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Effect of iron and zinc enriched organics on nutrient content and uptake by potato in loamy sand soil (Typic Ustipsamments) of Sardarkrushinagar

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Abstract
A field experiment was conducted at the Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of Fe and Zn enriched organics on nutrient content and uptake by potato in loamy sand (Typic Ustipsamments) during the *rabi* seasons of 2016-17 and 2017-18. The pooled results revealed that an application of 5 t vermicompost ha^{-1} resulted in significantly higher concentration of Fe and Zn and also higher uptake of N, P, K, Fe and Zn by both tuber and haulm of potato as compared to 20 t FYM ha^{-1}. An application of organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn recorded significantly higher N, P, K, Fe and Zn content in tuber and haulm of potato as compared to no application of Fe and Zn. The maximum concentration and removal of N, P, K, Fe and Zn by both tuber and haulm were registered under treatment of organics @ 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn ha^{-1} over control (No Fe and Zn). Combined application of 5 t vermicompost ha^{-1} + vermicompost @ 2 t ha^{-1}enriched with 6 kg Fe and 4 kg Zn recorded significantly higher content of Fe and Zn and uptake of N, P, K, Fe and Zn by both tuber and haulm as compared to control (No Fe and Zn).

Keywords: Iron, zinc, FYM, vermicompost, potato

Introduction
Micronutrient deficiencies in Indian soils and crops have been on the increase since the adoption of modern agricultural technology with increased use of NPK fertilizers generally free from micronutrients, intensive cultivation with fertilizer responsive improved varieties of crops with more irrigation facilities, scarce use of organic manure and restricted recycling of crop residues (Prasad, 1999) [8]. On the basis of 7587 soil samples collected from different districts of Gujarat, it was found that 25.9 and 25.6 percent soil samples were deficient in Fe and Zn, respectively (Ramani *et al.*, 2018) [9]. Desai *et al.* (2018) [1] collected 556 soil samples from different *talukas* of Banaskantha district and found that 34.8 and 37.6 percent samples were low in Fe and Zn, respectively. Iron and zinc deficiencies are common micronutrient deficiency in light textured soils of North Gujarat limiting both crop production and nutritional quality. The productivity could be sustained through integration use of organics with inorganic fertilizers. Supplementation of deficient nutrients is necessary for higher crop yields. Iron and zinc application in the enriched from may enhance the fertilizer use efficiency.
Potato is an important crop of North Gujarat particularly in Banaskantha district. The process of enrichment of organics with Fe and Zn not only improves the nutrient use efficiency but also helps in reducing the load of inorganic chemicals as well as quantity of organics to a considerable extent. Present study was aimed at assessing the effect of Fe and Zn enriched organics on content and uptake of nutrients by potato crop.

Materials and Methods
A field experiment was conducted at the Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the *rabi* seasons of 2016-17 and 2017-18 to study the effect of Fe and Zn enriched organics on content and uptake of nutrients by potato crop. The soil of the experimental plot was loamy sand in texture, low in organic carbon, available N and DTPA-extractable Fe and Zn; medium in available P_2O_5, K_2O and S whereas high in DTPA-extractable Mn and Cu content. Twelve treatment combinations comprising of two organics *viz.*, 20 t FYM ha^{-1} (M_1) and 5 t vermicompost ha^{-1} (M_2) and six treatments of Fe

and Zn supplementation *viz.*, No Fe and Zn (N_1), 6 kg Fe and 4 kg Zn ha^{-1} (Inorganic) (N_2), organics 2 t ha^{-1} enriched with 3 kg Fe (N_3), organics 2 t ha^{-1} enriched with 2 kg Zn (N_4), organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn (N_5) and organics 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn (N_6) were laid out under factorial randomized block design with four replications. The enrichment process was started 45 days before their use in *rabi* experiments (2016-17 and 2017-18) on potato. The required quantities of organics (FYM and vermicompost) were thoroughly mixed with 1% cow dung slurry and the solution of $FeSO_4.7H_2O$ and $ZnSO_4.7H_2O$ having required concentration as per treatments *viz.*, 3 kg Fe, 2 kg Zn, 6 kg Fe and 4 kg Zn and 3 kg Fe and 2 kg Zn through 2 tonnes of organics (FYM and vermicompost) per hectare. The mixture was filled in pre-dug pit and the pit was covered with polythene in natural chelation during the process of composting. The mixture was turned over periodically (weekly) and moisture loss was maintained. The data for total N, P, K, Fe and Zn content of FYM and vermicompost before and after enrichment are given in Table 1, 2 and 3.

