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Utilization of Weed Biomass for Nitrogen Substitution in Rice (*Oryza sativa*)-Rice System

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ABSTRACT

Field experiments were conducted during summer and **kharif** seasons of 2001 and 2002 to evaluate the possibility of utilizing the biomass of weeds viz., *Ipomoea carnea* and *Eichhornia crassipes* either as fresh or as vermicompost prepared from such weed biomass for substituting fertilizer nitrogen in rice-rice system under puddle soil conditions. Results revealed that vermicompost prepared from either *I. carnea* or *E. crassipes* was at par or superior to fresh biomass incorporation and FYM in increasing crop yield, nitrogen uptake and improvement in soil nutrient status. Results also showed the possibility of supplementing 25 to 50% nitrogen through fresh biomass incorporation of *I. carnea* or vermicompost prepared from either *I. carnea* or *E. crassipes*. Significant increase in soil microbial population was also recorded due to incorporation of different sources of organic manure over the recommended nitrogen as fertilizer alone.

Key words : Weed utilization, nutrient supplement, weed management

INTRODUCTION

Productivity of soil cannot be sustained with fertilizer alone. Increasing cost of chemical fertilizer, growing environmental concern and global energy crisis have created considerable interest for search of alternative and cheap sources of plant nutrients for supplementing chemical fertilizer and improving soil health. Further, organic manures like FYM have become scarce. Weed biomass generated in and around farm land may be a potential source of organic manure and nutrients, if properly utilized. Available literature revealed the positive influence of weed biomass and vermicompost prepared from such biomass on crop growth and yield (Vasanthi and Kumaraswamy, 1999; Rajkhowa and Gogoi, 2001). As the information relating to the possibility of utilization of weed biomass for nitrogen substitution in rice-rice system is limited, hence, the present study was undertaken.

MATERIALS AND METHODS

The field experiment was conducted during summer and **kharif** seasons consecutively for two years (2001 and 2002) to study the possibility of substituting fertilizer nitrogen in rice (autumn)-rice (winter) cropping sequence through utilizing weed biomass of two species viz, *Ipomoea carnea* and *Eichhornia crassipes* available in and around farm land as fresh and as vermicompost prepared from such biomass. Soil of the experimental field was acidic (pH 5.2) with organic carbon 8.2 g/kg, available N 240 kg/ha, P 6.2 kg/ha and K 74 kg/ha. The soils of the experimental site had 3.2 x 10^3 fungal and 4.5 x 10^6 bacterial populations per gram of soil. The treatments comprised five sources of organic manure viz., fresh biomass of *I. carnea*, fresh biomass of *E. crassipes*, vermicompost prepared from *I. carnea*, vermicompost prepared from *E. crassipes*, FYM and two N-substitution levels viz,. 25 and 50% substitution alongwith two control–No nitrogen and recommended dose of nitrogen (40 kg/ha). The experiment was laid out in factorial randomized block design with three replications. The rice varieties "Lachit" and "Ranjit" were grown during summer and **kharif** season, respectively. The weed biomass was collected, chopped and incorporated in soil 15 days before final puddling, while vermicompost and farm yard manure were applied at the time of final puddling of the soil as per treatment plan. Vermicompost was prepared from the above two weed species. The biomass of the *I. carnea* and *E. crassipes* was collected, chopped into 2-3 cm size and heaped under sun for a week. The vermicompost was prepared in concrete tanks of 1 m (L) x 0.75 m (B) x 0.5 m (D) size. A thin layer (1-2 cm) of ground soil was placed at the bottom of the tanks above which respective weed biomass and partially decomposed cow dung in

60 : 40 ratio was placed in alternate layers. Earthworm species *Eisenia foetida* was released to the tanks @ 2 kg worms/t of biowaste. The tanks were then covered with Hessian cloth. Sprinkling of water was done as and when necessary to keep the compost mixture moist. The maturity of the compost was judged visually by the formation of dark brown granular structure of the compost after 60 days of composting (Table 1). The crop was transplanted at a spacing of 20 x 15 cm and recommended agronomic practices were followed. During the investigation, different growth and yield parameters as well as yield were recorded. The soil and plant samples were analyzed following standard procedures (Subbiah and Asija, 1956; Jackson, 1973). The build-up of microbial population in soil was studied at harvest of the crop.

