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RESEARCH ARTICLE :

Impact of different sources of organic manures in comparison with RDF and INM on important growth and yield parameters of rice variety CO(R) 48 with derived correlation and regression equations under site-specific organic farming condition

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SUMMARY : Objective: Field experiments were carried out at Tamil Nadu Agricultural University, Coimbatore, India during *Samba* 2012 (August-December) and *Samba* 2013 to study the impact of different sources of organic manures in comparison with RDF and INM on important growth and yield parameters of rice variety CO(R)48 with derived correlation and regression equations under site-specific organic farming condition.**Methodology:** The field experiment consisted of fourteen treatments which were laid out in Randomized Block Design, replicated thrice and square planting (25 x 25 cm) was adopted, the same layout was maintained for next year *Samba* rice season. The important growth parameters like plant height at harvest, leaf area index at panicle initiation and flowering stage, dry matter production at flowering and harvest stages were recorded, Similarly, the important yield attributes like number of productive tillers m^{-2}, panicle length, panicle weight, total number of grains $panicle^{-1}$, filled grains $panicle^{-1}$, percentage of filled grains, thousand grain weight and grain yield were recorded during *Samba* season of rice during 2012 and 2013. The uptake of NPK by the crop at harvest was also recorded. **Findings:**All theimportant growth and yield parameters were subjected to correlation and regression analysis and the separate correlation and regression equations were derived for grain yield of rice for both the years of study under site-specific organic farming condition. The important growth and yield parameters and the uptake of NPK at harvest of rice, was higher recorded with INM practice followed by RDF treatment, whereas among the organic treatments, 100% RDN through green manure followed, by 25% RDN through each organic manures combination recorded more uptake of major nutrients in both the years of experimentation. **Novelty/Improvement:** Different sources of organic manures on various combinations were compared with RDF and INM practices on growth and yield of medium duration rice variety CO(R)48 with detailed correlation and regression equations under organic farming condition.

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BACKGROUND AND OBJECTIVES

Green revolution was achieved due to greater use of synthetic agro-chemicals such as fertilizers and pesticides with adoption of nutrient responsive high yielding varieties of crops, which boosted the production. However, now this increase in production is showing downward trend and in many cases there are indications of declining productivity and production. Besides the environmental and health problems associated with the use of agro-chemicals have been documented which has brought a major shift of people towards organic farming (Proctor, 2002). Organic production systems maintained and improved the soil health through stimulating the activity of soil organisms. Organic manures are also helpful in alleviating the increasing incidence or deficiency of secondary and micronutrients and are capable of sustaining crop productivity. Application of organic manures not only improves the soil organic carbon for sustaining the soil physical quality but also increases the soil nitrogen. However, nitrogen use efficiency is very low particularly in rice and is difficult to sustain in the soil system due to volatilization, leaching and denitrification losses. Hence, N is the element to be first trust in sense of organic farming (Magar, 2004).

Balancing productivity, profitability and environmental health is a key challenge for agricultural sustainability. Organic farming can provide quality food without adversely affecting the soil health and environment. The number of organic farms are increasing in India day by day. The demand for organic products are increasing all over the world as increasing number of people are becoming health conscious. Food materials produced organically has got in place in food market in developed and developing countries (Urkurkar *et al*., 2010). In this direction, organic production of rice may increase the profitability of the farmers by earning foreign exchange through exports (Mahajan *et al*., 2012). Organic sources of nutrients are the best alternative for improving physical and biological properties of soil and improving crop productivity of rice based high value crops (Yadav *et al*., 2013) food crops.

Research programmes undertaken to increase the production and productivity of rice is of great value in the service of mankind and the nation (Barwale, 1993). A knowledge of association between yield and morpho-physiological and quality traits will help to make simultaneous selection for more characters. Partitioning the correlation co-efficients into direct and indirect effects will help in estimating the actual contribution of an attribute and its influence through other characters. The nitrogen content in the flag leaf, which contributes more for photosynthesis and translocation of source to sink needs to be taken into consideration for realizing higher yields in rice. These evidences suggest that the use of organic manures like farmyard manure, vermicompost, poultry manure and green manures could be a key factor for achieving and maintaining high level of production in rice and rice based cropping sequences (Magar, 2004). Therefore, the field experiment was conducted to find out the impact of different sources of organic manures in comparison with RDF and INM on important growth and yield parameters of rice variety CO(R) 48 with derived correlation and regression equations under site-specific organic farming condition.

RESOURCES AND METHODS

Description of the study site:

Field experiments were carried out at Tamil Nadu Agricultural University, Coimbatore, India during *Samba* 2012 and 2013 (August-December) and the experimental plot was in 'O' block of the Wetland farm, situated at the Western agro-climatic zone of Tamil Nadu at 11°N latitude and 77°E longitude and at an altitude of 426.7 m above mean sea level. The soil of the experimental field was clay loam in texture belonging to *Typic haplustalf* with low in available N (254.0 and 260.0 kg ha^{-1}), low in available P (16.7 and 17.8 kg ha^{-1}) and high in available K (402.0 and 418.0 kg ha^{-1}) during the first and second years, respectively.

Materials used for the experiment:

Planting materials:

The medium duration rice variety called CO (R) 48 was used in *Samba* season as the test crop during 2012-2013.

Treatments and experimental design:

Treatment details :

T_1 : Absolute control (No fertilizers / manures)
T_2: 100% recommended dose of nitrogen (RDN) through FYM
T_3: 100% RDN through vermicompost
T_4: 100% RDN through poultry manure
T_5: 100% RDN through green manure*

T_6 : 50% RDN through FYM + 50% RDN through vermicompost

T_7 : 50% RDN through FYM + 50% RDN through poultry manure

T_8 : 50% RDN through FYM + 50% RDN through green manure*

T_9 : 50% RDN through vermicompost + 50% RDN through poultry manure

T_{10} : 50% RDN through vermicompost + 50% RDN through green manure*

T_{11} : 50% RDN through poultry manure + 50% RDN through green manure*

T_{12} : 25% RDN each through FYM + Vermicompost + Poultry manure + Green manure*

T_{13} : Recommended Dose of Fertilizers (RDF) through inorganic fertilizers (150:50:50) NPK kg ha^{-1}

T_{14} : Integrated Nutrient Management (INM) practice (RDF + GM @ 6.25 t ha^{-1})

*Green manure : Dhaincha (*Sesbania aculeata*) incorporation as green leaf manure at the time of puddling (two weeks prior to transplanting) . T_{13} and T_{14} involving inorganic fertilizer applied plots were established separately well away from organic treatmental plots.

