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Effect of Integrated nutrient management practices on nutrient content and uptake by rice (*Oryza sativa* L.)

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Abstract
A field experiment was carried out in kharif 2019 at Agronomy Research Farm of A. N. D. U. A. & T, Kumarganj, Ayodhya (U.P.). The experiment was laid out in Randomized Block Design (RBD) with three replications and eleven treatments *viz.,* T_1- 100% RDF (Inorganic fertilizer) (150N + $60P_2O_5$ + $40K_2O$ Kg/ha.) + 25 kg/ha $ZnSO_4$, T_2- 50% RDF through (IF) + 50% RDN through FYM, T_3- 50% RDF through (IF) + 50% RDN through Poultry Manure, T_4- 50% RDF through (IF) + 50% RDN through Neem Cakes, T_5- 75% RDF through (IF) + 25% RDN through FYM, T_6- 75% RDF through (IF) + 25% RDN through Poultry Manure, T_7- 75% RDF through (IF) + 25% RDN through Neem Cakes, T_8- 100% RDF through (IF) + 25% RDN through FYM, T_9- 100% RDF through (IF) + 25% RDN through Poultry Manure, T_{10}- 100% RDF through (IF) + 25% RDN through Neem Cakes, T_{11}- 100% RDF through FYM (Organic source). The results revealed that nutrient content and uptake were significantly influenced due to different treatments. The nutrient content and its uptake by rice was observed higher with the application of 100% RDF through (IF) + 25% RDN through Neem Cake as compare to other treatments. The lowest nutrient content and its uptake was found under100% RDF through FYM (Organic source).

Keywords: inorganic fertilizer, organic source, nutrient content and uptake, rice

Introduction
Rice (*Oryza sativa* L.) is one of the most important stable food crops in the world. It is an aquatic grass belongs to genus *Oryza* and family Poaceae. About 90% of the rice production takes place in the tropical/sub-tropical Asia where 60% of the world population lives. In India, rice occupies an area of 43.79 million hectares with production of 115.60 million tonnes with an average productivity of 2578 kg/ha. (Anonymous, 2018) [1]. An Integrated nutrient management plays a vital role in sustaining both the soil health and crop production on long term basis. INM has been shown to considerably improve rice yields by minimizing nutrient losses to the environment and managing the nutrient supply and thereby in high nutrient use efficiency (Parkinson *et al.,* 2013) [8]. Organic resources are largely biological in origin and they have several nutrients in their composition which on decomposition are released in to soil. Application of neem cakes in combination with 100% recommended dose of inorganic fertilizers results in higher content of nutrient and uptake compared to rest of the treatments. Integrated nutrient management (INM) aims for efficient and judicious use of all the major sources of plant nutrients in an integrated manner (Farouque and Takeya, 2007) [2].

Material and Methods
A field experiment was conducted in the Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P) during kharif season 2019. The experiment was laid out in a Randomized Block Design (RBD) with 11 treatment combinations, comprised of inorganic and organic sources of nutrients *i.e.* T_1- 100% RDF (Inorganic fertilizer) (150N + $60P_2O_5$ + $40K_2O$ Kg/ha.) + 25 kg/ha $ZnSO_4$, T_2- 50% RDF through (IF) + 50% RDN through FYM, T_3- 50% RDF through (IF) + 50% RDN through Poultry Manure, T_4- 50% RDF through (IF) + 50% RDN through Neem Cakes, T_5- 75% RDF through (IF) + 25% RDN through FYM, T_6- 75% RDF through (IF) + 25% RDN through Poultry Manure, T_7- 75% RDF through (IF) + 25% RDN through Neem Cakes, T_8- 100% RDF through (IF) + 25% RDN through FYM, T_9- 100% RDF through (IF) + 25% RDN through Poultry Manure, T_{10}- 100% RDF through (IF) + 25% RDN through Neem Cakes, T_{11}- 100% RDF through FYM (Organic source). Experiment site is situated at latitude of 26^0 47` N and longitude of $82^0$ 12` with altitude of 113m above the sea level in Indo-Gangetic regions of Uttar Pradesh. The experimental plot was Silt loam in texture, pH (8.46), organic carbon (0.24%), available nitrogen (165.3 kg ha^{-1}), available phosphorus (15.45 kg ha^{-1}) and available

