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To evaluate the effect of INM on content and uptake of nutrients on wheat

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Abstract
The present investigation were conducted for two rabi seasons during 2014-15 in the field of Department of Soil Science and Agricultural Chemistry, CSAUAT, Kanpur U. P. to evaluate the effect of INM on content and uptake of nutrients of wheat Effect of integrated nutrient management on nutrient content in grain and straw presented in contents of N, P, K, S and Zn increased significantly in all the treatments in comparison to control. The highest concentration of N, P, K, S and Zn in grain and straw was noted with T7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) followed by T5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) and minimum at control. Integration of FYM, S, Zn and Vermicompost also influences N, P, K, S and Zn contents in grain and straw. It was also observed that integration of S and Zn showed higher concentration of N, P, K, S and Zn with 100% RDF treatments in comparison to 75% RDF treatments.

Keywords: Nutrient, uptake of nutrients, grain and straw etc

Introduction
Wheat (*Triticum aestivum* L.) is the world most widely cultivated food grain crop of the family gramineae and second important staple food grain crops next to rice. Wheat being an energy rich winter cereal contributes around 35% to the food grain basket of the country. Globally wheat (*Triticum aestivum* L.) is grown 124 countries and occupied an area of about 215 million hectare with a production of 725.50 mt. of grain during 2014-15. Fertilizer application proved to be a great success and production of cereal crops increased almost three fold in our country. It is a point of satisfaction for today but is not sufficient to meet future needs of rapidly growing population. There is not only the need to sustain the production but it also maintains steady rate of progress. Intensive cultivation and excess use of chemical fertilizers resulted in ill health of soil and unstable yield of crops. Continuous use of inorganic fertilizer has depleted soil organic matter, resulting into inherent loss of native soil N, available P, K and lower productions. Indiscriminate use of high analysis chemical fertilizers results in the deficiency of secondary and micronutrients in soils (Singh 2007) [13]. The present NPK use ratio in India is about 6.9:2.6:1.0 as against the recommended ratio of 4:2:1. Imbalance use of inorganic fertilizers has shown detrimental effects on physical, chemical and biological properties of soil, which deteriorate the soil health.

Method and materials
The experiment was conducted at Field No. 107, Nawabganj farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during rabi season 2014-15 which lies in the sub-tropical and semi-arid zone. It is located between latitude of 25028' to 26058' north and 79031' to 80034' east with an elevation of 125.9mtr from the sea level. The total rainfall during the crop season is about 320 mm.

The soil was, Class Loam in texture, having Mechanical separates Sand (%)-56.80, Silt (%)-23.40, Clay (%)-19.85, pH (1:2.5)- 8.20, EC (1:2.5) (dSm-1 at 250C)-0.65, CEC (Cmol (P)kg-1)-12.50, Organic Carbon (%)- 0.43, Available Nitrogen (kg ha-1)- 250.0, Available Phosphorus (kg ha-1)-13.50, Available Potassium (kg ha-1)-141.50, Available Sulphur (kg ha-1)-12.80, Available Zinc (ppm)-0.48. The experiment comprising of eleven treatments was laid out in a Randomized Block Design (RBD) with 3 replications. The details of the treatments were T1-125% RDF, T2-100% RDF (120:60:60), T3-100% RDF + 25% N FYM, T4-100% RDF + 25% N FYM + S, T5-100% RDF + 25% N FYM + S + Zn, T6-100% RDF + 25% N Vermicompost, T7-100% RDF + 25% N Vermicompost + S+ Zn, T8-75% RDF, T9-75% RDF + 25% N FYM + S + Zn, T10-75% RDF + 25% N Vermicompost + S +

Zn, T11-Control. Wheat (PBW 550) was sown during third week of October and harvested in the first week of March. At harvest samples were collected, oven dried, processed. The chemical analysis of the plant sample was carried out by wet digesting with HNO3: HClO4 (4:1) di-acid mixture as per the procedure outlined by (Jackson 1973) [19] and to determine concentrations of N, P, K, S and Zn at harvest using procedure described by (Jackson 1973) [19]. The grain and straw yield of wheat were recorded and soil samples (0–20 cm) were collected from each plot after harvest of wheat. These samples were analysed for pH (1:2.5 soil: water suspension), electrical conductivity by conductivity meter (Jackson, 1973) [19], organic carbon by rapid titration method (Walkley and Black, 1936). Available N was estimated by alkaline permanganate method (Subbiah and Asija, 1956) [10], available P by Olsen's method (Olsen *et al*. 1954) [21], available K by ammonium acetate extraction method (Jackson, 1967) [19] and available S was estimated by turbidimetric method (Chesnin and Yien, 1950). The Available Zn was extracted with DTPA and determined by atomic absorption spectrophotometer as described by (Lindsay and Norvell, 1978) [17]. The analysis of variance was carried out using the randomized complete block design (Gomez and Gomaz, 1984). The computation of uptake of the nitrogen, phosphorus, potassium, sulphur, zinc and boron at harvest in both grains as well as straw.

