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Effect of FYM, Zn and *Trichoderma spp.* on content and uptake of N, P, K, Fe, Mn, Cu, Zn and Cd by spinach beet grown in Cd contaminated soil

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Abstract
An investigation entitled "Effect of FYM, Zn and *Trichoderma spp.* applications on growth, yield and cadmium uptake by spinach beet grown in Cd contaminated soil" was carried out during *rabi* 2016 at Department of Natural Resources Management, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. The present pot trial consisting of 18 treatment combinations involving three levels of FYM (F_0: control, F_1: 10 t ha^{-1} and F_2: 20 t ha^{-1}) and two levels of *Trichoderma* (T_0:- Control, T_1:- 2 kg ha^{-1}) and three levels of Zinc (Z_0: control, Z_1: 2.5 mg kg^{-1} and Z_2: 5.0 mg kg^{-1}) was conducted in FCRD with three repetitions. The significantly highest content of N (3.20, 3.08 and 3.02 percent), P (0.23,0.23 and 0.16 percent) and K(3.86, 3.38 and 3.51 percent), Fe (526.79, 615.88, 313.10 ppm), Mn (53.61,50.10, 49.05 ppm), Cu (5.13, 6.08, 5.55 ppm) and Zn (15.48, 14.5, 15.78 ppm) were found due to application of FYM @ 20 t ha^{-1} over F_1 and F_0 during 1st, 2nd and 3rd, respectively. However, significantly lowest Cd content was found due to application of FYM @ 20 t ha^{-1} over F_0 during 1st, 2nd and 3rd cutting with magnitude in decrease by 9.06, 16.22 and 10.37 percent, respectively in leaves and 17.91 percent in root. However, N, P and K content significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) except during 2nd cutting in K content. Fe content was significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) except Fe content during 2nd and 3rd cutting. While Cu and Cd content in leaves during 1st and 3rd cuttings and Cd content in root were significantly affected due to application of *Trichoderma* (2 kg ha^{-1}) over the control. The concentration of macro and micro nutrient were significantly higher with Z_2 treatment as compared to Z_1 and Z_0 treatment. However, macro and micro nutrients uptake by leaves significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) during 1st, 2nd and 3rd cutting. However, significantly highest N, P, K, Fe, Mn, Cu and Zn uptake by leaves were found due to application of Zinc @ 5 mg kg^{-1}(Z_2) over Z_1 and Z_0 with corresponding value of 0.302.0, 0.296, 0.275 g pot^{-1}; 0.0226, 0.0215, 0.0137 g pot^{-1} and 0.394, 0.331, 0.341 g pot^{-1}; 5.13, 6.21 and 2.95 mg pot^{-1}; 0.53, 0. 51 and 0.48 mg pot^{-1}; 0.050, 0.059 and 0.052 mg pot^{-1}; and 0.1622, 0.1460 and 0.1489 mg pot^{-1}, respectively during 1st, 2nd and 3rd cutting.

Keywords: Spinach beet, FYM, Zn, *Trichoderma*, content, uptake

Introduction

Spinach (*Spinacea oleracea* Linn) a member of the chenopodiaceae family, is also known as "Palak". Spinach is an annual plant. It is a nutritive leafy vegetable. It is rich in vitamins especially vitamin A and other vitamins like ascorbic acid, riboflavin, and thiamine. There are also appreciable quantities of minerals like iron and calcium. Spinach is an important vegetable in our daily food intake. Food should ful fill the daily requirements without creating health problems. Adverse effects of agro-chemicals (like cancer, off spring's with neural tube defects and limb anomalies, harm nervous system and Blue baby syndrome) on the health of farmers using them and the society consuming the chemically grown food have now started to become more evident all over the world. Though low in calories; it contains higher concentration of minerals, vitamins and other amino acids. It has high contain of niacin and zinc and also a very good source of dietary fiber, protein and vitamins (A, C, K, thiamine, riboflavin, B6 and foliate) and essential micronutrients (Ca, Fe, Mg, P, K, Cu, Mn). Being a leafy vegetable, spinach beet is widely grown in kitchen garden especially in urban areas. Major sources of heavy metal inputs to ecosystems are mining, smelting and metallurgical industries, sludge disposal and agricultural practices (Horak and Friesl, 2007) [2]. Cd accumulation in plants has a positive correlation with their availability and plant growth inhibition (Greger and Bertell, 1992) [4]. Exposures of heavy metals at higher concentration can result in damaged central and mental processes, reduction in body energy levels, damaged to blood composition, blood pressure, liver, kidney, lungs and various other vital organs.

