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IMPROVEMENT OF PRODUCTIVITY, AGRO-METEOROLOGICAL INDICES, ENERGETICS AND NUTRIENT BALANCE OF RICE-GROUNDNUT CROPPING SYSTEM

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Abstract

Effects of two rice establishment methods namely, direct seeding (DSR) and transplanting (TPR) and three nutrient management practices in rice and three nutrient management practices in groundnut of rice (*Oryza sativa* L.)- groundnut (*Arachis hypogaea* L.) system were investigated. TPR produced 7.1 and 5.6% higher grain (5.75 t/ha) and straw (6.81 t/ha) yields than DSR with superior yield attributing characters. INM (green manuring + 50% STBN + 100% P_2O_5 + 100% K_2O) enhanced grain and straw yields of rice by 13.3 and 10.0% over inorganic (100% STBF) and by 15.2 and 8.2% over organic (green manuring + 1/3rd STBN through vermicompost + 1/3rd STBN through neem oil cake) management practices, respectively. INM practice in groundnut (75% STBN + 25% STBN (FYM) + lime 0.2 LR + biofertilizers (*Rhizobium* + PSB) **+** 100% P_2O_5 + 100% K_2O) also produced the highest pod (2.74 t/ha) and haulm (3.62 t/ha) yield, which were, respectively, 39.8 and 5.5% higher over 75% STBF and 20.2 and 1.4% more than 100% STBF. But, DSR resulted in higher system yield (12.7 t REY/ha), system productivity (34.7 kg REY/ha/day), energy productivity and accumulated heat use efficiency than TPR system. INM practice in rice showed maximum system yield, productivity and P and K balance whereas, organic approach resulted in higher N balance. INM in groundnut produced the maximum system yield, productivity, HUE and N balance, but 75% STBF showed maximum agro-meteorological indices, P and K balance in spite of lowest system yield and system productivity. Energy productivity and efficiency were higher with 100% STBF in groundnut.

Introduction

Rice-groundnut is the predominant cropping system of Odisha as agriculture in Odisha is synonymous to rice farming during *kharif* season, and groundnut is the most preferred crop after rice under different ecosystems depending upon residual soil moisture and irrigation facility tofetch higher returns, meet the vegetable oil demand and sustain productivity of the system. But, both the crops in the system are nutrient exhaustive, need more non-renewable energy and heavy farm machineries and are sensitive to changing climate. Deterioration of soil properties due to improper crop and nutrient management has threatened the productivity and sustainability of the system in the state (Patra *et al*. 2019). Rice is grown mostly through transplanting but due to scarcity of labour, irrigation water and soil degradation, farmers switch over to direct seeding (DSR). Under optimum plant population and weed management condition, DSR is reported to be as good as transplanted rice, but having better adaptation and mitigation mechanism to climate change. Moreover, DSR matures earlier and hands over the land 10 days early, improves the physical condition of soil for the succeeding non-rice crop and enhances sustainability of the rice-based cropping system as compared to puddled transplanting (Bandyoapadhyay *et al*. 2019).

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Integrated nutrient management (INM) is a flexible approach, which minimizes the use of inorganic nutrient sources but maximizes nutrient use efficiency, improves soil health and yield of crops and sustains the productivity of the system (Aruna *et al.* 2014, Ghosh *et al.* 2021). But the unusual weather during crop growth stages under changing climate adversely affects the crop productivity. However, the climatic resources and their interactions with agricultural parameters help increase the crop productivity (Ko *et al.* 2010). Growing degree days and photo thermal units are good estimators of crop growth stages as each stage is having its own heat and photothermal requirements (Prabhakar *et al.* 2007). Energy is an essential input for agricultural production and maximum benefits in agricultural production can be obtained through optimal and proper utilization of energy inputs involved in various farm operations (Patel *et al.* 2018). Nutrient management in any cropping system including the rice-groundnut one needs to be evaluated agronomically, climatologically as well as in terms of nutrient and energy use efficiency for better productivity, profitability, sustainability and adoptability.