Farm yard manure @ 20 t ha^{-1} and vermicompost @ 5 t ha^{-1} were manually applied in previously opened furrows as per treatment in both the years. The entire quantity of phosphorus (137.5 kg ha^{-1}) and potassium (275 kg ha^{-1}) whereas, half quantity of nitrogen (137.5 kg ha^{-1}) were applied uniformly in opened furrows in the form of diammonium phosphate, muriate of potash and ammonium sulphate, respectively. The required quantity of Fe and Zn in the form of $FeSO_4.7H_2O$ (19% Fe) and $ZnSO_4.7H_2O$ (21% Zn) were applied in furrow, respectively. After that application of Fe, Zn and Fe + Zn enriched FYM or vermicompost @ 2 t ha^{-1} were applied in furrows as per the treatments. Light planking was done after basal application of fertilizers. The remaining half dose of nitrogen (137.5 kg ha^{-1}) was top dressed in the form of urea at 45 days after planting. The treatment-wise representative samples of tubers and haulm were drawn at the time of harvest. The potato tuber was properly washed with water and then cleaned and dried. Potato tubers were hand pooled and cut longitudinally and then tuber was cut into slices of 1.3 to 1.4 mm thickness with the help of slicing machine manually. Samples of tuber and haulm are air dried first and subsequently dried in oven at 65 ºC till constant weight was obtained. The oven dried samples of tuber and haulm were finely ground in a stainless steel willey mill and were digested with HNO3 and HClO4 (3:1) diacid mixture as per procedure outlined by Jackson (1973) except for analysis of nitrogen. The nitrogen was determined by modified micro-kjeldahl's method using (KELPLUS model). The acid extract prepared after digestion was used for estimation of P, K, Fe and Zn. After determination of nutrient content in tuber and haulm separately, the values were multiplied by corresponding dry weight to get uptake of nutrient.

Table 1: Nutrient content of FYM and vermicompost (before enrichment)

Sr. No.	Parameters	FYM		Vermicompost	
		2016-17	2017-18	2016-17	2017-18
1	Nitrogen (%)	0.61	0.58	1.55	1.52
2	Phosphorus (%)	0.32	0.31	1.09	1.01
3	Potassium (%)	0.56	0.53	0.67	0.59
4	Iron (mg kg^{-1})	3825	3510	4354	4120
5	Zinc (mg kg^{-1})	90	85	120	108

Table 2: Nutrient content of FYM and vermicompost after enrichment (2016-17) Nutrient content of FYM and vermicompost after enrichment (2016-17)

Sr. No.	Treatment combination code	Treatment combinations	Chemical parameters				
			N (%)	P_2O_5 (%)	K_2O (%)	Fe (mg kg^{-1})	Zn (mg kg^{-1})
1	M_1N_3	FYM 2 t ha^{-1} enriched with 3 kg Fe	0.62	0.36	0.58	5696	110
2	M_1N_4	FYM 2 t ha^{-1} enriched with 2 kg Zn	0.63	0.35	0.55	4040	191
3	M_1N_5	FYM 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	0.64	0.37	0.57	8151	270
4	M_1N_6	FYM 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	0.63	0.36	0.56	5848	204
5	M_2N_3	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe	1.66	1.27	0.85	6350	150
6	M_2N_4	Vermicompost 2 t ha^{-1} enriched with 2 kg Zn	1.64	1.15	0.76	4580	225
7	M_2N_5	Vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	1.69	1.30	0.82	8810	395
8	M_2N_6	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	1.62	1.25	0.79	6480	230

Table 3: Nutrient content of FYM and vermicompost after enrichment (2017-18)

