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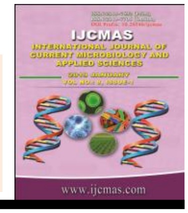

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Rescheduling of Fertilizer Doses in Rabi Rice for Central Telangana

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A B S T R A C T

A field experiment was conducted at Rice block in RARS Warangal, during Rabi-2015-16 and 2016-17 to study the rescheduling of fertilizer doses in Rice for Central Telangana. The results revealed that the non significantly higher grain yield and significantly, higher straw yields (6816 and 6187 kg/ha, respectively) were recorded by the application of nitrogen, phosphorus and potassium 150%-100%-100% (180-60-40kg/ha) recommended dose over the others. Significantly maximum N, P, K, Zn, Cu, Fe and Mn uptake 199 kg/ha, 25.69 kg/ha, 134 kg/ha, 341g/ha, 67g/ha, 3492g/ha, 1403g/ha, respectively were recorded by the application of nitrogen, phosphorus and potassium 150%-100%-100% (180-60-40 kg/ha) recommended dose, respectively over the others. The highest benefit cost ratio (1.84) and net income (45,236/-) was recorded by application of nitrogen, phosphorus and potassium 150%-100%-100% (180-60-40 kg/ha) alone and lowest benefit cost ratio (1.46) and net income 30,655/- was recorded by the application of nutrients based on current recommended dose of fertilizers along with vermicompost application @2 t/ha.

Introduction

Fertilizer application is one of the efficient means of increasing agricultural profitability. The fertilizer prices have gone up and hence their use in required amounts depends much upon the purchasing ability of the farmers. At the same time a balanced fertilization has to be considered for maintaining soil health for sustainable use because indiscriminate and imbalanced use of fertilizers has already distorted soil fertility and deteriorated soil health in India (Santhi *et al.*, 2011). Accordingly much attention is given to the integrated use of organic and mineral nutrition for meeting the economic needs of farmers as well as for sustainability in terms of productivity and soil fertility. Soil test based fertilizer recommendations result in efficient fertilizer use and maintenance of soil fertility. Several approaches have been used for fertilizer recommendation based on chemical soil test so as to attain maximum yield per unit of fertilizer use. Among the various approaches, the targeted yield approach (Ramamoorthy *et al.*, 1967) had received wide acceptability and popularity in India. Targeted yield concept is based on quantitative idea of the fertilizer needs based on yield and nutritional requirement of the crop, per cent contribution of the soil available nutrient and that of the applied fertilizer. This method not only estimates soil test based fertilizer dose but also the level of yield the farmer can achieve with that particular dose. Targeted yield approach also provides scientific basis for balanced fertilization not only between the nutrients from the external sources but also from the internal sources.

Degradation of soil health has also been reported due to long-term imbalanced use of fertilizer nutrients. Although, overall nutrient use (N: P_2O_5:K_2O) of 4:2:1 is considered ideal for Indian soils, the present use ratio of 6.8:2.8:1 is far off the mark. This imbalance of nutrient use has resulted in wide gap between crop removal and fertilizer application. Long-term experiments, in India have in general showed that P and K status in soils at all centres has gone down when only N was applied. Declining soil fertility and mis management of plant nutrients have made this task more difficult. Balanced NPK fertilization has received considerable attention in India (Gosh *et al.,* 2004; Hegde *et al.,* 2004 and Prasad *et al.,* 2004). Soil testing helps the farmers to use fertilizers according to needs of crop. In the intensive agriculture system integrated fertilizer recommendation is an urgent need since, it balance soil and applied nutrients from inorganic as well as organic sources to balance nutrition of crops and maintenance of soil health.

Assessment of the nutrient requirements of the different crops for desired yield levels from a cropping sequence is an important step in developing fertilizer management practices. Soil fertility and productivity changes over time and this change is towards negative direction because of intensive cropping with modern varieties, improper and imbalance use of fertilizers and manures and also declining soil organic matter to a considerable extent. Again crops grown in different cropping patterns and cropping zones responded differently to fertilizer nutrients. A crop production system with high yield targets cannot be sustained unless balanced nutrient inputs are supplied to soil against nutrient removal by crops (Bhuiyan *et al.,* 1991). Mineral fertilizer inputs are the crucial factors to the overall nutrient balance in intensive cropping system (Islam and Haq 1998). Soils and fertilizer management is very complex and dynamic in nature. Fertilizer recommendation for crops in a cropping pattern needs change after a certain period of time. With the advancement of technology and with a progress of fertility and fertilizer management research in the country, there has been a continuous need for updating the Fertilizer Recommendation Guide. The application of fertilizer in proper amounts must be done to boost up agricultural production to an economically desirable level (Panaullah *et al.,* 1998).

