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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON NUTRIENT CONTENT AND UPTAKE PATTERN BY MAIZE

M. K. Yadav *et al.,*

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M. K. YADAV*, H. S. PUROHIT, C. K. JANGIR, S. C. MEENA AND H. K. JAIN
Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology
Udaipur -313 001, Rajasthan
e-mail: yadavmahendraparihar@gmail.com

ABSTRACT

Field experiment was conducted during kharif seasons of 2014 at Rajasthan College of agriculture Udaipur, (Rajasthan) to study the effect of Integrated Nutrient Management on nutrient content and uptake pattern by maize. The results revealed that highest nutrient uptake by maize crop was recorded by application of 100 % RDF + vermicompost at 4t ha^{-1}. The conjoint use of vermicompost with 100 % RDF significantly improved the status of N, P and K content over the chemical fertilizer alone. The combined use of inorganic and organic sources of improve soil fertility

***Corresponding author**

INTRODUCTION

One of the most important challenges facing humanity today is to conserve/sustain natural resources, including soil and water, for increasing food production while protecting the environment. On the other hand, nutrient mining has occurred in many soils due to lack of affordable fertilizer sources and where fewer or no organic residues are returned to the soils. Arid and semiarid subtropical soils of Rajasthan, developed under harsh climate, are inherently poor in organic matter, fertility and water-holding capacity. In these soils, N, P and S deficiencies are principal yield-limiting factors for crop production. INM approach has increased the soil

organic C and available nutrients (Sharma *et al.,* 2013). Integrated nutrient management(INM), which entails the maintenance/adjustment of soil fertility to an optimum level for crop productivity to obtain the maximum benefit from all possible sources of plant nutrients organics as well as inorganics in an integrated manner (Aulakh and Grant, 2008), is an essential step to address the twin concerns of nutrient excess and nutrient depletion. Nitrogen is most important in yield and quality formation in crops through manifestation of growth and development (Singh et al., 2013).Integrated nutrient management is also important for marginal farmers who cannot afford to supply crop nutrients through costly chemical fertilizers.

Objectives

To study the effect of INM on maize

To finalize the nutrient uptake by maize

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* 2014 at Instructional farm, Rajasthan College of Agriculture, Udaipur, (Rajasthan). the experiment consisted of 12 treatments comprising chemical fertilizers, organic manure, and their combinations, *viz.*, , 100 % RDF + FYM at 10t ha^{-1}, 75 % RDF + FYM at 10t ha^{-1}, 50 % RDF + FYM at 10t ha^{-1}, 100 % RDF + vermicompost at 4t ha^{-1}, 75 % RDF + vermicompost at 4t ha^{-1}, 50 % RDF + vermicompost at 4t ha^{-1} , FYM at 20t ha^{-1}, vermicompost at 8t ha^{-1}, 100 % RDF, 75 % RDF, 50 % RDF, and control. These treatments were evaluated under randomized block design (RBD) with three replications. Maize cultivar (pratap makka- 5) was taken as test crop.

RESULTS

Effect of Integrated nutrient managemment on nutrient content of maize

nitrogen content in stover

A cursory look of the data (Table 1) reveal that in comparison to control, all the nutrient application treatments gave significantly higher N content in stover of maize plants at harvest. The soil enriching with 100% RDF + Vermicompost 4 t ha^{-1} tended to give maximum N content (0.724%) than all other treatments and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 34 and 30 per cent

Table 1: Effect of INM treatments on nitrogen content and nitrogen uptake by maize

Treatment	Nitrogen content (per cent)		Nitrogen uptake (kg ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1 – Control	1.319	0.541	19.46	22.30	41.76
T_2 - 50% RDF	1.331	0.545	22.33	25.59	47.92
T_3 - 75% RDF	1.526	0.576	28.07	29.51	57.58
T_4 - 100% RDF	1.824	0.701	45.93	39.95	85.88
T_5 - Vermicompost at 8 tha^{-1}	1.820	0.690	33.59	35.48	69.07
T_6 - FYM at 20 tha^{-1}	1.625	0.621	29.17	31.41	60.58
T_7 - 50% RDF + vermicompost at 4t ha^{-1}	1.556	0.587	28.01	29.23	57.25
T_8 - 75% RDF + vermicompost at 4t ha^{-1}	1.824	0.657	35.82	35.56	71.38
T_9 - 100% RDF + vermicompost at 4t ha^{-1}	1.919	0.724	53.10	56.66	109.75
T_{10} - 50% RDF + FYM at 10 t ha^{-1}	1.535	0.534	26.86	25.79	52.66
T_{11} - 75% RDF + FYM at 10 t ha^{-1}	1.657	0.587	31.82	31.08	62.89
T_{12} -100% RDF + FYM at 10 t ha^{-1}	1.826	0.704	48.34	52.87	101.21
SEm ±	0.018	0.011	1.291	1.842	2.530
CD (p = 0.05)	0.051	0.031	3.741	5.337	7.330
C.V.%	1.86	2.99	6.67	9.22	6.43

