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Nutrient Uptake as Influenced by Organic and Inorganic Sources of Nutrients Under Aerobic Rice Cultivation

S. Jaffar Basha, R. Basavarajappa, N. S. Hebsur

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Abstract A field experiment was conducted to determine the effect of organic and inorganic sources of nutrients on total nutrient uptake under aerobic rice cultivation during *kharif* of 2013 and 2014. The experiment consisted of twenty four treatment combinations comprising of six main plot treatments (manurial practices) as RDF (100:50:50 kg N, P_2O_5, K_2O ha^{-1}), RDF + FYM (5 t ha^{-1}) + microbial consortium, FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN, FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN + microbial consortium, FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN with FYM (5 t ha^{-1}) and FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN with FYM + microbial consortium and four sub plot treatments (liquid organic manures) as soil application of jeevamrut @ 500 l ha^{-1}, foliar application of cow urine @ 500 l ha^{-1}, soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS and control (no liquid manure application) which were replicated thrice. Significantly higher grain yield (4262 kg ha^{-1}), straw yield (6033 kg ha^{-1}), total nitrogen (108.11 kg ha^{-1}), phosphorus (23.73 kg ha^{-1}) and potassium (101.87 kg ha^{-1}) uptake by grain and straw was observed with application of RDF + FYM (5 t ha^{-1}) + microbial consortium with soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS in rice under aerobic cultivation.

Keywords Aerobic tice, Chemical fertilizers, N, P and K content and uptake, Organic sources.

Introduction

Rapid degradation of rice (*Oryza sativa* L.) ecologies due to imbalanced use of fertilizers and unscientific water management has put treatmendous pressure on the rice growers to make rice farming economically viable and ecologically sustainable under aerobic rice system (ARS). Increased prices of manufactured fertilizers and concerns about the sustainability of intensive cropping systems have led some countries to promote organic materials as a source of nutrients for

S. J. Basha*, R. Basavarajappa
Department of Agronomy,
College of Agriculture, UAS,
Dharwad 580005, Karnataka, India

N. S. Hebsur
Department of Soil Science and Agricultural Chemistry,
College of Agriculture, UAS,
Dharwad 580005, Karnataka, India
e-mail : shaik.jaffarbasha@gmail.com
*Correspondence

crops and as an amendment to inprove soil properties. Organic farming minimizes the use of external inputs and aims to optimization of crop productivity rather than its maximization through renewal and strengthening of ecological processes and functions of farm ecosystem [1]. In this direction, integrated management of solid and liquid organic manures needs priority. Using organic sources like farm yard manure, compost, vermicompost in combination with liquid organic manures like cattle urine, bio-digested liquid manure, jeevamrut deserves priority for sustained production and better on farm resource recycling and utilization. The application of chemical fertilizers with farmyard manure or wheat straw in alternate wetting and dtying condition increased N, P, and K uptale by rice plants, increased 1000 grain weight and grain yield of rice [2]. Application of organic manures in combination with inorganic fertilizers improves soil health and maximizes sustainable productivity through increased soil humic substances which leads to higher availability of macro and micronutrients to crops. Liquid organic manures will provide nutrients, growth promoting substances as well as they are microbial enriched products having a role in organic rice production. On going through the above facts in the mind, a study was conducted during *kharif*, 2013 and 2014 to find out the impact of various sources of nutrients on total nutrient uptake under aerobic rice cultivation.