Sr. No.	Treatment combination number	Treatment combinations	Chemical parameters				
			N (%)	P_2O_5 (%)	K_2O (%)	Fe (mg kg^{-1})	Zn (mg kg^{-1})
1	M_1N_3	FYM 2 t ha^{-1} enriched with 3 kg Fe	0.61	0.35	0.57	5580	97
2	M_1N_4	FYM 2 t ha^{-1} enriched with 2 kg Zn	0.60	0.34	0.58	3990	178
3	M_1N_5	FYM 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	0.61	0.36	0.59	8016	248
4	M_1N_6	FYM 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	0.62	0.35	0.59	5710	210
5	M_2N_3	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe	1.62	1.13	0.63	6260	144
6	M_2N_4	Vermicompost 2 t ha^{-1} enriched with 2 kg Zn	1.61	1.18	0.64	4470	212
7	M_2N_5	Vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	1.65	1.26	0.69	8780	381
8	M_2N_6	Vermicompost 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	1.62	1.23	0.68	6315	223

Result and Discussion

Concentration of nutrients

The pooled data given in Table 4 revealed that concentration of N, P and K in both tuber and haulm were remained unchanged due to organics treatment. However, Fe and Zn content in both tuber and haulm were significantly higher under 5 t vermicompost ha^{-1}as compared to 20 t FYM ha^{-1}. The considerable increase in Fe and Zn content in both tuber and haulm due to vermicompost could be attributed to fact that its beneficial effects in mineralization of native as well as its own nutrient content by creating favourable condition for microbial as well as chemical activity (Nardi *et al.* 2002) [4] which enhanced available Fe and Zn content in soil and thereby resulting in higher content of Fe and Zn in both tuber and haulm.

Among different treatments of Fe and Zn supplementation, an application of organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn registered significantly higher concentration of N, P and K in tuber and haulm as compared to control (no Fe and Zn) and supplementation of 6 kg Fe and 4 kg Zn ha^{-1} in inorganic form but remained at par with application of organics 2 t ha^{-1} enriched with either 3 kg Fe or 2 kg Zn or 3 kg Fe and 2 kg Zn. The observed significant increase in concentration of N, P and K in both tuber and haulm with Fe and Zn enriched organics could be ascribed to increase the availability of N, P and K in soil due to improves the physical, chemical and biological properties of soil. The beneficial effect also due to mineralization of native as well as nutrient in soil through added fertilizer in addition of its own nutrient content of organics which enhance the available nutrient pools of the soil. The increased availability of these nutrients in the root zone coupled with increased metabolic activity at cellular levels might have synthesized more nutrients and their accumulation in various plant parts. The results are in accordance with those reported by Patel *et al.* (2016) [7] in cumin and Parmar (2016) [5] in fenugreek.

The effect of different treatments of Fe and Zn supplementation was found significant on Fe and Zn content in both tuber and haulm (Table 4). Significantly the highest Fe and Zn content in tuber (302 and 31.87 mg kg^{-1}, respectively) and in haulm (1027 and 24.77 mg kg^{-1}, respectively) were obtained with application of organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn over rest of the treatments. The percent improvement in Fe and Zn content in tuber due to organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn was 41.8 and 51.1 percent, respectively over no application of Fe and Zn (Control).

An application of Fe and Zn enriched organics caused their higher concentration in tuber and haulm over control might be due to its beneficial effect on mobilizing native Fe and Zn nutrients to increase their availability in soil and also addition of Fe and Zn in the soil in naturally chealted form to provide better nutrition over longer time that caused higher utilization of Fe and Zn by tuber and haulm. The results are in confirmation with those reported by Gurjar (2016) [2], Parmar (2016) [5] and Parmer *et al.* (2016) [5].

The data presented in Table 5 and 6 revealed that the interaction effect between organics and Fe and Zn supplementation (M×N) on Fe and Zn content in tuber and haulm was found significant. The treatment combination M_2N_5 (5 t vermicompost ha^{-1} + vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn) registered significantly the highest Fe content in tuber (305 mg kg^{-1}) and in haulm (1032 mg kg^{-1}) as well as Zn content in tuber (34.18 mg kg^{-1}) and in haulm (26.27 mg kg^{-1}) over rest of the treatment combinations except M_2N_2 and M_1N_5 in tuber and M_1N_5 in haulm (Table 5 and 6). Combined application of 5 t vermicompost ha^{-1} and vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn considerable increase in Fe and Zn content in tuber and haulm could be due to addition of vermicompost add organic matter to the soil which helps in mobilizing the native nutrients besides the incorporation of nutrients present in it. Further, enrichment of Fe and Zn with vermicompost increased the total Fe and Zn content in it and enrichment techniques fix the nutrient in natural chelation form which is expected to growing crop over a longer time which might have helped to provide balance nutrition of Fe and Zn to crop that ultimately increased Fe and Zn content in tuber and haulm.