potassium (262.7 kg ha^{-1}). Rice variety "NDR-2064" twenty-five days aged, 1-2 seedling hill^{-1} at 20 ^{x} 10 cm spacing on 14th July, 2019. The crop was harvested on 3rd November, 2019. Nitrogen content in grains and straw was determined by modified Kjeldahl's method as describe by Jackson (1973) [4]. Phosphorus content in grains and straw was determined by Vandomolybdo phosphoric yellow color method as suggested by Jackson (1973) [4]. Potassium content in grains and straw was estimated with the help of Flame photometer as described by Jackson (1973) [4]. Nutrient uptake in grain and straw as well as their total uptake ha^{-1} was calculated taking corresponding yield and nutrient content by using following formula.

Nutrient Uptake (kg ha^{-1}) = Nutrient content (%) × Yield (q ha^{-1})

The available nitrogen content in soil samples was determined by alkaline permanganate method as described by Subbiah and Asija (1956). The available phosphorus in soil determined by Olsen's method as per procedure described by Olsen *et al.* (1954) [7]. The available potassium in soil was determined by Flame photometer method as advocated by Jackson (1973) [4]. Statistical data were analyzed by Fisher and Yates (1949).

Results and Discussion

N, P, K content in grain and straw

Nutrient content (%) of grain and straw and its uptake as affected by various INM practices. The higher N, P and K content in grains and straw was found higher under treatment T_{10} (100% RDF through (IF) + 25% RDN through Neem Cakes) followed by T_9 (100% RDF through (IF) + 25% RDN through Poultry Manure) and are not affected by different INM practices. Similar responses were observed by Kumar *et al.* (2007) [5], Kumar *et al.* (2008) [6] and Sultana *et al.* (2015) [10]. A critical observation of the data in table 1 and depicted in Fig. A, reveals that the higher nitrogen content in grain was recorded with treatment T_{10} with 1.23 % and lowest under treatment T_{11} with 1.13 %. However, the differences due various treatments were found non-significant. The data presented in Table 1 and depicted in Fig.1 reveals that the higher nitrogen content in straw was recorded with treatment T_{10} with 0.47 % which was at par with T_9 and T_8 while significant over rest of the treatments. The lowest nitrogen content in straw found under treatment T_{11} with 0.37 %. It is evident from table 2 and Fig. B, that the higher phosphorus content in grain was recorded with treatment T_{10} with 0.29% which was at par with T_9 while significant over rest of the treatments. However, the lowest phosphorus content in grains was found under treatment T_{11} with 0.22%. Similarly, the higher phosphorus content in straw was recorded with treatment T_{10} with 0.111% and T_9 with 0.111%. The lowest phosphorus content in straw was found under T_{11} with 0.101%. The phosphorus content in straw was not affected significantly by application of various treatments. The data (Table 3) and (Fig. C) showed that higher potassium content in grain was recorded with treatment T_{10} with 0.37% which was at par with T_9, T_8, T_7 and T_1 while significant over rest of the treatments. However, the lowest potassium content in grains was found under treatment T_{11} with 0.31%. Similarly, the higher potassium content in straw was recorded with treatment T_{10} with 1.46% and the lowest potassium content in straw was found under T_{11} with 1.37%. The differences due to various treatments on potassium content in straw was found non-significant.

