



Effect of Nutrient Management Interventions on Nutrient Uptake of Rice-zero Till Ragi under Coastal Lands

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ABSTRACT

Background: The excessive usage of chemical fertilizers and the negligence on soil health regarding the conservation and use of organic sources of nutrients have not only caused the exhaustion of soil nutrient reserves but also resulted in soil health problems which is not conducive to achieving consistent increase in agricultural production. The beneficial influence of organic matter on the physical, chemical and biological properties of the soil is well known, the full appreciation of the same remains which is unfortunately ignored in modern agriculture. The regular recycling of organic wastes in the soil is the most efficient method of maintaining optimum nutrient reserves of soil and nutrient uptake by the plant. The Present Study was conducted to evaluate the nutrient status of soil under integrated usage of organic and inorganic sources.

Methods: A field experiment entitled "Nutrient Management Interventions in Rice-Ragi Sequence" was conducted during *kharif* and *rabi* seasons of 2017-18 and 2018-19 on sandy loam soil of the Agricultural College Farm, Bapatla. The seven treatments consisted of T₁: 100% RDF (100-60-40 kg N-P-K ha⁻¹); T₂: 100% RDF + Soil application of ZnSO₄ @ 50 kg ha⁻¹; T₃: 125% RDF+Soil application of ZnSO₄ @ 50 kg ha⁻¹; T₄: 75% RDF + Poultrymanure @ 0.82 t ha⁻¹ + Soil application of ZnSO₄ 50 kg ha⁻¹; T₅: 75% RDF + FYM @ 5.0 t ha⁻¹ + Soil application of ZnSO₄ @ 50 kg ha⁻¹; T₆: 50% RDF + Poultrymanure @ 1.6 t ha⁻¹ + Soil application of ZnSO₄ @ 50 kg ha⁻¹ and T₇: 50% RDF + FYM @ 10 t ha⁻¹ + Soil application of ZnSO₄ @ 50 kg ha⁻¹. The experiment was laidout in randomized block design with seven treatments and replicated thrice during *kharif* rice and in *rabi* each *kharif* treatment was subdivided into four sub treatments (S₁: Nofertilizer, S₂: 100% RDF, S₃: 75% RDF and S₄: 50% RDF) and hence, The split plot design was adopted in *rabi*. Total No. of plots per each replication in the *rabi* was 28 (7x4=28).

Result: Nutrient content and uptake of nitrogen, phosphorus, potassium and zinc have increased significantly with the fertility levels and organics. 50% RDF + FYM @ 10 t ha⁻¹ + ZnSO₄ @ 50 kg ha⁻¹ recorded the highest nitrogen, phosphorus, potassium and zinc contents and uptakes in grain and straw of rice. In no till *rabi* ragi, N, P, K, Zn and calcium content and uptake in grain and straw were found to be significantly superior with 100% RDF (S₂) to the rest of the treatments in both the years and in pooled data.

Key words: Nutrient content, Nutrient uptake, Rice-zero till ragi.

INTRODUCTION

Increasing awareness towards conservation of environment and also human health hazards associated with agrochemicals, consumer's preference is to safe and hazard-free food are the major factors that lead to the growing interest towards organic agriculture in the world. Green revolution encourages greater use of off-farm agrochemicals viz., fertilizers and pesticides with adoption of New Plant Types and HYVs of crops have exponential increasing the production output per hectare in most cases. However, this increase in production has decline the soil fertility and productivity over a long run. The main principle of maintaining the soil fertility status is to annually replenish those nutrients which are removed by the crops from the field. For maintaining fertility status of soil on a longrun, we should dependent on the different nutrient sources rather than chemical fertilizers alone. Rice-pulse crop sequence is more predominant in north coastal zone and Krishna Godavari Zone of Andhra Pradesh. But, the area under this sequence (Rice-pulse) is recently declining due to late planting of rice because of delay in onset of monsoon and severe in cadence of yellow mosaic virus on pulse crop which lead to complete failure of pulse crop. In this context, ragi is

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an alternative crop in the rice fallows in place of pulse crops. The farmers of the North Coastal and Krishna zones are showing interest in raising of ragi as an alternative to pulse crop in the *rabi* season in rice fallows.