Materials and Methods

The field experiment was conducted for two consecutive years during *kharif* and *rabi* season of 2019-20 and 2020-21 at Agronomy Main Research Farm, Odisha University of Agriculture and Technology, Bhubaneswar (20°15' N, 85°52' E, 25.9 m above MSL) under East and South Eastern Coastal Plain agro-climatic zone of Odisha, India. The soil was loamy sand, *Typic Endoaquepts*, pH 5.28, organic carbon 0.57% and available N, P and K of 187.5, 18.4 and 189.4 kg/ha, respectively. The experiment was laid out in a split-plot design with three replications. Six treatment combinations comprising of two establishment methods [direct seeded rice (DSR) and transplanted rice (TPR)] and three levels of nutrient management [inorganic-100% soil test-based fertilizers (STBF), organic- green manuring + 1/3rd STBN (vermicompost) + 1/3rd STBN (neem oil cake) and integrated nutrient management (INM)-green manuring + 50 % STBN + 100% P_2O_5 + 100% K_2O] to rice during *kharif* were allotted to the main-plots. Three nutrient management practices to groundnut during *rabi* season *viz.*,75% STBF (inorganic), 100% STBF (inorganic) and INM-75% STBN + 25% STBN (FYM) + lime 0.2 LR + biofertilizers (*Rhizobium* + PSB) + 100% P_2O_5 + 100% K_2O were allotted to the sub-plots at the same site during both the years in rice-groundnut cropping system.

Rice cv. 'CR DHAN 307'and groundnut cv. 'ICGV 91114'were grown with recommended package of practices. In DSR, rice was sown with *Dhaincha* and in transplanting; rice was transplanted after incorporation of *Dhaincha* at 35 days stage. *Dhaincha* in DSR was also brown manured at same stage. All the organic manures like vermicompost and well-powdered neem oil cake were applied basal based on their N equivalence after layout of the experiment as per the treatments. The daily weather data were collected from the agro-meteorological observatory of Odisha University of Agriculture and Technology, India. Growing degree days (GDD), helio thermal unit (HTU) and heat use efficiency (HUE) were calculated according to the formulae proposed by Khavse *et al.* (2015). Photo thermal index (PTI)and Crop heat unit (CHU) were calculated as per Ram *et al.* (2012) and Ali(2017), respectively. Various energy input-output relationships were calculated by considering energy equivalence of different sources as per Devasenapathy *et al.* (2009) and using the formula suggested by Bohra and Kumar (2015). Available soil N, P and K were determined following the standard procedures i.e., Alkaline $KMnO_4$, Bray's and Flame photometry method, respectively. Balance sheet of available nutrients was computed as per Denesh *et al.* (2005). Data collected from the experiment on various observations were subjected to pooled analysis over two years following standard NOVA technique.

Results and Discussion

Transparent rice (TPR) produced more yield attributes *i.e.*, panicles (288.3/m^2) and heavier panicles (4.12 g) resulting insignificant increase in grain and straw yields by 7.1 and 5.6% over DSR, respectively (Table 1).Transplanting also improved the harvest index of rice crop. This could be due to better microclimatic condition and improvement in soil physico-chemical properties for better water uptake as well as better availability and utilization of nutrients in properly spaced puddle transplanted crop (Dileep *et al.* 2018). But 1000-seed weight (24.45 g) was higher in DSR. Among the nutrient management practices, INM recorded higher panicles/m^2 (331) and 1000-seed weight (24.59 g) than organic and inorganic, whereas panicles were heavier (4.23 g) in organic treatment. The INM practice to rice resulted in the highest grain (6.06 t/ha) and straw (7.02 t/ha) yields and harvest index (46.5%). The grain yield under INM was13.3 and 15.2% higher than inorganic and organic treatment, respectively. Integrated use of green manures and fertilizer N was more beneficial than their individual application even on equal nutrient basis. This might be because of improvement in soil physical conditions and soil microbial activity leading to increased availability and overall balanced nutrition (Ghosh *et al.* 2021).

The pods/plant (18.0), pod weight/plant (16.2 g) and 100-pod weight (88.7 g) of groundnut were higher when was grown after DSR than TPR, resulting in 25.7% higher pod yield and 4.9% (absolute value) more harvest index than TPR (Table 1). The yield reduction in groundnut after TPR might be due to breakdown of soil aggregates and formation of hard pan through puddling, which was detrimental to the succeeding non-rice crop (Bandyopadhyay *et al.* 2019).The strength of puddled soil increases rapidly upon drying and may restrict root growth of the second crop reducing access to plant nutrients and water.Therefore, besides early maturity, DSR is known to offer the option to resolve edaphic conflicts between rice and the subsequent non-rice crop and enhance sustainability of the rice-based cropping systems and succeeding winter crops (Farooq *et al.* 2011).