Table 2: Effect of INM treatments on phosphorus content and phosphorus uptake by maize

Treatment	Phosphorus content (per cent)		Phosphorus uptake (kg ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1 – Control	0.302	0.124	4.46	5.13	9.59
T_2 - 50% RDF	0.352	0.145	5.91	6.83	12.74
T_3 - 75% RDF	0.364	0.159	6.70	8.18	14.88
T_4 - 100% RDF	0.371	0.164	9.36	9.36	18.73
T_5 - Vermicompost at 8 tha^{-1}	0.371	0.163	6.85	8.41	15.26
T_6 - FYM at 20 tha^{-1}	0.363	0.152	6.52	7.73	14.25
T_7 - 50% RDF + vermicompost at 4t ha^{-1}	0.360	0.148	6.50	7.40	13.90
T_8 - 75% RDF + vermicompost at 4t ha^{-1}	0.370	0.160	7.27	8.66	15.92
T_9 - 100% RDF + vermicompost at 4t ha^{-1}	0.380	0.164	10.52	12.84	23.35
T_{10} - 50% RDF + FYM at 10 t ha^{-1}	0.359	0.148	6.28	7.15	13.43
T_{11} - 75% RDF + FYM at 10 t ha^{-1}	0.369	0.159	7.10	8.44	15.54
T_{12} -100% RDF + FYM at 10 t ha^{-1}	0.372	0.164	9.84	12.36	22.20
SEm ±	0.004	0.002	0.256	0.396	0.498
CD (p = 0.05)	0.010	0.007	0.741	1.147	1.443
C.V. %	1.70	2.58	6.09	8.03	5.45

increase N content over control.

Nitrogen content in grain

An examination of data (Table 1) reveal that application of plant nutrients significantly increased N content in grain at harvest. Maximum N content (1.919%) was recorded by use of 100% RDF + Vermicompost 4 t ha^{-1} application and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 45 and 38 per cent increase N content over control.

Phosphorus content in stover

The data (Table 2) explicate that application of balanced and integrated nutrient supply tended to increase the P content over control. Application of integrated use of 100% RDF + Vermicompost 4 t ha^{-1} resulted in maximum P content (0.1649%) and and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 33 and 32 per cent increase P content over control.

Phosphorus content in grain

In comparison to control, enrichment of soil by various combinations and sources of plant nutrients resulted in significantly higher P content in grain. The maximum P content (0.3802%) was accounted in soil fortification with 100% RDF + Vermicompost 4 t ha^{-1} (Table 2) and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 26 and 21 per cent increase P content over control.

Potassium content in stover

A reference to data (Table 3) reveal that application of plant nutrients significantly improved K content in stover at harvest stage. Maximum K content (1.099%) was found in crop provided 100% RDF + Vermicompost 4 t ha^{-1} and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 13 and 12 per cent increase K content over control.

Potassium content in grain

The data (Table 3) indicates that addition of plant nutrients in balanced or integrated forms proved significantly superior in increasing K content in maize grain over no fertilization. Maximum K content (0.444%) of maize grain at harvest was recorded in 100% RDF + Vermicompost 4 t ha^{-1} applied treatment and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 19 and 16 per cent increase K content over control.