MATERIALS AND METHODS

The present investigation was conducted at Agricultural College Farm, Bapatla on sandy loam during *kharif* and *rabi*

seasons of 2017-18 and 2018-19 which is located at 15054'N latitude and 80025'E longitude with an altitude of 5.49 meters above the mean sea level (MSL) and about 8 km away from the Bay of Bengal coast. The soil was sandy loam in texture, slightly alkaline in reaction, low in organic carbon, available nitrogen and available phosphorus and medium in available potassium. The experiment was laid out in RBD with seven treatments, *i.e.*, T₁:100% RDF (100-60-40 kg N-P-K ha⁻¹); T₂:100% RDF + Soil application of ZnSO₄ @ 50 kg ha⁻¹; T₃: 125% RDF + Soil application of ZnSO₄ @ 50 kg ha⁻¹; T₄:75% RDF + Poultrymanure @ 0.82 t ha⁻¹+ Soil application of ZnSO₄ @ 50 kg ha⁻¹; T₅:75% RDF + FYM @ 5.0 T ha⁻¹+ Soil application of ZnSO₄ @50 kg ha⁻¹; T₆:50% RDF+ Poultrymanure @1.6 T ha⁻¹+Soil application of ZnSO₄ @ 50 kg ha⁻¹ and T₇: 50% RDF + FYM @ 10 t ha⁻¹ + Soil application of ZnSO₄ @ 50 kg ha⁻¹. In *rabi*, each main treatment was divided into four sub plots and hence, in *rabi* the design was Split plot design. The sub plot treatments are S₁:No fertilizer, S₂:100% RDF, S₃:75% RDF and S₄:50% RDF. Nitrogen, phosphorus, potassium and zinc content and uptake of rice and in ragi calcium along with above four nutrients were estimated by following methods detailed below.

Nutrient	Method
Nitrogen	Microkjeldhal distillation (Bremner,1965)
Phosphorus	Vando-molybdo-phosphoric yellow colour method (KoeingandJohnson,1942)
Potassium	Flamephotometer (Jackson,1973)
Zinc	AAS(Atomic Absorption Spectrophotometer)

Nutrient uptake can be estimated by using this formula.

Nutrient uptake (kg/ha) =

$$\frac{\text{Nutrient content (\%)} \times \text{Dry matter (kg/ha)}}{100}$$

The data were statistically analyzed following the analysis of variance method as described by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Nitrogen content and uptake

In grain N content (Table 1) was higher in 50% RDF + FYM @ 10 t ha⁻¹+ZnSO₄ @ 50 kg ha⁻¹ (1.60% and 1.63%) which was on par with 125% RDF+ZnSO₄ @ 50 kg ha⁻¹ (1.53% and 1.57%) and T₆ (1.43% and 1.45%). Remaining treatments on par with each other. In the straw also significantly the highest N content was recorded with T₇ (0.81% and 0.82%) but it was on par with the T₃ (0.79% and 0.79%). Similar trend was followed in both the years of the study and in pooled data. Highest nitrogen uptake (Table 3) in grain was recorded with the application of 50% RDF + FYM @10 t ha⁻¹ + ZnSO₄ @ 50 kg ha⁻¹ (85.5 and 88.9 kg ha⁻¹) and which was

Table 1: Nitrogen and phosphorus content of *kharif* as influenced by nutrient management interventions.

Treatment	Nitrogen						Phosphorus						Pooled	
	2017			2018			2017			2018			2017	
	Grain	Straw		Grain	Straw		Grain	Straw		Grain	Straw		Grain	Straw
T ₁ :100% RDF	1.23	0.60		1.25	0.62		1.24	0.61		0.23	0.06		0.23	0.06
T ₂ :100% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	1.27	0.61		1.29	0.64		1.28	0.62		0.25	0.06		0.24	0.07
T ₃ :125% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	1.53	0.79		1.57	0.79		1.55	0.79		0.29	0.08		0.28	0.10
T ₄ :75% RDF+PM @ 0.82 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	1.30	0.62		1.34	0.65		1.32	0.63		0.26	0.07		0.25	0.08
T ₅ :75% RDF+FYM @5.0 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	1.33	0.64		1.37	0.66		1.35	0.65		0.26	0.06		0.25	0.08
T ₆ :50% RDF+PM @ 1.6 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	1.43	0.65		1.45	0.67		1.44	0.66		0.27	0.07		0.26	0.08
T ₇ :50% RDF+FYM @10 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	1.60	0.81		1.63	0.82		1.61	0.81		0.32	0.09		0.30	0.12
S.E.m±	0.063	0.030		0.054	0.029		0.058	0.029		0.012	0.01		0.011	0.009
CD (P=0.05)	0.19	0.09		0.16	0.08		0.17	0.08		0.03	0.02		0.03	0.02
CV(%)	10.1	10.1		8.5	9.5		9.3	9.8		10.2	12.9		9.6	11.7