$$\text{Uptake of nutrient } (kg\ ha^{-1}) = \frac{\text{Nutrient content (\%) X Yield } (kg\ ha^{-1})}{100}$$

Results and Discussion

Nutrient content

It is obvious from the data given in Table-1 that N content in grain and straw increased significantly in all the treatments in comparison to control. Maximum N content 2.18% & 0.54% in grain and straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) followed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) and minimum N content 1.92% & 0.30% in grain and straw was recorded with control. Integration of organic & inorganic fertilizer with 100% RDF & 75% RDF also influence N content both in grain & straw but the increase in N content was found non - significant. Variation in N content within 75% RDF, 100% RDF & 125% RDF was also found non - significant. It is also obvious from the data that N content in grain was recorded higher than straw.

It is visualized from the data given in table-1 that P content in grain and straw was increased in all the treatments in comparison to control. But the increase in P content in grain & straw was found non - significant. Maximum P content 0.37% & 0.11% in grain & straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) fallowed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) & minimum 0.23% & 0.04% at control. Integration of organic & inorganic fertilizer also showed positive effect on P content in both grain and straw. It is also obvious from the data that P content was recorded higher in grain than straw.

It is obvious from the data in table-1 that all the treatments showed increase in grain and straw in comparison to control but the increase in K content in grain and straw was found in general non - significant. Maximum K content in grain & straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) followed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) & minimum K content in grain and straw was recorded in control. Integration of S, Zn, FYM & Vermicompost with 100% RDF & 75% RDF also influence K content in grain and straw but the rate of increase was found non -significant. Variation in K content within 100% RDF, 75% RDF and 125% RDF treatments was also found non - significant. It is interesting to report here that K content in straw was recorded higher than grain.

That S content was increased significantly in all the treatments in comparison to control. Integration of sulphur with 100% RDF & 75% RDF also showed significant increase in S content both in grain and straw. It is also obvious from the data that integration of zinc also showed increase in S content in grain and straw but the increase in S content was found significant in both grain & straw. Maximum S content in grain and straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) followed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) & minimum at control. It was also observed that S content in grain was higher than straw. Narrower variation in S content within 100% RDF, 75% RDF and 125% RDF was recorded both in grain than straw.

It is visualized from the data given in Table-1 that Zn content in grain and straw was significantly increased in all the treatments in comparisons to control. Integration of Zn showed significant influence in its content when applied with 100% RDF & 75% RDF. Application of sulphur also increased significantly the zinc content in grain and straw. Maximum Zn content in grain and straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) followed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) & minimum at control. Variation in Zn content within 75% RDF, 100% RDF and 125% RDF was also found significant in both grain and straw.

Table 1: Effect of integrated nutrient management on Nutrients content (%) in grain and straw.

S.No.	Treatments	Grain					Straw				
		N	P	K	S	Zn	N	P	K	S	Zn
1	T_1	2.04	0.29	0.40	0.16	24	0.39	0.07	1.50	0.07	20.15
2	T_2	2.02	0.28	0.38	0.15	23	0.37	0.06	1.48	0.06	19.08
3	T_3	2.05	0.30	0.41	0.15	25	0.40	0.07	1.51	0.08	21.20
4	T_4	2.10	0.32	0.44	0.17	27	0.44	0.08	1.54	0.09	22.25
5	T_5	2.16	0.36	0.50	0.20	32	0.52	0.10	1.61	0.11	25.15
6	T_6	2.06	0.31	0.42	0.16	26	0.41	0.07	1.52	0.08	21.70
7	T_7	2.18	0.37	0.52	0.21	34	0.54	0.11	1.63	0.12	26.00
8	T_8	1.98	0.27	0.37	0.13	21	0.34	0.05	1.46	0.05	17.05
9	T_9	2.11	0.33	0.45	0.17	28	0.46	0.08	1.55	0.09	22.00
10	T_{10}	2.14	0.35	0.48	0.19	30	0.49	0.09	1.58	0.10	24.00
11	T_{11}	1.92	0.23	0.32	0.10	19	0.30	0.04	1.39	0.03	15.30