Zinc content in stover

A cursory look of the data (Table 4) reveal that in comparison

Table 3: Effect of INM treatments on potassium content and potassium uptake by maize

Treatment	Potassium content (per cent)		Potassium uptake (kg ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1 – Control	0.374	0.971	5.51	40.09	45.60
T_2 - 50% RDF	0.419	1.056	7.03	49.75	56.78
T_3 - 75% RDF	0.422	1.061	7.76	54.44	62.21
T_4 - 100% RDF	0.434	1.089	10.92	62.20	73.12
T_5 - Vermicompost at 8 tha^{-1}	0.435	1.069	7.84	54.96	62.80
T_6 - FYM at 20 tha^{-1}	0.415	1.057	7.45	53.50	60.95
T_7 - 50% RDF + vermicompost at 4t ha^{-1}	0.430	1.071	7.74	53.33	61.07
T_8 - 75% RDF + vermicompost at 4t ha^{-1}	0.434	1.087	8.52	58.77	67.30
T_9 - 100% RDF + vermicompost at 4t ha^{-1}	0.444	1.099	12.29	85.66	97.95
T_{10} - 50% RDF + FYM at 10 t ha^{-1}	0.425	1.064	7.44	51.40	58.83
T_{11} - 75% RDF + FYM at 10 t ha^{-1}	0.428	1.068	8.21	56.54	64.75
T_{12} -100% RDF + FYM at 10 t ha^{-1}	0.435	1.090	11.49	81.86	93.34
SEm ±	0.006	0.006	0.301	2.649	2.712
CD (p = 0.05)	0.016	0.018	0.873	7.674	7.855
C.V.%	2.29	1.00	6.13	7.84	7.00

Table 4: Effect of INM treatments on Zinc content and Zinc uptake by maize

Treatment	Zinc content (mg cm^{-3})		Zinc uptake (g ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1 – Control	46.86	17.39	691.41	717.68	1409.09
T_2 - 50% RDF	47.83	18.18	802.87	856.37	1659.24
T_3 - 75% RDF	49.26	18.21	906.29	934.52	1840.81
T_4 - 100% RDF	49.64	18.60	1251.07	1058.77	2309.84
T_5 - Vermicompost at 8 tha^{-1}	57.18	19.55	1036.78	1004.74	2041.51
T_6 - FYM at 20 tha^{-1}	55.73	18.22	1000.42	922.32	1922.75
T_7 - 50% RDF + vermicompost at 4t ha^{-1}	57.28	18.59	1031.97	926.66	1958.63
T_8 - 75% RDF + vermicompost at 4t ha^{-1}	62.75	23.15	1231.21	1256.30	2487.51
T_9 - 100% RDF + vermicompost at 4t ha^{-1}	63.19	24.52	1751.86	1914.68	3666.53
T_{10} - 50% RDF + FYM at 10 t ha^{-1}	59.90	22.47	1048.34	1085.56	2133.90
T_{11} - 75% RDF + FYM at 10 t ha^{-1}	61.75	23.15	1204.90	1225.46	2430.36
T_{12} -100% RDF + FYM at 10 t ha^{-1}	63.08	24.43	1667.52	1834.97	3502.48
SEm ±	0.915	0.361	50.451	55.787	87.035
CD (p = 0.05)	2.651	1.045	146.150	161.609	252.129
C.V.%	2.82	3.04	7.70	8.44	6.61

to control, all the nutrient application treatments gave significantly higher Zn content in stover of maize plants at harvest. The soil enriching with 100% RDF + Vermicompost 4 t ha^{-1} tended to give maximum Zn content (24.52 ppm) than all other treatments and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 41 and 40 per cent increase Zn content over control.

Zinc content in grain

An examination of data (Table 4) reveal that application of plant nutrients significantly increased Zn content in grain at harvest. Maximum Zn content (63.19 ppm) was recorded by use of 100% RDF + Vermicompost 4 t ha^{-1} application and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 35 per cent increase Zn content over control.

Iron content in stover

The data (Table 5) explicate that application of balanced and integrated nutrient supply tended to increase the Fe content over control. Application of integrated use of 100% RDF + Vermicompost 4 t ha^{-1} resulted in maximum Fe content (130.83 ppm) and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 18 per cent increase Fe content over control. the extent of increase in Fe content under various treatments applications varied from 110.70 ppm in control to 130.83 ppm in 100% RDF + Vermicompost 4 t ha^{-1} .

Iron content in grain

In comparison to control, enrichment of soil by various combinations and sources of plant nutrients resulted in significantly higher Fe content in grain. the maximum Fe content (74.43 ppm) was accounted in soil fortification with 100% RDF + Vermicompost 4 t ha^{-1} (Table 5) and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 15 and 13 per cent increase Fe content over control.