RDF: 100-60-40 kg NPK ha⁻¹; PM- Poultry manure; FYM- Farm yard manure.

significantly superior with the rest of the treatments and in straw, the highest nitrogen uptake was recorded with T_7 (49.7 and 53.4 kg ha⁻¹) and it was on par with the T_3 (45.2 and 47.5 kg ha⁻¹) but significantly superior over the rest of the treatments. Similar trend was noticed in both the years of study and in pooled data.

In no till *rab*i ragi, significantly the highest grain and straw nitrogen content in Table 5. (1.19, 1.29% and 0.37%, 0.35%) and uptake in Table 7 (22.12, 24.49 kg ha⁻¹ and 10.57, 10.82 kg ha⁻¹) was recorded with 50% RDF + FYM @ 10 t ha⁻¹+ ZnSO₄ @ 50 kg ha⁻¹ as residual effect and in fertilizer doses, 100% RDF (24.41, 26.34 and 8.04, 11.82 kg ha⁻¹) followed by S_3 . Similar trend was followed in both the years of study and in pooled data.

The combined use of organic and inorganic fertilizers was found significantly better than inorganic fertilizers alone for N content and uptake. Integrated use of organic manures and inorganic fertilizers is helpful in maintaining higher concentration of soil NH₄⁺ N for a longer period and restore humus status of the soil ecosystem to hold its fertility and productivity, thus realizing higher N uptake of rice and ragi. These results are in conformity with the results of Kabat *et al.* (2006), Manuja *et al.* (2013) and Kumar *et al.* (2017).

Phosphorus content and uptake

In grain maximum P content (Table 1) observed with T_7 (0.32%) which was significantly superior to the all treatments except T_3 (0.29%). In straw also similar trend followed as that observed in grain P content. Maximum recorded with T_7 (0.15%) and minimum was recorded with T_1 (0.07%). Similar trend was noticed in both the years of study and in pooled data.

The highest grain P uptake (Table 3) was recorded with application of 50% RDF + FYM @ 10t ha⁻¹+ ZnSO₄ @ 50 kg ha⁻¹ (15.0 and 17.3 kg ha⁻¹) but it was on par with 125% RDF along with 50 kg ZnSO₄ ha⁻¹. In straw, maximum P uptake (Table 3) was recorded with T_7 (5.7 and 9.9 kg ha⁻¹) but it was remained on par with T_3 (4.8 and 7.5 kg ha⁻¹). In the second year of study and pooled data also reported almost similar trend.

In *rab*i no till ragi, maximum phosphorus content in grain (Table 5 and Table 7) was recorded with T_7 (0.21 % and 0.22%) which was on par with the T_6 (0.20% and 0.21%) and T_5 (0.19% and 0.20%). However, it was found significantly superior to the rest of the treatments as a residual treatment. In straw, highest P content was noticed with T_7 (0.09% and 0.10%) which was followed by T_6 (0.07% and 0.08%) however, except T_1 remaining treatments were remained statistically on par with each other. In the second year and in pooled data also followed similar trend.

Enhanced P Content and uptake with judicious application of organic manures and inorganic fertilizers might be due to a combination of factors that enhance P availability in soils. These include production of organic acids through decomposition of organic matter and subsequent releases of phosphate ions, formation of phospho-humic complexes and isomorphous replacement of phosphate ions by humate ions and also by synergistic effect existing between N and

Table 2: Potassium and zinc content of *kharif* rice as influenced by nutrient management interventions.