S.E. ±	0.028	0.008	0.006	0.016	0.696	0.020	0.007	0.017	0.015	0.343
C.D. (at 5%)	0.059	0.016	0.013	0.33	1.461	0.041	0.015	0.036	0.031	0.721

Nutrient Uptake

The data in regard to N uptake given in Table-2 revealed that all the treatments showed significant increase in N uptake in grain and straw in comparison to control. Maximum N uptake in grain 101.15 kg ha^{-1} and in straw 30.95 kg ha^{-1} was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) followed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) & minimum grain (43.60 kg ha^{-1}) and straw (9.20 kg ha^{-1}) in control. On an average maximum N uptake of 101.15 kg ha^{-1} in grain and 30.95 kg ha^{-1} in straw were computed 132 and 236.41% higher than N uptake 43.6 and 9.20 kg ha^{-1} in grain and straw at control (T_{11}). Zn, Vermicompost & FYM with 75% RDF & 100% RDF treatments also influence N uptake significantly both treatment in grain and straw. It was also observed that 100% RDF, 75% RDF and 125% RDF also showed significant variation in N uptake both grain than straw.

It is visualized from the data given in Table-2 that all the treatments showed significant increase in P uptake both grain and straw in comparison to control. Maximum P uptake of 17.17 kg ha^{-1} in grain and 6.30 kg ha^{-1} in straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}). It was computed 225.19% and 416.39% higher than minimum P uptake in 5.28 kg ha^{-1} & 1.22 kg ha^{-1} in S, Zn, Vermicompost & FYM with 100% RDF & 75% RDF also showed significant increase in P uptake both in grain and straw. Variation in P uptake within 75**%** RDF, 100**%** RDF and 125% RDF was also found significant in both in grain and straw.

It is apparent from the data given in Table-2 that K uptake in grain and straw was significantly influenced in all the treatments in comparison to control. Maximum K uptake of 24.13 kg ha^{-1} in grain and 93.40 kg ha^{-1} in straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}). It was computed 232.36% and 119.09% higher than control. Integration of FYM, Vermicompost, S and zinc also influenced K uptake significantly both in grain and straw. It was also observed that K uptake in 125% RDF showed significant increase in grain and straw in comparison to 100% RDF & 75% RDF treatments. It is also obvious from the data that straw showed higher accumulation of K in comparison to grain.

The data in regard to S uptake given in Table-2 Clearly revealed that S uptake in grain and straw was significantly influenced in all the treatments over control. Maximum accumulation of sulphur in grain and straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) fallowed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) & minimum at control. Integration of S, zinc, FYM and Vermicompost also showed significant increase in S uptake both in grain and straw. It is also obvious from the data that grain showed higher removal of sulphur than straw.

The data depicted in table 2 Clearly showed that all the treatments significantly influenced Zn accumulation in both grain and straw in comparison to control. Higher Zn uptake in grain and straw was recorded with T_7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) fallowed by T_5 (100% RDF + 25% N, FYM + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) and minimum at control. Integration of S, zinc, FYM and Vermicompost also showed significant increase in Zn accumulation both in grain and straw. Variation in P uptake within 75**%** RDF, 100**%** RDF and 125% RDF was also found significant.

Table 2: Effect of integrated nutrient management on Nutrients uptake Kg ha^{-1} in grain and straw