With respect to residual effect of nutrient management practices in rice on succeeding crop, the groundnut crop grown on rice plot with organic nutrition produced higher pods/plant (18.2), pod weight/plant (16.8 g) and 100-pod weight (91.6 g) resulting in 17.0% higher pod yield (2.48 t/ha) than after inorganic practice but at par yield after INM (2.38 t/ha).This might be due to continuous and balanced supply of nutrients for a prolonged period due to organic management in preceding rice (Talathi *et al.* 2009). Besides the residual effect, nutrient management practices in groundnut also affected the yield attributes and yield of the crop. The INM practice in groundnut crop increased the yield attributes resulting in20.2 and 39.8% higher pod yield but at par haulm yield leading to10.3 and 17.9% higher harvest index over 100 and 75% STBF, respectively. The higher yield parameters and yield in groundnut was owing to solubility and availability of N, improvement of soil pH, physico-chemical properties, instant availability of nutrients due to the inorganic fertilisers in combination with biofertilizers, lime and FYM (Singh *et al.* 2011).

The rice establishment methods and nutrient management options affected the system yield and productivity of the rice-groundnut cropping system (Table 3) because of the variations in the yield of the component crops. Direct seeded rice (DSR), on an average, produced 9.5% higher system yield (12.7 t/ha/year)and productivity (34.7 kg/ha/day) than TPR because of the higher yield of succeeding groundnut crop in the system (25.7%) for the reasons stated earlier, although TPR produced 7.1% higher rice yield than DSR.INM to rice resulted in the highest system yield of 12.8 t REY/ha and productivity of 35.0 kg/ha/year, which were, on an average, 4.1 and 13.0% higher than organic and inorganic nutrition, respectively, because of 13.3 and 15.2% higher rice yield under INM, but at par groundnut yield under residual effect of both INM and organic to rice. Integrated use of organics and inorganicsto groundnut also resulted in the highest system yield of

13.4 t REY/ha and productivity of 36.7 kg/ha/year, which were 11.8 and 21.7% more than 100 and 75% STBF, respectively. This observation is in agreement with the findings of Aruna *et al.* (2014) and Chavan *et al.* (2014).

TPR exhibited higher agro-meteorological indices at physiological maturity stage *i.e.* ,9.3, 14.0, 8.3 and 10.2% higher GDD(^{0}C day), HTU(^{0}C day hour), PTI(^{0}C days/day) and CHU (^{0}C day), respectively, than DSR (Table 2). But HUE in DSR (1.22 g/m^{2} ^{0}C day hour) was higher than TPR (1.14 g/m^{2} ^{0}C day hour) due to better exploitation of climatic and soil moisture at important growth stages under DSR (Kumar *et al.* 2020). The highest GDD (4552^{0}C day), HTU (22,661^{0}C day hrs), PTI (35.3^{0}C days/day) and CHU (13,567^{0}C day) were recorded under organic management in rice followed by INM and the lowest agro-indices were associated with inorganic practice. Maximum HUE (1.32 g/m^{2} ^{0}C day hrs) was recorded in INM followed by organic and inorganic, which in turn were at par with each other. It might be due to a greater number of days taken by crops for maturity in conformity with the findings of Islam and Sikder (2011) in different rice cultivars under organic and inorganic conditions. Application of 75% STBF to groundnut improved the agro-meteorological indices of the system, which resulted in the maximum GDD, HTU, PTI and CHU of 4535^{0}C day, 22, 538^{0}C day hrs, 35.2 ^{0}C days/day and 13, 515^{0}C day, respectively, followed by 100% STBF and INM in order. But, HUE was maximum with INM practice (1.25 g/m^{2} ^{0}C day hour) followed by 100 and 75% STBF in conformity with Kumar *et al.* (2020). This might be due to difference in prevailing daily mean temperature and actual bright sun shine hours in a particular year. The variation of sunshine hours affected the heliothermal unit and the influence of temperature on phenology and yield of the crop were expressed through accumulated heat unit system (Srivastav *et al.* 2018).