Uptake of nutrients

The data given in Table 7 indicated that an application of 5 t vermicompost ha^{-1} recorded significantly higher removal of N, P, K, Fe and Zn by tuber and haulm over 20 t FYM ha^{-1}. The average improvement in removal of N, P and K by tuber was 16.2, 16.6 and 15.8 percent higher, respectively due to 5 t vermicompost ha^{-1} than 20 t FYM ha^{-1}.

Among different treatments of Fe and Zn supplementation, an application of organics 2 t ha^{-1}enriched with 6 kg Fe and 4 kg Zn registered significantly the highest removal of N, P, K, Fe and Zn by tuber and haulm over rest of treatments except treatment receiving organics 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn by tuber. The magnitude of increase in uptake of N, P and K by tuber due to application of organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn was to the tune of 31.4, 32.2 and 27.3 percent, respectively over no Fe and Zn application (control). A significant improvement in uptake of N, P and K by tuber and haulm of potato as observed in present study under Fe and Zn enriched organics with Fe and Zn might be the outcome of increased these nutrients (N, P and K) in tuber and haulm as well as increased the yield of tuber and haulm. The results are in accordance with those reported by Gurjar (2016) [2] in mustard, Parmar (2016) [5] in fenugreek and Shivran (2016) [10] in isabhol.

The Fe and Zn enriched organics (FYM and vermicompost) caused higher utilization of micronutrients mainly due to its beneficial effect in mobilizing the native nutrients to increase their availability besides addition of Fe and Zn to the soil in naturally chelated form. This might have provided better nutrition over longer time to cause better crop growth and thereby higher yields. The higher removal of Fe and Zn by tuber and haulm could also be attributed to priming effect of externally added nutrients to improve crop growth and yield. Hence higher concentration of Fe and Zn in tuber and haulm and also higher tuber and haulm yield due to Fe and Zn enriched organics might have attributed towards higher uptake of Fe and Zn by tuber and haulm. These findings are in agreement with the results of Patel *et al.* (2016) [7] and Shivran (2016) [10].

The interaction effect of organics × Fe and Zn supplementation (M×N) was found significant on uptake of N, P, K, Fe and Zn by tuber and haulm (Table 8, 9, 10, 11, 12). Among different treatment combination, the treatment combination M_2N_5 (5 t vermicompost ha^{-1} + vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn) registered significantly the highest removal of N, P, K, Fe and Zn by

tuber and haulm over rest of treatment combination except M_2N_6 (5 vermicompost ha^{-1} + vermicompost 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn) treatment combination in case of N, P and K uptake by tuber. The higher removal of N, P, K, Fe and Zn by tuber and haulm of potato under treatment combination of 5 t vermicompost ha^{-1} + vermicompost 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn could be due to synergistic effect of vermicompost and Fe and Zn enriched vermicompost that increased the availability of major and Fe and Zn nutrients in soil which enhanced the concentration of nutrients in tuber and haulm and also better crop growth under this treatment combination as a results of better absorption of these nutrients and thereby increased crop yield. An increased in nutrient content in tuber and haulm as well as yield of tuber and haulm which attributed to higher removal of nutrients by tuber and haulm.

Table 4: Nutrient content in tuber and haulm of potato as influenced by organics and Fe and Zn supplementation (Pooled)