Rice is the most important staple food for more than half of the world's population. In Asia, more than two billion people are getting 60-70 percent of their energy requirement from rice and its derived products, a major source of dietary protein for most people in tropical Asia (Juliano 1993). In India rice (*Oryza sativa*) is the staple food crop for more than two thirds of the population. The slogan "RICE is life" is most appropriate for India as this crop plays a vital role in our national food security and is a means of livelihood for millions of rural households. In India, it is grown on an area of 44.1m ha with a production of 106.7 m t with a productivity of 2.42t ha^{-1}. In Telangana state, rice is also the principal food crop cultivated throughout the state. The crop is cultivated in an area of about 2.01m ha with an annual production of 6.62 m t and productivity of 3.29 t ha^{-1} (statistical year book 2015). The continuous cultivation of high yielding varieties of rice and indiscriminate use of fertilizers leads to imbalance in nutrient status of soils. Under present conditions fertilizer recommendations developed decades back were not meet the requirement of rice crop to get the optimum yields. Hence there is need to work out the rescheduling of fertilizer doses in Rice for Central Telangana. Therefore, the present study was carried out to determine an economically optimal dose of fertilizer nutrients at which rice gave maximum paddy yield.

Materials and Methods

The field experiment was conducted during Rabi-2015-16 and 2016-17 at Rice block in RARS Warangal, located at 18^0 01.077 N latitude 79^0 36.197 E longitudes and an altitude of 259 m above mean sea level to study the rescheduling of fertilizer doses in Rice for Central Telangana. A composite soil sample was collected from 0-20 cm depth during the study years, processed and analysed in laboratory for pH and Electrical Conductivity(EC) (1:2, soil : water suspension), by pH and Ec meters, respectively (Jackson, 1973), Organic Carbon percentage (OC) was estimated by rapid titration method (Walkley and Black 1934), available nitrogen by alkaline permanganate method (Subbaiah and Asija, 1956), available phosphorus by Olsens method (Olsen *et al.*, 1954), available potassium by ammonium acetate extraction method (Jackson 1973), available Zinc, Copper, Iron and Manganese were extracted with DTPA and estimated using AAS as described by Lindsay and Norvell (1978). Boron was extracted by hot water and measured colorimetrically using Azomethine-H (Keren 1996). The experiment was laid out in factorial randomized block design with 6 treatments in two sets one set without vermicompost and another with vermicompost application @ 2t/ha replicated in three times. The details of treatments were depicted in table 1.

Rice (RNR-15048) was sown during second week of December, transplanted in second week of January by adopting 15x15cm spacing with three seedlings per hill and fertilizers applied as per the treatments protocol. The other cultural practices were carried out according to the standard practices in the rice fields and harvested at 125 days after sowing. The grain and straw samples were collected at harvest, oven dried at 70^0C processed and estimated for total content of N, P, K, Zn, Cu, Fe and Mn following standard procedures. The nitrogen content in grain and straw was determined after digesting the samples with single acid (H_2SO_4) using kelplus nitrogen analyser. The P, K, Zn, Cu, Fe and Mn in grain and straw were determined after digesting the samples with di-acid (nitric and perchloric acid 9:4 ratio). The phosphorus was determined by ammonium molybdate method and potassium was determined by using flame photometer method. Zn, Cu, Fe and Mn were determined using atomic absorption spectrophotometer (Jackson 1973).

The economics were also calculated on the basis of cost of cultivation, gross return, net return and benefit cost ratios. The cost of cultivation for each treatment was calculated by summing all the variable cost items in the production process. Similarly gross returns were calculated based on prevailing market price of the produce. The net returns were obtained after deducting the cost of cultivation from gross returns. Thus, the benefit cost analysis was obtained by dividing total returns from a unit with total cost of a unit.