Experimental design :

The experiments were laid out in a Randomized Block Design with three replications. The gross and net plot sizes were 5.0 x 4.0 m and 4.5 x 3.5 m, respectively.

Experimental procedure:

Organic manure application:

On N equivalent basis, required quantities of farmyard manure, decomposed poultry manure, vermicompost were applied in the soil one week before transplanting, whereas the dhaincha(*Sesbania aculeata*) green manure was applied two weeks prior to transplanting on wet weight basis. Different sources of organic manures nutrient content were furnished in (Table A) and the quantity applied as per treatment schedule were furnished in (Table B).

Table A : Nutrient content of organic manures used in the field experiment on dry weight basis

Organic manures	*Samba* 2012			Nutrient content (%)			*Samba* 2013			Nutrient content (%)		
	N	P	K	Ca	Mg	C : N ratio	N	P	K	Ca	Mg	C : N ratio
Farm yard manure	0.60	0.42	0.64	0.21	0.18	20:96	0.58	0.40	0.68	0.18	0.17	23:00
Vermicompost	1.91	0.64	1.20	0.31	0.27	18:98	1.88	0.68	1.24	0.33	0.28	18:82
Poultry manure	2.27	1.42	1.24	4.22	0.65	17:36	2.25	1.45	1.22	4.01	0.62	17:41
Green manure (Dhaincha) *Sesbaniaaculeata*	2.67	0.68	1.26	1.17	0.75	18:91	2.65	0.66	1.28	1.07	0.77	18:64

Table B : Quantity of organic manures added on N equivalent basis and quantity of P_2O_5 and K_2O substituted (kg ha^{-1})

Treatments	Quantity added for 100 % N		P_2O_5 and K_2O		P_2O_5 and K_2O	
	2012	2013	Substituted during 2012		Substituted during 2013	
T_1 : Absolute control	-	-	-	-	-	-
T_2 : 100% RDN through FYM	25000	25862	105.00	160.00	103.00	176.00
T_3 : 100% RDN through VC	7853	7979	50.30	94.24	54.26	98.94
T_4 : 100% RDN through PM	6608	6667	93.83	81.94	96.67	81.34
T_5 : 100% RDN through GM	25281	25470	38.20	70.79	37.36	72.45
T_6 : 50% RDN each of FYM + VC	12500 + 3927	12931 + 3990	77.65	127.12	78.63	137.47
T_7 : 50% RDN each of FYM + PM	12500 + 3304	12931 + 3334	99.42	120.97	99.84	128.67
T_8 : 50% RDN each of FYM + GM	12500 + 12640	12931 + 12735	71.60	115.40	70.18	124.23
T_9 : 50% RDN each of VC + PM	3927 + 3304	3990 + 3334	72.07	88.09	75.47	90.14
T_{10} : 50% RDN each of VC + GM	3927 + 12640	3990 + 12735	44.25	82.52	45.81	85.70
T_{11} : 50% RDN each of PM + GM	3304 + 12640	3334 + 12735	66.02	76.37	67.02	76.90
T_{12} : 25% RDN each of FYM + VC + PM +GM	6250 + 1963 + 1653 + 6320	6466 + 1995 + 1666 + 6368	71.86	101.75	72.83	107.19
T_{13} : RDF : (150 : 50 : 50) NPK kg ha^{-1}	-	-	-	-	-	-
T_{14} :INM practice (RDF + GM @ 6.25 t ha^{-1})	-	-	-	-	-	-

FYM : Farmyard manure, VC : Vermicompost , PM : Poultry manure and GM: Green manure Dhaincha (*Sesbaniaaculeata*)
INM : (150:50:50) NPK kg ha^{-1},*Azospirillum* @ 2.5 kg ha^{-1}, *Phosphobacteria* @ 2.5 kg ha^{-1}, Zinc sulphate @ 50 kg ha^{-1} and Green manure 6.25 t ha^{-1}

Inorganic fertilizer application :

Recommended doses of 150:50:50 kg ha^{-1} of N, P and K in the form of urea, single super phosphate and muriate of potash were applied to the rice crop in respect of treatment T_{13}. The N was applied in four equal splits *viz.,* at basal, active tillering, panicle initiation and flowering stages. The entire dose of P and K were applied basally before sowing. Only rice crop was fertilized while green gram was raised as a residual crop without any organic and fertilizer application.

Integrated nutrient management (INM) application:

In INM treatment T_{14}, 6.25 t ha^{-1} of green manure Dhaincha (*Sesbania aculeata*) was incorporated two weeks prior to transplanting along with the recommended doses of 150:50:50 kg ha^{-1} N, P and K in the form of urea, single super phosphate and muriate of potash were applied to the rice crop. In addition to this, application of 5 kg ha^{-1} of *Azospirillum*, 5 kg ha^{-1} of *Phosphobacteria* and 50 kg ha^{-1} of zinc sulphate were applied as basal prior to transplanting.

Water management :

The experimental plots were irrigated to 2 cm depth uniformly in all the treatments after the appearance of hair line cracks, upto panicle initiation stage. After panicle initiation, the crop was irrigated to 5 cm depth. Irrigation was stopped 15 days prior to harvesting of the crop.

Weed management :

One cono weeding was given on 15 days after transplanting followed by two hand weeding on 30th and 45th day after transplanting to keep the field under weed free condition. No herbicide was applied for organic treatments whereas for inorganic and INM treatments Butachlor @ 2.5 lit ha^{-1}as pre-emergence herbicide applied on 3 DAT.

Plant protection :

Neem seed kernel exract @ 3% and *Panchagavya* @ 3% were sprayed at 35 and 50 days after transplanting as a prophylactic measure against rice leaf folder and stem borer. *Panchagavya* @ 3% was again sprayed at 70 days after transplanting along with liquid formulation of *Pseudomonas fluorescens* @ 500 ml ha^{-1} against the neck blast, leaf spot diseases and grain discoloration. For the inorganic treatments (T_{13} and T_{14}), the chemical plant protection measures were taken as recommended in CPG (2012) on need basis.

Biometric observation on rice :

Growth components:

Five plants in each plot were selected at random and tagged.These plants were used for recording biometric observation at different stages of crop growth as indicated below.

Plant height :

Plant height was measured from ground level to the tip of the longest leaf stretched at harvest stage of rice and expressed as cm.

Number of productive tillers m^{-2}:

Total number of productive tillers was counted at harvest, the numbers were expressed as tillers m^{-2}.

