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Effect of vermicompost and zinc application on nutrient content and uptake by maize

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Abstract
A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan during 2018 to Effect of vermicompost and zinc application on nutrient content and uptake by maize crop. The experiment was laid out in a randomized block design, comprising vermicompost and zinc and their combination, *viz*., T_1 control, T_2 vermicompost (1.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_3 vermicompost (1.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_4 vermicompost (1.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_5 vermicompost (3.0 t ha^{-1}) + zinc (0 kg ha^{-1}), T_6 vermicompost (3.0 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_7 vermicompost (3.0 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_8 vermicompost (4.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_9 vermicompost (4.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_{10} vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), treatments replicated three times. The result revealed that the application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) significantly increased nutrient content in seed such as N (2.069), P (0.346), K (0.496), Zn (59.62), Fe (31.72), Mn (14.74), Cu (31.71) and stover such as N (0.697), P (0.182), K (1.990), Zn (27.140), Fe (212.05), Mn (42.730), Cu (10.260) as compared to control. The application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) significantly increased nutrient uptake by seed such as N (80.62), P (13.48), K (19.32), Zn (2323.16), Fe (1236.16), Mn (574.32), Cu (1235.53) and stover such as N (37.745), P (9.858), K (107.661), Zn (1472.33), Fe (11484.12), Mn (2315.22), Cu (555.61) as compared to control.

Keywords: Vermicompost, zinc application, nutrient content, uptake by maize

Introduction
Maize is an important cereals crop ranking 3rd after wheat and rice in respect of area and production. Maize (*Zea mays* L.) belongs to Gramineae family; it is considered as the native to Central America & Mexico. Maize is one of most important cereal crop in term of world agriculture economy both as food for man and feed for animal. It is a miracle crop as its grain yield potential (GYP) is twice as high as compared to other cereal crops. There is no cereal on earth which has so immense potentiality and that is why it is also called "queen of cereals". Maize is grown in almost all the states of India. Maize grain contains about 10% protein, 4% oil, 70% carbohydrate 2.3% crude fiber, 10.4% aluminizes, 1.4% ash. Maize protein 'Zein' is rich in tryptophan and lysine, the two essential amino acids. Being highly cross pollinated, maize has become highly polymorphic through the course of natural and domesticated evolution and thus contains enormous genetic variability. Maize may also have the capacity to tolerate salinity stress Maize crop furnishes huge quantities of green fodder for cattle.

Vermicompost is a good substitute to commercial fertilizers and has more N, P and K content than the normal heap manure (Srivastava and Beohar, 2004) [9]. The application of vermicompost helps to improves and conserves the fertility of soil. Vermicompost imparts a dark colour of the soil and thereby help to maintain the temperature of soil. Vermicompost is one of the manure used by the farmer in growing crops because of early availability and presence of almost all the nutrients required by plants.

Zinc is an essential element for plant growth, crop yield and quality. When the supply of plant-available zinc is insufficient, crop yields are reduced and the quality of crop products is frequently impaired (Alloway *et al*., 2003) [1]. Natural levels of zinc in the soil range from 10 to 300 mg kg^{-1} with an average of 50 mg kg^{-1} (Mulligan *et al.*, 2001) [7]. It is estimated that 30 per cent of the world's cultivated soils are deficient in zinc (Suzuki *et al.*, 2006) [10] and Grain-yield reductions of upto 80 per cent along with reduced grain zinc level have been observed under zinc deficiency (Cakmak *et al.*, 1998) [3]

Material and methods

A field experiment was conducted during *kharif* season of 2018 at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan. The soil was sandy clay loamy. The soil had pH value of 8.10, medium in available nitrogen (338.32 kg N ha^{-1}), medium in available phosphorus (28.32 kg P_2O_5 ha^{-1}) and high in potassium (352.68 kg K_2O ha^{-1}). The experiment was laid out in a randomized block design, comprising vermicompost and zinc and their combination, *viz*., T_1 control, T_2 vermicompost (1.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_3 vermicompost (1.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_4 vermicompost (1.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_5 vermicompost (3.0 t ha^{-1}) + zinc (0 kg ha^{-1}), T_6 vermicompost (3.0 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_7 vermicompost (3.0 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_8 vermicompost (4.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_9 vermicompost (4.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_{10} vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), treatments replicated three times. Seed rate 25 kg ha^{-1} of maize variety 'PHEM-2' was used in this study. Whole amount of vermicompost as per treatment was broadcasted uniformly at the time of sowing and The recommended dose of nitrogen (120 kg ha^{-1}) through urea, phosphorus (60 kg ha^{-1}) through DAP, potassium (40 kg ha^{-1}) through MOP and zinc through $ZnSO_4.7H_2O$ were applied as basal as per treatments.