Results and Discussion

The field experiment was conducted at Rice block in RARS Warangal, located at 18^0 01.077 N latitude 79^0 36.197 E longitude and an altitude of 259 m above mean sea level during Rabi-2015-16 and 2016-17 to study the rescheduling of fertilizer doses in Rice for

Central Telangana. The soil was clay in texture, moderately alkaline in reaction (pH 8.15), non saline in nature (EC 0.44 dSm^{-1}), higher in organic carbon (OC 0.88%), medium in available nitrogen (339 kg/ha), higher in available phosphorus (68 kg/ha), lower in available potassium (235 kg/ha), sufficiently available Zn, Cu, Fe and Mn 0.66, 1.38, 11.48 & 3.56 mg/kg, respectively.

Grain yield

The results presented in table 2 shows that, the application of varying N, P and K levels arrived by different concepts of fertilizers application without vermicompost and with vermicompost to the rabi rice and observed that the overall grain yield was non significantly influenced by varying N, P and K levels in both the years and in pooled mean. However, higher grain yields 6763, 6764 and 6764 kg/ha were recorded in rabi-2015-16, 2016-17 and in pooled mean, respectively by T_6 over the others. Similarly, lower grain yields 6428, 6399 and 6414 kg/ha were recorded in rabi-2015-16, 2016-17 and in pooled mean, respectively by T_1. The increase in growth might be due to enhanced cell division and cell elongation induced by abundant nitrogen supply with increase in nitrogen levels, favouring enlargement and better development of panicle resulting in more number of total grains $panicle^{-1}$ and keep leaves green even at the time of maturity. Hence, the contribution of carbohydrates from photosynthetic activity resulting in efficient translocation of food material into the sink (grain) thereby increased number of filled grains $panicle^{-1}$. These results were in accordance with the findings of Prasada Rao *et al.,* (2013).

Non significantly higher grain yield (6692kg/ha) was recorded by the application of varying N, P, K levels along with vermicompost in rabi-2015-16 and significantly higher grain yields 6730 and 6711 kg/ha were recorded in rabi-2016-17 and in pooled mean, respectively over N, P and K alone. With application of a single chemical fertilizer, dry matter accumulation and nutrient uptake in rice were mainly concentrated at the tillering and booting stages, but were mainly concentrated from the heading to maturity stage in response to combined application of chemical and organic fertilizers, which could increase the number of panicles per unit area and the number of grains per panicle (Guindo *et al.,* 1994; Yang *et al.,* 2004; Yang *et al.,* 2010).

The results showed that combined application of organic and inorganic fertilizers promoted the transfer of nutrients to the grains and improved rice yields. The present study showed that vermicompost application in combination with varying N, P and K levels promoted the uptake and utilization of nitrogen, phosphorus and potassium by rice plants.

The interaction effect of varying N, P and K levels along with vermicompost on grain yield was non significant in both the years and in pooled mean.

Straw yield

Straw yield in rabi rice was non significantly influenced by varying N, P and K levels in 2015-16, significantly influenced in 2016-17 and in pooled mean. However, higher straw yield 5723 kg/ha was recorded in rabi-2015-16 over the others and significantly higher straw yields 6650 and 6187 were recorded in 2016-17 and in pooled mean, respectively by T_6 over the others but it is at par with T_5. The dry matter production at all growth stages, straw yield, and harvest index were maximum at 180 kg N ha^{-1} over low level of 120 kg N ha^{-1}. These results were in accordance with the findings of Prasada Rao *et al.*, (2013).

Significantly higher straw yields 5859, 6224 and 5967 kg/ha were recorded by the application of vermicompost along with varying N, P and K levels over the N, P and K alone 5341, 5829 and 5643 kg/ha in rabi 2015-16, 2016-17 and in pooled mean, respectively. These results were in accordance with the findings of Prasada Rao *et al.,* (2013).

The interaction effect of N, P, K levels with vermicompost on straw yield was non significant in both the years and in pooled mean (Table 3).

N uptake

Nitrogen uptake by rabi rice was significantly influenced by varying N, P and K levels in both the years and in pooled mean. However, significantly higher N uptake (199 kg/ha) was recorded by T_6 over T_1 and T_2 but at par with others in 2015-16, and significantly higher N-uptake was found 222 and 211 kg/ha in 2016-17 and in pooled mean, respectively by T_6 over T_1, T_2, T_3, T_4 but at par with T_5.

