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RESEARCH PAPER

Effect of organic nutrient management practices on yield and nutrient uptake of aerobic rice

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Abstract : The present investigation was undertaken during *Kharif* 2011 at University of Agricultural Sciences, Dharwad to know the response of organic nutrient management practices on yield and nutrient uptake of aerobic rice. The experiment was laid out in Split Plot Design with 2 main plot treatments, 8 sub plot treatments and 2 controls. The main plot treatments comprised of M_1- EC (1/3) + VC (1/3) + GLM (1/3) equivalent RDN and M_2- EC (1/3) + VC (1/3) + GLM (1/3) equivalent to RDF + FYM, sub plot treatment comprised of L_1- bio-digester @ 500 l ha^{-1} applied at planting, 30 and 60 DAS applied to soil, L_2 -jeevamrut @ 500 l ha^{-1} applied at planting, 30 and 60 DAS applied to soil, L_3-*Panchagavya* @ 5 per cent foliar application at panicle emergence and flowering stages, L_4- cow urine @ 10 per cent foliar application at panicle emergence and flowering stages, L_5-L_1+ *Panchagavya* @ 5 per cent foliar application at panicle emergence and flowering stages, L_6 -L_1+ cow urine @ 10 per cent foliar application at panicle emergence and flowering stages, L_7- L_2 + *Panchagavya* spray @ 5 per cent at panicle emergence and flowering stages and L_8-L_2 + cow urine @ 10 per cent foliar application at panicle emergence and flowering stages and two controls were RDF only and RDF + FYM. Application of different organic manures significantly increased the yield and nutrient uptake of aerobic rice. The Results revealed that integrated application of M_2- EC (1/3) + VC (1/3) + GLM (1/3) equivalent to RDF + FYM with soil application of jeevamrut @ 500 l ha^{-1} at planting, 30 and 60 DAS + *Panchagavya* foliar application @ 5 per cent at panicle emergence and flowering stages recorded significantly higher grain yield (3837 kg ha^{-1}) and straw yield (5855 kg ha^{-1}) with higher nutrients uptake.

Key Words : Aerobic rice, Bio-digester, *Panchagavya*, Jeevamrut, Nutrient uptake, Cow urine

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INTRODUCTION

Rice is the staple food for billions of people worldwide. India occupies a pride place in rice production among the food crops cultivated in the world. Rice production system, without constant standing water in non-puddled soils, referred to as 'aerobic rice' is considered to be one of the most promising technologies in terms of water saving. In this system, rice is sown directly into dry soil and irrigation is given to keep the soil sufficiently moist for good plant growth, but the soil is never flooded (Bouman, 2001). The major gain is saving in water, which may be 50–60 per cent less in aerobic rice system as compared to transplanted puddled

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rice (TRP). Rainfed rice is being grown under more complex and unpredictable environment than most crops. Poor nutrient management are among the major constraints in rice production. Adequate supply of plant nutrients and others that may become deficient under aerobic conditions. The concept of organic farming has been gaining momentum with the use of different manures and crop residues in order to increase the productivity of crop as well as the soil fertility status. The shift from flooded to aerobic soil conditions causes changes in soil water status, soil aeration and nutrient availability (Timsina and Connor, 2001). The present investigation has been carried out to know the response of organic nutrient management practices on yield and nutrient uptake of aerobic rice.

