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Effect of Various Nutrient Management Practices on Soil Chemical and Biological Properties after Harvest of Different Traditional Paddy (*Oryza sativa* L.) Varieties

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A field experiment was conducted during *kharif* 2014 in red gravely loam soil at AHRS, Honnavile, Shivamogga to study the effect of different nutrient management practices on soil chemical and biological properties after harvest of traditional Paddy varieties. The experiment was laid out in a Randomized Complete Block Design (Factorial concept) with four varieties and four different nutrient management practices with three replications. Among the different varieties, significantly higher soil available nitrogen (246.7 kg ha^{-1}), phosphorus (29.5 kg ha^{-1}) and potassium (219.8 kg ha^{-1}) was recorded with variety Mysore mallige. However, significantly higher microbial population (66.58 X 10^{6} CFU g^{-1} soil, 12.25 X 10^{4} CFU g^{-1} soil and 13.16 X 10^{4} CFU g^{-1} soil of total bacteria, fungi and actinomycetes respectively) was recorded with variety JGL-1798. Among the different nutrient management practices, application of Rec. FYM + 100 % Rec. N equivalent through organics recorded significantly higher available nitrogen (239.9 kg ha^{-1}), phosphorus (26.7 kg ha^{-1}) and potassium (212.3 kg ha^{-1}), total bacteria (62.66 X 10^{6} CFU g^{-1} soil), fungi (9.33 X 10^{4} CFU g^{-1} soil) and actinomycetes (11.08 X 10^{4} CFU g^{-1} soil) in soil after harvest of different paddy varieties.

Key words: Actinomycetes, Bacteria, Grain yield, Nitrogen, Potassium.

Rice is the staple food for about 50 per cent of the world's population that resides in Asia. But 91 per cent of the world's rice is grown and consumed in Asia (Dobermann *et al.* 2003). In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products**.** Long-term experiments have shown that neither organic sources nor mineral fertilizers alone can achieve sustainability in crop production. Continuous use of FYM is effective in stabilizing rice productivity under low to medium cropping intensity where the nutrients demand is relatively small. Nonetheless, integrated use of organic and mineral fertilizers has been found to be more effective in maintaining higher productivity and stability through correction of deficiencies of secondary and micronutrients in the course of mineralisation on one hand favourable physical and soil ecological conditions on the other. Organic manuring also improves the physical, chemical and microbial conditions of soil and enhances fertilizer use efficiency when applied in conjunction with mineral fertilizers. Thus, all the major sources of plant nutrients such as soil, mineral, organic and biological should be utilized in an efficient and judicious manner for sustainable crop production in rice cropping system.

MATERIALS AND METHODS

The field experiment was conducted during the *kharif* 2014 at the Agriculture and