N, P, K uptake by grain and straw (kg ha^{-1})

The uptake of nitrogen, phosphorus and potassium in grain and straw in rice was recorded significantly higher with the treatment T_{10} (100% RDF through (IF) + 25% RDN through Neem Cakes). This result is closely related with finding of Ghose *et al.* (2014) [3]. The data presented in Table 1 and depicted in Fig. A reveals that application of T_{10} resulted higher total (grain + straw) nitrogen uptake with 85.77 kg ha^{-1} which was significant overall of the treatments. The lowest value of total nitrogen uptake 36.67 kg ha^{-1} was recorded in the treatments T_{11}. Likewise, the higher nitrogen uptake by grain 56.06 kg ha^{-1} was also noted in treatment T_{10} which was significant overall of the treatments and the higher nitrogen uptake by straw 29.71 kg ha^{-1} was noted under treatment T_{10} which was significant overall of the treatments. The lowest nitrogen uptake by grain 24.35 kg ha^{-1} and straw 12.32 kg ha^{-1} was noted under treatment T_{11}. The uptake of phosphorus and potassium was statistically at par with T_9 (100% RDF through (IF) + 25% RDN through Poultry Manure). It might due to organic manures modify the physical conditions of the soil and help in absorption and translocation of nutrients from soil. The application of fertilizer in combination with organic manure is known to improve various physico-chemical properties resulting in enhanced nutrient absorption and uptake. These findings are in conformity with the findings of Kumar *et al.*, (2008) [6]; and Shrivastava and Singh (2017) [9]. It is evident from Table 2 and Fig. B that application of T_{10} resulted higher total (grain + straw) phosphorus uptake 20.13 kg ha^{-1} which was significant overall of the treatments. The lowest value of total phosphorus uptake 8.06 kg ha^{-1} was recorded in the treatments T_{11}. Likewise, the higher phosphorus uptake by grains 13.12 kg ha^{-1} was also noted under treatment T_{10} which was significant overall of the treatments and the higher phosphorus uptake by straw 7.01 kg ha^{-1} was noted under treatment T_{10} which was at par with T_9 while significant over rest of the treatments. The lowest phosphorus uptake by grains 4.70 kg ha^{-1} and straw 3.36 kg ha^{-1} was noted under treatment T_{11}. The data (Table 3) and (Fig. C) showed that application of T_{10} resulted higher total (grain + straw) potassium uptake 109.04 kg ha^{-1} which was significant overall of the treatments. The lowest value of total potassium uptake 52.25 kg ha^{-1} was recorded in the treatments T_{11}. Likewise, the higher potassium uptake by grains 16.74 kg ha^{-1} was also noted under treatment T_{10} which was at par with T_9 while significant over rest of the treatments and the higher potassium uptake by straw 92.30 kg ha^{-1} was noted under treatment T_{10} which was at par with T_9 while significant over rest of the treatments. The lowest potassium uptake by grains 6.62 kg ha^{-1} and straw 45.63 kg ha^{-1} was noted under treatment T_{11}.

Table 1: Effect of integrated nutrient management on nitrogen content and uptake in grain and straw of rice

	Treatments	Nitrogen content (%)		Nitrogen uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	100% RDF (inorganic fertilizer) (150N + 60P_2O_5 + 40K_2O Kg/ha.) + 25 Kg/ha. $ZnSO_4$	1.19	0.44	45.71	23.86	69.57
T_2	50 % RDF through (IF) + 50% RDN through FYM	1.14	0.38	27.32	13.99	41.31
T_3	50% RDF through (IF) + 50% RDN through Poultry Manure	1.15	0.39	29.43	15.00	44.43
T_4	50% RDF through (IF) + 50% RDN through Neem Cakes	1.16	0.40	32.41	17.00	49.41
T_5	75% RDF through (IF) + 25% RDN through FYM	1.17	0.41	35.36	18.03	53.39
T_6	75% RDF through (IF) + 25% RDN through Poultry Manure	1.18	0.42	38.31	19.77	58.08
T_7	75% RDF through (IF) + 25% RDN through Neem Cakes	1.18	0.43	41.80	21.57	63.37
T_8	100% RDF through (IF) + 25% RDN through FYM	1.21	0.45	48.89	25.96	74.85
T_9	100% RDF through (IF) + 25% RDN through Poultry Manure	1.22	0.46	52.58	27.67	80.25
T_{10}	100% RDF through (IF) + 25% RDN through Neem Cakes	1.23	0.47	56.06	29.71	85.77
T_{11}	100% RDF through FYM (Organic source)	1.13	0.37	24.35	12.32	36.67
SEm ±		0.03	0.01	0.99	0.51	1.50
C.D.		NS	0.03	2.94	1.53	4.47

