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Residual effect of organic nutrient management on yield and economics of greengram in rice-greengram cropping system

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ABSTRACT

Field experiments were carried out at Gadarupasha, Puri, Odisha, India during 2014-15 and 2015-16 to study the effect of different sources of organic manures in comparison with RDF on economics of rice with succeeding greengram. The experiment consisted of twelve treatments, which were laid out in Randomized Block Design. In case of greengram the highest gross return was obtained in 50% RDN from vermicompost + 50% RDN from Dhaincha i.e. Rs. 47945/- which is statically at par with 50% RDN from FYM + 50% RDN from vermicompost. The pooled data revealed that the crop receiving 50% RDN from vermicompost + 50% RDN from Dhaincha recorded highest net return i.e. Rs. 32832/- per ha which was remain at par with 50% RDN from FYM + 50% RDN from vermicompost and significantly higher than other organic sources as sole as well as their combinations. The lowest gross return, net return and return per rupee invested were obtained in control treatment where no fertiliser or organic matter was applied.

Key words: Economics, greengram, Odisha, residual effect

INTRODUCTION

Rice-pulse (Greengram or Blackgram) is the predominant cropping system of major rice growing areas of Odisha. The cropping sequence of rice-pulse is practically feasible, viable, economical, eco-friendly, water saving technology for sustaining soil fertility and rice productivity (Lakshmi et al., 2012). In the recent years, crop productivity has modest increase or stagnated in spite of consumption of increased rate of chemical fertilizers (Brisson et al., 2010; Hawkesford, 2014). As a result, agricultural ecosystems face various situations like chemical nutrient saturation, huge nutrient loss through leaching, run-off, volatization, emissions, and immobilization resulting in low nutrient use efficiency. Benefits of organic manures like farm yard manure (FYM), green manures, Azolla and vermicompost (VC) are well known, but their availability is reducing day by day (Sarangi et al., 2016). These organic manures are not only good sources of nutrients but also improve the physical structure of the soil and economics of the farmer (Alagappan and Venkitaswamy, 2016; Sarangi et al., 2016).

Keeping the above points in view, the present study was undertaken to the effect of organic nutrient management on economics of scented rice and its residual effect on economics of green gram in rice-green gram cropping system.

MATERIALS AND METHODS

A field experiment entitled at Gadarupasha, Gop, Puri, Odisha during 2014-15 and 2015-16. The field is situated at 19° 53’ 27’’ N latitude and 86° 06’ 01’’ E longitude with an average altitude of 2 m above mean sea level. It comes under East and South Eastern Coastal Plain Agro-climatic Zone of Odisha. Field experiment was conducted with 12 treatments and 3 replications. The soil

of the experimental plot was sandy clay loam in texture, acidic in soil reaction with medium level of organic carbon and available nitrogen, but high level of available phosphorus and medium level of potassium. The climate of the area is warm and moist with hot and humid summer and mild winter. The rainfall is monsoonal and unimodal.

The study was conducted on aromatic rice–greengram cropping system where rice-greengram cropping system was follwed. The experiment was carried out in randomized block design to study the organic nutrient management in aromatic rice in kharif 2014 and 2015. Its residual effect on greengram was studied in respective *rabi* seasons. During both the years of experimentation, randomization of treatments in *kharif* and *rabi* season remained the same. All the plots demarcated by 10 cm high ridges on all sides. Adequate numbers of irrigation channels were also constructed to provide irrigation independently to each plot.

Treatment details

T_1: Control [No chemical fertilizer or organic Matter OM)]; T_2: 100% RDN (Recommended dose of nitrogen) from chemical fertilizer (60:30:30); T_3: 100% RDN from farm yard manure (FYM); T_4: 100% RDN from vermicompost (VC); T_5: 100 % RDN from Dhaincha; T_6: 100% RDN from Azolla; T_7: 50% RDN from FYM + 50% RDN from VC; T_8: 50% RDN from FYM + 50% RDN from Dhaincha; T_9: 50% RDN from FYM + 50% RDN from Azolla; T_{10}: 50% RDN from VC + 50% RDN from Dhaincha; T_{11} : 50% RDN from VC + 50% RDN from Azolla; T_{12}: 50% RDN from Dhaincha + 50% RDN from Azolla