Dry matter production (DMP) :

From the sampling area in each plot, five plants were removed randomly at flowering and harvest stages. These samples were first air dried in shade and then oven dried at 70^{0}C to constant weight and dry weight was recorded and expressed in kg ha^{-1}.

Growth analysis :

Leaf area index (*LAI*) :

The maximum length and breadth of the third leaf from the top of five tagged plants were measured at panicle initiation and flowering stages and the mean value was multiplied with total number of leaves. The LAI was calculated by using the formula suggested by Yoshida *et al.* (1976).

$$\text{LAI} = \frac{\text{K (L x W) x number of leaves hill}^{-1}}{\text{Land area occupied by the plan}}$$

where,

K = Constant factor (0.73 for *Samba* season rice),

L = Maximum length of the third leaf blade from the top (cm) and

W = Maximum width of the leaf blade (cm).

Panicle length :

Panicle length was measured from the point of neck nodescar to the tip of the panicle obtained from five primary panicles of the tagged hills and mean length of panicle was calculated and expressed in cm.

Table C : Analytical methods employed in plant and organic manure analysis

Parameters	Methods	Reference
Di acid extract	Sulphuric acid: Perchloric acid (5:2)	Biswas *et al.* (1977)
Tri acid extract	Nitric acid: Sulphuric acid: Perchloric acid (9:2:1)	Piper (1966)
Total N	MicroKjeldahl's method using di acid extract	Humphries (1956)
Total P	Vanadomolybdophosphoric yellow colour method using tri acid extract	Piper (1966)
Total K	Flame photometry using tri acid extract	Piper (1966)

Panicle weight :

Five primary panicles collected for measuring panicle length were weighed using an electronic balance and the mean weight of the panicle was calculated and expressed in g.

Thousand grain weight

Thousand grains selected randomly was counted, taken from each plot and the test weight was expressed in g.

Number of spikelets and filled grains panicle $^{-1}$:

The total number of spikelets from each of five primary panicles were separated and sorted into filled and ill-filled grains and the mean values of filled grains panicle^{-1} was worked out.

Fertility percentage :

The percentage of spikelets fertility was worked out using the following formula:

$$\text{Fertility percentage} = \frac{\text{Number of filled grains per panicle}^{-1}}{\text{Number of spikelets panicle}^{-1}} \text{x100}$$

Grain yield :

Harvesting was done manually using hand sickles and for the rice crop, border rows in the plots were harvested first and the net plots were then harvested and threshed, cleaned and dried to 14 per cent moisture level and the grain yield from net plot was calculated and expressed in kg ha^{-1} (Hemalatha *et al*., 2000).

NPK uptake of plant analysis :

Green manure (Dhaincha) sample at the time of incorporation and rice plant samples collected at harvest stage of rice for DMP were chopped, dried and ground into fine powder in a Willey mill and used for chemical analysis. For calculating nutrient uptake at harvest, nutrient content of grain and straw was multiplied with respective dry weights. The methods used for plant analysis are furnished in Table C.

$$\text{Nutrient uptake} = \frac{\text{Nutrient content x Total dry matter production (kg/ha}^{-1})}{100}$$

Correlation and regression :

The data on important growth, yield parameters and nutrient uptake were correlated with the rice grain yield and their significant relationship was tested using 't' test and these levels of significance was noted as * for (0.05) and ** for (0.01). The significant parameters were further regressed using stepwise regression analysis and regression equations were derived. Correlation studies were made between grain yield and yield parameters. The values of correlation co-efficient (r) was calculated and tested for their significance at five per cent as per the procedure outlined by Snedekar and Cochran (1967). Simple regression analysis was also made and test of significance was done at five per cent as outlined by Snedekar and Cochran (1967).

Statistical analysis :

The data on various characters studied during the course of investigation were statistically analysed as suggested by Gomez and Gomez (2010). Wherever, the treatment differences were found significant by the ' F ' test, critical differences were worked out at five per cent probability level and the values furnished. Treatment differences that were non-significant were denoted by ' NS '. The correlation analysis was made between yield components and yield.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Growth parameters of rice:

Plant height:

The plant height was measured at harvest stages in

both *Samba* 2012 and 2013were presented in (Table 1). During 2012 and 2013, the tallest plants were recorded with INM practice (T_{14}) at harvest (130.4 and 134.1 cm) stages, respectively and it was comparable with all treatments except the absolute control (T_1) during both the years of study. Among organic treatments, 100% RDN through green manure (T_5) recorded taller plants 116.9 and 119.8 cm during 2012 and 2013, respectively) at harvest stage followed by 25% RDN though each organic manure (T_{12}). The absolute control (T_1) registered the shortest plants at harvest during both the years of study. Maximum plant height was recorded at INM practice at harvest stage of the crop due to immediate mineralization of inorganic nutrients applied through this treatment and it was comparable with recommended NPK fertilizers.

Number of productive tillers m^{-2} :

Number of productive tillers produced in rice was recorded at maturity stage of rice (Table 1). Treatments under study had significant influence on number of productive tillers m^{-2} of rice during both the years of study. During 2012 and 2013 significantly higher the number of productive tillers m^{-2} was with INM practice (T_{14}) at harvest (584 and 588) stage, respectively and it was comparable with 100% RDN through green manure (T_5) followed by recommended NPK fertilizers (T_{13}). Among the organic treatments, more number of productive tillers m^{-2} was recorded with 100% RDN through green manure (T_5) at harvest (510 and 512) stage during 2012 and 2013, respectively and it was followed by 25% RDN through each organic manure (T_{12}). Absolute control (T_1) produced the minimum number of productive tillers m^{-2} as 300 at harvest stage in 2012. Similar results were observed during 2013 also. Single seedling planted on 14 days after sowing (DOS) registered significantly more number of productive tillers m^{-2} during both the years. Transplanting of younger seedlings *i.e.,* less than 15 day old seedlings in square planting *i.e.* (25 x 25 cm) / SRI method had higher tillering capacity both in conventional and organic farming systems. This result is in conformity with the findings of Thiyagarajan (2003).