Nitrogen uptake increased with increase in the level of nitrogen up to 180 kg ha^{-1} over low level of 120 kg N ha^{-1}. The increase in nitrogen uptake at higher levels may be ascribed to the fact that the plant absorbed nitrogen proportionately as the pool of available nitrogen improved in soil by the addition of higher amount of nitrogen. These results were in accordance with the findings of Prasada Rao *et al.,* (2013) (Table 4).

Nitrogen uptake by rabi rice was significantly influenced by vermicompost application along with varying N, P, and K levels in both the seasons and in pooled mean. However, significantly higher N uptake 195, 213 and 204 kg/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by the application of vermicompost along with varying N, P, and K levels over N, P and K alone 169, 178 and 173 in 2015-16, 2016-17 and in pooled mean, respectively. The increase in N uptake by rice with the application of FYM and N might be due to increase in N availability in the soil, and increased in yield.

Rice variety KMP101 was treated with both organic and inorganic manure. The field and experimental studies were conducted, before applying organic and inorganic manures. The values obtained for available nitrogen, phosphorous and potassium were 360 kg/ha, 12 kg/ha and 166 kg/ha respectively. After treatment and harvest there was a gradual increase in available nitrogen, phosphorus and potassium ranging between 335-415, 14-23 and 173-235 kg/ha respectively among the treatments. Applying 15 t of vermicompost/ha and 10 t of vermicompost/ha and recommended dose of fertilizer showed a greater availability of nitrogen and phosphorus. It is revealed that after addition of organics into the soil year-wise, the soil became more stable. Also, the biological activity increased in the soil and was influenced to maintain the available nitrogen in the soil. Therefore, it is evident that vermicompost significantly increases the availability of available nutrients (Shwetha and Narayana 2014).

The interaction effect of varying N, P and K levels with vermicompost on nitrogen uptake was non significant in both the years and in pooled mean rabi rice.

P-uptake

Phosphorus uptake in Rabi rice was non-significantly influenced by varying N, P and K levels in both the years and in pooled mean. However, higher P uptakes 22.04, 29.34 and 25.69 kg/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_6 over the others. The increase in P uptake by rice with the application of P might be due to increase in P availability in the soil, and increased in yield (Table 5).

Phosphorus uptake by Rabi rice was non significantly influenced by vermicompost application along with varying N, P and K levels in both the seasons and in pooled mean. However, higher P uptake 21.06, 28.33 and 24.70 kg/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by the application of vermicompost along with varying N, P and K levels over N, P and K alone 20.29, 26.22 and 23.25 in 2015-16, 2016-17 and in pooled mean, respectively. Increase in P uptake of rice by vermicompost application might be due to organic acids produced during decomposition are capable of releasing the phosphorus associated with clay minerals. Besides this, organic manures form complexes with iron, aluminium ions and hydrous oxide thereby preventing its fixation as inorganic complexes (Sri Ranjitha, 2011).

The solubilizing action of organic acids produced during decomposition of organic manures or green manure might have increased the release of native P, stimulated microbial growth in soil, and favoured root growth which had finally led to increased P uptake by rice. Dwivedi *et al.,* (2007) also recorded higher P uptake due to combined application of inorganic fertilizers with organic manure (FYM) under soybean-wheat cropping sequence in a Vertisol.

The interaction effect of varying N, P and K levels with vermicompost on phosphorus uptake was non significant in both the years and in pooled mean in rabi rice.

Potassium uptake

Potassium uptake by rabi rice was significantly influenced by varying N, P and K levels in both the years and in pooled mean. However, significantly higher K uptakes 116,151 and 134 kg/ha were recorded by T_6 over the others but at par with T_5 in 2015-16, 2016-17 and in pooled mean, respectively. The increase in K uptake by rice with the application of K might be due to increase in K availability in the soil, and increased in yield.

Potassium uptake by rabi rice was significantly influenced by vermicompost application along with varying N, P and K levels in both the years and in pooled mean. However, significantly higher potassium uptake 114, 137 and 126 kg/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by the application of vermicompost along with varying N, P and K levels over application of N, P and K alone 98, 127 and 112 in 2015-16, 2016-17 and in pooled mean, respectively (Table 6).