Treatment	Potassium (%)						Zinc (ppm)					
	2017			2018			2017			2018		
	Grain	Straw	Pooled	Grain	Straw	Pooled	Grain	Straw	Pooled	Grain	Straw	Pooled
T_1 : 100% RDF	0.23	1.20	0.25	1.23	0.24	1.21	21.67	17.00	22.33	22.00	18.00	22.00
T_2 : 100% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	0.25	1.22	0.27	1.25	0.26	1.23	24.00	19.00	25.00	24.50	20.33	24.50
T_3 : 125% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	0.30	1.27	0.33	1.30	0.315	1.28	27.33	22.33	28.33	27.80	23.17	27.80
T_4 : 75% RDF+PM @ 0.82 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	0.26	1.22	0.27	1.25	0.26	1.23	25.67	20.33	26.67	26.10	21.33	26.10
T_5 : 75% RDF+FYM @ 5.0 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	0.27	1.23	0.29	1.27	0.28	1.25	28.33	23.33	29.00	28.60	24.00	28.60
T_6 : 50% RDF+FYM @ 1.6 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	0.27	1.23	0.29	1.28	0.28	1.25	28.00	24.00	30.00	29.00	25.00	29.00
T_7 : 50% RDF+FYM @ 10 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	0.32	1.29	0.37	1.34	0.34	1.31	30.33	25.67	32.33	31.30	27.00	31.30
S.E.m±	0.011	0.020	0.014	0.032	0.012	0.026	1.031	0.675	1.375	1.203	0.736	1.203
CD (P=0.05)	0.03	0.06	0.04	0.09	0.035	0.075	3.09	2.02	4.12	3.60	2.20	3.60
CV (%)	9.5	8.6	10.7	10.9	10.1	9.75	8.6	6.9	11.0	9.8	7.2	9.8
RDF: 100-60-40 kg NPK ha ⁻¹ ; PM- poultry Manure; FYM- farm yard manure.												

Table 3: Nitrogen and phosphorus uptake of *kharif* rice as influenced by nutrient management interventions.

Treatment	Potassium (kg ha ⁻¹)						Phosphorus (kg ha ⁻¹)					
	2017			2018			2017			2018		
	Grain	Straw	Pooled	Grain	Straw	Pooled	Grain	Straw	Pooled	Grain	Straw	Pooled
T ₁ :100%RDF	49.7	27.2	51.9	31.8	46.2	25.4	9.1	2.6	9.4	3.6	9.25	3.1
T ₂ :100% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	52.8	28.6	55.3	32.6	50.5	27.7	9.8	3.0	10.7	4.4	10.25	3.7
T ₃ :125% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	74.3	45.2	78.2	47.5	67.2	38.9	13.1	4.8	14.6	7.5	13.85	6.15
T ₄ :75% RDF+ PM @ 0.82 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	55.3	30.1	58.3	33.7	53.0	28.6	10.1	3.4	11.3	4.5	10.7	3.95
T ₅ :75% RDF+ FYM @5.0 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	57.4	32.1	61.4	35.6	55.1	29.4	10.3	3.2	11.6	5.3	10.95	4.25
T ₆ :50% RDF+ PM @1.6 t ha ⁻¹ +ZnSO ₄ @ 50kg ha ⁻¹	62.5	32.1	66.6	36.6	58.9	31.0	10.8	3.4	12.3	5.7	11.55	4.55
T ₇ :50% RDF+ FYM @10 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	85.5	49.7	88.9	53.4	75.6	43.6	15.0	5.7	17.3	9.9	16.15	7.8
S.Em ±	3.3	2.5	2.5	2.2	3.04	1.81	0.7	0.41	0.64	0.57	0.67	0.49
CD (P=0.05)	10.1	7.4	7.5	6.6	9.1	5.4	2.1	1.2	1.9	1.7	2.0	1.45
CV(%)	12.5	14.3	8.5	12.6	11.6	12.6	10.5	9.8	11.5	13.7	11.0	11.7

RDF:100-60-40 kg NPK ha⁻¹; PM-poultry Manure; FYM-farm yard manure.**Table 4:** Potassium and zinc uptake of *kharif* rice as influenced by nutrient management interventions.