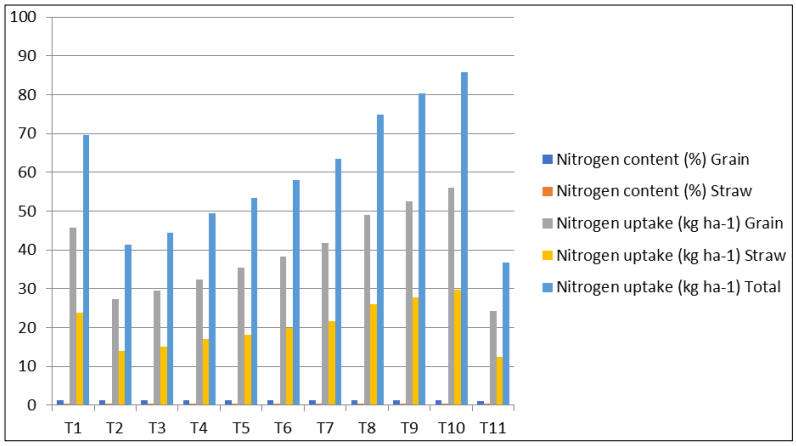

Fig 1(A): Effect of integrated nutrient management on nitrogen content and uptake in grain and straw of rice

Table 2: Effect of integrated nutrient management on phosphorus content and uptake in grain and straw of rice

	Treatments	Phosphorus content (%)		Phosphorus uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	100% RDF (inorganic fertilizer) (150N + 60P_2O_5 + 40K_2O Kg/ha.) + 25 Kg/ha. $ZnSO_4$	0.27	0.109	10.30	5.91	16.21
T_2	50 % RDF through (IF) + 50% RDN through FYM	0.23	0.103	5.47	3.79	9.26
T_3	50% RDF through (IF) + 50% RDN through Poultry Manure	0.24	0.104	6.10	4.00	10.10
T_4	50% RDF through (IF) + 50% RDN through Neem Cakes	0.25	0.105	6.95	4.46	11.41
T_5	75% RDF through (IF) + 25% RDN through FYM	0.26	0.107	7.83	4.70	12.53
T_6	75% RDF through (IF) + 25% RDN through Poultry Manure	0.26	0.108	8.43	5.08	13.51
T_7	75% RDF through (IF) + 25% RDN through Neem Cakes	0.27	0.108	9.50	5.41	14.91
T_8	100% RDF through (IF) + 25% RDN through FYM	0.27	0.110	10.84	6.34	17.18
T_9	100% RDF through (IF) + 25% RDN through Poultry Manure	0.28	0.111	11.98	6.67	18.65
T_{10}	100% RDF through (IF) + 25% RDN through Neem Cakes	0.29	0.111	13.12	7.01	20.13
T_{11}	100% RDF through FYM (Organic source)	0.22	0.101	4.70	3.36	8.06
SEm ±		0.00	0.00	0.21	0.13	0.34
C.D.		0.01	NS	0.65	0.38	1.03