Dry matter production :

In both the years of study, the dry matter production (DMP) was increased steadily with the advancement of

Table 1 : Effect of organic manures, RDF and INM on panicle parameters and test weight of rice

Treatments	*Samba* 2012				*Samba* 2013			
	Productive tillers (No. m^{-2})	Panicle weight (g)	Panicle length (cm)	1000 grain weight (g)	Productive tillers (No. m^{-2})	Panicle weight (g)	Panicle length (cm)	1000 grain weight (g)
T_1 : Absolute control	228	1.60	19.0	16.2	236	1.68	19.2	16.2
T_2 : 100% RDN through FYM	270	1.61	21.9	17.8	272	1.61	22.9	17.8
T_3 : 100% RDN through VC	278	1.71	22.9	17.8	280	1.77	23.7	17.9
T_4 : 100% RDN through PM	288	1.77	23.1	17.9	292	1.85	23.9	17.9
T_5 : 100% RDN through GM	310	2.68	24.4	17.9	308	2.64	24.4	17.9
T_6 : 50% RDN each of through FYM + VC	259	1.49	20.1	17.6	260	1.53	20.7	17.6
T_7 : 50% RDN each of through FYM + PM	299	1.79	23.4	17.9	300	1.91	24.3	17.9
T_8 : 50% RDN each of through FYM + GM	274	1.67	22.4	17.8	276	1.71	23.2	17.8
T_9 : 50% RDN each of through VC + PM	301	1.85	23.9	17.9	304	1.95	24.5	17.9
T_{10} : 50% RDN each of through VC + GM	264	1.53	20.7	17.7	268	1.60	21.4	17.7
T_{11} : 50% RDN each of through PM + GM	282	1.94	23.1	17.9	284	2.00	24.2	17.9
T_{12} : 25% RDN each of through FYM + VC + PM + GM	306	2.64	24.0	17.9	308	2.62	24.2	17.9
T_{13} : RDF (150 : 50 : 50) NPK kg ha^{-1}	312	2.70	24.6	17.9	316	2.68	24.8	17.9
T_{14} : INM practice (RDF + GM @ 6.25 t ha^{-1})	328	2.98	26.2	18.2	330	3.00	26.6	18.3
S.E.±	26	0.18	2.1	1.6	26	0.19	2.1	1.7
C.D. (P=0.05)	54	0.38	4.3	NS	55	0.39	4.4	NS

NS= Non-significant

the crop growth (Table 3). The DMP was favourably increased at all stages due to INM practice, recommended NPK fertilizer application and organic manures. During the course of investigation, the INM practice (T_{14}) recorded significantly higher DMP (11789 and 13705 kg ha^{-1} during 2012; 12080 and 13760 kg ha^{-1} during 2013) at flowering and harvest stages, respectively, which was however, comparable with recommended NPK fertilizers (T_{13}) and 100% RDN through green manure (T_5). Similar results were observed during 2013 also. Among the organic treatments, 100% RDN through green manure (T_5) recorded more DMP (10608 and 11529) at flowering and harvest stages during 2012 and (10962 and 11607) during 2013, respectively and was followed by 25%RDN through each organic manure (T_{12}) at flowering and harvest stages, the same results were observed in both the years. The lowest dry matter production at all stages of crop growth period was associated in absolute control (T_1) (7411 and 8509; 7770 and 8585 during 2012 and 2013, respectively) at flowering and harvest stages. This was significantly inferior to the dry matter produced by all the organic, inorganic and INM treatment during both the years of investigation. This was significantly inferior to the dry matter produced by all the organic, inorganic and INM treatment during both the years of investigation. The probable reason might be attributed to the continuous slow release of nutrients which might have enabled the leaf area duration to extend, thereby providing an opportunity for plants to increase the photosynthetic rate which could have led to higher accumulation of dry matter. Similar results were obtained by Sangeetha *et al*. (2013). In general, the beneficial effect of N supplied through organic treatments (T_2 to T_{12}) on the growth characters *viz.*, plant height, number of tillers, LAI and DMP of rice cultivar (CO (R) 48) during *Samba* 2012 and 2013 was observed when compared to absolute control. In the present study, the non supply of N through any source resulted in poor performance of rice and noticed by the lowest values of all the growth parameters in absolute control. When N was not supplied through organic or inorganic source rice has to obviously depend upon initial N, which was not sufficient to produce even reasonable yields. Similar results were obtained from the findings of Reddy (1988) and Khan (1990).

Leaf area index :

In general, the leaf area index (LAI) had increased as the advancement of crop growth and it reached the maximum at flowering and thereafter declined towards harvest in both the years of study (Table 3). The higher LAI of rice was observed in the INM treatment (5.88

Table 2 : Effect of organic manures, RDF and INM on grain filling of rice

Treatments	*Samba* 2012			*Samba* 2013		
	Total grains panicle^{-1}	Filled grains panicle^{-1}	Percentage of filled grains	Total grains panicle^{-1}	Filled grains panicle^{-1}	Percentage of filled grains
T_1 : Absolute control	99	70	70.7	102	74	72.5
T_2 : 100% RDN through FYM	132	103	79.0	134	106	79.1
T_3 : 100% RDN through VC	136	116	85.3	139	109	78.4
T_4 : 100% RDN through PM	140	111	79.3	142	114	80.3
T_5 : 100% RDN through GM	152	132	86.8	156	138	88.5
T_6 : 50% RDN each of through FYM + VC	128	102	79.7	130	104	80.0
T_7 : 50% RDN each of through FYM + PM	143	113	79.0	145	118	81.4
T_8 : 50% RDN each of through FYM + GM	134	105	78.4	136	108	79.4
T_9 : 50% RDN each of through VC + PM	147	115	78.2	148	117	79.1
T_{10} : 50% RDN each of through VC + GM	130	103	79.2	132	105	79.5
T_{11} : 50% RDN each of through PM + GM	138	109	78.9	140	111	79.3
T_{12} : 25% RDN each of through FYM + VC + PM + GM	150	131	87.3	153	128	83.7
T_{13} : RDF (150 : 50 : 50) NPK kg ha^{-1}	154	134	87.0	157	139	88.5
T_{14} : INM practice (RDF + GM @ 6.25 t ha^{-1})	175	159	90.8	180	164	91.1
S.E.±	13	11	7.6	13	11	7.6
C.D. (P=0.05)	28	22	16.1	28	22	16.1

and 7.98 during 2012) at panicle initiation and flowering stages, respectively, whereas, it was on par with recommended NPK fertilizers (T_{13}). Similar trend was noticed during 2013 also. Among the organic treatments, 100% RDN through green manure (T_5) recorded higher LAI (5.40 and 6.93 during 2012; 4.99 and 6.92 during 2013) at panicle initiation and flowering stages, respectively and it was followed by 25% RDN through each organic manures (T_{12}). Similar trend was noticed in at flowering and harvest stages of crop growth in both the years of study. During the course of investigation, LAI was least in the treatment T_1 (absolute control), the values being 2.98 and 4.34 during 2012 and 3.26 and 4.36 during 2013, respectively at panicle initiation and flowering stages of the crop. Application of green manures along with organic compost gave higher LAI than chemical fertilizers alone (Sujathamma and Srinivasulu, 1988). Green manure substituted about 100 per cent of N requirement of rice crop (Matiwade and Sheelavantar,1994). Bindra and Thakur (1995) reported that *Sesbania aculeata* was a better green manure than any other green manures. In the present study, green manure application gave higher LAI, number of tillers m^{-2} than other organic sources compared, in both the years of experimentation. Green manures have a good potential to maintain soil fertility, supplement nutrient supply to