Material and Methods

Pot experiment was conducted during *Rabi* season of 2016 at polyhouse, Department of Natural Resources Management, ASPEE college of Horticulture & Forestry, Navsari Agricultural University, Navsari, Gujarat. Total 18 treatment combinations comprising of three levels of FYM (F_0: control, F_1: 10 t ha^{-1} and F_2: 20 t ha^{-1}) and two levels of *Trichoderma* (T_0: Control, T_1: 2 kg ha^{-1}) and three levels of Zinc (Z_0: control, Z_1: 2.5 mg kg^{-1} and Z_2: 5.0 mg kg^{-1}) were evaluated in Factorial CRD with three replications. The soil of experiment pot was collected from the Vapi industrial area having *verisols* order. The soil was clayey in texture having EC (0.56 dS m^{-1}) and soil pH (7.98). The soil is medium in organic Carbon (0.58%), low in available nitrogen (124.90 kg ha^{-1}), available phosphorus (54.70 kg ha^{-1}) and fairly rich in available potassium (570.17 kg ha^{-1}) with 5.42 ppm Cd content. Spinach beet variety palak all green were sown at 20 seed per pot, the entire dose of nitrogen and phosphorus applied at basal application just before sowing and nitrogen was applied after each cutting. FYM, *Trichoderma* and Zn were applied as per the treatment.

Results

1. Nutrient content (%)

Primary nutrients: With respect to primary nutrients content in leaves of spinach beet is concern, N, P and K content in leaves of spinach beet were differed significantly due to individual effect of FYM, *Trichoderma* and Zinc at 1st, 2nd, 3rd cutting of spinach beet except application of *Trichoderma* at 2nd cutting in K content. The significantly highest content of N (3.20, 3.08 and 3.02 percent), P (0.23,0.23 and 0.16 percent) and K(3.86, 3.38 and 3.51 percent) were found due to application of FYM @ 20 t ha^{-1} over F_1 and F_0 during 1st, 2nd and 3rd, respectively (Table 1). However, N, P and K content significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) except during 2nd cutting in K content. However, the significant increase in content of N, P and K due to T_1 with corresponding to value of 3.00, 2.92, 2.88 percent; 0.21, 0.21, 0.13 percent and 3.56, 3.13, 3.30 percent, respectively over T_0 during 1st, 2nd and 3rd cutting. Among the different Zn levels, N, P and K concentration in leaves were ranged from (2.75 to 3.09%, 2.67 to 3.04% and 2.65 to 2.93%), (0.152 to 0.230%, 0.165 to 0.220% and 0.108 to 0.144%) and (2.75 to 4.02%, 2.84 to 3.39% and 2.79 to 3.63%) during 1st, 2nd and 3rd cutting respectively.

Micronutrients

The Fe, Mn, Cu and Zn content measured at 1st, 2nd and 3rd cuttings were significantly higher with treatment F_2 over F_1 and F_0 with a tune value of 526.79, 615.88, 313.10 ppm; 53.61,50.10, 49.05 ppm; 5.13, 6.08, 5.55 ppm and 15.48, 14.54, 15.78 ppm, respectively (Table 2). The data further showed that F_2 was at par with treatment F_1 in Zn content during 1st cutting with corresponding value of 14.68 ppm. The data further showed that content of Fe, Mn, Cu and Zn with F_2 were significantly superior over F_0 by 24.15, 11.60, 12.93 percent; 8.46, 14.04, 13.07 percent; 24.21, 11.97, 16.11 and 14.75, 14.85, 11.60 percent, respectively during 1st, 2nd and 3rd cutting. Fe content was significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) except Fe content during 2nd and 3rd cutting. However, the magnitude of significant increase in Fe content during 1st cutting was 7.23 percent over T_0. Cu content was significantly affected due to application of *Trichoderma* (2 kg ha^{-1}) over the control during 1st and 3rd cutting with tune value of 4.75 ppm and 5.27 ppm, respectively. Significantly highest Fe, Mn, Cu and Zn contents in leaves were found during 1st, 2nd and 3rd cutting due to application of Zinc @ 5 mg kg^{-1}(Z_2) over Z_1 and Z_0 with corresponding value of 523.19, 638.04, 314.98 ppm; 54.03, 52.39, 50.97 ppm; 5.10, 6.06, 5.54 ppm and 16.59, 14.98, 15.88 ppm, respectively during 1st, 2nd and 3rd cutting.