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Horticultural Research station, Honnavile, University of Agricultural and Horticultural sciences, Shivamogga. The soil was red gravely loam (Sand 81.1 %, Clay 11.5 % and Silt 7.4%) with acidic pH (5.6) and electrical conductivity of 0.14 dS m^{-1} with a bulk density of 1.25 Mg m^{-3} and low organic carbon (0.42g kg^{-1}). The available nitrogen was low (224.6 kg ha^{-1}), medium phosphorus (26.7 kg ha^{-1}) and potassium (206.3 kg ha^{-1}). The organic manures was applied and incorporated 15 days before transplanting of seedlings. Entire recommended P and K with 50% recommended N was applied at transplanting. While 25% recommended N each was top-dressed 30 and 50 days after transplanting. The experiment was laid out in a Randomized Complete Block Design (Factorial concept) with four varieties and four different nutrient management practices with three replications. The traditional cultivars *viz.*, Chinnaponni, Mysore mallige, Coimbatore sanna and high yielding variety JGL - 1798 were used and different nutrient sources *viz.*, Rec. FYM + 100 % Rec. NPK through organics, 100 % Rec. NPK through inorganics (100:50:50 NPK kg ha^{-1}), Rec. FYM + 50% NPK through organics + 50% NPK through inorganics and Rec. FYM + 100 % Rec. NPK through inorganics. The separate nursery beds were prepared near to the main field and seeds were sown in nursery bed @ 62 kg ha^{-1} and 25 days old seedlings were transplanted at the spacing of 20 cm X 10 cm (one seedling $hill^{-1}$). The soil samples were collected from 0-15 cm soil depth after harvest of the crop from each treatment dried under shade, powdered and passed through 2 mm sieve. The organic carbon (Walkey and Blades K_2Cr_2O wet oxidation method), available nitrogen (alkaline permanganate steam distillation Microkjeldhal method), phosphorus (Brays-P) and potassium (Neutral NH_4OAc extraction) were estimated from these samples Jackson (1967). Microbial populations were enumerated from the soil samples collected at 0-15 cm depth. The samples were mixed thoroughly and were subjected to serial dilution using 1 gram of soil in 100 ml of sterile water. The enumeration of microorganisms was done after culturing these organisms using different media by standard dilution plate technique. The media used were soil extract agar for bacteria, Martins Rose Bengal agar with streptomycin sulphate for fungi and Kusters agar for actinomycetes. The number of colonies appeared on agar medium in plate were counted and multiplied by the representative dilution for each group of microorganisms and expressed as number of colonies per gram of oven dry soil. The data obtained were subjected to statistical analysis by adopting Fisher's method of analysis of variance as outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Grain and straw yield

Grain and straw yield differed significantly due to varieties and nutrient management practices. Significantly higher grain and straw yield was recorded with high yielding paddy variety JGL-1798 (4997 and 5488 kg ha^{-1}, respectively) compared to all traditional varieties. However, among the traditional paddy varieties Chinnaponni recorded higher grain and straw yield (3610 and 4892 kg ha^{-1}, respectively) compared to Coimbatore sanna (2881 and 4105 kg ha^{-1}, respectively) and Mysore mallige (1767 and 2458 kg ha^{-1}, respectively) (Table 1). Increase in grain and straw yield in high yielding paddy variety (JGL-1798) may be due to the higher yield attributing parameters. The results of this present investigation are in conformation with the findings of Ahmed *et al.* (1990) and Dahatonde (1998). Whereas, the traditional paddy varieties produce significantly less yield and yield attributing characters as compared to high yielding JGL-1798 paddy variety. Among the different nutrient management practices application of Rec. FYM + 100 % Rec. N equivalent through organics noticed significantly higher grain and straw yield (3581 and 4559 kg ha^{-1}, respectively), followed by Rec. FYM + 100 % Rec. NPK through inorganics (3394 and 4295 kg ha^{-1}, respectively) and Rec. FYM + 50 % N equivalent through organics + 50 % NPK through inorganics (3245 and 4166 kg ha^{-1}, respectively). This might be due to supply of organic source of nutrients have provided nutrients continuously as well as growth hormones that are linked to the increase in leaf area/plant as a consequence of more assimilatory surface area which promoted production of larger quantities of photosynthates finally resulting in better plant growth and development. Further, the possible reason is the availability of optimum quantity of major and micronutrients and the action of growth

hormones produced by the different sources of organic manures resulted higher yield and yield parameters (Muthuramalingam *et al.*, 2001; Prabhakaran, 2002).

Soil chemical properties

Among the different paddy varieties JGL-1798 recorded significantly higher organic carbon (0.54 %) compared to all other varieties. However, significantly higher soil available nitrogen (246.7 kg ha^{-1}), phosphorus (29.5 kg ha^{-1}) potassium (219.1 kg ha^{-1}) were recorded with variety Mysore mallige as compared to other varieties. Among the different nutrient sources application of Rec. FYM + 100 % Rec. N equivalent through organics recorded significantly higher organic carbon (0.56 %), soil available nitrogen (239.9 kg ha^{-1}), phosphorus (26.7 kg ha^{-1}) potassium (212.3 kg ha^{-1}) in soil after harvest of the crop. Whereas, it was on par with application of Rec. FYM + 100 % Rec. NPK through inorganics and Rec. FYM + 50 % N equivalent