Result and discussion:

Nutrient content and uptake by maize

The application of vermicompost (4.5 t ha^{-1}) and zinc (2.5 kg ha^{-1}) significantly increased nutrient content and uptake by grain and stover as compared to control. The increased content and uptake nitrogen could be ascribed to rapid release and higher availability of nitrogen as influenced by the application of vermicompost (4.5 t ha^{-1}) at higher rate. The increased content and uptake phosphorus could be ascribed to comparatively higher phosphorus content of vermicompost under the experiment which consequently improved root growth and uptake of nutrient including phosphorus.

The increase in zinc content and uptake as influence by vermicompost could be due to a combination of factors. Vermicompost contained relatively more Zn than other manures used which could result in increased availability and subsequently uptake and content in both grain and stover. Vermicompost used also contained more nitrogen than other organic manure resulting in improved yield which directly improve the uptake. Iron content and uptake by grain and stover significantly increased with application of 4.5 t ha^{-1} vermicompost. This could be due to the fact the iron content in vermicompost manure used in this study significantly increased. The presence of higher microbial and enzymatic activity in vermicompost possibly stimulated the root growth and thus resulted in higher uptake of micronutrients in general by maize and iron in particular. Similar finding were reported by Wong *et al*. (1999) [11], Basavaraju, S.D (2007) [2], Hussain (2008) [5], Pagliari *et al.* (2009) [8], Leytem and Bjorneberg (2009) [6], Yazdani *et al*. (2011) [12],

The application of zinc significantly increased both concentration and uptake of macro (N, P, K) and micro nutrient (Zn, Fe, Cu, Mn) compared to over control. Application of zinc in the soil deficient in Zn increased the availability of Zn in rhizosphere. The beneficial role of zinc in increasing the cation exchange capacity of roots helped in enhanced absorption of nutrient from the soil. Further the beneficial role in chlorophyll formation and acts as structural constituent of chloroplast and hence the chlorophyll content in maize, regulating the auxin concentration and its stimulatory effect on most of physiological and metabolic process of the plant might have helped the plant in absorption of greater amount of nutrients from soil. Arya and Singh (2001) also reported similar findings. Thus, favorable influence of zinc on photosynthesis and metabolic process augment the production of photosynthesis and their translocation to different plant parts which ultimately increased the concentration of nutrient in the grains and stover. The increased uptake of N, P, K and Zn, Fe, Mn, Cu seem partly due to their increased concentration in grain as well as stover along with increased grain and stover yields. These finding are in agreement with the finding of Dwivedi *et al*. (2002) [4] who also reported the increase in concentration and uptake of zinc with increase in zinc application.

Table 1: Effect of vermicompost and zinc application on N, P, K (%) content in seed and stover of maize

Treatment	Seed			Stover		
	N	P	K	N	P	K
T_1 Control	1.470	0.236	0.412	0.506	0.125	1.19
T_2 VC (1.5 t)+ Zn (0 kg)	1.588	0.249	0.422	0.534	0.133	1.273
T_3 VC (1.5 t)+ Zn (2.5 kg)	1.625	0.257	0.432	0.556	0.139	1.343
T_4 VC (1.5 t)+ Zn (5.0 kg)	1.668	0.274	0.441	0.582	0.147	1.43
T_5 VC (3.0 t)+ Zn (0 kg)	1.810	0.28	0.449	0.596	0.152	1.513
T_6 VC (3.0 t)+ Zn (2.5 kg)	1.849	0.287	0.457	0.609	0.157	1.593
T_7 VC (3.0 t)+ Zn (5.0 kg)	1.898	0.304	0.466	0.636	0.164	1.667
T_8 VC (4.5 t)+ Zn (0 kg)	1.95	0.321	0.474	0.645	0.169	1.77
T_9 VC (4.5 t)+ Zn (2.5 kg)	1.991	0.329	0.483	0.668	0.175	1.900
T_{10} VC (4.5 t)+ Zn (5.0 kg)	2.069	0.346	0.496	0.697	0.182	1.990
SE.m ±	0.012	0.001	0.002	0.001	0.001	0.019
CD (P=0.05)	0.036	0.004	0.007	0.004	0.004	0.058

Table 2: Effect of vermicompost and Zinc application on Zn, Cu, Fe, Mn (mg kg^{-1}) content in seed and stover of maize