Cd content in leaves and root

The data presented in table 3 revealed that Cd content in leaves during 1st, 2nd and 3rd cutting and root were significantly affected due to different levels of FYM, however, significantly lowest Cd content was found due to application of FYM @ 20 t ha^{-1} over F_0 during 1st, 2nd and 3rd cutting with magnitude in decrease by 9.06, 16.22 and 10.37 percent, respectively in leaves and 17.91 percent in root. The magnitude of significant decrement in Cd content in leaves during 2nd cutting was 6.82 percent with T_1 over T_0 and 5.39 percent in root. Data pertaining to Zinc level showed that Cd was significantly affected due to different levels of Zinc. However, significantly lowest Cd content was found due to application of Zinc @ 5 mg kg^{-1}(Z_2) over Z_1 and Z_0 with corresponding value of 5.56, 5.10 and 6.59 ppm in leaves during 1st, 2nd and 3rd cutting, respectively and 21.26 ppm in root after 3rd cutting. However, Z_1 was statistically at par with Z_0 during 1st cutting with a tune vale of 5.81 ppm Cd.

Nutrient uptake

Major nutrients The results pertaining to N, P, and K uptake (g pot^{-1}) by leaves of spinach beet (Table 4) as influenced by different levels of FYM, *Trichoderma* and Zn are presented in table 4 The results indicated that uptake of N, P and K by leaves were affected significantly due to application of FYM and *Trichoderma*and Zn. Significantly higher N, P and K uptake by leaves was recorded in F_2(20 kg ha^{-1}), T_1(2 kg ha^{-1})and Z_2 (5 mg kg^{-1})over the other treatment during 1st, 2nd and 3rd cutting.

Micronutrients: An appraisal of the results presented in table 5 revealed that uptake of Fe, Mn, Zn and Cu by leaves of spinach beet were significantly affected by individual effect of FYM, *Trichoderma* and Zn during 1st, 2nd and 3rd cutting. As far as effects of different levels of FYM, *Trichoderma* and Zn are concerned, Fe uptake (5.25, 6.11 and 2.93 mg pot^{-1}), (4.66, 5.49 and 2.66 mg pot^{-1}), (5.13, 6.21 and 2.95 mg pot^{-1}), Mn uptake (0.53, 0.50 and 0.46 mg pot^{-1}), (0.48, 0.44 and 0.41 mg pot^{-1}), (0.53, 0. 51 and 0.48 mg pot^{-1}), Cu uptake (0.0513, 0.0601 and 0.0520 mg pot^{-1}), (0.0445, 0.0541 and 0.0468 mg pot^{-1}) (0.050, 0.059 and 0.052 mg pot^{-1}) and Zn uptake (0.1543, 0.1440 and 0.1478 mg pot^{-1}), (0.1383, 0.1295 and 0.1341mg pot^{-1}), (0.1622, 0.1460 and 0.1489 mg pot^{-1}) by leaves of spinach beet were significantly higher with treatment of F_2 over F_1 and F_0, T_1 over $T_0$and Z_2 over Z_1 and Z_0during 1st, 2nd and 3rd cutting, respectively.

Cd uptake by leaves and root: The data pertaining Cd uptake by leaves found during the 1st, 2nd and 3rd cutting and by root after 3rd cutting of spinach beet shown in table 6. The data further revealed that Cd uptake by leaves recorded during 1st cutting was significantly affected due to levels of FYM and Zinc during 1st cutting and 3rd cutting. Significantly highest Cd uptake by leaves was found due to application of FYM @ 20 t ha^{-1} over F_1 and F_0 during 1st cutting with a tune figure of 0.0548 mg pot^{-1}. However, significantly highest uptake of Cd was found during 1st and 3rd cutting due to application of Zinc @ 5 mg kg^{-1}(Z_2) over Z_1 and Z_0 with corresponding value of 0.054 and 0.0616 mg pot^{-1}, respectively.