Table 3 : Effect of organic manures, RDF and INM on grain yield, straw yield and harvest index of rice

Treatments	*Samba* 2012						*Samba* 2013					
	Grain yield (kg ha^{-1})	Plant height at harvest	LAI at panicle initiation	LAI at flowering	DMP at flowering	DMP at harvest	Grain yield (kg ha^{-1})	Plant height at harvest	LAI at panicle initiation	LAI at flowering	DMP at flowering	DMP at harvest
T_1 : Absolute control	3602	95.3	2.98	3.34	7411	8509	3646	98.5	3.02	3.36	7770	8585
T_2 : 100% RDN through FYM	4164	108.6	3.78	4.28	7757	9588	4190	112.1	3.82	4.40	8055	9615
T_3 : 100% RDN through VC	4296	109.2	4.02	4.52	8011	9845	4380	113.4	4.08	4.64	8305	9998
T_4 : 100% RDN through PM	4377	110.4	4.10	4.59	8170	9985	4550	114.6	4.16	4.66	8464	10310
T_5 : 100% RDN through GM	5084	112.2	4.46	4.92	10608	11529	5140	118.5	4.52	4.96	10962	11607
T_6 : 50% RDN each of through FYM + VC	3910	109.8	3.82	4.32	7687	9030	3980	112.4	3.91	4.38	7981	9155
T_7 : 50% RDN each of through FYM + PM	4721	108.7	3.84	4.34	8813	10745	4833	105.9	3.90	4.41	9107	10988
T_8 : 50% RDN each of through FYM + GM	4236	109.1	3.86	4.36	7898	9730	4316	107.9	3.92	4.42	8192	9884
T_9 : 50% RDN each of through VC + PM	4923	110.6	3.98	4.48	9197	11178	4986	108.8	4.04	4.50	9491	11290
T_{10} : 50% RDN each of through VC + GM	4079	111.2	4.02	4.52	7699	9400	4140	106.5	4.08	4.54	7993	9525
T_{11} : 50% RDN each of through PM + GM	4322	111.2	4.06	4.56	8057	9900	4430	107.0	4.12	4.60	8351	10085
T_{12} : 25% RDN each of through FYM + VC + PM + GM	5004	112.2	4.26	4.78	9454	11380	5120	116.8	4.34	4.82	9745	11575
T_{13} : RDF (150 : 50 : 50) NPK kg ha^{-1}	5603	116.8	4.28	4.82	10588	12706	5680	120.8	4.38	4.85	10879	12808
T_{14} : INM practice (RDF + GM @ 6.25 t ha^{-1})	6235	128.2	4.52	4.95	11789	13705	6270	132.0	4.61	4.97	12080	13760
S.E.±	425	11.3	0.37	0.42	899	984	432	11.5	0.36	0.41	930	997
C.D. (P=0.05)	874	23.8	0.78	0.87	1888	2066	889	24.1	0.76	0.86	1953	2094

rice crop and could contribute to greater food security Palaniappan (2000).

Panicle weight :

The panicle weight (g) was significantly varied due to the INM practice, organic manures and recommended NPK fertilizers in both the years of experimentation (Table 1). The panicle weight ranged from 1.60 to 2.98 g during 2012 and from 1.68 to 3.00 g during 2013. The INM practice (T_{14}) registered higher panicle weight (2.98 and 3.00 during 2012 and 2013, respectively) and it was comparable with recommended NPK fertilizers (T_{13}). Among the organic treatments,100% RDN through green manure (T_5) recorded higher panicle weight (2.68 during 2012) and was followed by 25% RDN through each organic manure (T_{12}). Similar trend was observed in 2013 also. The lower panicle weight was recorded with absolute control (T_1) (1.60 and 1.68 in 2012 and 2013, respectively).

Panicle length :

The panicle length (cm) had significantly influenced by treatments in both the years of experimentation (Table 1). The panicle length extended from 19.0 to 26.2 cm during 2012 and from 19.2 to 26.6 cm during 2013. The length of the panicle was found to increase with the INM practice (T_{14}) (26.2 in 2012 and 26.6 in 2013, respectively) and which was comparable with recommended NPK fertilizers (T_{13}). Among the organic treatments, 100% RDN through green manure (T_5) recorded with increased panicle length (24.4 and 24.4 during 2012 and 2013, respectively) and it was followed by 25% RDN through each organic manure (T_{12}). The absolute control (T_1) noted with shorter panicle length (19.0 in 2012). Similar nature of results were observed during 2013 also.

Thousand grain weight :

Thousand grain weights did not vary due to the application of organic manures and recommended NPK fertilizers during 2012 and 2013 (Table 1). However, the thousand grain weight ranged from 16.2 to 18.2 g during 2012 and from 16.2 to 18.3 g during 2013.

Total grains panicle^{-1}:

The total grains panicle^{-1} was significantly influenced by imposed treatments in both the years of investigation (Table 2). More number of total grains panicle^{-1} were produced with the INM practice (T_{14}) (175 and 180 during 2012 and 2013, respectively) and was comparable with recommended NPK fertilizers (T_{13}), Among the organic treatments, 100% cent RDN though green manure (T_5) recorded higher number of grains panicle^{-1}

Table 4 : Effect of different organic manures, RDF and INM on NPK uptake (kg ha^{-1}) at different growth stages of rice during *Samba* 2012 - 2013