RESULTS AND DISCUSSION

Effect on Growth

Growth components in rice significantly varied with the sources of organic manures (Table 2). Significant increase in dry matter production, LAI, chlorophyll content and nitrate reductase activity was recorded with the use of vermicompost from *I. carnea* or *E. crassipes* compared to their fresh biomass incorporation. Farm yard manure as a source of organic manure was comparable to the fresh biomass incorporation in improving different growth components. The increase in plant height was significant only in winter rice and followed the similar trend as that of other growth components. The improvement in growth components in rice due to application of vermicompost compared to fresh biomass incorporation might be due to increased and prolonged availability of nitrogen from this source. Similar results were also reported by Patra *et al.* (2000) and Parihar (2004). Levels of nitrogen substitution could not bring any significant variation in growth components in rice.The overall improvement in growth components in rice

Table 1. Nutrient content and requirement per hectare of vermicompost, weed biomass and FYM

Source	Nutrient content (%)			Requirement (t/ha)	
	N	P	K	25% N substitution level	50% N substitution level
Vermicompost (*I. carnea*)	2.5	1.8	2.9	0.48	0.96
Vermicompost (*E. crassipes*)	2.2	1.3	1.8	0.54	1.08
FYM	0.4	0.2	0.2	2.40	4.80
I. carnea	2.3	0.8	3.0	0.74	1.50
E. crassipes	1.5	0.7	2.5	1.20	2.40

Effect onYield Attributes and Yield

Vermicompost prepared from either *I. carnea* or *E. crassipes* resulted in significantly higher panicle number, panicle length, grains/panicle, panicle weight as well as grain and straw yield of rice compared to the fresh biomass incorporation of *I. carnea, E. crassipes* as well as FYM (Table 3). The effect was similar in both autumn and winter rice. The increased and prolonged availability of nitrogen from vermicompost with narrow C : N ratio might have resulted in increased yield components which ultimately reflected in higher grain yield. Similar observations were also made by Kumar *et al.* (2001). Farm yard manure was comparable to the incorporation of fresh biomass of *I. carnea* or *E. crassipes* in improving the yield components and yield of rice. The overall improvement in yield attributes and yield of rice due to different sources of organic manure was at par with the recommended nitrogen applied as urea. Different levels of nitrogen substitution could not show any significant influence in yield components and yield except the panicle number, which was significantly higher at 50% substitution level.

Effect on Nitrogen Uptake

Sources of organic manure resulted in significant variation in nitrogen uptake by rice. Incorporation of fresh biomass of *E. crassipes* as a source of nitrogen resulted in the lowest nitrogen uptake by autumn and winter rice and was comparable to that of FYM incorporation (Table 4). Vermicompost prepared either from *I. carnea* or *E. crassipes* was at par and

Table 2. Influence of organic manure and levels of nitrogen substitution on growth components in rice (Pooled data of 2001 and 2002)

Treatment	Autumn rice					Winter rice				
	Plant height (cm)	Plant dry matter (60 DAT) (g/hill)	LAI	Chlorophyll content (mg/g tissue)	NRA (nmole NO_2 fr. wt./30 min)	Plant height (cm)	Plant dry matter (60 DAT) (g/hill)	LAI	Chlorophyll content (mg/g tissue) at 60 DAT	NRA (nmole NO_2 fr. wt./30 min) at 60 DAT
Sources of organic manures										
Fresh biomass of *I. carnea*	78.88	19.89	3.34	1.85	1118	83.92	17.71	4.24	2.06	1599
Fresh biomasss of *E. crassipes*	78.7	18.95	2.95	1.75	1038	78.70	15.41	4.19	1.93	1495
Vermicompost from *I. carnea*	84.9	23.25	3.89	2.31	1766	86.78	25.863	4.65	2.59	2120
Vermicompost from *E. crassipes*	84.08	22.75	3.81	2.17	1698	87.72	23.93	4.63	2.50	2063
FYM	82.51	20.9	3.36	2.05	1387	86.16	20.32	4.35	2.17	1616
LSD (P=0.05)	NS	3.05	0.34	0.15	130	5.06	3.50	0.15	0.29	134
Levels of N substitution										
25%	80.81	20.24	3.39	2.04	1416	83.22	20.09	4.33	2.30	1800
50%	82.86	21.67	3.55	2.01	1387	86.12	21.30	4.45	2.20	1757
LSD (P=0.05)	NS	NS	NS	NS	NS	1.45	NS	NS	NS	NS
Treatment vs. control										
Treatment mean	81.84	20.95	3.45	2.02	1401	84.67	20.73	4.41	2.25	1779
No nitrogen	67.35	8.85	1.59	1.37	884	68.16	9.81	3.08	1.32	901
LSD (P=0.05)	3.59	4.61	0.09	0.16	72	7.47	2.25	0.17	0.14	105
Recommended nitrogen	82.64	25.22	3.76	2.09	1401	83.85	23.02	4.35	2.35	1920
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS–Not Significant.