Treatment	Potassium(kg ha ⁻¹)						Zinc(gha ⁻¹)					
	2017			2018			2017			2018		
	Grain	Straw	Pooled	Grain	Straw	Pooled	Grain	Straw	Pooled	Grain	Straw	Pooled
T ₁ :100%RDF	9.4	54.1	10.3	63.0	9.85	58.55	87.5	76.4	93.1	92.2	90.3	84.3
T ₂ :100% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	10.3	56.8	11.5	63.8	10.9	60.3	99.6	88.6	107.4	104.1	103.5	96.35
T ₃ :125% RDF+ZnSO ₄ @ 50 kg ha ⁻¹	14.6	72.3	16.5	78.1	15.5	75.2	132.6	126.6	141.3	138.2	136.9	132.4
T ₄ :75% RDF+PM @ 0.82 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	10.9	58.6	12.1	65.0	11.5	61.8	109.1	98.0	17.6	110.6	63.35	104.3
T ₅ :75% RDF+FYM @5.0 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	11.8	61.1	12.9	69.0	12.35	65.0	122.6	116.4	130.4	130.5	126.5	123.4
T ₆ :50% RDF+PM @1.6 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	11.7	60.4	13.3	70.1	12.5	65.2	122.2	118.1	137.7	137.3	129.9	127.7
T ₇ :50% RDF+FYM @10 t ha ⁻¹ +ZnSO ₄ @ 50 kg ha ⁻¹	16.9	78.3	20.1	86.7	18.5	82.5	162.4	156.4	177.1	174.7	169.7	165.5
S.Em±	0.5	2.1	0.6	2.2	0.55	2.15	6.2	4.5	7.5	4.4	6.85	4.45
CD (P=0.05)	1.7	6.2	1.8	6.6	1.75	6.4	18.7	13.7	22.6	13.1	20.65	13.4
CV(%)	10.4	7.3	10.1	8.0	10.2	7.6	11.6	9.1	12.9	7.7	12.25	8.4

RDF: 100-60-40 kg NPK ha⁻¹; PM-poultry manure; FYM-farm yard manure.

Table 5: Nitrogen and phosphorus content of no till *rabi* ragi as influenced by nutrient management interventions.

Treatment	Nitrogen (%)				Pooled		Phosphorus (%)				Pooled	
	2017-18		2018-19				2017-18		2018-19			
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Residual effect of nutrient interventions imposed to <i>kharif</i> rice												
T ₁	1.03	0.31	1.08	0.32	1.06	0.32	0.14	0.05	0.15	0.06	0.15	0.06
T ₂	1.07	0.34	1.15	0.32	1.11	0.33	0.16	0.05	0.17	0.06	0.17	0.06
T ₃	1.09	0.31	1.16	0.32	1.13	0.32	0.17	0.06	0.18	0.07	0.18	0.07
T ₄	1.15	0.33	1.21	0.35	1.18	0.34	0.18	0.07	0.19	0.08	0.19	0.08
T ₅	1.17	0.34	1.20	0.35	1.19	0.35	0.19	0.07	0.20	0.08	0.20	0.08
T ₆	1.19	0.34	1.23	0.34	1.21	0.34	0.20	0.07	0.21	0.08	0.21	0.08
T ₇	1.19	0.37	1.29	0.35	1.24	0.36	0.21	0.09	0.22	0.10	0.22	0.10
SEm±	0.024	0.008	0.019	0.006	0.021	0.007	0.006	0.003	0.006	0.003	0.006	0.003
CD (p=0.05)	0.07	0.025	0.060	0.017	0.07	0.02	0.020	0.008	0.019	0.008	0.02	0.01
CV (%)	7.4	8.5	5.6	5.0	6.5	6.8	12.3	13.7	11.0	11.9	11.7	12.8
Fertilizer doses applied to ragi												
S ₁	0.92	0.28	1.02	0.29	0.97	0.29	0.10	0.04	0.11	0.05	0.11	0.05
S ₂	1.26	0.38	1.29	0.37	1.28	0.38	0.23	0.10	0.24	0.11	0.24	0.11
S ₃	1.16	0.34	1.22	0.35	1.19	0.35	0.20	0.07	0.21	0.08	0.21	0.08
S ₄	1.18	0.33	1.22	0.34	1.20	0.34	0.19	0.06	0.20	0.07	0.20	0.07
SEm±	0.023	0.008	0.017	0.004	0.02	0.006	0.004	0.003	0.004	0.003	0.004	0.003
CD (p=0.05)	0.06	0.02	0.048	0.010	0.05	0.02	0.012	0.007	0.011	0.007	0.01	0.01
CV(%)	9.2	10.3	6.5	7.1	7.9	8.7	10.4	15.2	10.6	15.3	10.5	15.3
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: S₁: No fertilizer; S₂:100% RDF (30-30-20 kg NPK ha⁻¹), S₃:75% RDF; S₄:50%RDF.