Treatments	N Uptake at harvest		P Uptake at harvest		K Uptake at harvest	
	2012	2013	2012	2013	2012	2013
T_1 : Absolute control	61.1	63.0	14.0	14.7	85.1	88.1
T_2 : 100% RDN through FYM	80.4	82.0	19.5	21.8	104.2	108.2
T_3 : 100% RDN through VC	84.2	86.0	19.6	22.2	110.3	116.3
T_4 : 100% RDN through PM	88.6	91.4	19.6	23.0	118.1	126.4
T_5 : 100% RDN through GM	96.4	99.8	22.4	24.5	131.4	138.5
T_6 : 50% RDN each of through FYM + VC	76.3	77.5	19.4	21.0	100.1	106.1
T_7 : 50% RDN each of through FYM + PM	90.4	93.2	19.6	23.4	124.2	132.2
T_8 : 50% RDN each of through FYM + GM	82.4	84.0	19.5	22.0	107.3	112.3
T_9 : 50% RDN each of through VC + PM	93.1	95.0	20.4	23.8	128.3	135.4
T_{10} : 50% RDN each of through VC + GM	78.4	79.4	19.4	21.4	102.1	106.1
T_{11} : 50% RDN each of through PM + GM	86.5	90.0	19.6	22.4	114.2	121.2
T_{12} : 25% RDN each of through FYM + VC + PM + GM	95.0	97.2	22.2	24.2	130.2	137.3
T_{13} : RDF (150 : 50 : 50) NPK kg ha^{-1}	99.1	102.0	22.8	24.6	133.1	139.4
T_{14} : INM practice (RDF + GM @ 6.25 t ha^{-1})	104.0	106.0	25.9	28.4	137.4	145.5
S.E.±	8.0	8.2	1.8	2.1	10.2	11.2
C.D. (P=0.05)	16.8	17.2	3.8	4.4	21.5	23.5

(152 in 2012) and was followed by 25% RDN through each organic manure (T_{12}). Similar trend was noticed in 2013 also. The absolute control (T_1) recorded the lesser number of total grains panicle^{-1} (99 during 2012 and 102 during 2013, respectively).

Filled grains panicle $^{-1}$

The number of filled grains per panicle had influenced by the imposed treatments in both the years of experimentation (Table 2). The number of filled grains panicle^{-1} ranged from 70 to 159 in 2012 and from 74 to 164 in 2013. The INM practice (T_{14}) enhanced filled grains panicle^{-1} (159, 164 in 2012 and 2013, respectively) and was comparable with recommended NPK fertilizers (T_{13}). Among the organic treatments, 100% RDN through green manure (T_5) recorded more number of filled grains panicle^{-1} (132 during 2012), and was followed by 25% RDN through each organic manure (T_{12}) (131 during 2012). Same nature of results were observed during 2013 also. The absolute control (T_1) recorded lesser filled grains panicle^{-1} (70 during 2012 and 74 during 2013).

Percentage of filled grains :

The percentage of filled grain which indicate the capacity of the plant to convert source to sink in the process of photosynthesis, was significantly influenced by the INM practice, organic manures and recommended NPK fertilizers in both the years of experimentation (Table 2). Higher percentage of filled grain was recorded under the INM practice (T_{14}) (90.8 and 91.1 during 2012 and 2013, respectively) and it was comparable with recommended NPK fertilizers (T_{13}). Among the organic treatments, 100% RDN through green manure (T_5) recorded higher filled grain per cent (86.8 and 88.5 during 2012 and 2013, respectively) and it was comparable with 25% RDN through each organic manure (T_{12}) which were on par with each other during both the years. The lower percentage of filled grain was noticed in the absolute control (T_1) (70.7 in 2012 and 72.5 in 2013).

Rice grain yield :

The treatments imposed had direct influence on rice grain yield in both the years of experimentation (Table 3). The grain yield of rice extended from 3602 to 6235 kg ha^{-1} during 2012 and from 3646 to 6270 kg ha^{-1} during 2013. The INM practice (T_{14}) recorded higher grain yield (6235 and 6270 kg ha^{-1} in 2012 and 2013, respectively). The percentage yield increased under INM ranged from 73.1 in 2012 to 72.0 in 2013 over absolute control. The grain yield under INM practices was comparable with recommended RDF (5603 and 5680 in 2012 and 2013, respectively) and resulted in yield reduction of 11.3 per cent and 11.4 per cent over INM in both the years of study. Among the organic treatments, 100% RDN though green manure (T_5) recorded higher grain yield (5084 and 5140 in 2012 and 2013, respectively) resulted in yield reduction of 22.6 per cent and 22.0 per cent over INM and the percentage yield increase over absolute control ranged from 41.1 in 2012 to 41.0 in 2013, respectively. Next to 100% RDN through green manure, higher grain yield was recorded with 25% RDN through each organic manure (T_{12}) (5004 and 5120 in 2012 and 2013, respectively) resulted in percentage yield increase over absolute control was 38.9 in 2012 and 40.9 in 2013. While comparing all the organic treatments, the percentage yield increase ranged from 8.5 to 41.1 in 2012 and 9.2 to 41.0 in 2013, respectively over absolute control.

The RDF treatment recorded higher grain yield (5603 and 5680 in 2012 and 2013, respectively) resulted in percentage yield reduction of 11.3 and 11.4 over INM and percentage yield increase of 9.9 and 10.5 over 100 per cent RDN through green manure treatment. The lower grain yield (3602 in 2012 and 3646 in 2013) was obtained with absolute control (T_1), which did not receive organic manures and recommended NPK fertilizers. The treatments like INM, RDF, 100% RDN through green manure, and 25% RDN through each organic manures resulted in percentage yield increase (73.1 and 72.0, 55.6 and 55.8, 41.1 and 41.0, and 38.9 and 40.9, respectively) over absolute control in both the years of study.

Physiologically proper partitioning might have occurred from source to sink, as a result improved the yield attributes. The results are similar to the findings of Kumar and Singh (2006). Mohandas *et al*. (2008) observed that the enhanced and continuous supply of nutrients by the enriched organics leading to better tiller production enhanced panicle length and filled grain of rice which ultimately leads to higher total biomass production of rice. Rao (1998) indicated that further filling of grains with photosynthates is likely to occur. Steady and continuous supply of N throughout the entire crop growth period due to gradual transformation and mineralization of organics, solubilization of water insoluble P compounds by organic acids released during decomposition of organics resulting in greater P availability

to crop coupled with higher native K availability might have played a key role in ensuring superior yield attributes by organics in combination with inorganic N like in INM practice. This was in agreement with the findings of several workers who reported all increase in yield contributing characters due to addition of mineral N along with organics like *Sesbania aculeata,* Gheethalakshmi (1996); Veerabadran and Solaiappan (1996) and Basnet (1999), FYM , Parida *et al*. (1995) and Geethalakshmi (1996), poultry manure, Dixit and Gupta (2000); Hemalatha *et al*. (1999) and Mohandas *et al*. (2008). Generally, the tiller formation in rice is highly influenced by solar radiation interception, total sunshine reception, nutrient uptake, rate of photosynthesis and other physiological phenomena and ultimately enhanced the growth and development and yield of rice reported by Yoshida (1972).