Table 3. Effect of organic manure and levels of nitrogen substitution on yield of autumn and winter rice (Pooled data of 2001 and 2002)

Treatment	Autumn rice						Winter rice					
	Panicles/ m^2	Panicle length (cm)	Grains/ panicle	Panicle weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Panicles/ m^2	Panicle length (cm)	Grains/ panicle	Panicle weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
Sources of organic manures												
Fresh biomass of *I. carnea*	229.8	19.09	83.65	2.14	3.5	6.2	272.8	21.28	127.75	2.87	4.1	7.3
Fresh biomasss of *E. crassipes*	200.8	19.21	79.50	2.03	3.2	5.8	256.2	20.67	127.14	2.88	3.9	7.2
Vermicompost from *I. carnea*	297.0	23.31	98.59	2.55	4.0	6.4	316.2	23.50	148.67	3.31	4.7	7.7
Vermicompost from *E. crassipes*	297.1	23.93	97.39	2.49	4.0	6.2	306.6	22.95	147.05	3.26	4.5	7.6
FYM	232.5	21.86	77.68	2.01	3.5	6.3	279.4	21.33	131.14	2.95	4.2	7.1
LSD (P=0.05)	12.6	1.70	6.50	0.14	0.3	0.3	32.5	1.18	6.05	0.11	0.2	0.5
Levels of N substitution												
25%	248.9	21.27	87.65	2.25	3.6	5.9	279.5	21.29	136.21	3.05	4.2	7.3
50%	254.5	21.51	87.07	2.24	3.6	6.5	291.2	21.60	136.49	3.06	4.3	7.3
LSD (P=0.05)	4.8	NS	NS	NS	NS	NS	9.8	NS	NS	NS	NS	NS
Treatment vs. control												
Treatment mean	251.5	21.39	87.36	2.24	3.6	6.2	285.6	21.95	136.4	3.05	4.3	7.3
No nitrogen	149.7	17.61	48.22	1.24	2.3	3.9	211.5	19.98	90.53	2.08	3.2	60
LSD (P=0.05)	39.5	1.80	2.50	0.19	0.5	1.5	15.1	0.52	3.64	0.17	0.3	0.3
Recommended nitrogen	266.1	22.98	95.39	2.44	3.8	5.8	274.3	21.59	133.78	3.04	4.1	7.5
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS–Not Significant.

resulted in significantly higher uptake of nitrogen over the other sources tried. Increased availability of nitrogen from vermicompost with narrow C : N ratio might have produced higher dry matter in plants which ultimately increased the nitrogen uptake. The increase in nitrogen uptake due to different sources of organic manure was significantly higher over no nitrogen and was at par with recommended dose of nitrogen applied as urea. Nitrogen uptake by rice did not vary due to different levels of nitrogen substitution tried.

Soil Nutrient Status

Significant variation in soil available nitrogen was recorded due to different treatments at the end of two years of experimentation (four cropping seasons). Use of vermicompost prepared either from *I. carnea* or *E. crassipes* resulted in highest build-up of available nitrogen in soil during the years of study (Table 4). The incorporation of fresh biomass of *I. carnea* or *E. crassipes* was at par with FYM in respect of available nitrogen in soil. Different levels of nitrogen substitution also showed significant variation in available nitrogen status in soil. Substitution of 50% nitrogen through organic sources resulted in significantly higher available nitrogen over 25%.