The interaction effect of N, P and K levels with vermicompost on potassium uptake was non significant in both the years and in pooled mean in rabi rice.

The uptake of N, P and K were highest with the supply of nitrogen at 180 kg/ha which was significantly superior over other nitrogen levels.

The total potassium accumulation in the rice plants showed a trend to increase with increasing nitrogen application level at different growth stages. The total potassium accumulation in all nitrogen application treatments showed a significant difference. These results indicated that combined application of organic and inorganic fertilizers increased potassium uptake in rice under the nitrogen application level of 180 kg N/ha (Guindo *et al.,* 1994; Yang *et al.,* 2004; Yang *et al.,* 2010).

Majumdar *et al.,* (2007) also observed significant increase in total N, P and K uptake in rice when FYM was applied in conjunction with fertilizer N.

Zn uptake

Zinc uptake in Rabi rice was non-significantly influenced by varying N, P and K levels in both the years and in pooled mean. However, higher Zn uptake 331, 350 and 341g/ha, were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_6 over the others and lower Zn uptake 305, 310 and 308 g/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_1

Zn uptake in rabi rice was non significantly varied by vermicompost application along with varying N, P and K levels in both the seasons and in pooled mean. However, higher Zn uptake 318, 342 and 330 g/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by the application of vermicompost along with varying N, P and K levels over N, P and K application alone 309, 319 & 314 in 2015-16, 2016-17 and in pooled mean, respectively (Table 7).

Table.1 Treatment wise details and N, P, K levels arrived in two seasons

Treatment Number	Treatment details	Rabi-2015-16	Rabi-2016-17
T_1	**Current RDF:** (N, P, K, Zn, S & B)	120-60-40	120-60-40
T_2	**Soil Test based fertilizer usage:** N, P, K (30% excess/less) Zn, S, B if deficient full recommended dose	156-42-28	120-42-28
T_3	**Soil Test Crop Response based Equation: Prod-I** (Current highest in dist/Zone) + RD of Zn, S, B if deficient.	172-23-73	35-30-67
T_4	**Soil Test Crop Response based Equation: Prod-II** (15% Higher) + RD of Zn, S, B if deficient.	217:53:90	77-30-83
T_5	**New treatment for Production-I** N=150%RDN if available N is <140Kg/ha else 125% RDN. P= 100%RDP if available P is high, else 125%. K=100%RDK if available K is medium and high other wise 125%RDK, Zn =125% if def. Else 25%RD Zn, S=125%RD sulphur if def. Else 25% RD Sulphur. B=125%RD Boron if def. Else 25% RD Boron.	150-60-40	150-60-40
T_6	**New treatment for Production-II** N=200%RDN if available N is <140Kg/ha else 150% RDN. P=100%RDP if available P is high, else 150%. K=100%RDK if available K is medium and high other wise 125%RDK, Zn =125% if def. Else 25%RD Zn, S=125%RD sulphur if def. Else 25% RD Sulphur. B=125%RD Boron if def. Else 25% RD Boron.	180-60-40	180-60-40

*RDF= Recommended dose of fertilizers   *RD= Recommended dose

Table.2 Grain yield of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	**With VC.**	**Mean**	**Without VC.**	**With VC.**	**Mean**	**Without VC.**	**With VC.**	**Mean**
T_1	6329	6528	6429	6389	6409	6399	6359	6469	6414
T_2	6227	6818	6523	6470	6708	6589	6349	6763	6556
T_3	6629	6677	6653	6619	6751	6685	6624	6714	6669
T_4	6617	6784	6701	6206	6517	6362	6412	6651	6532
T_5	6386	6410	6398	6427	6707	6567	6407	6559	6483
T_6	6708	6953	6831	6222	7306	6764	6465	7130	6798
Mean	**6483**	**6695**		**6389**	**6733**		**6447**	**6711**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P, K levels	NS	172		NS	119		NS	146	
Vermicompost	NS	100		201	69		196	85	
interaction	NS	244		NS	168		NS	206	