Rice nutrient uptake :

Nitrogen uptake:

The N uptake was influenced by the INM practice, recommended NPK fertilizers and organic manures at

Table 5 : Correlation of growth, yield parameters and uptake of nutrients in rice (*Samba* 2012)

	Grain yield	Plant height at harvest	LAI at panicle initiation	LAI at flowering	DMP at flowering	DMP at harvest	Number of productive tillers m^{-2}	Panicle length	Panicle weight	Total number of grains $panicle^{-1}$	Filled grains $panicle^{-1}$	Fertility (%)	N – uptake at Harvest	P – uptake at Harvest	K - uptake at harvest
Grain yield	1														
Plant height at Harvest	0.954**	1													
LAI at Panicle initiation	0.964**	0.891**	1												
LAI at Flowering	0.936**	0.927**	0.926**	1											
DMP at Flowering	0.979**	0.927**	0.957**	0.886**	1										
DMP at Harvest	0.976**	0.923**	0.954**	0.880**	1.000**	1									
Number of Productive tillers m^{-2}	0.931**	0.947**	0.906**	0.969**	0.903**	0.899**	1								
Panicle Length	0.914**	0.950**	0.880**	0.963**	0.882**	0.878**	0.989**	1							
Panicle Weight	0.901**	0.811**	0.949**	0.790**	0.932**	0.933**	0.777**	0.758**	1						
Total number of grains $panicle^{-1}$	0.949**	0.937**	0.923**	0.984**	0.909**	0.904**	0.976**	0.959**	0.797**	1					
Filled grains $panicle^{-1}$	0.965**	0.913**	0.970**	0.954**	0.947**	0.943**	0.943**	0.922**	0.896**	0.971**	1				
Fertility (%)	0.771**	0.809**	0.738**	0.894**	0.707**	0.700**	0.907**	0.889**	0.545**	0.926**	0.840**	1			
N- uptake at Harvest	0.946**	0.931**	0.951**	0.987**	0.911**	0.907**	0.982**	0.965**	0.823**	0.981**	0.964**	0.888**	1		
P- uptake at Harvest	0.939**	0.908**	0.919**	0.944**	0.910**	0.907**	0.942**	0.918**	0.824**	0.984**	0.975**	0.911**	0.949**	1	
K- uptake at Harvest	0.945**	0.920**	0.951**	0.972**	0.918**	0.914**	0.979**	0.954**	0.829**	0.963**	0.953**	0.852**	0.992**	0.926**	1

** indicate significance of value at P= 0.01 level (2-tailed)

all stages of crop growth during both the years of study (Table 1). The N uptake was progressively increased with advancement in the growth stages of rice. The uptake of N varies from 61.1 to 104.4 kg ha^{-1} during 2012; 63.0 to 106.0 kg ha^{-1} during 2013, respectively at harvest stage of the crop. The increased N uptake was observed in the INM practice (T_{14}) (104.4 in 2012 and 106.0 kg ha^{-1} in 2013, respectively) at harvest , and it was comparable with recommended NPK fertilizers (T_{13}), 100% RDN through green manure (T_5) and 25% RDN through each organic manures (T_{12}). The N uptake was lower in absolute control (T_1) (61.1 kg ha^{-1}in 2012; 63.0 kg ha^{-1} in 2013, respectively) at harvest stage of both the years of study.

Phosphorus uptake:

The P uptake was also influenced by the INM practice, recommended NPK fertilizers and organic manures application (Table 4). During 2012 and 2013 the INM treatment (T_{14}) recorded higher P uptake (25.9

Table 6 : Correlation of growth, yield parameters and uptake of nutrients in rice (*Samba* 2013)

	Grain yield	Plant height at harvest	LAI at panicle initiation	LAI at flowering	DMP at flowering	DMP at harvest	Number of productive tillers m^{-2}	Panicle length	Panicle weight	Total number of grains $panicle^{-1}$	Filled grains $panicle^{-1}$	Fertility (%)	N – uptake at Harvest	P - uptake at Harvest	K - uptake at harvest
Grain yield	1														
Plant height at harvest	0.956**	1													
LAI at panicle initiation	0.973**	0.939**	1												
LAI at flowering	0.939**	0.909**	0.987**	1											
DMP at flowering	0.973**	0.930**	0.926**	0.874**	1										
DMP at harvest	0.975**	0.936**	0.929**	0.878**	1.000**	1									
Number of productive tillers m^{-2}	0.940**	0.947**	0.965**	0.968**	0.904**	0.909**	1								
Panicle length	0.889**	0.922**	0.942**	0.962**	0.835**	0.842**	0.979**	1							
Panicle weight	0.920**	0.849**	0.874**	0.805**	0.944**	0.939**	0.804**	0.731**	1						
Total number of grains $panicle^{-1}$	0.962**	0.932**	0.987**	0.983**	0.920**	0.924**	0.968**	0.945**	0.840**	1					
Filled grains $panicle^{-1}$	0.979**	0.921**	0.970**	0.940**	0.969**	0.969**	0.927**	0.874**	0.926**	0.973**	1				
Fertility (%)	0.806**	0.810**	0.877**	0.926**	0.734**	0.742**	0.913**	0.923**	0.605**	0.926**	0.839**	1			
N- uptake at harvest	0.955**	0.918**	0.987**	0.989**	0.910**	0.912**	0.977**	0.950**	0.845**	0.980**	0.959**	0.903**	1		
P- uptake at harvest	0.925**	0.888**	0.968**	0.983**	0.866**	0.870**	0.950**	0.936**	0.776**	0.991**	0.945**	0.958**	0.969**	1	
K- uptake at harvest	0.947**	0.900**	0.975**	0.971**	0.906**	0.908**	0.968**	0.930**	0.840**	0.960**	0.940**	0.866**	0.991**	0.945**	1

** indicate significance of value at P=0.01 level (2-tailed)

and 28.4 kg ha^{-1}, respectively) at harvest stage, and it was on par with recommended NPK fertilizers (T_{13}), 100% RDN through green manure (T_5) and 25% RDN through each organic manure (T_{12}). The lower P uptake was observed in absolute control (T_1) (14.0 and 14.7 kg ha^{-1} respectively) at harvest of rice during 2012 and 2013.