Treatments	N content (%)		P content (%)		K content (%)		Fe content (mg kg^{-1})		Zn content (mg kg^{-1})	
	Tuber	Haulm	Tuber	Haulm	Tuber	Haulm	Tuber	Haulm	Tuber	Haulm
Organics (M)										
M_1: FYM @ 20 t ha^{-1}	2.33	2.23	0.210	0.189	1.62	2.33	258	957	25.29	20.78
M_2: Vermicompost @ 5 t ha^{-1}	2.35	2.25	0.212	0.191	1.63	2.36	273	994	28.11	21.97
S.Em.±	0.01	0.01	0.001	0.001	0.01	0.01	1.35	3.61	0.14	0.13
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	4	10	0.40	0.36
Fe and Zn supplementation (N)										
N_1: No Fe and Zn	2.21	2.12	0.198	0.174	1.56	2.20	213	929	21.09	16.97
N_2: 6 kg Fe and 4 kg Zn ha^{-1} (Inorganic)	2.26	2.16	0.203	0.178	1.58	2.26	275	976	26.48	21.56
N_3: Organics 2 t ha^{-1} enriched with 3 kg Fe	2.37	2.27	0.214	0.194	1.64	2.38	284	982	23.22	19.01
N_4: Organics 2 t ha^{-1} enriched with 2 kg Zn	2.40	2.28	0.215	0.196	1.65	2.39	229	947	28.43	22.70
N_5: Organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	2.42	2.32	0.219	0.199	1.67	2.43	302	1027	31.87	24.77
N_6: Organics 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	2.41	2.30	0.217	0.198	1.66	2.41	289	994	29.08	23.25
S.Em.±	0.02	0.02	0.002	0.002	0.01	0.02	2.34	6.26	0.24	0.22
C.D. (P=0.05)	0.05	0.05	0.005	0.005	0.03	0.05	7	18	0.68	0.62
Interaction (M×N)										
S.Em.±	0.03	0.02	0.003	0.003	0.02	0.03	3.31	8.85	0.34	0.31
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	9	25	0.97	0.88
C.V.%	3.25	3.00	3.35	4.03	2.70	3.12	3.53	2.57	3.63	4.13

Table 5: Interaction effect of M×N on iron content (mg kg^{-1}) in tuber and haulm of potato (Pooled)

Organics	Fe and Zn supplementation					
	N_1	N_2	N_3	N_4	N_5	N_6
	Tuber					
M_1	211	255	274	226	298	282
M_2	215	296	293	232	305	295
S.Em.±	3.31					
C.D.(P=0.05)	9					
	Haulm					
M_1	889	965	971	909	1021	987
M_2	968	986	993	984	1032	1000
S.Em.±	8.85					
C.D.(P=0.05)	25					

Table 6: Interaction effect of M×N on zinc content (mg kg^{-1}) in tuber and haulm of potato (Pooled)

Organics	Fe and Zn supplementation					
	N_1	N_2	N_3	N_4	N_5	N_6
	Tuber					
M_1	20.28	25.39	22.46	27.00	29.57	27.02
M_2	21.91	27.58	23.99	29.86	34.18	31.13
S.Em.±	0.34					
C.D.(P=0.05)	0.97					
	Haulm					
M_1	16.73	21.03	19.38	21.78	23.26	22.50
M_2	17.21	22.09	18.64	23.63	26.27	24.00
S.Em.±	0.31					
C.D.(P=0.05)	0.88					

Table 7: Nutrient uptake by tuber and haulm of potato as influenced by organics and Fe and Zn supplementation (Pooled)

Treatments	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		Fe uptake (g ha^{-1})		Zn uptake (g ha^{-1})	
	Tuber	Haulm	Tuber	Haulm	Tuber	Haulm	Tuber	Haulm	Tuber	Haulm
Organics (M)										
M_1: FYM @ 20 t ha^{-1}	154	40.10	13.88	3.40	107	41.96	1707	1725	168	37.51
M_2: Vermicompost @ 5 t ha^{-1}	179	47.30	16.19	4.03	124	49.52	2085	2082	216	46.69
S.Em.±	1.02	0.57	0.10	0.05	0.68	0.62	12.82	25.54	1.42	0.60
C.D. (P=0.05)	3	1.60	0.28	0.14	2	1.75	36	72	4	1.69
Fe and Zn supplementation (N)										
N_1: No Fe and Zn	140	35.63	12.61	2.93	99	37.04	1353	1560	134	28.51
N_2: 6 kg Fe and 4 kg Zn ha^{-1} (Inorganic)	157	39.23	14.14	3.26	111	41.04	1929	1778	185	39.22
N_3: Organics 2 t ha^{-1} enriched with 3 kg Fe	166	43.80	15.05	3.75	115	45.92	2000	1893	164	36.54
N_4: Organics 2 t ha^{-1} enriched with 2 kg Zn	171	44.74	14.40	3.85	118	46.94	1637	1861	204	44.68
N_5: Organics 2 t ha^{-1} enriched with 6 kg Fe and 4 kg Zn	184	51.38	16.67	4.41	126	53.77	2292	2275	244	55.39
N_6: Organics 2 t ha^{-1} enriched with 3 kg Fe and 2 kg Zn	180	47.44	16.32	4.09	124	49.73	2165	2052	219	48.27
S.Em.±	1.76	0.98	0.17	0.09	1.18	1.07	22.21	44.24	2.45	1.04
C.D. (P=0.05)	5	2.77	0.48	0.25	3	3.03	63	125	7	2.93
Interaction (M×N)										
S.Em.±	2.49	1.39	0.24	0.12	1.67	1.52	31.41	62.57	3.47	1.47
C.D. (P=0.05)	7	3.92	0.68	0.35	5	4.28	89	177	10	4.14
C.V.%	4.23	8.99	4.53	9.46	4.09	9.38	4.69	9.30	5.12	9.86