Table 1. Grain and straw yield of different paddy varieties as influenced by various nutrient management practices

Varieties	Grain yield (kg ha^{-1}) Nutrient levels				
	N_1	N_2	N_3	N_4	Mean
V_1	3908	3277	3562	3696	3610
V_2	1997	1505	1686	1880	1767
V_3	3132	2638	2785	2970	2881
V_4	5284	4730	4946	5029	4997
Mean	3580	3037	3244	3393	3314
Comparison of mean	S.Em ±			C.D. at 5%	
Varieties	62			177	
Nutrient levels	62			177	
V X N	124			NS	

Varieties	Straw yield (kg ha^{-1}) Nutrient levels				
	N_1	N_2	N_3	N_4	Mean
V_1	5125	4618	4875	4951	4892
V_2	2813	2052	2386	2579	2458
V_3	4488	3874	4015	4043	4105
V_4	5809	5147	5389	5606	5487
Mean	4558	3916	4166	4294	4436
Comparison of mean	S.Em ±			C.D. at 5 %	
Varieties	73			211.1	
Nutrient levels	73			211.1	
V X N	146			NS	

Varieties (V)
V_1: Chinnaponni.
V_2: Mysore mallige
V_3: Coimbatore sanna
V_4: JGL- 1798

Nutrient Levels (N)
N_1 : Rec. FYM + 100 % Rec. N equivalent through organics.
N_2 : 100 % Rec. NPK through inorganics (100:50:50 NPK kg ha^{-1}).
N_3 : Rec. FYM + 50 % N equivalent through organics + 50 % NPK through inorganics
N_4 : Rec. FYM + 100 % Rec. NPK through inorganics
Rec. : Recommended
NS: Non SignificantRecommended dose of fertilizer: 100:50:50 kg NPK ha^{-1}

through organics + 50 % NPK through inorganics (Table 2). This might be due to higher grain and straw yields of crop, which results in extraction most of the soil nutrients. The FYM might have helped to improve the soil chemical and biological properties leading to overall improvement in soil health. Similar views are expressed by Singh *et al.* (2005). Reddy *et al*. (2011) also observed higher soil organic carbon after harvest of rice where higher doses of FYM and BDLM were applied at Mandya, Nagenahalli, Bramhavar and Kathalegere. Application of organic manures at higher dose than the recommendation improved the N, P and K status of soil. It was mainly due to mineralization of nitrogen from organic manures through increased activity of soil micro organisms (Singh *et al.,* 1996).

Soil biological properties

Increased rice yields could also be attributed to significant increase in nutrient uptake of rice in respective treatments involving organic manure. The added organic manure might have enhanced the activity of beneficial soil microflora increasing the availability and uptake of nutrients by the crop. Significantly higher bacteria (66.58 X 10^6 CFU g^{-1} soil), fungi (12.25 X 10^4 CFU g^{-1} soil) and actinomycetes (13.16 X 10^4 CFU g^{-1} soil) was recorded with variety JGL-1798 as compared to other varieties. Among the different nutrient management practices application of Rec. FYM +

Table 2. Soil chemical properties after harvest of different paddy varieties as influenced by various nutrient management practices

Treatments	OC (%)	Nitrogen(kg ha^{-1})	Phosphorus(kg ha^{-1})	Potassium (kg ha^{-1})
Initial nutrient status of soil	0.42	224.6	26.7	206.3
Varieties (V)				
V_1	0.53	236.5	24.9	206.8
V_2	0.48	246.7	29.5	219.1
V_3	0.52	242.7	27.2	213.7
V_4	0.54	226.6	22.4	204.9
S.Em.±	0.01	1.7	0.3	4.1
C.D. at 5 %	0.04	4.9	0.8	11.9
Nutrient Levels (N)				
N_1	0.56	239.9	26.7	212.3
N_2	0.47	236.4	24.6	209.7
N_3	0.51	237.6	26.3	211.0
N_4	0.52	238.6	26.4	203.1
S.Em.±	0.01	1.7	0.3	4.1
C.D. at 5 %	0.04	4.9	0.8	11.9
Interaction (V X N)				
S.Em.±	0.03	3.4	0.6	8.2
C.D. at 5 %	NS	NS	NS	NS