Materials and Methods

A field experiment was conducted at Main Agricultural Research Station, UAS, Dharwad, Karnataka during *kharif* of 2013 and 2014 to study the effect of organic and inorganic sources of nutrients on total nutrient uptake under aerobic rice cultivation. The soil of the experimental site was clay, having low organic carbon (4.90 g kg^{-1}) and available N P K (263.42; 23.30 and 285.60 NPK kg ha^{-1}, respectively). The total rainfall of 484 mm and 618.6 mm was received in 45 and 48 rainy days during crop growth period of 2013 and 2014, respectively. The experiment was laid out in a split plot design with three replications. The main-plot treatments comprised of six manurial combinations as M_1-Recommended dose of chemical fertilizer (RDF) (100:50:50 kg N, P_2O_5, K_2O ha^{-1}), M_2-RDF + Farm yard manure (5 t ha^{-1}) + microbial consortium (Azospirillum + Phosfate solubilizing bacteria) (MC), M_3- FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN, M_4- FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN + microbial consortium, M_5- FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN with recommended FYM (5 t ha^{-1}), M_6- FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN with recommended FYM + microbial consortium. The subplot treatments consisted of four liquid organic manure treatments L_1: Soil application of jeevamrut @ 500 l ha^{-1} at 30, 60 and 90 DAS, L_2: Foliar application of cow urine @ 500 l ha^{-1} at 30, 60 and 90 DAS, L_3: Soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS, L_4: Control (no liquid manure application). Organic manures equivalent to RDN through FYM, vermicompost and green leaf manure (*Gliricidia* spp.) were applied 15 days before sowing as per the treatments. The seeds of variety MAS-26 developed specifically for aerobic rice production from UAS, Bengaluru were used and two seeds were dibbled $hill^{-1}$ at 30 cm × 15 cm spacing on 4th July, 2013 and 16th July, 2014 during 2013-14 and 2014-15 respectively.

Nitrogen content was determined by Micro kjeldhal method. Phosphorus content was determined by Vanadomolybdate phosphoric yellow color method and Potassium content was determined by using Flame Photometer [3].

The uptake of N, P and K by crop at harvest was computed by using the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%)} \times \text{Yield of dry matter (kg)}}{100}$$

The experimental data obtained were pooled and subjected to statistical analysis by adopting Fisher's method of analysis of variance [4]. The level of significance used in 'F' test was at 5%. The mean values of main plot, sub plot and interaction were separately subjected to Duncan' multiple range test using the corresponding error mean sum of squares and degrees of freedom.

Table 1. Effect of organic and inorganic sources of nutrients on grain yield, straw yield (kg ha^{-1}) N, P and K content (%) in grain and straw. Means followed by the same alphabet do not differ significantly by DMRT (0.05).