MATERIAL AND METHODS

A field experiment was conducted at Main Agriculture Research Station, University of Agricultural Sciences, Dharwad during year 2011. The Main Agricultural Research Station is situated in Northern transitional zone (Zone-8) of the Karnataka. This zone receives rainfall from both South-West and North-East monsoons and hence, it is well distributed from June to November with lower co-efficient of variation. The soil of the experimental site was red loamy in nature having a neutral pH of 7.02, organic carbon 0.59 per cent and available N, P_2O_5 and K_2O were 191.2, 20.36 and 283 kg ha^{-1}, respectively. Also the available micronutrients present are Fe- 6.02, Mn- 10.45, Zn- 0.59 and Cu- 2.04 ppm. The experiment was laid out in Split Plot Design with 16 treatments and two controls. The main plot treatments comprised of M_1 EC (1/3) + VC (1/3) + GLM (1/3) equivalent RDN and M_2- EC (1/3) + VC (1/3) + GLM (1/3) equivalent to RDF + FYM, sub plot treatment comprised of L_1- bio-digester @ 500 l ha^{-1} applied at planting, 30 and 60 DAS applied to soil, L_2 -jeevamrut @ 500 l ha^{-1} applied at planting, 30 and 60 DAS applied to soil, L_3-*Panchagavya* @ 5 per cent foliar application at panicle emergence and flowering stages, L_4- cow urine @ 10 per cent foliar application at panicle emergence and flowering stages, L_5-L_1+ *Panchagavya* @ 5 per cent foliar application at panicle emergence and flowering stages, L_6 -L_1+ cow urine @ 10 per cent foliar application at panicle emergence and flowering stages, L_7- L_2 + *Panchagavya* spray @ 5 per cent at panicle emergence and flowering stages and L_8-L_2 + cow urine @ 10 per cent foliar application at panicle emergence and flowering stages and two controls were RDF only and RDF + FYM. The enriched compost (EC), Vermicompost (VC), green leaf manure (GLM) were incorporated in soil as basal and liquid organic manures were applied as per treatments and in controls full dose of P_2O_5 (Di ammonium phosphate) and K_2O (Muriate of potash) was applied and half dose of N (urea) was applied before sowing and half was applied 30 DAS as top dressing. Before sowing seeds were soaked in water for 8 hours and at the time of sowing seeds were treated with trichoderma, *Pseudomonas* and *Azospirillum* @ 4g per kg. Before sowing furrows were opened at 30 cm apart on both the sides interval with the help of marker and hill marking was done at 30 x 30 cm. Two seeds were dibbled per hill at 30 cm apart. In aerobic rice, as weeds posed problem and regular weed management was undertaken. Inter cultivation thrice with rotary hoe was done at 20, 40 and 60 DAS and two hand weeding at 40 DAS and 60 DAS was taken to manage weeds. To manage the insect pests, spray of neem oil, trichoderma and *Pseudomonas* fluroscence. Neem oil dose depends on the *Azadiracta* content present in it, *Trichoderma* and *Pseudomonas fluorescence* was sprayed @ 4 g l^{-1} of water on 30, 60 and 90 DAS. Yield and yield parameters were calculated after harvest at maturity. Five randomly selected plants from each net plot were oven dried and used for chemical analysis then straw and grains were separated from each other and were powdered and sieved for determination of NPK and micronutrients (Fe, Mn, Zn and Cu) separately. Nitrogen content was determined by by microkjeldhal method in an alkaline condition and titrated against standard acid (Piper,1966).Phosphorus was determined by Vanadomolybdate phosphoric yellow colour method and observation was recorded at 430 nm using Spectrophotometer instrument (Piper, 1966). and potassium contents was determined by diacid digested extract with the digital flame photometer (Piper, 1966). Micronutrients (Fe, Mn, Zn and Cu) content were determined in an aliquot of the diacid digested extract by using atomic absorption spectrometer (AAS) method as described by Follett and Lindsay (1969). The uptake of nitrogen, phosphorus, potassium, copper, iron, zinc and manganese by rice crop at harvest was computed by using the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)}}{100} \times \text{Dry weight (kg ha}^{-1}\text{)}$$

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Yield and yield attributing characters :

The results of the present investigation showed beneficial effect of different solid organic manure and liquid organic manures on yield. The grain yield and straw yield was significantly influenced by application of EC (1/3)+VC (1/3)+ GLM (1/3) equivalent to RDF (100:50:50 N, P_2O_5, K_2O) + 10 t FYM over EC (1/3) + VC (1/3) + GLM (1/3) equivalent to recommended dose of nitrogen (RDN) as it helped in optimizing the availability of nutrients coincides with crop demand. The application of EC (1/3) +VC (1/3) +GLM (1/3) equivalent to RDF (100:50:50N,P_2O_5,K_2O+10 t FYM) recorded significantly higher grain yield and straw yield of (3442 kg ha^{-1} and 4566 kg ha^{-1}, respectively) this might be due integrated application of FYM which could be attributed to the availability of nutrients throughout the crop growth and its higher uptake by the crop apart from favourable effect of FYM on soil physicochemical and biological properties. These results are in conformity with the findings of (Singh and Verma,1999, Dhurandher and Tripathi, 1999 and Reddy, 2006). Addition of FYM enhanced the available nutrient status of soil considerably due to mineralization of native soil and unavailable forms of nutrients in addition to applied nutrients (Babu and Reddy, 2000; Singh *et al.*,2001; Sudha and Chandini, 2003 and Yadav and Chhipa, 2007). The grain yield and straw yield of aerobic rice was significantly influenced by the application of liquid organic manures. The, Significantly higher grain and straw yields were recorded with soil application of jeevamrut @ 500 l ha^{-1} at planting, 30 and 60 DAS + *Panchagavya* foliar spray @ 5% at panicle emergence and flowering stages (3387 kg ha^{-1} and 4632