Manganese content in stover

A reference to data (Table 6) reveal that application of plant nutrients significantly improved Mn content in stover at harvest stage. Maximum Mn content (44.64 ppm) was found in crop provided 100% RDF + Vermicompost 4 t ha^{-1} and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 21 and 19 per cent increase Mn content over control.

Manganese content in grain

The data (Table 6) indicates that addition of plant nutrients in balanced or integrated forms proved significantly superior in

Table 5: Effect of INM treatments on iron content and uptake by maize

Treatment	Fe content (mg cm^{-3})		Fe uptake (g ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1 – Control	64.83	110.70	956.60	4573.56	5530.17
T_2 - 50% RDF	68.67	116.60	1151.58	5494.31	6645.89
T_3 - 75% RDF	68.69	122.67	1263.98	6301.70	7565.68
T_4 - 100% RDF	70.19	124.23	1767.57	7087.94	8855.50
T_5 - Vermicompost at 8 tha^{-1}	71.75	129.17	1324.02	6639.25	7963.27
T_6 - FYM at 20 tha^{-1}	72.02	129.11	1292.83	6535.72	7828.55
T_7 - 50% RDF + vermicompost at 4t ha^{-1}	72.73	125.33	1308.78	6243.33	7552.11
T_8 - 75% RDF + vermicompost at 4t ha^{-1}	73.67	126.43	1447.03	6836.06	8283.08
T_9 - 100% RDF + vermicompost at 4t ha^{-1}	74.43	130.83	2059.75	10202.08	12261.83
T_{10} - 50% RDF + FYM at 10 t ha^{-1}	70.78	128.67	1238.71	6215.14	7453.85
T_{11} - 75% RDF + FYM at 10 t ha^{-1}	73.00	128.93	1401.73	6825.81	8227.55
T_{12} -100% RDF + FYM at 10 t ha^{-1}	73.50	130.28	1942.85	9784.60	11727.45
SEm ±	0.543	2.053	49.005	335.717	348.381
CD (p = 0.05)	1.572	5.947	141.963	972.533	1009.220
C.V.%	1.32	2.84	5.94	8.43	7.25

Table 6: Effect of INM treatments on Manganese content and uptake by maize

Treatment	Mn content (mg cm^{-3})		Mn uptake (g ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1 – Control	11.75	37.00	173.33	1527.95	1701.28
T_2 - 50% RDF	12.52	38.54	211.76	1812.92	2024.68
T_3 - 75% RDF	12.68	39.22	233.30	2011.92	2245.22
T_4 - 100% RDF	14.03	42.35	353.32	2413.39	2766.72
T_5 - Vermicompost at 8 tha^{-1}	14.40	42.45	265.73	2181.77	2447.50
T_6 - FYM at 20 tha^{-1}	14.38	42.23	258.18	2137.57	2395.75
T_7 - 50% RDF + vermicompost at 4t ha^{-1}	14.33	41.33	258.04	2056.21	2314.24
T_8 - 75% RDF + vermicompost at 4t ha^{-1}	14.46	41.60	284.00	2249.23	2533.23
T_9 - 100% RDF + vermicompost at 4t ha^{-1}	15.06	44.64	416.80	3476.42	3893.21
T_{10} - 50% RDF + FYM at 10 t ha^{-1}	14.12	40.58	247.04	1960.19	2207.23
T_{11} - 75% RDF + FYM at 10 t ha^{-1}	14.37	40.76	275.84	2157.92	2433.76
T_{12} -100% RDF + FYM at 10 t ha^{-1}	14.98	43.90	395.61	3297.28	3692.89
SEm ±	0.294	0.429	11.950	95.766	98.091
CD (p = 0.05)	0.853	1.244	34.619	277.423	284.159
C.V.%	3.66	1.80	7.36	7.30	6.65

increasing Mn content in maize grain over no fertilization. Maximum Mn content (15.06 ppm) of maize grain at harvest was recorded in 100% RDF + Vermicompost 4 t ha^{-1} applied treatment and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 28 and 27 per cent increase Mn content over control.

Copper content in stover

A cursory look of the data (Table 7) reveal that in comparison to control, all the nutrient application treatments gave significantly higher Cu content in stover of maize plants at harvest. The soil enriching with 100% RDF + Vermicompost 4 t ha^{-1} tended to give maximum Cu content (8.43 ppm) than all other treatments and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 31 and 26 per cent increase Cu content over control.