Treatments	Grain yield	Straw yield	N			P			K		
			Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Manurial practices (M)											
M_1-RDF (100:50:50 kg N, P_2O_5, K_2O ha^{-1})	3666[b]	4979[b]	1.35	0.66	2.00	0.29	0.15	0.44	0.25	1.31	1.56
M_2-RDF + FYM + MC	4086[a]	5380[a]	1.42	0.69	2.11	0.30	0.16	0.46	0.27	1.38	1.65
M_3-FYM (1/3) + VC (1/3)+ GLM (1/3) equi RDN	2683[e]	3644[d]	1.05	0.53	1.58	0.23	0.12	0.35	0.20	1.17	1.36
M_4-FYM (1/3)+VC (1/3)+GLM (1/3) equi RDN+MC	2771[e]	3785[d]	1.07	0.54	1.61	0.24	0.13	0.37	0.21	1.20	1.41
M_5-FYM (1/3)+VC (1/3)+ GLM (1/3) equi RDN+FYM	3020[d]	3871[cd]	1.14	0.55	1.69	0.26	0.13	0.39	0.22	1.20	1.42
M_6-FYM (1/3)+VC (1/3)+ GLM (1/3)	3152[c]	4083[c]	1.16	0.55	1.71	0.26	0.14	0.40	0.23	1.24	1.47
SEm±	38.32	79.66	0.01	0.006	0.01	0.004	0.004	0.004	0.003	0.01	0.01
CD (0.05)	121	125	0.04	0.02	0.04	0.01	0.01	0.01	0.01	0.03	0.01
Liquid organic manures (L)											
L_1-Jeevamrut @ 500 l ha^{-1} at 30. 60 and 90 DAS	3278[a]	4243[c]	1.19	0.58	1.77	0.27	0.14	0.40	0.21	1.25	1.47
L_2-Cow urin @ 500 l ha^{-1} at 30, 60 and 90 DAS	3334[a]	4497[b]	1.24	0.60	1.83	0.27	0.14	0.41	0.24	1.31	1.55
L_3-Bio digester @ 2500 l ha^{-1} at 30, 60 and 90 DAS	3396[a]	4784[a]	1.26	0.63	1.89	0.28	0.15	0.43	0.24	1.33	1.57
L_4-Control (no liquid manure application)	2910[b]	3638[d]	1.10	0.54	1.63	0.23	0.12	0.36	0.20	1.11	1.31
SEm±	52.28	53.39	0.01	0.013	0.02	0.003	0.003	0.003	0.003	0.01	0.01
CD (0.05)	150	153	0.04	0.04	0.04	0.01	0.001	0.01	0.01	0.02	0.03
Interactions-(M × L)											
M_1L_1	3706[de]	4880[de]	1,33	0.67	2.00	0.29	0.15	0.44	0.24	1.27	1.51
M_1L_2	3767[cd]	5255[cd]	1.40	0.67	2.07	0.29	0.15	0.44	0.25	1.32	1.57
M_1L_3	3833[b-d]	5563[bc]	1.40	0.70	2.10	0.30	0.16	0.46	0.26	1.38	1.64
M_1L_4	3360[ef]	4219[f-h]	1.26	0.60	1.86	0.28	0.14	0.42	0.24	1.27	1.51
M_2L_1	4122[a-c]	5235[cd]	1.40	0.67	2.07	0.31	0.16	0.46	0.28	1.43	1.71
M_2L_2	4195[ab]	5656[b]	1.47	0.70	2.17	0.32	0.16	0.48	0.28	1.43	1.71
M_2L_3	4262[a]	6033[a]	1.47	0.74	2.21	0.32	0.17	0.48	0.29	1.48	1.77
M_2L_4	3764[cd]	4595[ef]	1.33	0.67	2.00	0.28	0.14	0.42	0.23	1.18	1.41
M_3L_1	2774[i-k]	3697[ij]	1.05	0.53	1.58	0.23	0.12	0.35	0.20	1.18	1.38
M_3L_2	2776[i-k]	3822[h-j]	1.05	0.53	1.58	0.23	0.12	0.35	0.21	1.24	1.45
M_3L_3	2838[h-k]	4035[g-i]	1.12	0.56	1.68	0.25	0.13	0.38	0.21	1.24	1.45
M_3L_4	2346[l]	3022[l]	0.98	0.49	1.47	0.21	0.11	0.32	0.17	1.00	1.17
M_4L_1	2822[h-k]	3766[ij]	1.05	0.53	1.58	0.24	0.13	0.36	0.21	1.22	1.43
M_4L_2	2889[g-i]	3954[g-i]	1.12	0.56	1.68	0.26	0.14	0.39	0.22	1.27	1.49
M_4L_3	2943[f-i]	4257[f-h]	1.12	0.60	1.72	0.26	0.14	0.40	0.22	1.27	1.49
M_4L_4	2430[kl]	3163[kl]	0.98	0.49	1.47	0.21	0.11	0.32	0.18	1.04	1.22
M_5L_1	3066[f-i]	3828[h-j]	1.16	0.56	1.72	0.27	0.13	0.40	0.21	1.18	1.39
M_5L_2	3133[f-i]	4051[g-i]	1.16	0.56	1.72	0.27	0.14	0.41	0.23	1.29	1.52
M_5L_3	3194[f-i]	4309[fg]	1.23	0.60	1.82	0.28	0.15	0.42	0.23	1.29	1.52
M_5L_4	2689[i-l]	3298[kl]	1.02	0.49	1.51	0.22	0.12	0.33	0.19	1.06	1.25
M_6L_1	3181[f-i]	4051[g-i]	1.16	0.56	1.72	0.27	0.14	0.41	0.22	1.21	1.43
M_6L_2	3248[f-h]	4245[f-h]	1.23	0.56	1.79	0.28	0.14	0.42	0.24	1.32	1.56
M_6L_3	3306[fg]	4506[ef]	1.23	0.60	1.82	0.28	0.15	0.42	0.24	1.32	1.56
M_6L_4	2873[h-i]	3530[jk]	1.02	0.49	1.51	0.22	0.12	0.33	0.70	1.10	1.30
SEm±	128.1	130.8	0.03	0.03	0.04	0.008	0.002	0.008	0.006	0.02	0.02
CD (0.05)	367	375	0.09	0.09	0.11	0.02	0.01	0.02	0.02	0.05	0.07