Varieties (V)
V_1: Chinnaponni.
V_2: Mysore mallige
V_3: Coimbatore sanna
V_4: JGL- 1798
Nutrient Levels (N)
N_1 : Rec. FYM + 100 % Rec. N equivalent through organics.
N_2 : 100 % Rec. NPK through inorganics (100:50:50 NPK kg ha^{-1}).
N_3 : Rec. FYM + 50 % N equivalent through organics + 50 % NPK through inorganics
N_4 : Rec. FYM + 100 % Rec. NPK through inorganics
Rec. : Recommended
NS: Non SignificantRecommended dose of fertilizer: 100:50:50 kg NPK ha^{-1}

Table 3. Soil biological properties after harvest of different paddy varieties as influenced by various nutrient management practices

Treatments	Total Bacteria (NO.X10^6 CFU/g soil)	Total Fungi (NO.X10^4 CFU/g soil)	Total Actinomycetes (NO.X10^4 CFU/g soil)
Initial	54.6	5.10	6.00
Varieties (V)			
V_1	62.75	9.50	10.75
V_2	56.66	5.83	7.70
V_3	59.16	7.08	9.58
V_4	66.58	12.25	13.16
S.Em.±	1.04	0.20	0.30
C.D. at 5 %	3.01	0.58	0.88
Nutrient Levels (N)			
N_1	62.66	9.33	11.08
N_2	59.50	7.75	9.14
N_3	61.25	8.66	10.00
N_4	61.75	8.91	10.70
S.Em.±	1.04	0.20	0.30
C.D. at 5 %	3.01	0.58	0.88
Interaction (V X N)			
S.Em.±	2.08	0.40	0.61
C.D. at 5 %	NS	NS	NS

Varieties (V)
V_1: Chinnaponni
V_2: Mysore mallige
V_3: Coimbatore sanna
V_4: JGL- 1798
Nutrient Levels (N)
N_1 : Rec. FYM + 100 % Rec. N equivalent through organics.
N_2 : 100 % Rec. NPK through inorganics (100:50:50 NPK kg ha^{-1}).
N_3 : Rec. FYM + 50 % N equivalent through organics + 50 % NPK through inorganics
N_4 : Rec. FYM + 100 % Rec. NPK through inorganics

Rec. : Recommended
NS: Non SignificantRecommended dose of fertilizer: 100:50:50 kg NPK ha^{-1}

100 % Rec. N equivalent through organics recorded significantly higher bacteria (62.66 X 10^6 CFU g^{-1} soil), fungi (9.33 X 10^4 CFU g^{-1} soil) and actinomycetes (11.08 X 10^4 CFU g^{-1} soil). However, it was on par with application of Rec. FYM + 100 % Rec. NPK through inorganics and Rec. FYM + 50 % N equivalent through organics + 50 % NPK through inorganics. Addition of FYM was highly beneficial in improving bacterial population of soil (Table 3). Addition of FYM increases the activity of beneficial micro-organisms due to fast decomposing organic matter fraction as a consequence there was higher availability of N, P and K in soil. Manjumdar *et al.* (2007) inferred that application of cattle urine to the soil results in increased microflora in soil. Similarly, Pradeep Gopakkali *et al*. (2011) found increase in soil microflora with the application of FYM and cattle urine in rice. Microbial population in soil decreased with the application of recommended dose of fertilizer (100:50:50 kg N:P_2O_5:K_2O ha^{-1}). This might be due to the lower availability of organic matter and unfavorable condition in the soil which resulted in lesser microbial activity.

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