VC: Vermicompost

Table.3 Straw yield of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	**With VC.**	**Mean**	**Without VC.**	**With VC.**	**Mean**	**Without VC.**	**With VC.**	**Mean**
T_1	5176	5713	**5445**	5782	6110	**5946**	5479	5912	**5696**
T_2	5461	5577	**5516**	5689	5982	**5836**	5575	5780	**5678**
T_3	5216	5957	**5587**	5241	5869	**5555**	5229	5913	**5571**
T_4	5394	5991	**5693**	5389	5722	**5556**	5392	5857	**5625**
T_5	5502	5767	**5635**	6423	6811	**6617**	5963	6289	**6126**
T_6	5298	6148	**5723**	6450	6851	**6651**	5874	6500	**6187**
Mean	**5341**	**5859**		**5829**	**6224**		**5585**	**6042**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P, K levels	NS	256		676	231		386	244	
Vermicompost	307	148		390	133		349	141	
Interaction	NS	362		NS	326		NS	344	

VC: Vermicompost

Table.4 N-uptake (kg/ha) of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	With VC.	Mean	Without VC.	With VC.	Mean	Without VC	With VC	Mean
T_1	158	165	162	186	215	201	172	190	181
T_2	161	180	171	187	212	200	174	196	185
T_3	175	196	186	125	190	158	150	193	172
T_4	167	218	193	162	189	176	165	204	185
T_5	164	197	181	210	227	219	187	212	200
T_6	187	211	199	199	245	222	193	228	211
Mean	**169**	**195**		**178**	**213**		**173**	**204**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P, K levels	20	7		19	7		20	7	
Vermicompost	12	4		11	4		12	4	
Interaction	NS	10		NS	9		NS	7	

VC: Vermicompost

Table.5 P-uptake (kg/ha) of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	With VC.	Mean	Without VC.	With VC.	Mean	Without VC.	With VC.	Mean
T_1	18.95	19.86	19.41	25.31	28.15	26.73	22.13	24.01	23.07
T_2	19.90	20.41	20.16	26.13	26.86	26.50	23.02	23.64	23.33
T_3	19.79	21.29	20.54	25.05	25.15	25.10	22.42	23.22	22.82
T_4	20.51	20.63	20.57	27.53	27.90	27.72	24.02	24.27	24.15
T_5	20.96	21.71	21.34	28.76	27.76	28.26	24.86	24.74	24.80
T_6	21.62	22.46	22.04	24.52	34.16	29.34	23.07	28.31	25.69
Mean	**20.29**	**21.06**		**26.22**	**28.33**		**23.25**	**24.70**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P, K levels	NS	0.98		NS	1.51		NS	1.25	
Vermicompost	NS	0.57		NS	0.87		NS	0.72	
Interaction	NS	1.39		NS	2.13		NS	1.76	

VC: Vermicompost

Table.6 K-uptake (kg/ha) of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	With VC.	Mean	Without VC.	With VC.	Mean	Without VC.	With VC.	Mean
T_1	99	108	104	115	126	120	107	117	112
T_2	100	105	103	121	130	125	111	118	114
T_3	89	113	101	121	130	126	105	122	114
T_4	96	106	101	129	119	124	113	113	118
T_5	100	122	111	140	154	147	120	138	129
T_6	102	130	116	137	164	151	120	147	134
Mean	**98**	**114**		**127**	**137**		**112**	**126**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P, K levels	9	3.18		22	7.57		11	4.08	
Vermicompost	5	1.84		13	4.37		7	2.35	
Interaction	NS	4.50		NS	10.70		NS	5.76	

VC: Vermicompost

Table.7 Zn-uptake (g/ha) of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	With VC.	Mean	Without VC.	With VC.	Mean	Without VC.	With VC.	Mean (A)
T_1	295	314	305	317	303	310	306	309	308
T_2	319	316	318	316	336	326	318	326	322
T_3	308	326	317	316	343	330	312	335	324
T_4	287	299	293	327	338	333	307	319	313
T_5	315	326	321	310	359	335	313	343	328
T_6	332	329	331	330	370	350	331	350	341
Mean	**309**	**318**		**319**	**342**		**314**	**330**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P, K levels	NS	3.49		NS	15.44		NS	8.23	
Vermicompost	NS	2.02		NS	8.92		NS	4.75	
Interaction	NS	4.94		NS	21.84		NS	11.64	