Results and Discussion

Grain and straw yield

The pooled data show that application of RDF FYM (5 t ha^{-1}) + microbial consortium (M_2) brought about significant improvement in grain yield (4086 kg ha^{-1}) and straw yield (5380 kg ha^{-1}) and established superiority over the application of organic N source (Table 1). The trend observed in increasing order was: $M_2>M_1>M_6>M_5>M_4>M_3$. The findings of the present investigation revealed profound effect of integrated application of inorganic and organic sources of nutrients on yield of rice. Among liquid organic manures, soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS (L_3) recorded significantly higher grain yield (3396 kg ha^{-1}) and straw yield (4784 kg ha^{-1}) which was on par with foliar application of cow urine @ 500 l ha^{-1} (L_2) or soil application of jeevamrut @ 500 l ha^{-1}) (L_1) at 30, 60 and 90 DAS (3334 and 3278 kg ha^{-1}, respectively). Integrated application of RDF + FYM + microbial consortium with soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS (M_2L_3) recorded significantly higher grain and straw yield (4262 and 6033 kg ha^{-1}, respectively). The application of organic manure and chemical fertilizers increased the grain and straw yields of rice [5]. Integrated use of fertilizer and manure significantly increased the effective tillers $hill^{-1}$ and grain yield from 26 to 59% [6]. Use of higher dose of nitrogen, phosphorus and potassium through inorganic and organic sources has optimize the availability of nutrients and helped in inducing good vegetative growth and this resulted in more number of tillers and higher number of panicles leading to higher yield [7]. Rice grain yield (5.57 t ha^{-1}) was significantly higher with the application of FYM @ 5 t ha^{-1} along with NPK (60:37.5:22.5 kg ha^{-1}) [8].

Nutrient content

Application of RDF (100:50:50 kg N, P_2O_5, K_2O ha^{-1}) + FYM (5 t ha^{-1}) + microbial consortium (Azospirillum + Phosfate solubilizing bacteria) (M_2) recorded significantly higher total N, P and K content (2.11, 0.46 and 1.65%, respectively) in total grain and straw over rest of the treatments (Table 1). Among liquid organic manures, soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS (L_3) recorded significantly higher total N, P and K content (1.89, 0.43 and 1.57%, respectively) in total grain and straw over rest of the treatments. Among the treatment combinations, integrated application of RDF + FYM + microbial consortium with soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS (M_2L_3) recorded significantly higher total N, P and K content (2.21, 0.48 and 1.77%, respectively) in total grain and straw over rest of the treatments. The higher levels of N, P, K and S concentrations in grain and straw were recorded in the combined application of fertilizer and manure compared to the chemical fertilizer alone [9]. The higher total NPKS uptake by grain and straw was recorded in the treatment application of recommended fertilizer 100% N ha^{-1} from urea [10].