Table 6: Potassium and zinc content of no till *rabi* ragi as influenced by nutrient management interventions.

Treatment	Potassium (%)				Pooled		Zinc(ppm)				Pooled	
	2017-18		2018-19		Grain	Straw	2017-18		2018-19		Grain	Straw
	Grain	Straw	Grain	Straw			Grain	Straw	Grain	Straw		
Residual effect of nutrient interventions imposed to <i>kharif</i> rice												
T ₁	0.19	0.90	0.20	0.96	0.20	0.93	22.75	13.83	23.75	14.83	23.25	14.33
T ₂	0.19	0.90	0.20	0.91	0.20	0.91	23.33	13.92	24.33	14.92	23.83	14.42
T ₃	0.19	0.92	0.20	0.96	0.20	0.94	25.00	15.42	26.00	16.42	25.50	15.92
T ₄	0.18	0.99	0.19	1.06	0.19	1.03	25.17	15.58	26.17	16.58	25.67	16.08
T ₅	0.20	0.99	0.21	1.04	0.21	1.02	26.08	15.42	27.08	16.42	26.58	15.92
T ₆	0.19	1.00	0.20	1.01	0.20	1.01	25.42	14.42	26.42	15.42	25.92	14.92
T ₇	0.21	1.08	0.22	1.10	0.22	1.09	26.00	16.58	27.00	17.58	26.50	17.08
SEm±	0.010	0.027	0.010	0.043	0.010	0.035	0.449	0.300	0.449	0.300	0.449	0.300
CD (p=0.05)	NS	0.084	0.030	0.133	0.03	0.11	1.383	0.926	1.383	0.926	1.38	0.93
CV (%)	12.4	7.6	13.4	6.0	12.9	6.8	7.8	6.4	6.9	6.1	7.4	6.3
Fertilizer doses applied to ragi												
S ₁	0.18	0.83	0.19	0.84	0.19	0.84	22.14	12.86	23.14	13.86	22.64	13.36
S ₂	0.22	1.10	0.23	1.16	0.23	1.13	27.95	17.38	28.95	18.38	28.45	17.88
S ₃	0.19	0.96	0.20	1.00	0.20	0.98	25.33	15.48	26.33	16.48	25.83	15.98
S ₄	0.19	0.97	0.20	1.01	0.20	0.99	23.86	14.38	24.86	15.38	24.36	14.88
SEm±	0.006	0.016	0.006	0.033	0.006	0.025	0.265	0.323	0.265	0.0323	0.265	0.178
CD (p=0.05)	0.018	0.047	0.018	0.093	0.02	0.07	0.757	0.923	0.757	0.923	0.76	0.92
CV (%)	14.5	7.6	13.3	4.2	13.9	5.9	7.2	6.3	7.0	5.9	7.1	6.1
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: S₁: No fertilizer; S₂:100% RDF (30-30-20 kg NPK ha⁻¹), S₃:75% RDF; S₄:50%RDF.

Table 7: Nitrogen and Phosphorus uptake of no till *rabi* ragi as influenced by Nutrient Management Interventions.