Copper content in grain

An examination of data (Table 7) reveal that application of plant nutrients significantly increased Cu content in grain at harvest. Maximum cu content (24.27 ppm) was recorded by use of 100% RDF + Vermicompost 4 t ha^{-1} application and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 17 per cent increase Cu content over control.

Effect of Integrated Nutrient Managemment on Nutrient Uptake of Maize

Nitrogen uptake at harvest

Total: A perusal of data shows that N uptake by maize plants by applying nutrients in various forms and combination increased from 41.76 to 109.75 kg ha^{-1} over control (Table 1 and fig.1). The maximum uptake was recorded by INM in the form of 100% RDF + Vermicompost 4 t ha^{-1} (109.75 kg ha^{-1}) which was followed by 100% RDF + FYM 10 t ha^{-1} (101.21 kg ha^{-1}) which represents 163 and 142 per sent increase N uptake over control.

Phosphorus uptake at harvest

Total: A perusal of data shows in Table 2 and depicted in Fig.1 that P uptake by maize plants at harvest by applying nutrients in various forms and combination increased from 9.58 to 23.38 kg ha^{-1} over control. The maximum uptake was recorded by balanced fertilization in the form of 100% RDF + Vermicompost 4 t ha^{-1} (23.38 kg ha^{-1}) and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 144 and 133 per cent increase P uptake over control.

Table 7: Effect of INM treatments on Copper content and uptake by maize

Treatment	Cu content (mg cm^{-3})		Cu uptake (g ha^{-1})		
	Grain	Stover	Grain	Stover	Total
T_1 – Control	20.82	6.42	307.15	265.25	572.40
T_2 - 50% RDF	23.13	6.93	388.21	325.59	713.80
T_3 - 75% RDF	23.36	7.08	429.89	363.30	793.19
T_4 - 100% RDF	23.56	7.15	593.61	406.80	1000.41
T_5 - Vermicompost at 8 tha^{-1}	23.66	7.90	436.59	406.01	842.59
T_6 - FYM at 20 tha^{-1}	23.48	7.20	421.41	364.30	785.72
T_7 - 50% RDF + vermicompost at 4t ha^{-1}	23.76	7.36	427.43	367.85	795.28
T_8 - 75% RDF + vermicompost at 4t ha^{-1}	23.90	7.42	469.37	400.68	870.04
T_9 - 100% RDF + vermicompost at 4t ha^{-1}	24.27	8.43	671.91	653.30	1325.22
T_{10} - 50% RDF + FYM at 10 t ha^{-1}	23.43	7.30	410.07	352.76	762.84
T_{11} - 75% RDF + FYM at 10 t ha^{-1}	23.82	7.41	457.37	392.48	849.85
T_{12} -100% RDF + FYM at 10 t ha^{-1}	24.17	7.68	638.27	577.03	1215.30
SEm ±	0.449	0.200	17.769	18.312	24.925
CD (p = 0.05)	1.299	0.579	51.475	53.048	72.206
C.V.%	3.31	4.70	6.54	7.81	4.92

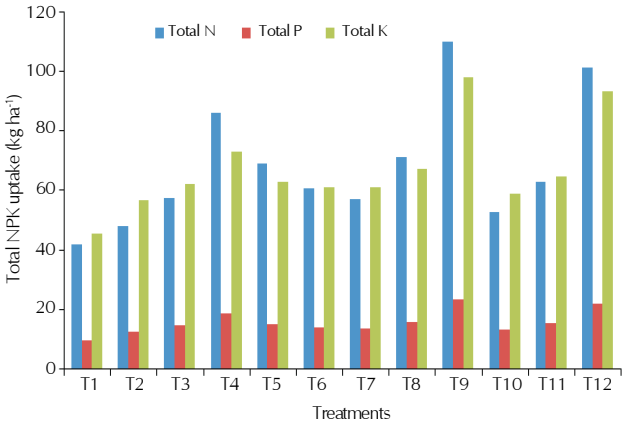

Figure 1: Effect of INM treatments on total uptake of nitrogen, phosphorus and potassium by maize