Nutrient uptake

Significantly higher total N (96.19 kg ha^{-1}), P (21.05 kg ha^{-1}) and K (86.04 kg ha^{-1}) uptake was observed on pooled basis with RDF (100:50:50 kg N: P: K ha^{-1}) along with 5 t of FYM ha^{-1} (Table 2). Among the organic manurial practices, application of FYM (1/3) + vermicompost (1/3) + green leaf manure (1/3) equivalent to RDN + 5 t FYM + microbial consortium recorded higher nutrient uptake of N (59.39 kg ha^{-1}), P (13.83 kg ha^{-1}) and K (57.98 kg ha^{-1}). The comparative over view of grain yield and nutrient supply clearly indicated strong positive relation established between N supplied in each treatment and the grain yield. The increment was higher due to slow release of nutrients through organic manures and enriching available pool of N. 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}[11]. In case of organic manures K uuptake was more and this might be due to less loss and less fixation of K in the soil. When FYM are added to the soil complex, nitrogenous compounds break down slowly and make steady N supply throughout the growth period of the crop. N is better utilized only in the presence of P and K. This might have attributed to more availability and subsequent uptake by the crop.

The increase in uptake of N (74.48 kg ha^{-1}), P (16.88 kg ha^{-1}), and K (72.62 kg ha^{-1}) with soil applica-

Table 2. Effect of organic and inorganic sources of nutrients on N, P and K uptake (kg ha^{-1}) by grain and straw. Means followed by the same alphabet do differ significantly by DMRT (0.05).