Table 1: Grain yield, straw yield and harvest index of aerobic rice as influenced by organic manures and liquid organic manures at harvest

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index		
M X L	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
L_1	2335	2995	2665	3421	3859	3640	0.406	0.437	0.422
L_2	2409	3169	2789	3575	3849	3712	0.403	0.452	0.428
L_3	2459	3084	2771	3478	4332	3905	0.414	0.416	0.415
L_4	2552	3161	2856	3464	4284	3874	0.424	0.425	0.425
L_5	2737	3733	3235	3602	4288	3945	0.432	0.465	0.449
L_6	2815	3739	3277	3425	4528	3976	0.451	0.452	0.452
L_7	2937	3837	3387	3410	5855	4632	0.463	0.396	0.433
L_8	2811	3819	3315	3562	5536	4549	0.441	0.408	0.423
Mean	2632	3442		3492	4566		0.430	0.432	
C_1		3648			5844			0.38	
C_2		3885			6023			0.39	
Comparison means of	S.E.±	LSD (P=0.05)		S.E.±	LSD (P=0.05)		S.E.±	LSD (P=0.05)	
Solid organic manures (S)	42	255		25	150		0.002	NS	
Liquid organic manures (L)	54	156		151	438		0.010	NS	
S x L	76	221		214	619		0.014	NS	
Interaction Vs control	90	258		200	574		0.01	0.04	

M_1- EC + VC + GLM equivalent to RDF + FYM: Enriched compost + vermicompost+ Green leaf manure equivalent to recommended dose of fertilizer (N, P_2O_5, K_2O @ 100:50:50 kg ha^{-1}) + 10 t FYM
M_2-EC+VC+GLM equivalent to RDN: Enriched compost +vermicompost+Green leaf manure equivalent to recommended dose of nitrogen (100 kg N ha^{-1})
L_1- Bio-digester @ 500 l ha^{-1} applied at planting, 30 and 60 DAS applied to soil
L_2 -Jeevamrut @ 500 l ha^{-1} applied at planting, 30 and 60 DAS applied to soil
L_3-Panchagavya @ 5% foliar application at panicle emergence and flowering stages
L_4- Cow urine @ 10% foliar application at panicle emergence and flowering stages
L_5-L_1+ Panchagavya @ 5% foliar application at panicle emergence and flowering stages
L_6 -L_1+ Cow urine @ 10% foliar application at panicle emergence and flowering stages
L_7- L_2 + Panchagavya spray @ 5% at panicle emergence and flowering stages
L_8-L_2 + Cow urine @ 10% foliar application at panicle emergence and flowering stages
C_1-RDF (N, P_2O_5, K_2O @ 100:50:50 kg ha^{-1}) , C_2- RDF (N, P_2O_5,K_2O @ 100:50:50 kg ha^{-1}) + 10 t FYM
NS=Non-significant