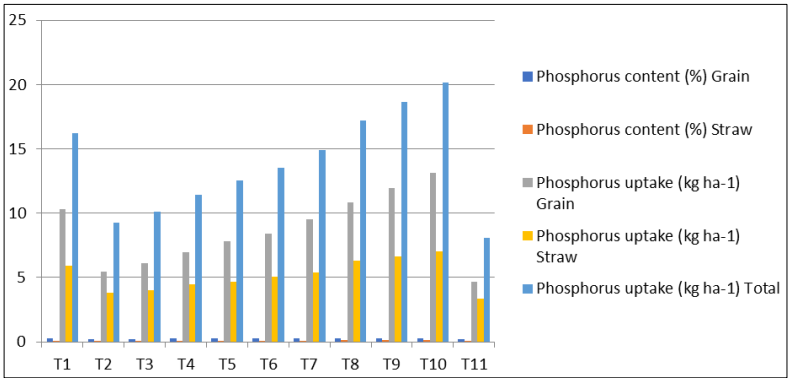

Fig 1(B): Effect of integrated nutrient management on phosphorus content and uptake in grain and straw of rice

Table 3: Effect of integrated nutrient management on potassium content and uptake in grain and straw of rice

	Treatments	Potassium content (%)		Potassium uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	100% RDF (inorganic fertilizer) (150N + 60P_2O_5 + 40K_2O Kg/ha.) + 25 Kg/ha. $ZnSO_4$	0.36	1.43	13.73	77.56	91.29
T_2	50 % RDF through (IF) + 50% RDN through FYM	0.32	1.37	7.94	50.44	58.38
T_3	50% RDF through (IF) + 50% RDN through Poultry Manure	0.32	1.39	8.13	53.47	61.60
T_4	50% RDF through (IF) + 50% RDN through Neem Cakes	0.33	1.39	9.17	59.08	68.25
T_5	75% RDF through (IF) + 25% RDN through FYM	0.34	1.40	10.24	61.57	71.81
T_6	75% RDF through (IF) + 25% RDN through Poultry Manure	0.34	1.41	11.02	66.39	77.41
T_7	75% RDF through (IF) + 25% RDN through Neem Cakes	0.35	1.42	12.31	71.24	83.55
T_8	100% RDF through (IF) + 25% RDN through FYM	0.37	1.44	14.86	83.10	97.96
T_9	100% RDF through (IF) + 25% RDN through Poultry Manure	0.37	1.45	15.83	87.23	103.06
T_{10}	100% RDF through (IF) + 25% RDN through Neem Cakes	0.37	1.46	16.74	92.30	109.04
T_{11}	100% RDF through FYM (Organic source)	0.31	1.37	6.62	45.63	52.25
SEm ±		0.00	0.03	0.29	1.71	2.00
C.D.		0.02	NS	0.86	5.09	5.95

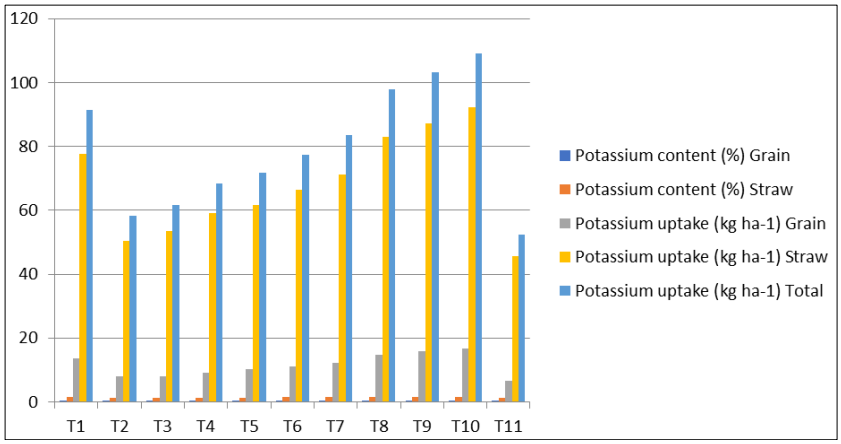

Fig 1(C): Effect of integrated nutrient management on potassium content and uptake in grain and straw of rice

Conclusions

From the present study it may be concluded that nutrient content (%) and its uptake by rice was recorded higher with the application of 100% RDF through (IF) + 25% RDN through Neem Cake as compared to other treatments. However, the lowest under T_{11} (100% RDF through FYM (Organic source).

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