Treatments	N			P			K		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Manurial practices (M)									
M_1-RDF (100:50:50 kg N, P_2O_5, K_2O ha^{-1})	50.29^{b}	32.99^{b}	83.28^{b}	10.61^{b}	7.61^{b}	18.22^{b}	9.19^{b}	65.77^{b}	74.96^{b}
M_2-RDF+FYM+MC	58.80^{a}	37.39^{a}	96.19^{a}	12.54^{a}	8.52^{a}	21.05^{a}	11.19^{a}	74.85^{a}	86.04^{a}
M_3-FYM+(1/3)+VC (1/3)+ GLM (1/3) equi RDN	28.43^{d}	19.18^{d}	47.61^{d}	6.18^{d}	4.45^{e}	10.62^{e}	5.36^{f}	42.82^{e}	48.18^{e}
M_4-FYM (1/3)+VC(1/3)+ GLM (1/3) equi RDN+MC	29.90^{d}	20.69^{cd}	50.59^{d}	6.72^{d}	4.89^{d}	11.61^{d}	5.80^{e}	45.84^{de}	51.64^{d}
M_5-FYM (1/3)+VC (1/3)+ GLM (1/3) equi RDN+FYM	34.71^{c}	21.42^{c}	56.13^{c}	7.86^{ec}	5.16^{d}	13.02^{c}	6.55^{d}	46.86^{d}	53.41^{d}
M_6-FYM (1/3)+VC (1/3)+GLM (1/3) equi RDN+FYM+MC	36.78^{c}	22.60^{c}	59.39^{c}	8.27^{c}	5.56^{c}	13.83^{c}	7.13^{c}	50.86^{c}	57.98^{c}
SEm±	0.71	0.61	1.22	0.2	0.11	0.29	0.09	0.99	1.0
Liquid organic manures (L)									
L_1-Jeevamrut @ 500 l ha^{-1} at 30, 60 and 90 DAS	40.08^{b}	25.16^{c}	65.24^{c}	8.89^{b}	5.86^{c}	14.75^{c}	7.60^{b}	53.50^{c}	61.10^{c}
L_2-Cow urine @ 500 l ha^{-1} at 30, 60 and 90 DAS	42.38^{a}	27.17^{b}	69.55^{b}	9.27^{ab}	6.47^{b}	15.74^{b}	8.11^{a}	59.44^{b}	67.55^{b}
L_3-Bio digester @ 2500 l ha^{-1} at 30, 60 and 90 DAS	43.84^{a}	30.64^{a}	74.48^{a}	9.63^{a}	7.25^{a}	16.88^{a}	8.40^{a}	64.22^{a}	72.62^{a}
L_4-Control (no liquid manure application)	32.98^{c}	19.88^{d}	52.86^{d}	7.00^{c}	4.54^{d}	11.54^{d}	6.03^{c}	40.84^{d}	46.87^{d}
SEm±	0.65	0.64	0.84	0.17	0.08	0.17	0.15	0.89	0.89
Interactions-(M×L)									
M_1L_1	50.23^{d}	32.74^{c}	82.97^{de}	10.71^{b}	7.37^{d}	18.09^{cd}	9.00^{b-d}	62.43^{d}	71.43^{d}
M_1L_2	53.57^{d}	35.14^{bc}	88.70^{cd}	10.88^{b}	7.92^{cd}	18.80^{c}	9.52^{bc}	69.86^{c}	79.37^{c}
M_1L_3	54.40^{cd}	38.95^{b}	93.36^{c}	11.46^{b}	9.11^{b}	20.57^{b}	10.10^{b}	76.87^{b}	86.97^{b}
M_1L_4	42.97^{e}	25.13^{e-g}	68.11^{f}	9.37^{cd}	6.05^{ef}	15.42^{ef}	8.16^{d-f}	53.92^{e-g}	62.08^{e-g}
M_2L_1	58.40^{bc}	34.85^{bc}	93.25^{c}	12.72^{a}	8.14^{c}	20.86^{b}	11.67^{a}	74.88^{bc}	86.55^{b}
M_2L_2	62.46^{ab}	39.63^{b}	102.09^{b}	13.39^{a}	9.22^{b}	22.61^{a}	11.87^{a}	81.00^{b}	92.87^{b}
M_2L_3	63.56^{a}	44.55^{a}	108.11^{a}	13.59a	10.13^{a}	23.73^{a}	12.49^{a}	89.38a	101.87^{a}
M_2L_4	50.77^{d}	30.54^{cd}	81.30^{e}	10.45^{bc}	6.57^{e}	17.02^{d}	8.73^{c-e}	54.15^{e-g}	62.88^{e-g}
M_3L_1	29.34^{hi}	19.42^{h-j}	48.75^{jk}	6.35^{h-j}	4.38^{ij}	10.73^{kl}	5.55^{ij}	43.60^{ij}	49.15^{jk}
M_3L_2	29.26^{hi}	19.93^{g-j}	49.19^{jk}	6.39^{h-j}	4.73^{i}	11.11^{k}	5.86^{h-j}	47.39^{g-i}	53.25^{h-j}
M_3L_3	31.92^{g-i}	22.56^{e-h}	54.48^{ij}	7.07^{g-i}	5.40^{gh}	12.46^{ij}	6.01^{h-j}	50.08^{f-i}	56.09g-j
M_3L_4	23.19^{j}	14.82^{j}	38.01^{k}	4.91^{k}	3.29^{k}	8.20^{n}	4.01^{k}	30.22^{l}	34.24^{m}
M_4L_1	29.91^{hi}	19.93^{g-j}	49.84^{jk}	6.73^{hi}	4.76^{i}	11.49^{jk}	5.94^{hj}	45.92^{hi}	51.86^{ij}
M_4L_2	32.62^{g-i}	22.03^{e-i}	54.65^{ij}	7.47^{f-h}	5.38^{gh}	12.85^{hi}	6.39^{g-i}	50.33^{f-i}	56.72^{f-i}
M_4L_3	33.07^{gh}	25.32^{ef}	58.39^{hi}	7.60^{e-h}	5.99^{e-g}	13.59^{hi}	6.47^{g-i}	54.20^{e-g}	60.67^{e-g}
M_4L_4	24.00^{j}	15.47^{j}	39.48^{l}	5.08^{jk}	3.44^{k}	8.52^{mn}	4.40^{k}	32.93^{kl}	37.33^{m}
M_5L_1	35.67^{fg}	21.26^{f-i}	56.93^{i}	8.24^{d-g}	4.92^{hi}	13.16^{hi}	6.47^{g-i}	44.94^{h-j}	51.41^{ij}
M_5L_2	36.36^{fg}	22.61^{e-h}	58.97^{g-i}	8.42^{d-g}	5.60^{fg}	14.02^{gh}	7.23^{fg}	52.02^{f-h}	59.24^{f-h}
M_5L_3	39.32^{ef}	25.72^{ef}	65.04^{fg}	8.90^{de}	6.29^{e}	15.19^{e-g}	7.39^{fg}	55.41^{ef}	62.80^{e-g}
M_5L_4	27.52^{ij}	16.09^{j}	43.61^{kl}	5.88^{i-k}	3.82^{jk}	9.70^{mn}	5.11^{jk}	35.08^{kl}	40.19^{lm}
M_6L_1	36.92^{fg}	22.77^{e-h}	59.70^{g-i}	8.56^{d-f}	5.60^{fg}	14.16^{f-h}	6.99^{f-h}	49.21^{f-i}	56.20^{g-j}
M_6L_2	40.01^{ef}	23.67^{e-h}	63.69^{f-h}	9.07^{d}	5.98^{e-g}	15.05^{e-g}	7.81^{ef}	56.05^{d-f}	63.86^{ef}
M_6L_3	40.77^{ef}	26.73^{de}	67.50^{f}	9.18^{cd}	6.57^{e}	15.75^{e}	7.93^{d-f}	59.41^{de}	67.34^{de}
M_6L_4	29.42^{hi}	17.24^{ij}	46.66^{k}	6.28^{h-j}	4.08^{j}	10.36^{kl}	5.78^{h-j}	38.76^{jk}	44.54^{kl}
SEm±	1.59	1.58	20.6	0.43	0.2	0.43	0.37	2.19	2.18