Treatment	Nitrogen (kg ha ⁻¹)				Pooled		Phosphorus (kg ha ⁻¹)				Pooled	
	2017-18		2018-19				2017-18		2018-19			
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Residual effect of nutrient interventions imposed to <i>kharif</i> rice												
T ₁	15.93	6.97	17.24	7.97	16.6	7.5	2.18	1.22	2.43	1.59	2.31	1.41
T ₂	16.62	8.19	19.43	8.45	18.0	8.3	2.52	1.29	2.94	1.70	2.73	1.50
T ₃	17.27	7.61	19.22	8.30	18.2	8.0	2.65	1.55	2.93	1.91	2.79	1.73
T ₄	19.00	8.05	20.84	9.37	19.9	8.7	3.05	1.67	3.35	2.08	3.20	1.88
T ₅	19.50	8.54	21.41	9.37	20.5	9.0	3.21	1.84	3.63	2.25	3.42	2.05
T ₆	20.86	8.85	22.95	9.69	21.9	9.3	3.61	1.78	4.04	2.19	3.83	1.99
T ₇	22.12	10.57	24.49	10.82	23.3	10.7	4.07	2.64	4.35	3.11	4.21	2.88
SEm±	0.395	0.359	0.431	0.278	0.41	0.31	0.106	0.059	0.113	0.075	0.110	0.067
CD (p=0.05)	1.21	1.10	1.32	0.85	1.27	0.98	0.327	0.181	0.349	0.233	0.34	0.21
CV (%)	7.3	12.5	8.3	10.5	7.8	11.5	11.3	14.3	8.5	7.9	9.9	11.1
Fertilizer doses applied to ragi												
S ₁	12.86	11.70	14.78	6.54	13.8	9.1	1.35	0.90	1.55	1.20	1.45	1.05
S ₂	24.41	8.04	26.34	11.82	25.4	9.9	4.44	2.94	4.85	3.43	4.65	3.19
S ₃	19.07	8.00	21.36	9.15	20.2	8.6	3.30	1.59	3.69	2.00	3.50	1.80
S ₄	18.69	11.70	20.71	9.05	19.7	10.4	3.07	1.43	3.45	1.84	3.26	1.64
SEm±	0.408	0.289	0.318	0.215	0.36	0.25	0.072	0.061	0.072	0.067	0.072	0.064
CD (p=0.05)	1.16	0.82	0.90	0.614	1.0	0.7	0.206	0.175	0.206	0.192	0.21	0.18
CV (%)	9.9	11.0	8.0	10.7	9.0	10.9	10.5	12.4	7.6	9.6	9.1	11.0
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: S₁: Nofertilizer; S₂:100% RDF(30-30-20 kg NPK ha⁻¹), S₃:75% RDF; S₄: 50% RDF.

P due to application of organic manures. Similar findings are reported with Satheesh and Balasubramanian (2003), These results are in agreement with the findings of Kumar *et al.* (2017) and Kumar *et al.* (2018).

Potassium content and uptake

The highest potassium content in grain and straw (Table 2) was recorded with the application of 50% RDF + FYM @ 10 t ha⁻¹ + ZnSO₄ @ 50 kg ha⁻¹ (0.32 and 0.37%) but it was on par with 125% RDF along with 50 kg ZnSO₄ ha⁻¹ (0.30 and 0.33%) in both the years of study in pooled data.

In grain, potassium content was did not differ significantly among the treatments. In straw, highest K content was noticed with T₇ (1.08% and 1.10%) which was followed by T₆ (1.00% and 1.01%) in *rabi* no till ragi as residual effect in both the years but in fertilizer doses, 100% RDF recorded significantly the highest potassium content (Table 6) over the rest of the treatments in both the years. Potassium uptake in grain and straw is concern (Table 8), T₇ as a residual treatment recorded significantly highest values as compare with remaining treatments. Among the fertilizer doses to ragi S₂ recorded significantly highest potassium uptake in both years and in pooled data.

Higher content and uptake of K might be due to the priming effect of organic manure on decomposition related release of organic acids that solubilise native K. In addition, higher magnitude of increases in K uptake by conjunctive use of organic manures and inorganic fertilizers showed that

organic manures presumably play key role in enhancing the use efficiency of applied fertilizer as well as inherent nutrient availability in the soil. This was also documented earlier by Singh *et al.* (2001) and Singh and Singh (2018).