A decline in available nitrogen was recorded in the treatment where no nitrogen was applied. The overall treatment mean in respect of available nitrogen was also significantly higher than the treatment receiving recommended nitrogen as fertilizer. The interaction effect of sources of organic manure and nitrogen substitution level was also significant. Use of vermicompost prepared from *I. carnea* resulted in the highest build-up of nitrogen both at 25 and 50% nitrogen substitution level.

Available P_2O_5 in soil also varied significantly due to sources of organic manures. The highest available P_2O_5 was recorded in the treatments that received vermicompost prepared from *I. carnea* and was at par with the treatment that received vermicompost from *E. crassipes*. Further, substitution of 50% nitrogen through organic sources also resulted in significantly higher build-up of available P_2O_5 over 25% substitution.

Different sources of organic manure also significantly influenced the available K_2O in soil. The available K_2O in soil was highest due to use of vermicompost prepared either from *I. carnea* or *E. crassipes.* Incorporation of fresh biomass of *I. carnea* or *E. crassipes* was at par with FYM in respect of available K_2O in soil. Substitution of 50% nitrogen

Table 4. Effect of treatments on nitrogen uptake (60 DAT), soil nutrient status (after two years of cropping) and microbial population in the post-harvest soil (after four seasons of cropping)

Treatment	Nitrogen uptake (kg/ha) (Pooled data of 2001 and 2002)		Available nutrient (kg/ha)			Bacteria ($X10^6$/g soil)	Fungi ($X10^4$/g soil)
	Autumn rice	Winter rice	N	P_2O_5	K_2O		
Sources of organic manures							
Fresh biomass of *I. carnea*	65.0	67.9	288	24.9	165	3.55	4.15
Fresh biomasss of *E. crassipes*	59.6	56.9	312	27.9	151	3.82	3.90
Vermicompost from *I. carnea*	79.9	94.3	323	32.7	186	5.07	7.15
Vermicompost from *E. crassipes*	78.5	94.2	315	35.1	190	5.23	7.17
FYM	66.4	72.5	295	26.9	151	4.43	5.28
LSD (P0.05)	9.8	13.5	6.6	1.6	7.5	0.12	0.26
Levels of N substitution							
25%	68.6	74.9	301	28.9	165	4.19	5.22
50%	71.2	78.2	312	30.1	173	4.65	5.84
LSD (P=0.05)	NS	NS	7.0	1.0	5.8	0.07	0.16
Treatment vs. control							
Treatment mean	69.9	76.5	306	29.5	169	4.42	5.53
No nitrogen	30.5	33.2	182	20.6	94	2.83	3.67
LSD (P=0.05)	5.9	8.0	11.2	4.4	9.6	0.28	0.61
Recommended nitrogen	73.6	83.8	275	25.5	162	3.43	4.77
LSD (P=0.05)	NS	NS	9.9	2.3	6.4	0.30	0.64

NS–Not Significant.

through organic manures also resulted in significantly higher available K_2O in soil over 25% substitution. The overall treatment mean in respect of available P_2O_5 and K_2O was significantly higher than the treatment receiving recommended nitrogen as fertilizer showing the beneficial effects of organic manures in build-up of available nutrients in soil. Similar results were also reported by Parihar (2004).

Microbial Population in Post-harvest Soil

Total microbial population (bacteria and fungi) was counted by serial dilution pour technique at the end of four cropping seasons. Significant variation in soil microbial population was recorded due to incorporation of different organic manures (Table 4). Vermicompost prepared either from *I. carnea* or *E. crassipes* recorded significantly higher bacteria and fungal population over the other sources of organic manures. Among the nitrogen substitution level, substitution of 50% recommended nitrogen through organic manures resulted in significantly higher bacteria and fungal population in soil over 25% substitution. Overall treatment mean recorded significantly higher population of bacteria and fungi over recommended nitrogen applied as fertilizer.

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