Potassium uptake:

During 2012 and 2013, the positive influence of treatments on K uptake by rice was evidenced (Table 4). The highest K uptake was associated with the INM treatment (T_{14}) (137 kg ha^{-1} in 2012 and 145 kg ha^{-1} in 2013) and it was comparable with recommended NPK fertilizers (T_{13}). Among the organic treatments, the higher K uptake was recorded with 100% RDN through green manure (T_5) (131 and138 kg ha^{-1} during 2012 and 2013, respectively) and was followed by 25% RDN through each organic manures (T_{12}). The lower K uptake was observed in absolute control (T_1) (85 and 88 kg ha^{-1}, respectively) at harvest of rice in both the years of study.

Higher grain and straw yield of crop might also be due to enhanced uptake of N, P and K as observed in the present study. Higher N concentration in plants due to better absorption of N contributed by green manure besides the contribution of P from green manure coupled with the solubilization of native P by organic acids released during the decomposition of the organic in enhancing P concentration and the priming effect with K supply by the organics as well as the higher native soil K might possibly have enhanced the concentration of K in the crop. This, coupled with higher DMP led to higher N, P and K uptake which in turn resulted in higher grain and straw yield in *Samba* rice–Summer green gram cropping sequence (Rajarathinam, 2002). The average increase in grain and straw yield due to integrated use of organic and inorganic N observed in the two year period over inorganic N revealed the direct, cumulative and residual effect of added organics in sustaining the productivity. The progressive decline in yield due to continuous cropping without nutrient application (absolute control) evidenced clearly that the soil on its own could barely sustain any crop and which depends or case of local availability, costs etc., to sustain the yield of crops in the rice based cropping systems.

Correlation analysis:

Correlation between grain yield with growth parameters, yield attributes and nutrient uptake of rice:

The correlation between the grain yield of rice with leaf area index at panicle initiation and flowering stages and the dry matter production at flowering and harvest

Table 7 : Regression analysis between the growth, yield attributes, nutrient uptake and yield of rice (*Samba* 2012-2013)

Sr. No.	Parameters	Regression equation	R^2 values
1.	Yield and growth attributing parameters (2012)	Y = 60.88 - 20 (LAI - PI) - 1 (LAI - F) + 7.1 (DMP - F) - 5.1 (DMP - H)	0.99**
2.	Yield and growth attributing parameters (2013)	Y = - 348.05 + 747 (LAI - PI) - 141 (LAI - F) - 1.0 (DMP - F) + 1.0 (DMP - H)	0.98**
3.	Yield and yield attributing parameters (2012)	Y = 20.8 + 13 (NPT) - 73 (PL) + 214 (PW) + 33 (TNS/P) + 8 (FS/P) - 44 (FERT %)	0.98**
4.	Yield and yield attributing parameters (2013)	Y= -13.4 + 10 (NPT) - 55 (PL) - 144 (PW) + 36 (TNS/P) +14 (FS/P) - 46 (FERT %)	0.99**
5.	Yield and nutrients uptake (2012)	Y = - 363.92 - 39 (N - H) + 150 (P - H) + 47 (K - H)	0.93**
6.	Yield and nutrients uptake (2013)	Y = - 228.36 + 52 (N - H) + 2 (P - H) + 2 (K - H)	0.92**

I. Growth attributes		II. Yield attributes		III. Nutrient uptake	
LAI - PI	Leaf area index at panicle initiation	NPT	Number of productive tillers m^{-2}	N - H	Nitrogen uptake at harvest (kg ha^{-1})
LAI - F	Leaf area index at flowering	PL	Panicle length (cm)	P - H	Phosphorus uptake at harvest (kg ha^{-1})
DMP - F	Dry matter production at flowering (kg ha^{-1})	PW	Panicle weight (g)	K - H	Potassium uptake at harvest (kg ha^{-1})
DMP - H	Dry matter production at harvest (kg ha^{-1})	TNS/P	Total number of grains $panicle^{-1}$		
		FS/P	Filled grains $panicle^{-1}$		
		FERT%	Fertility percentage		

stages were positive during 2012 and 2013 (Table 5 and 6). The correlation between grain yield, number of productive tillers m^{-2}, panicle length, panicle weight, total number of grains $panicle^{-1}$ and fertility percentage $panicle^{-1}$ were positively correlated at one per cent level during 2012 and 2013. Similarly, the rice grain yield was positively correlated with uptake of nutrients (N, P and K) at harvest stage at one per cent level in both years of study.

Regression analysis :

Regression between grain yield with growth parameters, yield attributes and nutrient uptake of rice:

The regression analysis was performed to assess the reliability of the most contributing independent variable (important growth parameters, yield parameters and nutrient uptake) on dependent variable (rice grain yield) over seasons. To see the stepwise regression analysis, the independent variables which had a significant relationship with a dependent variable from the correlation study were selected and used.

The equations presented in Table 7, represents the influence of various parameters on rice grain yield during 2012 and 2013. The growth attributing parameters like leaf area index at panicle initiation and flowering stages and dry matter production at flowering and harvest stages on grain yield of rice regressed with the R^2 values of 0.99 and 0.98 during samba 2012 and 2013. Similarly, the yield attributing characters like number of productive tillers m^{-2}, panicle length, panicle weight, total number of grains $panicle^{-1}$, filled grains $panicle^{-1}$ and fertility percentage on grain yield of rice was regressed with the R^2 values of 0.98 and 0.99 in both years of study. The nutrient uptake at harvest stage for N, P and K regressed with the grain yield of rice with the R^2 values of 0.93 and 0.92 during 2012 and 2013.

Conclusion :

The important growth and yield parameters and the uptake of NPK at harvest of rice, was higher recorded with INM practice followed by RDF treatment, whereas among the organic treatments, 100% RDN through green manure followed, by 25% RDN through each organic manures combination recorded more uptake of major nutrients along with growth and yield attributes of rice in both the years of experimentation. This study mainly focussed on the correlation and regression analysis. The correlation between the grain yield of rice with leaf area index at panicle initiation and flowering stages and the dry matter production at flowering and harvest stages were positive during 2012 and 2013. The correlation between grain yield, number of productive tillers m^{-2}, panicle length, panicle weight, total number of grains $panicle^{-1}$ and fertility percentage $panicle^{-1}$ were positively correlated at one per cent level during 2012 and 2013. Similarly, the rice grain yield was positively correlated with uptake of nutrients (N, P and K) at harvest stage at one per cent level in both years of study. The regression analysis was performed to assess the reliability of the most contributing independent variable (important growth parameters, yield parameters and nutrient uptake) on dependent variable (rice grain yield) over seasons. To see the stepwise regression analysis, the independent variables which had a significant relationship with a dependent variable. Separate regression equations were derived and furnished in Table 7.

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