VC: Vermicompost

Table.8 Cu-uptake (g/ha) of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	With VC.	Mean (A)	Without VC.	With VC.	Mean (A)	Without VC.	With VC.	Mean (A)
T_1	51.18	55.25	53.21	57.03	61.11	59.07	54.11	58.18	56.15
T_2	53.14	57.18	55.16	57.42	65.46	61.44	55.28	61.32	58.30
T_3	61.54	59.89	60.72	59.93	65.47	62.70	60.74	62.68	61.71
T_4	56.19	57.57	56.88	61.69	64.91	63.30	58.94	61.24	60.09
T_5	62.23	69.97	66.10	61.86	67.96	64.91	62.05	68.97	65.51
T_6	64.32	71.41	67.86	62.70	71.13	66.93	63.51	71.27	67.39
Mean	**58.10**	**61.88**		**60.11**	**66.01**		**59.10**	**63.94**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P&K levels	NS	1.21		NS	2.47		NS	1.52	
Vermicompost	NS	0.70		NS	1.42		NS	0.88	
Interaction	NS	1.72		NS	3.48		NS	2.15	

VC: Vermicompost

Table.9 Fe-uptake (g/ha) of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	With VC.	Mean (A)	Without VC.	With VC.	Mean (A)	Without VC.	With VC.	Mean (A)
T_1	2729	3024	2876	2701	3119	2910	2715	3072	2893
T_2	3042	3113	3077	2815	3382	3099	2929	3248	3088
T_3	3287	3243	3265	2783	4107	3445	3035	3675	3355
T_4	3029	3287	3158	3303	3606	3455	3166	3447	3307
T_5	3208	3163	3185	3007	4049	3528	3108	3606	3357
T_6	3393	3271	3332	3141	4161	3651	3267	3716	3492
Mean	**3115**	**3183**		**2958**	**3737**		**3037**	**3460**	
Factors	**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**		**CD (P=0.05)**	**SEm±**	
N, P, K levels	NS	59		NS	153		NS	74	
Vermicompost	NS	34		NS	88		NS	43	
Interaction	NS	84		NS	216		NS	105	

VC: Vermicompost

Table.10 Mn-uptake (kg/ha) of Rabi rice as influenced by rescheduling of fertilizer doses

Factor	Rabi-2015-16			Rabi-2016-17			Pooled		
	Without VC.	With VC.	Mean (A)	Without VC.	With VC.	Mean (A)	Without VC.	With VC.	Mean (A)
T_1	1094	1208	1151	1010	1141	1076	1052	1175	1114
T_2	1183	1230	1207	1007	1295	1151	1095	1263	1179
T_3	1331	1257	1294	1026	1312	1169	1179	1285	1232
T_4	1229	1291	1260	1192	1372	1282	1211	1332	1272
T_5	1268	1315	1292	1156	1463	1309	1212	1389	1301
T_6	1359	1336	1348	1323	1593	1458	1341	1465	1403
Mean	1244	1273		1119	1363		1182	1318	
Factors	CD (P=0.05)	SEm±		CD (P=0.05)	SEm±		CD (P=0.05)	SEm±	
N, P, K levels	61	21		136	46.40		81	28	
Vermicompost	NS	12		79	26.79		47	16	
Interaction	NS	30		NS	65.62		NS	39	

VC: Vermicompost

Table.11 Economics of applied inputs to rice crop

Treatments	Cost of cultivation (Rs/ha)		Gross income (Rs/ha)		Net income (Rs/ha)		B:C ratio	
	Without VC	With VC	Without VC	With VC	Without VC	With VC	Without VC	With VC
T_1	56230	66230	95550	96885	39320	30655	1.70	1.46
T_2	54538	64538	95235	102465	40697	37927	1.75	1.59
T_3	54124	64124	99360	100710	41540	36586	1.74	1.57
T_4	55799	65799	96180	99750	40381	33951	1.72	1.52
T_5	55870	65870	96105	99045	40235	33175	1.72	1.50
T_6	56260	66260	97800	105105	45236	38845	1.84	1.59

VC: Vermicompost

The increase in Zn uptake by rice with the application of FYM and Zn might be due to increase in Zn availability in the soil, and increased in yield

The interaction effect of varying N, P and K levels with vermicompost on Zn-uptake in rabi rice was non significant in both the years and in pooled mean.

