorded highest organic carbon content (0.62 and 0.60 %, respectively) than the vermicompost. Increase in organic carbon content by the application of vermicompost and poultry manure might be due to addition of considerable amount of organic matter at the harvest compared to beginning by these organic manures and also due to faster rate of decomposition compared to FYM. It has an impact on soil pH and liming due to varying amount of calcium carbonate in poultry feed. The data are presented in Table 4.

pH:

Initially pH didn't vary during active tillering and slight decline in pH was observed up to harvest stage (8.40 to 8.13) due to incorporation of green manure and 8.45 to 8.25 due to application of vermicompost. This decrease in pH may be due to organic acids and CO_2 produced during decomposition of green manure which can furnish the protons to the soil, inducing decrease in pH. Release of organic acids during decomposition of organic manures decreased soil pH and low pH favoured the availability of N, P and K nutrients to the soil. The data are presented in Table 4.

Electrical conductivity:

In general, EC of the soil didn't vary much due to addition of organics. In the present study, maximum EC

Table 5 : Electrical conductivity (dSm^{-1}) of soil at different growth stages of rice as influenced by different organic sources of nutrients with and without green manure incorporation

Manures application (M)	Active tillering			Panicle initiation			Flowering			At harvest		
	Green manuring (G)											
	G_0	G_1	Mean	G_0	G_1	Mean	G_0	G_1	Mean	G_0	G_1	Mean
M_1	0.63	0.62	0.63	0.38	0.44	0.41	0.45	0.32	0.39	0.36	0.23	0.29
M_2	0.40	0.48	0.44	0.23	0.31	0.27	0.37	0.37	0.37	0.32	0.32	0.32
M_3	0.59	0.22	0.40	0.32	0.26	0.29	0.37	0.23	0.30	0.26	0.22	0.24
M_4	0.28	0.32	0.30	0.27	0.35	0.31	0.23	0.20	0.21	0.18	0.16	0.17
Mean	0.47	0.41		0.30	0.34		0.35	0.28		0.28	0.23	
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
G	0.005	0.021		0.010	0.045		0.015	0.066		0.009	0.039	
M	0.011	0.024		0.011	0.025		0.017	0.036		0.010	0.022	
G at M	0.014	0.035		0.017	0.052		0.026	0.076		0.015	0.045	
M at G	0.015	0.034		0.016	0.036		0.024	0.051		0.014	0.031	

Table 6 : Nutrient uptake (kg ha^{-1}) by the crop at harvest as influenced by different organic sources of nutrients with and without green manure incorporation

Manures application (M)	N kg ha^{-1}			P kg ha^{-1}			K kg ha^{-1}		
	Green manuring (G)								
	G_0	G_1	Mean	G_0	G_1	Mean	G_0	G_1	Mean
M_1	77.21	88.70	82.96	18.23	19.02	18.63	80.10	89.26	84.68
M_2	86.13	95.00	90.57	19.68	20.40	20.04	84.90	108.42	96.66
M_3	102.41	105.30	103.86	21.75	24.13	22.94	88.80	132.10	110.45
M_4	92.36	100.90	96.63	21.20	21.10	21.15	95.32	123.57	109.45
Mean	89.53	97.48		20.22	21.16		87.28	113.34	
	S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
M	1.29	5.55		0.21	0.90		2.00	8.61	
G	2.71	5.90		0.73	1.58		2.67	5.82	
G at M	3.56	NS		0.91	NS		3.83	10.57	
M at G	3.83	NS		1.03	NS		3.78	8.23	

NS-Non significant

was recorded in the treatment without green manure than green manuring plot. EC of green manured plot increased at active tillering stage and this may due to the waterlogged condition at the beginning and this increase in EC has been short-lived. Conductivity was declined gradually from active tillering and up to the harvest stage (0.40 to 0.13 dSm^{-1}). This decrease in EC was due to addition of readily decomposable organic matter in the form of green manure which would decrease in Eh and accumulation of CO_2. The decrease in EC after and initial rise may be due to reprecipitation of Fe^{2+} and Mn^{2+} and consequent adsorption of other cations on the exchange sites, decrease in P_{CO2} and decomposition of organic acids. Electrical conductivity was more in the control than the FYM, poultry manure and vermicompost. This may be due to stagnation of water alone, where there was absolutely no organic sources. Application of organic manures reduced the EC. Vermicompost treated plot was with the lowest EC values followed by poultry manure. This decrease in EC was observed because of addition organic matter to the soil in the form of organic manure. Data related to EC are depicted in Table 5.