Zinc Content and uptake

The maximum zinc content in grain (Table 2) was noticed with T₇ (30.33 and 32.33 ppm) which was on par with T₃ (27.33 and 28.33 ppm). In straw T₇ recorded the highest zinc content (25.67 and 27.00 ppm) which remained statistically on par with 125% RDF + FYM @ 10 t ha⁻¹ + ZnSO₄ @ 50 kg ha⁻¹ (22.33 and 23.17 ppm). Similar trend was noticed with second year and pooled data also.

In grain, significantly the highest zinc uptake (Table 4) was noticed with T₇ (162.4 and 177.1 g ha⁻¹) followed by T₃ (132.6 and 141.3 g ha⁻¹). Similar trend was noticed with zinc uptake in straw as noticed that in grain zinc uptake in both the years of study.

In no till *rabi* ragi T₇ as a residual treatment recorded maximum zinc content (Table 6) and uptake (Table 8) in grain and straw in both the years of study and in fertilizer doses S₂ recorded significantly superior over the rest of the treatments.

These results are inconformity with the findings of Kumar *et al.* (2014) Kandali *et al.* (2015), Singh *et al.* (2016), Alagappan and Venkitiswamy (2016) Sarkar *et al.* (2016), Naher and Paul (2017) and Kumar *et al.* (2018).

Conflict of interest: None.

Table 8: Potassium and Zinc uptake of no till *rabi* ragi as influenced by Nutrient Management Interventions.

Treatment	Potassium (kg ha ⁻¹)				Pooled		Zinc (g ha ⁻¹)				Pooled	
	2017-18		2018-19				2017-18		2018-19			
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Residual effect of nutrient interventions imposed to <i>kharif</i> rice												
T ₁	3.00	20.01	3.28	23.87	3.14	21.94	35.06	31.01	38.16	36.68	36.61	33.85
T ₂	3.00	21.39	3.45	24.06	3.23	22.73	36.19	33.01	41.25	39.35	38.72	36.18
T ₃	3.05	22.57	3.35	25.01	3.20	23.79	39.71	37.79	43.06	42.74	41.39	40.27
T ₄	2.90	24.29	3.22	28.49	3.06	26.39	41.19	38.78	45.04	44.83	43.12	41.81
T ₅	3.31	25.10	3.73	28.02	3.52	26.56	43.52	38.94	48.38	44.40	45.95	41.67
T ₆	3.35	26.50	3.77	28.68	3.56	27.59	44.55	38.42	49.61	44.02	47.08	41.22
T ₇	3.87	30.82	4.16	33.72	4.02	32.27	48.11	46.74	51.36	53.26	49.74	50.00
SEm±	0.180	0.956	0.187	0.824	0.184	0.890	0.843	1.238	0.725	0.970	0.784	1.104
CD (p=0.05)	0.556	2.94	0.575	2.53	0.57	2.74	2.59	3.814	2.23	2.99	2.41	3.40
CV (%)	20.1	9.4	14.7	8.4	17.4	8.9	8.7	7.2	9.5	5.9	9.1	6.6
Fertilizer doses applied to ragi												
S ₁	2.47	17.35	2.71	18.91	2.59	18.13	30.88	26.80	33.64	31.09	32.26	28.95
S ₂	4.21	33.77	4.63	37.50	4.42	35.64	54.28	52.80	59.20	59.14	56.74	55.97
S ₃	3.18	23.09	3.56	26.45	3.37	24.77	41.76	37.11	46.10	43.46	43.93	40.29
S ₄	2.98	23.32	3.36	26.76	3.17	25.04	37.84	34.54	42.12	40.74	39.98	37.64
SEm±	0.101	0.663	0.107	0.773	0.104	0.718	0.614	0.965	0.642	1.161	0.628	1.063
CD (p=0.05)	0.289	1.89	0.305	2.20	0.30	2.05	1.75	2.75	1.83	3.31	1.79	3.03
CV(%)	17.0	11.4	14.1	9.0	15.6	10.2	11.1	10.7	9.5	9.2	10.3	10.0
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: S₁:No fertilizer; S₂:100% RDF (30-30-20 kg NPK ha⁻¹), S₃: 75% RDF;S₄: 50% RDF.

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