Table 1. Nutrient content (%) and quantity of organic material applied during *kharif* experiment

Materials used	Content (%) on dry weight basis			Applied quantity (t ha^{-1})
	N	P_2O_5	K_2O	
Farm yard manure (FYM)	0.48	0.25	0.46	12.5
Vermicompost (VC)	1.20	0.42	0.58	5.0
Green leaf manure (Dhaincha)	0.60	0.10	0.25	10.0
Azolla	0.43	0.20	0.40	14.0

As per the treatment nutrients were applied through inorganic as well as organic sources to rice during *kharif* season. In case of organic sources the nutrients were applied through FYM, vermicompost, green leaf manure (Dhaincha) and *Azolla* as whole as well as their combination as per the treatments. All the organic sources were applied as basal dose to rice at the stage of final land preparation and transplanting. The fertilizers were applied as per recommended dose *viz.* 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1}. Half of nitrogen and full amount of phosphorus and potassium were applied in case of inorganic treatment as basal before transplanting and remaining quantity of N was applied in two splits as top dressing *i.e.* 25% of nitrogen was top dressed at 45 days after transplanting (active tillering stage) and rest 25% of nitrogen was top dressed at 75 days after transplanting (panicle initiation stage). The sources of fertilizers were urea for N, single super phosphate (SSP) for P and Muriate of potash (MOP) for K.

Cost of cultivation and gross return were calculated taking into account the prevailing price of inputs and outputs. Net return per hectare and return per rupee invested were also worked out as per the following formula.

Net return = Gross return - Cost of cultivation

$$\text{Return per rupee invested} = \frac{\textit{Gross return}}{\textit{Total Cost of cultivation}}$$

Statistical analysis

The data were analyzed statistically by applying 'analysis of variance' technique for a randomized block design (Cochran and Cox, 1957).

The significance of different sources of variation was tested by error mean square of Fisher Snedecor's 'F' test at probability level of 0.05. Standard error of mean (SEm) was determined in all the cases, while critical difference (CD) at 5% level of significance was estimated only in cases where 'F' test was found significant and provided in the summary tables of the results to compare the difference between the treatment means.

RESULTS AND DISCUSSION

Crop productivity

The seed yield, stick yield and harvest index recorded after harvesting and processing of the crop were presented below.

Seed yield (kg ha^{-1})

The seed yield recorded from each plot at harvest was analyzed statistically and presented in the Table 2. Perusal of seed yield data reflected that residual effect of nutrients management practices of rice had significant effect on seed yield of greengram. As per the pooled data the highest seed yield was produced by 50% RDN from VC + 50% RDN from Dhaincha (946.8 kg ha^{-1}) which remained at par with 50% RDN from FYM + 50% RDN from VC (921.7 kg ha^{-1}) and 50% RDN from FYM + 50% RDN from Dhaincha (898.3 kg ha^{-1}) which significantly differed from other treatments including residual effect from 100% RDN from RDF (670 kg ha^{-1}). The lowest seed yield was observed in control (655 kg ha^{-1}). Similar findings were reported by Mohanty et al. (2015). In continuation to this study, in our earlier report growth and yield attributes also followed similar pattern (Mahunta et al., 2017).

Stick yield (kg ha^{-1})

The stick yield recorded from each plot at harvest was analyzed statistically and presented in the Table 2. Residual effect of nutrient management practices of rice exerted significant effect on stick yield of greengram. Stick yield of greengram followed similar trend as grain yield. As per the pooled data stick yield was found to be highest in 50% RDN from VC+50% RDN from Dhaincha (2786.7 kg ha^{-1}) which was significantly different from all other treatments. The lowest stick yield was observed in control (1558.3 kg ha^{-1}).