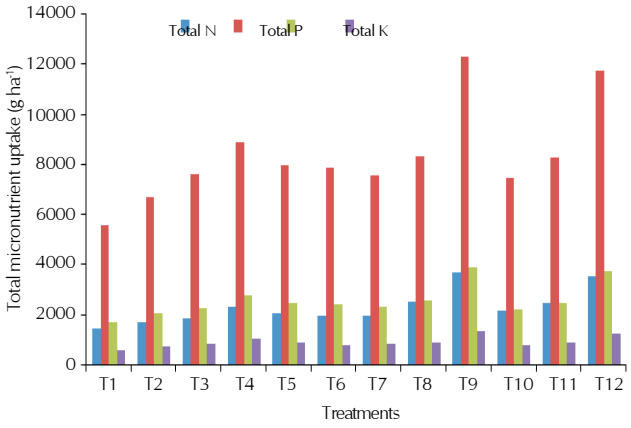

Figure 2: Effect of INM treatments on total uptake of zinc, iron, manganese and copper by maize

Potassium uptake at harvest

Total: The K uptake by maize at harvest ranged from 45.60 kg ha^{-1} (control) to 97.95 kg ha^{-1} (100% NPK + Vermicompost 4 t ha^{-1}). The data (Table 3 and Fig.1) reveal that the effect of 100% NPK + Vermicompost 4 t ha^{-1} was significantly superior over rest of the treatments and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 115 and 105 per cent increase K uptake over control.

Zinc uptake at harvest

Total: A perusal of data shows that Zn uptake by maize plants by applying nutrients in various forms and combination increased from 1409.09 to 3666.53 g ha^{-1} over control (Table 4 & Fig.2). The maximum uptake was recorded by INM in the form of 100% RDF + Vermicompost 4 t ha^{-1} (3666.53 g ha^{-1}) and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 160 and 149 per cent increase Zn uptake over control.

Iron uptake at harvest

Total: A perusal of data shows in Table 5 and depicted in Fig.2 that Fe uptake by maize plants at harvest by applying nutrients in various forms and combination increased from 5530.17 to 12261.83 g ha^{-1} over control. The maximum uptake was recorded by balanced fertilization in the form of 100% RDF + Vermicompost 4 t ha^{-1} (12261.83 g ha^{-1}) and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 122 and 112 per cent increase Fe uptake over control.

Manganese uptake at harvest

Total: The Mn uptake by maize at harvest ranged from 1701.28 g ha^{-1} (control) to 3759.35 g ha^{-1} (100% NPK + Vermicompost 4 t ha^{-1}). The data (Table 6 & Fig.2) reveal that the effect of 100% NPK + Vermicompost 4 t ha^{-1} was significantly superior over rest of the treatments and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 129 and 117 per cent increase Mn uptake over control.

Copper uptake at harvest

Total: A perusal of data shows in Table 7 and depicted in Fig.2 that Cu uptake by maize plants at harvest by applying nutrients in various forms and combination increased from 572.40 to 1325.22 g ha^{-1} over control. The maximum uptake was recorded by balanced fertilization in the form of 100% RDF + Vermicompost 4 t ha^{-1} (1325.22 g ha^{-1}) and which was followed by 100% RDF + FYM 10 t ha^{-1} which represents 132 and 112 per cent increase Cu uptake over control.

DISCUSSION

Data presented show that integration of 100 % NPK with Vermicompost 4 t ha^{-1} brought about significant improvement in N, P,K and micro nutrient (Zn, Fe, Mn and Cu) content and uptake over unfertilized control and 100 % NPK. However, accumulation of N, P, K and micro nutrient (Zn, Fe, Mn and Cu) were at par with the results obtained by 100 % NPK + FYM 10 t ha^{-1}. This indicated a favourable soil micro climate régime induced by the incorporation of Vermicompost.

Application of FYM reduces P fixation by releasing considerable aborints and variety of organic acids during deposition and as well as inducing chelating effects on micronutrients which probably enhanced the availability of phosphorus (Behera and Singh (2009). Applications of Vermicompost not only solubilize the availability of micronutrients but also contains significant amount of N, P and K. Thus application of Vermicompost has resulted in an overall significant increase in uptake of nutrients at lesser cost but longer in durability or duration.

Combined use of organic manure and chemical fertilizer has been found to be providing not only in maintaining higher productivity but also in providing stable crop yields for sustainable crop production through organic manure and balanced use of chemical fertilizers. These are in confirmation with findings of Behera and Singh, (2009), Dadarwal *et al*. (2009) and Das *et al*. (2010) Sharma and Banik (2012) Kumawat *et al*. (2014).

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