S. No.	Treatment	Grain					Straw				
		N	P	K	S	Zn	N	P	K	S	Zn
1	T_1	74.85	10.63	14.68	5.86	892.60	18.90	3.38	72.66	3.38	971.50
2	T_2	71.00	9.84	13.35	5.23	808.60	17.30	2.73	69.20	2.80	892.00
3	T_3	75.64	11.07	15.13	5.66	922.53	19.36	3.39	73.00	3.86	1025.00
4	T_4	86.54	13.18	18.13	7.00	1112.30	23.38	4.24	81.82	4.78	1182.60
5	T_5	95.88	15.95	22.15	8.86	1417.60	29.17	5.60	90.32	6.17	1411.00
6	T_6	77.76	11.70	15.85	6.04	941.40	20.10	3.43	74.55	3.92	1064.00
7	T_7	101.15	17.17	24.13	9.74	1577.60	30.95	6.30	93.40	6.88	1556.60
8	T_8	62.96	8.59	11.76	4.13	667.80	14.96	2.20	64.14	2.19	749.25
9	T_9	86.08	13.46	18.36	6.93	1142.40	24.60	4.28	82.92	4.81	1176.96
10	T_{10}	93.09	15.22	20.88	8.26	1305.00	26.82	4.92	86.51	5.47	1314.13
11	T_{11}	43.60	5.28	7.26	2.27	430.80	9.20	1.22	42.63	0.92	468.95
S.E. ±		1.262	0.323	0.252	0.578	34.138	0.951	0.320	0.951	0.696	60.938
C.D. (at 5%)		2.651	0.679	0.529	1.215	71.71	1.998	0.673	1.998	1.463	128.01

Effect of integrated nutrient management on soil properties

Data in regarded to soil properties soil i.e. PH, E.C, O.C, and available status of N, P, K, S & Zn are given in Table-3 showed that slightly decrease in soil PH values in all the treatments in comparison to its initial values, while maximum decrease in PH was recorded with the integration of organic fertilizer treatments fallowed by inorganic treatments. Unlike PH. Integration of organic fertilizer showed slight increase in EC values, while inorganic fertilizer showed slight decrease in E.C values. Organic carbon content of the soil increases slightly in all the treatments in comparison to its initial values. Maximum increase in O.C content was noted with the integration of organic treatments fallowed by inorganic treatments. Available status of N, P, K, S & Zn was slightly increase in all the treatments in comparison to control. Maximum increase in available status of N, P, K, S & Zn was recorded with T7 (100% RDF+ 25% N, Vermicompost + 30 kg S ha-1 + 5 kg Zn ha-1) and minimum at control (T11). Integration of S & Zn also showed slight improvement in available status of N, P, K, S & Zn, when integrated with 75% RDF and 100% RDF treatments. These findings are in line to the findings of Sharma *et al*. (2001), Katyal *et al*. (2006), Dhonde and Bhakare (2008), Pandey *et al*. (2009) and Walia *et al*. (2010) [6].

Table 3: Effect of integrated nutrient management on Soil properties

S.No.	treatments	P^H	E.C	O.C	N	P	K	S	Zn
1	T_1	8.19	0.84	0.43	253.0	14.2	143.5	13.00	0.52
2	T_2	8.19	0.84	0.43	252.0	13.4	142.0	12.90	0.50
3	T_3	8.18	0.86	0.45	252.5	13.6	142.2	12.95	0.51
4	T_4	8.17	0.85	0.46	252.6	13.8	142.5	13.80	0.52
5	T_5	8.17	0.86	0.46	252.7	14.0	142.8	13.85	0.54
6	T_6	8.17	0.87	0.47	253.2	13.8	142.6	13.06	0.50
7	T_7	8.16	0.87	0.48	253.6	14.5	143.0	13.95	0.56
8	T_8	8.20	0.84	0.43	251.0	13.6	141.6	12.85	0.49
9	T_9	8.18	0.86	0.44	251.8	13.5	142.0	13.02	0.51
10	T_{10}	8.17	0.87	0.45	252.3	14.7	142.3	13.10	0.52
11	T_{11}	8.20	0.85	0.42	249.0	12.9	140.3	12.70	0.47
S.E. ±		0.008	0.008	0.004	0.536	0.232	0.391	0.247	0.034
C.D. (at 5%)		0.016	0.017	0.012	1.126	0.487	0.822	0.519	N/A

Conclusion

Concentration & accumulation of N, P, K, S and Zn increased significantly at all the treatments in comparison to control. Maximum increase in N, P, K, S and Zn content & uptake were recorded with T_7 (100% RDF + 25% N Vermicompost + 30 kg S ha^{-1} + 5 kg Zn ha^{-1}) and minimum at control. Integration of FYM, Vermicompost, S & Zn with 100% RDF showed maximum increased in content & uptake of all the nutrients in comparison to other treatments. The uptake of N, P, S and Zn was recorded higher in grain than straw where as the uptake of K in straw. Integration of S & Zn showed slight improvement in available status of N, P, K, S & Zn in comparison to its initial values. Integration of S & Zn showed slight improvement in available status of N, P, K, S & Zn in comparison to its initial values.

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