Table 1: Effect of FYM, Trichoderma and Zn on N, P and K content in leaves of spinach beet

Treatment	N content (%)			P content (%)			K content (%)		
	Cutting			Cutting			Cutting		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
F_0	2.69	2.64	2.58	0.152	0.165	0.092	2.96	2.79	2.87
F_1	2.93	2.87	2.78	0.201	0.191	0.120	3.44	3.01	3.23
F_2	3.20	3.08	3.02	0.235	0.232	0.156	3.86	3.38	3.51
S.Em.±	0.04	0.04	0.04	0.005	0.004	0.003	0.08	0.07	0.05
C.D.@5%	0.11	0.12	0.11	0.013	0.013	0.007	0.22	0.20	0.15
T_0	2.88	2.81	2.71	0.186	0.185	0.111	3.29	2.99	3.11
T_1	3.00	2.92	2.88	0.206	0.207	0.134	3.56	3.13	3.30
S.Em.±	0.03	0.03	0.03	0.004	0.004	0.002	0.06	0.06	0.04
C.D.@5%	0.09	0.10	0.09	0.011	0.011	0.006	0.18	NS	0.12
Z_0	2.75	2.67	2.65	0.152	0.165	0.108	2.75	2.84	2.79
Z_1	2.98	2.88	2.80	0.207	0.203	0.115	3.50	2.94	3.19
Z_2	3.09	3.04	2.93	0.230	0.220	0.144	4.02	3.39	3.63
S.Em.±	0.04	0.04	0.04	0.005	0.004	0.003	0.08	0.07	0.05
C.D.@5%	0.11	0.12	0.11	0.013	0.013	0.007	0.22	0.20	0.15
C.V.%	5.71	6.29	5.73	9.77	9.72	8.97	9.66	9.49	6.78

Table 2: Effect of FYM, *Trichoderma* and Zn on Fe, Mn, Cu and Zn content in leaves of spinach beet

Treatment	Fe content (ppm)			Mn content (ppm)			Cu content (ppm)			Zn content (ppm)		
	Cutting			Cutting			Cutting			Cutting		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
F_0	424.33	551.85	277.24	49.43	43.93	43.38	4.13	5.43	4.78	13.49	12.66	14.14
F_1	490.21	564.79	296.49	51.02	46.16	46.02	4.58	5.81	5.20	14.68	13.67	14.79
F_2	526.79	615.88	313.10	53.61	50.10	49.05	5.13	6.08	5.55	15.48	14.54	15.78
S.Em.±	9.82	11.45	5.52	0.62	0.98	0.91	0.10	0.08	0.06	0.34	0.29	0.33
C.D.@5%	28.16	32.84	15.84	1.77	2.81	2.62	0.29	0.22	0.17	0.98	0.84	0.94
T_0	462.43	564.96	291.19	50.84	46.20	45.56	4.47	5.71	5.08	14.33	13.32	14.69
T_1	498.46	590.06	300.04	51.87	47.26	46.73	4.75	5.84	5.27	14.77	13.93	15.13
S.Em.±	8.02	9.35	4.51	0.50	0.80	0.75	0.08	0.06	0.05	0.28	0.24	0.27
C.D.@5%	22.99	NS	NS	NS	NS	NS	0.24	NS	0.14	NS	NS	NS
Z_0	439.21	508.71	276.25	49.30	41.19	41.55	4.13	5.53	4.81	12.58	12.46	14.15
Z_1	478.92	585.78	295.61	50.73	46.60	45.92	4.61	5.74	5.18	14.48	13.43	14.69
Z_2	523.19	638.04	314.98	54.03	52.39	50.97	5.10	6.06	5.54	16.59	14.98	15.88
S.Em.±	9.82	11.45	5.52	0.62	0.98	0.91	0.10	0.08	0.06	0.34	0.29	0.33
C.D.@5%	28.16	32.84	15.84	1.77	2.81	2.62	0.29	0.22	0.17	0.98	0.84	0.94
C.V.%	8.67	8.41	7.93	5.11	8.90	8.40	9.30	5.54	4.78	9.99	9.10	9.32

Table 3: Effect of FYM, *Trichoderma* and Zn on Cd content in leaves and root of spinach beet