Table 2. Residual effect of organic nutrient management in rice on greengram productivity

Treatment	Seed yield (kg ha^{-1})			Stick yield (kg ha^{-1})		
	2015	2016	Pooled	2015	2016	Pooled
T_1 – Control (No fertilizer or OM)	646.7	663.3	655.0	1520.0	1596.7	1558.3
T_2 – 100% RDN from RDF (60:30:30)	653.3	686.7	670.0	1703.3	1836.7	1770.0
T_3 – 100% RDN from FYM (12.5 t ha^{-1})	690.0	693.3	691.7	1913.3	1973.3	1943.3
T_4 – 100% RDN from VC (5 t ha^{-1})	763.3	760.0	761.7	2046.7	2100.0	2073.3
T_5 – 100 % RDN from Dhaincha (10 t ha^{-1})	723.3	756.7	740.0	1996.7	1969.7	1983.2
T_6 – 100% RDN from *Azolla* (14 t ha^{-1})	663.3	670.0	666.7	1860.0	1930.0	1895.0
T_7 – 50% RDN from FYM + 50% RDN from VC	913.3	930.0	921.7	2440.0	2430.0	2435.0
T_8 – 50% RDN from FYM + 50% RDN from Dhaincha	893.3	903.3	898.3	2386.7	2400.0	2393.3
T_9 – 50% RDN from FYM + 50% RDN from *Azolla*	793.3	810.0	801.7	2136.7	2146.7	2141.7
T_{10} – 50% RDN from VC + 50% RDN from Dhaincha	953.3	940.3	946.8	2783.3	2790.0	2786.7
T_{11} – 50% RDN from VC + 50% RDN from *Azolla*	860.0	893.3	876.7	2246.7	2210.0	2228.3
T_{12} –50% RDN from Dhaincha + 50% RDN from *Azolla*	803.3	830.0	816.7	2163.3	2263.3	2213.3
SEm (±)	17.65	17.72	16.73	81.52	79.89	79.19
CD (P=0.05)	51.77	51.96	49.07	239.10	234.31	232.24

OM= Organic material; RDF (Recommended dose of fertilizer) = 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1};

RDN (Recommended dose of nitrogen) = 60 kg N ha^{-1}; FYM = Farm yard manure; VC = Vermicompost

Economics of greengram

Economics of greengram under residual effect of different organic nutrient management practices in rice with respect to cost of cultivation, gross return, net return and return per rupee invested were calculated and presented in Table 3.

Cost of cultivation (₹ ha^{-1})

As greengram was grown as residual crop after harvest of rice without any direct application of fertilizer to greengram the cost of cultivation of greengram remained the same for all the treatments during the experimental year, but there was a slight increase (5% approx) in subsequent year due to increase in cost of other variable inputs. The cost of cultivation for greengram is presented Table 3. The cost of cultivation was increased in subsequent years as expected with mean value of ₹15,113 ha^{-1}.

Gross return (₹ ha^{-1})

In residual greengram cultivation, gross return recorded in each plot after harvesting of greengram was analyzed statistically and presented in the Table 3. Organic nutrient management practices showed significant effect on gross return of greengram in both the years. As per the pooled data of 2015 and 2016 the highest gross return was achieved in treatment with 50% RDN from VC + 50% RDN from Dhaincha (₹47,945 ha^{-1}), which was statistically at par with 50% RDN from FYM + 50% RDN from VC (₹46,327 ha^{-1}). The lowest gross return was obtained in control treatment (₹32,918 ha^{-1}). The same trend was observed in both the experimental years.

Net return (₹ ha^{-1})

The net return estimated by subtracting cost of cultivation from gross return recorded in each plot after harvesting of greengram was analyzed statistically and presented in the Table 3. Organic nutrient management practices in *kharif* rice showed significant effect on net return of residual greengram during both the years. The pooled data revealed that the crop receiving 50% RDN from VC + 50% RDN from Dhaincha recorded the highest net return (₹32,832 ha^{-1}), which remained statistically at par with 50% RDN from FYM + 50% RDN from VC (₹31,213 ha^{-1}) and significantly higher than other organic sources as sole and combination of organic sources. The lowest net return was achieved in control (₹17,804 ha^{-1}). Similarly, INM treatment recorded the highest grain yield of 6270 kg ha^{-1} and the higher gross return (1,17,175) and net return (70,690) and which was comparable with 100% RDN through green manure with the grain yield of 5140 kg ha^{-1} and the gross return of 1,15,380 and the net return of 69,340 respectively (Alagappan and Venkitaswamy, 2016).