Energetics of the rice-groundnut cropping system was affected by nutrient management and rice establishment methods because of the variations in input requirements, and yield of the component crops (Table 3). DSR increased energy input, energy output, net energy, energy output efficiency and energy productivity by 4.5, 2.1, 1.9, 7.0 and 5.3 per cent, respectively, over TPR. But specific energy (1.8 MJ/ha) and energy efficiency (12.8) were higher in TPR than DSR. Inorganic practice to rice resulted in 10.3 and 23.5% higher energy input as well as 36.5 and 50.0% higher specific energy than INM and organic practice, respectively. But energy output, net energy and energy output efficiency were higher with INM *i.e.*, 5.8, 4.5 and 7.0 % higher than organic practice and 11.7, 14.0 and 11.0% more than inorganic management. Organic management to rice resulted in higher energy efficiency of 14.9 kg REY/MJ, which was 17.3 and 44.7% higher than INM and inorganic practice, respectively. INM recorded energy productivity (0.59 kg REY/MJ) at par with organic and 25.5% higher than inorganic.

Integrated use of organic and inorganic to groundnut resulted in the highest energy input and output of 22, 004 and 25, 7440 MJ/ha, respectively, and improved the energy input by 21.8 and 25.9 and output by 10.6 and 17.1% over 100and 75% STBF, respectively. Application of 100% STBF to groundnut resulted in the energy productivity and energy efficiency of 0.61 kg REY/MJ and 13.1, respectively, followed by 75% STBF and INM. Maximum specific energy (1.8 MJ/kg REY) was associated with INM, which was 5.9% higher than 100% STBF but was at par with 75% STBF. The higher energy use efficiency was attributed to production of higher yield and comparatively lesser energy utilization in line with the findings of Yadav *et al.* (2013) and Bohra and Kumar (2015) in rice- based cropping system.

Comparison of N, P and K status indicated a net gain (+) in soil N and P, but a net loss (-) in K status at the end of the two year cropping cycle (Table 4). DSR, INM in both rice and groundnut resulted in a net gain (+) of N *i.e*., 28.0, 22.6 and 29.0 kg/ha, respectively. Inclusion of legumes (here groundnut) in cropping systems increases soil N by fixing atmospheric N, having crop

Table 1. Yield attributes and yield of rice and groundnut in rice-groundnut cropping system as affected by nutrient management and rice establishment methods (pooled over twoyears).

Treatment	Rice						Groundnut					
	Panicles/ m^2	Panicle weight (g)	1000-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Pods/ plant	Pod weight/ plant (g)	100-pod weight (g)	Pod yield (t/ha)	Haulm yield (t/ha)	Harvest index (%)
Rice establishment method												
DSR	264.8	3.74	24.5	5.37	6.45	45.6	18.0	16.2	88.7	2.59	3.59	41.7
TPR	288.3	4.12	24.4	5.75	6.81	45.9	16.0	14.3	88.4	2.06	3.49	36.9
SEm (±)	5.03	0.15	0.16	0.05	0.10	0.34	0.12	0.6	0.8	0.05	0.07	0.71
CD (*P= 0.05*)	14.8	NS	NS	0.15	0.31	1.1	0.4	1.8	NS	0.15	0.23	2.2
Nutrient management in rice												
Inorganic	270.8	3.43	24.3	5.35	6.38	45.8	16.1	13.8	84.8	2.12	3.31	38.4
Organic	227.7	4.23	24.4	5.26	6.49	44.8	18.2	16.8	91.6	2.48	3.65	40.2
INM	331.0	4.14	24.6	6.06	7.02	46.5	16.6	15.1	89.2	2.38	3.66	39.2
SEm (±)	6.16	0.19	0.20	0.06	0.12	0.41	0.15	0.7	0.9	0.06	0.09	0.82
CD (*P= 0.05*)	18.2	NS	NS	0.18	0.38	1.3	0.4	2.2	2.7	0.18	0.29	2.7
Nutrient management in groundnut												
75% STBF	267.1	3.59	24.0	5.47	6.05	47.5	16.1	13.7	84.6	1.96	3.43	36.3
100% STBF	275.8	3.89	24.2	5.52	6.52	45.9	16.7	15.1	89.3	2.28	3.57	38.8
INM	286.6	4.31	24.9	5.68	7.32	43.7	18.2	16.8	91.7	2.74	3.62	42.8
SEm (±)	0.45	0.22	0.22	0.01	0.14	0.51	0.29	0.6	0.4	0.10	0.15	1.30
CD (*P= 0.05*)	1.3	0.63	0.6	0.04	0.40	1.5	0.8	1.7	1.2	0.30	0.44	3.7

Table 2. Agro-meteorological indices in rice- groundnut cropping system under nutrient management and rice establishment methods.