Nutrient uptake:

Incorporation of green manure recorded higher N and P uptake than the without green manure incorporation. Application of poultry manure recorded higher N and P uptake than the FYM and vermicompost. The interaction effect was found significant only with respect to K. Incorporation and decomposition of green manure has solublising effect of N, P and K and micronutrients in the soil and thus resulted in increased nutrient uptake of rice. Application of poultry manure recorded higher N, P and K uptake over other manures. Poultry manure known to have a favourable effect on soil structure, texture and tilth and thus facilitate quick and greater availability of plant nutrients and provides a better environment for root growth and proliferation, thereby creating more absorptive surface for uptake of nutrients. Green manure incorporation with poultry manure application resulted in higher soil available N, P and K uptake. Related data of nutrient uptake are presented in Table 6.

Conclusion:

Green manure incorporation *in situ* followed by poultry manure application on N equivalent basis resulted in higher grain and straw yield with the highest soil available N, P and K uptake. Higher N and P uptake and soil available K was recorded with green manuring and poultry manure application. Incorporation of green manure *in situ*, vermicompost and poultry manure decreased the soil EC, pH and increased organic carbon content of soil.

REFERENCES

Barker, R., Herdt, R.W. and Rose, B. (1985). The Rice Economy in Asia. Resources for the Poor. Washington, DC.

Bouldin, D.R. (1988). Effect of green manure on soil organic matter content and nitrogen availability. In: *Sustainable agriculture-green manure in rice farming*, IRRI, Los Banos, Philippines. pp. 151-163.

Gurung, G.B. and Sherchan, D.P. (1996). Study on biomass production of *Daincha* when relayed under maize and its green manuring effect on rice. PAC-Technical-paper-Pakhribas. Agricultural Centre. 170.

Humphries, E.C. (1956). Mineral components and ash analysis. In: *Modern method of plant analysis*, Springer-Verlar, Berlin, 1 p: 468-502.

Jabhakar, M.L. (1992). **Proc**: National seminar on Organic farming. ICAR Publication New Delhi.

Jackson, M.L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, India. p: 498.

Kale, R. D. and Bano, K. (1986). Field trials with vermicompost (Vee comp. E-83 UAS) on organic fertilizer. Proc: National seminar on organic Waste Utilization, Vermicompost, Part B, Worms and Vermicomposting, pp. 151-160.

Modgal, S.C., Singh, Y. and Gupta, P.C. (1995). Nutrient management in rice-wheat cropping system. *Fert. News*, **40**(5): 49-54.

Nambiar, K.K.M. and Ghosh, A.B. (1994). Highlights of research of a long-term fertilizer experiments in India (1971-82). LTFE Res. Bull., 1, IARI, New Delhi. p.101.

Olsen, S.R., Cole, C.V., Watanabe, P.S. and Dean, A.L. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *USDA. Circ.*., p.939.

Raj Gopal, D. and Sree Ramulu, K.R. (1999). Organic farming in sustaining soil health. *Indian Farming*, **49**(2)**:** 7-10.

Sharma, A.R. and Mittra, B.N. (1988). Effect of green manuring and mineral fertilizer on growth and yield of crops in rice-based cropping system on *Laterite* soil. *J. agric. Sci., Cambridge*, **110:** 605-608.

Shukla, R.K., Choudhari, D.C. and Mahapatra, B.S. (2001). Response of transplanted rice to organic manures and nitrogen fertilization. *J. Farming System Res. & Development*, **7**(1): 52-55.

Somani, L.L. (1987). Decompostion of some organic materials in hilly soils of Rajasthan. *Acta Agronomica Hungarica*, **36:** 103-119.

Srivastava, O. P. (1998). Integrated nutrient management for sustained fertility of soil. *Indian J. agric. Chem*., **31**: 1-12.

Stanford, S. and English, L. (1949). Use of flame photometer in rapid soil tests of K and Ca. *Agron. J*., **41**: 446-447.

Subbaiah, B.V. and Asija, G.L. (1956). A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci*., **25**: 259-260.

Swarup, A. (1986). Effect of pre transplanting submergence and green manure on yield and sodic soil improvement. *IRRN.,* **11:** 39

Walkey, A. and Black, C.A. (1934). An estimation of different methods for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci.,* **37**: 29-38.

WHO (1998). *Guidelines for drinking-water quality*. 2nd Ed: Addendum to Vol.2. Health Criteria and other supporting information, World Health Organization, Geneva.

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