tion of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS was ascribed to increased biological efficiency of crop plants and creating greater source and sink capacities in the plant system, that might have helped in

absorption of the nutrients. Combined application of manurial practices and liquid organic manure sources, increased the uptake of nutrients. The treatment combinations of RDF + FYM + microbial consortium and soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS (M_2L_3) are evidenced by nutrient uptake of 108.11, 23.73 and 101.87 kg ha^{-1} N, P and K. The greater yield level in relation to supply clearly indicates a strong positive relation between N supplied in each treatment and the grain yield. Increased uptake of nutrients may be attributed to improved nutrient availability as a consequence of synergistic relationship between the organic manures and inorganic sources. FYM is known to have a favorable effect on soil structure, texture and tilth and thus facilitates quick and greater availability of plant nutrients and provides a better environment for root growth and proliferation, thereby creating more absorptive surface for uptake of nutrients [12]. Treatments which received combination of organic and inorganic fertilizer showed higher uptake values of all the three nutrients most probably due to higher yields received in these treatments [13]. Application of 100% RDF + jeevamrutha (N vasis) + vermicompost at 5 t ha^{-1} recorded highest nutrient uptake of 100.94 kg N, 23.90 kg P_2O_5 and 106.09 kg K_2O respectively in the rice over other treatments [14]. Significant higher N, P and K uptake (124.2, 30.6 and 93.9 kg ha^{-1} respectively) recorded with application of RDF (100:50:50 kg N:P:K ha^{-1}) + 10 tonnes of FYM ha^{-1} [15].

Conclusion

Conjunctive application of RDF (100:50:50 kg N, P_2O_5, K_2O ha^{-1}) + FYM (5 t ha^{-1}) + micribial consortium along with soil application of biodigester @ 2500 l ha^{-1} at 30, 60 and 90 DAS sets a congenial soil environment for enhancement in the contents of nutrients in plants and obviously, their uptake in grain and straw at harvest which results in higher yields.

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