Treatment	Accumulated growing degree days (GDD) (^{0}C day)	Accumulated heliothermal units (HTU) (^{0}C day hour)	Accumulated heat use efficiency (HUE) (g/m^2 ^{0}C day/ hour)	Accumulated photo thermal index (PTI) (^{0}C days/day)	Accumulated crop heat unit (CHU) (^{0}C day)
Rice establishment method					
DSR	4197	21,323	1.22	33.7	12,751
TPR	4784	23,311	1.14	36.5	14,052
SEm (±)	1.8	7.1	0.09	0.09	5.8
CD (*P= 0.05*)	5	21	0.27	0.27	18
Nutrient management in rice					
Inorganic	4441	22,039	1.11	35.0	13,270
Organic	4552	22,661	1.11	35.3	13,567
INM	4479	22,251	1.32	35.1	13,369
SEm (±)	2.2	8.7	0.11	0.11	7.1
CD (*P= 0.05*)	6	26	0.34	0.33	22
Nutrient management in groundnut					
75% STBF	4535	22,538	1.10	35.2	13,515
100% STBF	4473	22,191	1.18	35.1	13,348
INM	4465	22,222	1.25	35.0	13,343
SEm (±)	0.7	4.8	0.22	0.22	1.4
CD (*P= 0.05*)	2	14	0.63	0.62	4

Table 3. System yield, system productivity and energetic in rice- groundnut cropping system under nutrient management and rice establishment methods.

Treatment	System yield (t REY/ha/year)	System productivity (kg REY/ ha/day)	Energy input (MJ/ha)	Energy output (MJ/ha)	Net energy (MJ/ha)	Specific energy (MJ/kg REY)	Energy output efficiency (MJ/day)	Energy productivity (kg REY/MJ)	Energy use efficiency
Rice establishment method									
DSR	12.7	34.7	19606	239109	219503	1.7	966	0.60	12.5
TPR	11.6	31.7	18759	234183	215424	1.8	903	0.57	12.8
SEm (±)	0.13	0.25	0.7	1291	1290	0.09	5.05	0.09	0.12
CD (*P*= *0.05*)	*0.4*	0.7	2	3806	NS	0.27	14.90	0.27	0.36
Nutrient management in rice									
Inorganic	11.3	31.0	21805	223769	201964	2.1	891	0.47	10.3
Organic	12.3	33.6	15976	236244	220268	1.4	924	0.70	14.9
INM	12.8	35.0	19767	249925	230158	1.7	989	0.59	12.7
SEm (±)	0.15	0.31	0.9	1581	1580	0.11	6.19	0.11	0.15
CD (*P*= *0.05*)	0.5	0.9	3	4662	4660	0.34	18.25	0.33	0.44
Nutrient management in groundnut									
75% STBF	11.0	30.2	17482	219770	202288	1.8	863	0.58	12.9
100% STBF	12.0	32.8	18062	232728	214666	1.7	923	0.61	13.1
INM	13.4	36.7	22004	257440	235436	1.8	1019	0.57	11.9
SEm (±)	0.30	0.61	1.5	2522	2521	0.22	9.82	0.22	0.26
CD (*P*= *0.05*)	0.9	1.7	4	7165	7162	NS	27.91	NS	0.75

Table 4. Nutrient balance in rice- groundnut cropping system under nutrient management and rice establishment methods at the end of two year cropping cycle.