kg ha^{-1}, respectively). Addition of the jeevamrut and supplementation of foliar sprays of *Panchagavya* and cow urine recorded higher grain yield and straw yield which might be due to panchagavya contains nutrients, beneficial microorganisms and plant growth promoters. Ramanathan (2006). Similarly, Yadav and Lourduraj (2006) showed that foliar spray of *Panchagavya* recorded significantly higher values of all the yield parameters of rice. The grain yield and straw yield are the manifestation of various growth and yield attributing characters. These significant increase in yield with the application of jeevamrut @ 500 l ha^{-1} applied at planting, 30 and 60 DAS applied to soil + *Panchagavya* spray @ 5 per cent at panicle emergence and flowering stages might be due to supply of uric acid by cow urine, the contents mainly gibberllic acid, auxins and other growth promoting hormones present in jeevamrut and *Panchagavya.* The beneficial effect of *Panchagavya* was mainly attributed to the presence of large quantities of IAA and GA which are physiologically active in photosynthesis and other processes (Somasundaram, 2003) and (Boomiraj,2003). He also reported that when it was sprayed, it has created stimuli in the plant system which, in turn, increased the production of growth regulating substances in the cell system. The organic treatment combination EC (1/3) + VC (1/3) + GLM (1/3) equivalent to RDF + FYM with soil application of jeevamrut @ 500 l ha^{-1} at planting, 30 and 60 DAS + *Panchagavya* foliar spray @ 5 per cent at panicle emergence and flowering stages (M_2L_7) recorded significantly higher grain yield and straw yield (3837 kg ha^{-1} and 5855 kg ha^{-1}). This was attributed to cementing action of polysaccharides and other organic compounds released during the decomposition of organic matters, provided better soil environment thus, leading to taller plants, increased number of leaves, tillers and intern the final yield. The organic manures have slow release of nitrogen due to its slow mineralization, which helped in the availability of nutrients commensurate with the growth of the plants and development and thus resulted in higher yield. (Channabasanagowda *et al.*, 2008) and (Alagesan,1997). These findings are in accordance with those of Shwetha and Babalad (2008), who had reported 25 to 35 per cent increase in seed yield of soybean with the application of beejamrut, jeevamrut and *Panchagavya* along with different organic manures.

Nutrients uptake by aerobic rice :

Maximum nutrient uptake increases the yield of the crop (87.26 N, 22.01 P_2O_5 and 78.18 K_2O kg ha^{-1}, 598.10

Table 2: Total N, P and K uptake of aerobic rice as influenced by organic manures and liquid organic manures at harvest

Treatments	Total N uptake (kg ha^{-1})			Total P uptake (kg ha^{-1})			Total K uptake (kg ha^{-1})		
M X L	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
L_1	59.50	70.34	64.92	12.98	15.95	14.46	61.10	68.91	65.00
L_2	60.47	71.72	66.09	13.20	16.69	14.94	62.01	69.66	65.84
L_3	62.14	79.93	71.04	13.31	17.74	15.53	62.68	70.58	66.63
L_4	62.07	80.02	71.04	13.40	17.89	15.65	63.49	71.07	67.28
L_5	65.11	82.67	73.89	13.54	18.57	16.06	64.96	72.22	68.59
L_6	65.66	84.87	75.26	14.84	19.14	16.99	65.87	74.63	70.25
L_7	69.82	87.26	78.54	15.38	22.01	18.69	66.62	78.18	72.46
L_8	68.69	88.88	78.79	14.80	19.68	17.24	66.76	75.95	71.35
Mean	64.19	80.71		13.93	18.46		64.19	72.66	
C_1		81.25			19.91			77.06	
C_2		87.14			22.30			79.09	
Comparison means of	S.E.±	LSD (P=0.05)		S.E.±	LSD (P=0.05)		S.E.±	LSD (P=0.05)	
Solid organic manures (S)	1.23	7.47		0.07	0.40		0.46	2.80	
Liquid organic manures(L)	1.37	3.97		0.22	0.63		0.32	0.92	
S x L	1.94	NS		0.31	0.89		0.45	1.30	
Interaction Vs control	2.04	5.87		0.29	0.84		0.58	1.67	