Cu uptake

Copper uptake in rabi rice was non-significantly influenced by varying N, P and K levels in both the years and in pooled mean. However, higher Cu uptake 67.86, 66.93 and 67.00 g/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_6 over the others and lower Cu uptake 53.21, 59.07 and 56 g/ha were recorded by T_1 in

2015-16, 2016-17 and in pooled mean, respectively (Table 8).

Copper uptake in rabi rice was non significantly varied by vermicompost application along with N, P and K levels in both the years and in pooled mean. However, higher Cu uptake 61.88, 66.01 and 63.94 g/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by the application of vermicompost along with N, P and K levels over N, P and K levels application alone 58.10, 60.11 & 59.10 in 2015-16, 2016-17 and in pooled mean, respectively. The interaction effect of N, P and K levels with vermicompost on Cu-uptake was non significant in both the years and in pooled mean in rabi rice.

Fe uptake

Iron (Fe) uptake in rabi rice was non-significantly influenced by different N, P and K levels in both the years and in pooled mean. However, higher Fe uptake 3332, 3651 and 3492 g/ha, were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_6 over the others and lower Fe uptake 2876, 2910 and 2893 g/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_1 (Table 9).

Fe uptake in rabi rice was non significantly influenced by vermicompost application in both the years and in pooled mean. However, higher Fe uptake 3183, 3737 and 3460 g/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by the application of vermicompost along with varying N,P and K levels over N, P and K alone application 3115, 2958 and 3037 in 2015-16, 2016-17 and in pooled mean, respectively.

The interaction effect of N, P and K levels with vermicompost on Fe-uptake in rabi rice was non significant in both the years and in pooled mean.

Mn uptake

Manganese (Mn) uptake in rabi rice was non-significantly influenced by different N, P, K levels in both the seasons and in pooled mean. However, higher Mn uptake 1348, 1458 and 1403 g/ha, were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_6 over the others and lower Mn uptake 1151, 1076 and 1114 g/ha were recorded in 2015-16, 2016-17 and in pooled mean, respectively by T_1.

Manganese uptake in rabi rice was non significantly varied by vermicompost application along with varied N, P and K levels in both the seasons and in pooled mean. However, higher Mn uptake 1273, 1363 and 1318 g/ha were recorded in 2015-16, 2016-17 & in pooled mean, respectively by the application of vermicompost along with varied N,P and K levels over N,P and K alone application 1244, 1119 and 1182 in 2015-16, 2016-17 and in pooled mean, respectively.

The interaction effect of N, P and K levels with vermicompost on Mn-uptake in rabi rice was non significant in both the years and in pooled mean (Table 10).

The higher nutrient uptake with organic manure might be attributed to solubilization of native nutrients, chelation of complex intermediate organic molecules produced during decomposition of added organic manures, their mobilization and accumulation of different nutrients in different plant parts. The results are in agreement with the findings of Mohapatra *et al.,* (2008).

Economics of applied inputs to rice crop

Due to application of varied N, P and K levels arrived by different concepts of fertilizer application alone and in combination with Vermicompost @ 2t/ha uniformly. The benefit cost ratio ranged from 1.46 to 1.84

and net income ranged from 30,655/- to 45,236/- rupees per hectare. The highest benefit cost ratio (1.84) and net income (45,236/-) was recorded by the application of nitrogen 150% (180 kg/ha), phosphorus is 100% (60 kg/ha) and potassium is 100% recommended dose (40 kg/ha) alone and lowest benefit cost ratio (1.46) and net income 30,655/- was recorded by the application of nutrients based on current RDF along with vermicompost. Though the grain, straw yields and gross income recorded higher by the application of vermicompost along with varying N, P and K levels the net income and benefit cost ratios were low due to higher cost of vermicompost (Table 11).

It may be concluded that the higher grain, straw yields, uptake of nutrients, highest benefit cost ratio (1.84) and net income (45,236/-) was recorded by the application of 180-60-40 kg N, P and K/ha alone and Lowest benefit cost ratio (1.46) was observed with the application of current RDF (120-60-40 kg N, P and K/ha) along with vermicompost application @ 2t/ha..

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