Treatments	Nitrogen (kg/ha)						Phosphorous (kg/ha)						Potassium (kg/ha)					
	Initial status	Nutrient added	Nutrient uptake	Expected balance	Actual balance	Gain(+) / loss(-)	Initial status	Nutrient added	Nutrient uptake	Expected balance	Actual balance	Gain(+) / loss(-)	Initial status	Nutrient added	Nutrient uptake	Expected balance	Actual balance	Gain(+) loss(-)
Rice establishment method																		
DSR	187.5	245.8	462.3	-29.0	215.5	28.0	15.4	66.4	84.1	-2.31	19.9	4.5	189.4	144.7	399.4	-65.3	170.6	-18.8
TPR	187.5	245.8	441.7	-8.4	197.6	10.1	15.4	67.0	82.4	-0.03	17.6	2.2	189.4	148.1	386.3	-48.8	182.3	-7.1
SEm±	-	-	3.79	3.79	0.43	0.43	-	-	0.76	0.76	0.04	0.04	-	-	4.13	4.13	3.76	3.76
CD(P=0 05)	-	-	11.9	11.9	1.4	1.4	-	-	2.4	NS	0.1	0.1	-	-	NS	13.0	NS	NS
Nutrient management in rice																		
Inorganic	187.5	245.8	422.0	11.3	195.2	7.7	15.4	67.4	77.7	5.09	18.0	2.6	189.4	131.4	368.5	-47.7	173.9	-15.5
Organic	187.5	245.8	458.6	-25.3	214.3	26.8	15.4	54.8	82.7	-12.47	18.3	2.9	189.4	131.4	398.6	-77.8	171.7	-17.7
INM	187.5	245.8	475.5	-42.1	210.1	22.6	15.4	77.8	89.3	3.88	20.1	4.7	189.4	176.4	411.4	-45.7	183.7	-5.7
SEm±	-	-	4.64	4.64	0.53	0.53	-	-	0.94	0.94	0.05	0.05	-	-	5.06	5.06	4.61	4.61
CD(P=0 05)	-	-	14.6	14.6	1.7	1.7	-	-	2.9	2.9	0.1	0.1	-	-	16.0	16.0	NS	NS
Nutrient management in groundnut																		
75% STBF	187.5	237.5	427.4	-2.4	198.5	11.0	15.4	60.1	79.3	-3.77	16.7	1.3	189.4	131.7	373.4	-52.3	169.0	-20.4
100% STBF	187.5	250.0	446.2	-8.6	204.6	17.1	15.4	68.8	82.0	2.26	17.8	2.4	189.4	148.3	386.6	-48.9	177.2	-12.2
INM	187.5	250.0	482.6	-45.1	216.5	29.0	15.4	71.0	88.4	-1.99	21.8	6.4	189.4	159.2	418.6	-70.0	183.1	-6.3
SEm±	-	-	7.51	7.51	0.24	0.24	-	-	0.7	0.7	0.1	0.1	-	-	6.42	6.42	0.33	0.33
CD(P=0 05)	-	-	21.9	21.9	0.7	0.7	-	-	1.96	1.96	0.2	0.2	-	-	18.7	18.7	1.0	1.0

residues with narrower C:N (<30:1), decomposes rapidly and releases N for uptake by itself and the succeeding crop. The temporary biological immobilization and continuous mineralization of green manure and FYM was responsible for higher postharvest N gain. Direct seeding of rice (DSR) and INM practice in both rice and groundnut have the net gain (+) of 4.5, 4.7 and 6.4 kg P/ha, respectively. This might be due to positive effect of growing crops in sequence and incorporation of crop residues into the soil, which resulted in increased soil microbial population and organic matter. Incorporation of green manure and FYM reduced the fixation of water-soluble P and increased the mineralization of organic P due to microbial action leading to higher gain of P in green manure and FYM added plots. Moreover, legumes in the system release organic acids anions such as citrate and malate and other compounds from their roots, which influence better P availability in soil. The negative K balance and net loss (-) in soil K, irrespective of the treatments, indicated higher removal of K through harvested crop produce and residues in the crop sequences. The negative K balance in the soil indicated that non-exchangeable form of K was released as a result of priming action of applied K. The net K loss was higher in DSR (-18.8 kg/ha), organic management in rice (-17.7 kg/ha) and 75% STBF in groundnut (-20.4 kg/ha) attributed to luxurious consumption of K by crops. Similar results with INM practice (RDF+green manuring) in rice-greengram cropping system was reported by Alagappan and Venkitaswamy (2016).

Thus, it may be concluded that integrated nutrient management practice in conjunction with *Dhaincha* green manuring + 50 % STBN + 100% P_2O_5 + 100% K_2O under direct seeded rice and integrated use of 75% STBN + 25% STBN + 0.2 lime+ biofertilizers (*Rhizobium*and PSB)for groundnut crop are best option for higher productivity and energetic, which can maintain the nutrient balance while sustaining the productivity of rice-groundnut system under irrigated condition in coastal plains of Odisha.

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