Fe, 607.93 Mn, 266.01 Zn and 134.23 Cu g ha^{-1} *viz.*,). The increment was higher due to slow release of nutrients through organic manures and enriching available pool of nitrogen. Mankotia *et al.* (2008) recorded higher values of nutrient uptake from the rice - wheat cropping system with 5 tonnes of FYM ha^{-1}, followed by 2.5 tonnes of FYM ha^{-1} along with mushroom spent compost at 1.25 t ha^{-1}. Significantly higher nutrient content and uptake by EC (1/3) + VC (1/3) + GLM (1/3) equivalent to RDF (100:50:50 N, P_2O_5, K_2O + 10 t FYM) over EC (1/3) + VC (1/3) + GLM (1/3) equivalent to recommended dose of nitrogen (RDN). According to Deepa Thomas (1996), higher N levels had marked influence on N, P and K and micronutrients uptake due to increased dry matter production. Higher grain yield and straw yield was due to higher availability of nutrients as indicated by increased uptake of nutrients which depicted through increased total dry matter production. The increase in uptake of nutrients with foliar spray of *Panchagavya* was ascribed to increased biological efficiency of crop plants and creating greater source and sink capacities in the plant system (Boomathi *et al.*, 2005), that might have helped in absorption of the nutrients. The organics in combination with liquid organic manures recorded increased microbial activity, higher nutrient availability and maximum nutrient uptake. Combined application of organic manures and liquid organic manure sources, increased the availability of nutrients which ultimately resulted in higher crop uptake. The treatment combination EC (1/3) + VC (1/3) + GLM (1/3) equivalent to RDF + FYM with soil application of jeevamrut @ 500 l ha^{-1} at planting, 30 and 60 DAS + *Panchagavya* foliar spray @ 5 per cent at panicle emergence and flowering stages (M_2L_7). The greater yield level in relation to supply clearly indicates a strong positive relation between N supplied in each treatment and the grain yield. Higher N levels had marked influence on N, P and K uptake due to increased dry matter production. The present findings are in close association with Sharma and Mittra (1990) and Paikaray *et al.* (2001). They noticed that, use of higher dose of nitrogen might have helped for good vegetative growth and root system, which increased the higher N uptake by plants and hence, increased yield and yield components of rice.

From the above discussion, it could be inferred that combined application of organic manures with liquid organic manures like jeevamrut, *Panchagavya* and cow urine should be applied for increasing productivity of

Table 3: Total Fe, Mn, Zn and Cu uptake of aerobic rice as influenced by organic manures and liquid organic manures at harvest

Treatments	Total Fe uptake (g ha^{-1})			Total Mn uptake (g ha^{-1})			Total Zn uptake (g ha^{-1})			Total Cu uptake (g ha^{-1})		
M X L	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
L_1	346.40	460.11	403.26	411.35	474.14	442.74	133.45	181.96	157.71	57.68	96.38	77.03
L_2	371.75	466.68	419.21	420.75	483.34	452.05	136.03	188.80	162.41	61.07	102.05	81.56
L_3	382.39	488.88	435.63	426.98	493.06	460.02	143.20	192.93	168.07	65.31	104.58	84.95
L_4	396.51	506.30	451.40	449.38	506.61	477.99	153.58	201.66	177.62	69.11	110.99	90.05
L_5	404.83	522.68	463.76	454.07	534.53	494.30	159.93	223.11	191.52	73.76	117.56	95.66
L_6	418.51	570.25	494.38	462.27	584.79	523.53	164.92	242.16	203.54	78.06	129.16	103.61
L_7	436.75	598.10	517.42	469.09	607.93	538.51	175.67	266.01	220.84	88.28	134.23	111.25
L_8	433.92	591.86	512.89	474.47	595.79	535.13	170.83	262.67	216.75	86.95	132.02	109.48
Mean	398.88	525.61		446.04	535.02		154.70	219.91		72.53	115.87	
C_1		587.61			607.67			260.82			129.33	
C_2		610.71			615.75			274.76			136.35	
Comparison means of	S.E.±	LSD (P=0.05)		S.E.±	LSD (P=0.05)		S.E.±	LSD (P=0.05)		S.E.±	LSD (P=0.05)	
Solid organic manures (S)	1.00	6.10		1.74	10.58		3.25	19.80		1.47	8.93	
Liquid organic manures (L)	4.45	12.89		3.19	9.23		2.40	6.95		1.17	3.40	
S x L	6.29	18.23		4.50	13.05		3.39	9.82		1.66	4.80	
Interaction Vs control	5.78	16.62		4.69	13.48		3.87	11.12		1.85	5.32	

aerobic rice with higher nutrients uptake.