Return per rupee invested (₹)

Organic nutrient management practices in *kharif* rice exerted significant impact on return per rupee invested of residual greengram during both the years. The return per rupee invested recorded in each plot after harvesting of greengram was analyzed statistically and presented in the Table 3. The return per rupee invested for different nutrient management practices followed the same trend as that of gross return and net return. As per the pooled data analysis the highest return per rupee invested was obtained with 50% RDN from VC + 50% RDN from Dhaincha (₹3.17) which was at par with 50% RDN from FYM + 50% RDN from VC (₹3.07) and 50% RDN from FYM + 50% RDN from Dhaincha (₹2.99) and significantly different from other treatments. Previous reports also found that integrated nutrient management produced the highest return (Lakshmi et al., 2012).

As regards to residual effect of organic nutrient management practices in rice on greengram, the treatment with 50% RDN from VC + 50% RDN from Dhaincha in rice resulted to be the best in terms of economics such as gross return, net return and return per rupee invested for residual greengram. Performance of residual effect of organic sources alone or in combination might be ascribed to prolonged availability of nutrients to the crop as compared to sole fertilizer application.

Table 3. Residual effect of organic nutrient management in rice on economics of greengram

Treatment	Cost of cultivation (₹ ha^{-1})			Gross return (₹ ha^{-1})			Net return (₹ ha^{-1})			Return rupee^{-1} invested (₹)		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T_1 – Control (No Fertilizer or OM)	14890	15337	15113	32485	33350	32918	17595	18014	17804	2.18	2.17	2.18
T_2 – 100% RDN from RDF (60:30:30)	14890	15337	15113	32837	34493	33665	17947	19156	18552	2.21	2.25	2.23
T_3 – 100% RDN from FYM (12.5 t ha^{-1})	14890	15337	15113	34691	34864	34778	19801	19527	19664	2.33	2.27	2.30
T_4 – 100% RDN from VC (5 t ha^{-1})	14890	15337	15113	38371	38210	38291	23481	22873	23177	2.58	2.49	2.53
T_5 – 100 % RDN from Dhaincha (10 t ha^{-1})	14890	15337	15113	36366	38030	37198	21476	22694	22085	2.44	2.48	2.46
T_6 – 100% RDN from *Azolla* (14 t ha^{-1})	14890	15337	15113	33353	33693	33523	18463	18356	18409	2.24	2.20	2.22
T_7 – 50% RDN from FYM + 50% RDN from VC	14890	15337	15113	45911	46743	46327	31021	31406	31213	3.08	3.05	3.07
T_8 – 50% RDN from FYM + 50% RDN from Dhaincha	14890	15337	15113	44905	45407	45156	30015	30070	30043	3.02	2.96	2.99
T_9 – 50% RDN from FYM + 50% RDN from *Azolla*	14890	15337	15113	39880	40715	40298	24990	25378	25184	2.68	2.65	2.67
T_{10} – 50% RDN from VC + 50% RDN from Dhaincha	14890	15337	15113	47945	47946	47945	33055	32609	32832	3.22	3.13	3.17
T_{11} – 50% RDN from VC + 50% RDN from *Azolla*	14890	15337	15113	43225	44888	44056	28335	29551	28943	2.90	2.93	2.91
T_{12} –50% RDN from Dhaincha + 50% RDN from *Azolla*	14890	15337	15113	40383	41726	41055	25493	26390	25941	2.71	2.72	2.72
SEm (±)	-	-	-	880.6	883.8	834.2	880.6	883.8	834.2	0.1	0.1	0.1
CD (P=0.05)	-	-	-	2582.8	2592.2	2446.6	2582.8	2592.2	2446.6	0.2	0.2	0.2

OM= Organic material; RDF (Recommended dose of fertilizer) = 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1}; RDN (Recommended dose of nitrogen) = 60 kg N ha^{-1}; FYM = Farm yard manure; VC = Vermicompost

CONCLUSION

From this study, it was concluded that, in case of greengram, the highest gross return was obtained in treatment receiving 50% RDN from vemicompost + 50% RDN from Dhaincha which is statically at par with treatment receiving 50% RDN from FYM+50% RDN from vemicompost. As regards to residual effect of nutrient management practices in rice on greengram, the combination of organic sources (vermicompost + Dhanicha) came to be the best in terms of economics such as gross return, net return and return per rupee invested. The lowest gross return, net return and return per rupee invested were obtained in control treatment where no fertiliser or organic matter was applied.

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