Treatment	Seed				Stover			
	Zn	Fe	Cu	Mn	Zn	Fe	Cu	Mn
T_1 Control	41.3	24.12	20.82	9.68	16.6	174.33	6.22	35.13
T_2 VC (1.5 t)+ Zn (0 kg)	44.96	25.68	21.72	10.24	17.94	178.12	6.92	36.18
T_3 VC (1.5 t)+ Zn (2.5 kg)	46.78	26.34	22.51	10.71	18.84	182.14	7.29	36.78
T_4 VC (1.5 t)+ Zn (5.0 kg)	49.28	27.193	23.72	11.24	19.94	186.18	7.72	37.58
T_5 VC (3.0 t)+ Zn (0 kg)	50.71	27.78	24.67	11.74	21.54	190.12	8.22	38.678
T_6 VC (3.0 t)+ Zn (2.5 kg)	52.58	28.64	25.62	12.19	22.44	194.64	8.67	39.28
T_7 VC (3.0 t)+ Zn (5.0 kg)	53.943	29.31	27.67	12.84	23.54	199.32	9.12	40.08
T_8 VC (4.5 t)+ Zn (0 kg)	55.32	29.9	28.66	13.64	25.143	203.14	9.52	41.23
T_9 VC (4.5 t)+ Zn (2.5 kg)	57.12	30.76	30.107	14.09	26.04	207.94	9.853	41.88
T_{10} VC (4.5 t)+ Zn (5.0 kg)	59.62	31.727	31.71	14.74	27.14	212.05	10.26	42.73
SE.m ±	0.444	0.183	0.223	0.135	0.255	1.19	0.103	0.155
CD (P=0.05)	1.321	0.544	0.661	0.401	0.757	3.55	0.305	0.46

Table 3: Effect of vermi compost and Zinc application on N, P, K uptake (kg ha-1) by seed and stover of maize

Treatment	Seed			Stover		
	N	P	K	N	P	K
T_1 Control	31.023	4.986	8.704	16.546	4.087	38.915
T_2 VC (1.5 t)+ Zn (0 kg)	41.745	6.544	11.09	21.445	5.328	51.137
T_3 VC (1.5 t)+ Zn (2.5 kg)	44.918	7.107	11.942	23.174	5.794	55.99
T_4 VC (1.5 t)+ Zn (5.0 kg)	48.074	7.897	12.71	24.991	6.312	61.404
T_5 VC (3.0 t)+ Zn (0 kg)	55.496	8.585	13.766	26.886	6.857	68.266
T_6 VC (3.0 t)+ Zn (2.5 kg)	60.038	9.318	14.836	28.72	7.404	75.142
T_7 VC (3.0 t)+ Zn (5.0 kg)	64.052	10.248	15.722	30.776	7.936	80.65
T_8 VC (4.5 t)+ Zn (0 kg)	68.731	11.314	16.701	31.818	8.337	87.314
T_9 VC (4.5 t)+ Zn (2.5 kg)	73.086	12.076	17.73	34.573	9.058	98.302
T_{10} VC (4.5 t)+ Zn (5.0 kg)	80.622	13.481	19.326	37.745	9.858	107.661
SE.m ±	0.799	0.085	0.16	0.131	0.086	0.821
CD (P=0.05)	2.375	0.251	0.477	0.391	0.256	2.44

Table 4: Effect of vermicompost and zinc application on Zn, Cu, Fe, Mn uptake (kg ha-1) by seed and stover of maize

Treatment	Seed				Stover			
	Zn	Fe	Cu	Mn	Zn	Fe	Cu	Mn
T_1 Control	872.16	510.27	440.64	205.58	542.83	5700.87	203.4	1148.87
T_2 VC (1.5 t)+ Zn (0 kg)	1186.88	676.2	572.13	269.17	720.47	7153.3	277.91	1452.99
T_3 VC (1.5 t)+ Zn (2.5 kg)	1292.67	728.7	622.21	296.05	785.25	7591.6	303.85	1532.99
T_4 VC (1.5 t)+ Zn (5.0 kg)	1420.4	783.78	683.61	323.94	856.22	7994.57	331.5	1613.69
T_5 VC (3.0 t)+ Zn (0 kg)	1554.77	851.87	756.39	359.95	971.67	8576.31	370.8	1744.78
T_6 VC (3.0 t)+ Zn (2.5 kg)	1707.59	930.42	832.38	395.74	1058.27	9179.22	408.88	1852.44
T_7 VC (3.0 t)+ Zn (5.0 kg)	1820.98	990.35	931.02	434.98	1139.1	9645.09	441.32	1939.47
T_8 VC (4.5 t)+ Zn (0 kg)	1950.14	1054.34	1010.65	480.7	1240.32	10020.9	469.62	2033.88
T_9 VC (4.5 t)+ Zn (2.5 kg)	2096.95	1129.45	1105.04	517.19	1348.24	10761.6	509.92	2167.34
T_{10} VC (4.5 t)+ Zn (5.0 kg)	2323.16	1236.11	1235.53	574.32	1472.33	11484.1	555.61	2315.22
SE.m ±	20.49	12.3	9.06	7.25	17.49	68.74	4.41	13.03
CD (P=0.05)	60.88	36.56	26.93	21.55	51.97	204.23	13.12	38.73

Conclusion

On the basis of experimental finding, it can be concluded that, higher nutrient content and uptake by maize crop (var. PHEM-2) can be obtained with the combined application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) under sandy clay loam soil of sub humid region of Rajasthan.

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