REFERENCES

Alagesan, A. (1997). Studies on optimizing nitrogen levels and time of application for wet seeded rice. M.Sc.(Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Babu, R.B.T. and Reddy, V.C. (2000). Effect of nutrient sources on growth and yield of direct seeded rice (*Oryza sativa* L.). *Crop Res.*, **19** : 189-193.

Boomathi, N., Suganya, Kanna, S. and Jeyarani, S. (2005). "*Panchakavya*" – A gift from our mother's nature. *Agrobios. Newslett*., **4** (3) : 20-21.

Boomiraj, K. (2003). Evaluation of organic sources of nutrients, *Panchagavya* and botanicals spray on Bhendi (*Abelmoschus esculentus Monech*). M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Bouman, B.A.M. (2001). Water efficient management strategies in rice production, Notes 16.2 *IRRI*, Philippines. pp. 17-22.

Channabasanagowda, N.K., Patil, Biradar B.N., Patil, J.S., Awaknavar, B.T., Ninganur and Hunge, Ravi (2008). Effect of organic manures on growth, seed yield and quality of wheat. *Karnataka J. Agric. Sci.*, **21**(3) : 366-368.

Dhurandher, R.L. and Tripathi, R.S. (1999). Impact of sowing method and N levels on productivity of late duration rice cultivars in vertisol. *Haryana J. Agron.*, **15**(1) : 1-5.

Follett, R.H. and Lindsay, W.L. (1969). Changes in DTPA extractable zinc, iron, manganese and copper in soils following fertilization. *Soil Sci. Soc. American Proc.*, **35**: 600-602.

Mankotia, B.S., Shekhar, J., Thakur, R.C. and Negi, S.C. (2008). Effect of organic and inorganic sources of nutrients on rice - wheat cropping system.*Indian J. Agron.*,**53**(1):32-36.

Paikaray, R.L., Mahapatra, B.S.L and Sharma, G.L. (2001). Integrated nitrogen management in rice (*Oryza sativa*) – wheat (*Tricum aestivum*) cropping system. *Indian J. Agron.*, **46** (4) : 592-600.

Piper, C.S. (1966). *Soil and plant analysis*, Academic press, NEW YORK, U.S.A.

Ramanathan, K. M. (2006). Organic farming for sustainability. *J. Indian Soc. Soil Sci*., **54**(4) : 418-425.

Reddy, Rajashekhara (2006). Agronomic investigations on integrated nutrient management in aerobic paddy (*Oryza sativa* L.). M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Bangalore, KARNATAKA (INDIA).

Sharma, A. R. and Mittra, B. N. (1990). Effect of N and P on rice and their residual effect on succeeding wheat/gram crop. *Indian J. Agron*., **34** : 40-44.

Shwetha, B.N. and Babalad, H.B. (2008). Effect of nutrient management through organics in soybean wheat cropping system. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Bangalore, KARNATAKA (INDIA).

Singh, N.B. and Verma, K.K. (1999). Integrated nutrient management in rice-wheat crop sequences, *Oryza*, **36** : 171-172.

Singh, Raghuraj, Singh, Sardhar and Prasad, Kedar (2001). Effect of fertilizers, FYM and row spacing on transplanted rice, *Crop Res.*, **22** (2) : 295-296.

Somasundaram, E. (2003). Evaluation of organic sources of nutrients and *Panchagavya* spray on the growth and productivity of maize-sunflower-greengram system. Ph. D. Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Sudha., B. and Chandini, B. (2002). Nutrient management in rice *(Oryza sativa* L.) *J. Trop. Agric.*, **40** : 63-64.

Thomas, Deepa (1996). Integrated nitrogen management for wet seeded rice. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Timsina, J. and Connor, D.J. (2001). Productivity and management of rice–wheat cropping systems: issues and challenges. *Field Crops Res.*, **69**:93–132.

Yadav, B.K. and Lourdaraj, C.A. (2006). Effect of organic manures and *Panchagavya* spray on yield attributes, yield and economics of rice (*Oryza sativa* L.) quality. *Crop Res.*, **32** (1) : 1-5.

Yadav, K.K. and Chhipa, B.R.(2007). Effect of FYM, gypsum and iran pyrites on fertility status of soil and yield of wheat irrigated with high RSC water. *J. Indian Soc. Soil Sci.*, **55** (3) : 324 - 329.