Table 8: Interaction effect of M×N on N uptake (kg ha-1) by tuber and haulm of potato (Pooled)

Organics	Fe and Zn supplementation					
	N_1	N_2	N_3	N_4	N_5	N_6
	Tuber					
M_1	135	147	156	158	167	162
M_2	146	168	177	185	202	199
S.Em.±	2.49					
C.D.(P=0.05)	7					
	Haulm					
M_1	35.33	38.02	40.18	40.49	44.48	42.13
M_2	35.93	40.45	47.43	48.98	58.28	52.75
S.Em.±	1.39					
C.D.(P=0.05)	3.92					

Table 9: Interaction effect of M×N on P uptake (kg ha^{-1}) by tuber and haulm of potato (Pooled)

Organics	Fe and Zn supplementation					
	N_1	N_2	N_3	N_4	N_5	N_6
	Tuber					
M_1	12.11	13.37	13.95	14.18	15.03	14.64
M_2	13.12	14.91	16.15	16.62	18.31	18.00
S.Em.±	0.24					
C.D.(P=0.05)	0.80					
	Haulm					
M_1	2.91	3.16	3.45	3.49	3.78	3.61
M_2	2.96	3.37	4.04	4.20	5.04	4.57
S.Em.±	0.12					
C.D.(P=0.05)	0.35					

Table 10: Interaction effect of M×N on K uptake (kg ha^{-1}) by tuber and haulm of potato (Pooled)

Organics	Fe and Zn supplementation					
	N_1	N_2	N_3	N_4	N_5	N_6
	Tuber					
M_1	94	103	107	109	115	112
M_2	105	118	123	126	138	136
S.Em.±	1.67					
C.D.(P=0.05)	5					
	Haulm					
M_1	36.71	39.74	42.11	42.71	46.39	44.07
M_2	37.36	42.34	49.72	51.17	61.14	55.39
S.Em.±	1.52					
C.D.(P=0.05)	4.28					

Table 11: Interaction effect of M×N on Fe uptake (g ha^{-1}) by tuber and haulm of potato (Pooled)

Organics	Fe and Zn supplementation					
	N_1	N_2	N_3	N_4	N_5	N_6
	Tuber					
M_1	1276	1667	1812	1505	2064	1917
M_2	1429	2190	2187	1770	2520	2413
S.Em.±	31.41					
C.D. (P=0.05)	89					
	Haulm					
M_1	1492	1719	1735	1630	1958	1814
M_2	1627	1838	2051	2092	2593	2291
S.Em.±	62.57					
C.D. (P=0.05)	177					

Table 12: Interaction effect of M×N on Zn uptake (g ha^{-1}) by tuber and haulm of potato (Pooled)

Organics	Fe and Zn supplementation					
	N_1	N_2	N_3	N_4	N_5	N_6
	Tuber					
M_1	123	166	148	180	205	184
M_2	146	204	179	228	282	255
S.Em.±	3.47					
C.D.(P=0.05)	10					
	Haulm					
M_1	28.12	37.23	34.55	39.09	44.70	41.36
M_2	28.90	41.20	38.52	50.27	66.08	55.18
S.Em.±	1.47					
C.D.(P=0.05)	4.14					

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