Treatment	Cd content in leaves (ppm)			Cd content in root (ppm)
	Cutting			At harvest
	1st	2nd	3rd	
F_0	6.07	6.04	7.33	24.17
F_1	5.81	5.51	6.90	22.60
F_2	5.52	5.03	6.57	19.84
S.Em.±	0.08	0.08	0.08	0.48
C.D.@5%	0.24	0.22	0.24	1.37
T_0	5.86	5.72	7.03	22.82
T_1	5.74	5.33	6.84	21.59
S.Em.±	0.07	0.06	0.07	0.39
C.D.@5%	NS	0.18	NS	1.12
Z_0	6.03	6.05	7.26	23.10
Z_1	5.81	5.43	6.96	22.26
Z_2	5.56	5.10	6.59	21.26
S.Em.±	0.08	0.08	0.08	0.48
C.D.@5%	0.24	0.22	0.24	1.37
C.V.%	6.03	5.95	5.19	9.14

Table 4: Effect of FYM, *Trichoderma* and Zn on N, P and K uptake by leaves of spinach beet

Treatment	N uptake (g pot^{-1}) Cutting			P uptake (g pot^{-1}) cutting			K uptake (g pot^{-1}) Cutting		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
F_0	0.225	0.216	0.206	0.0130	0.0136	0.0074	0.249	0.227	0.230
F_1	0.261	0.255	0.242	0.0180	0.0171	0.0105	0.309	0.267	0.282
F_2	0.318	0.304	0.282	0.0235	0.0229	0.0146	0.387	0.335	0.330
S.Em.±	0.005	0.005	0.005	0.0004	0.0004	0.0003	0.008	0.007	0.006
C.D.@5%	0.015	0.015	0.014	0.0013	0.0013	0.0008	0.024	0.021	0.016
T_0	0.256	0.246	0.232	0.0168	0.0164	0.0096	0.295	0.262	0.267
T_1	0.280	0.271	0.255	0.0195	0.0194	0.0121	0.335	0.291	0.294
S.Em.±	0.004	0.004	0.004	0.0004	0.0004	0.0002	0.007	0.006	0.005
C.D.@5%	0.012	0.012	0.011	0.0010	0.0010	0.0006	0.019	0.017	0.013
Z_0	0.228	0.217	0.210	0.0127	0.0136	0.0087	0.228	0.231	0.222
Z_1	0.274	0.263	0.245	0.0192	0.0186	0.0102	0.322	0.267	0.279
Z_2	0.302	0.296	0.275	0.0226	0.0215	0.0137	0.395	0.331	0.341
S.Em.±	0.005	0.005	0.005	0.0004	0.0004	0.0003	0.008	0.007	0.006
C.D.@5%	0.015	0.015	0.014	0.0013	0.0013	0.0008	0.024	0.021	0.016
C.V.%	8.35	8.50	8.27	10.46	10.43	10.68	11.16	11.21	8.55

Table 5: Effect of FYM, *Trichoderma* and Zn on Fe, Mn, Cu and Zn uptake by leaves of spinach beet

Treatment	Fe uptake (mg pot^{-1}) Cutting			Mn uptake (g pot^{-1}) cutting			Cu uptake (g pot^{-1}) Cutting			Zn uptake (g pot^{-1}) Cutting		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
F_0	3.57	4.53	2.21	0.41	0.36	0.35	0.0345	0.0443	0.0381	0.1140	0.1037	0.1127
F_1	4.36	5.03	2.58	0.45	0.41	0.40	0.0409	0.0515	0.0452	0.1310	0.1216	0.1287
F_2	5.25	6.11	2.93	0.53	0.50	0.46	0.0513	0.0601	0.0520	0.1543	0.1440	0.1478
S.Em.±	0.11	0.12	0.06	0.01	0.01	0.01	0.0009	0.0009	0.0007	0.0037	0.0029	0.0033
C.D.@5%	0.32	0.34	0.16	0.02	0.03	0.03	0.0027	0.0027	0.0019	0.0106	0.0083	0.0094
T_0	4.13	4.95	2.49	0.45	0.41	0.39	0.0399	0.0498	0.0434	0.1279	0.1166	0.1253
T_1	4.66	5.49	2.66	0.48	0.44	0.42	0.0445	0.0541	0.0468	0.1383	0.1295	0.1341
S.Em.±	0.09	0.10	0.05	0.01	0.01	0.01	0.0008	0.0008	0.0005	0.0030	0.0024	0.0027
C.D.@5%	0.26	0.28	0.13	0.02	0.03	0.02	0.0022	0.0022	0.0015	0.0087	0.0068	0.0076
Z_0	3.66	4.13	2.19	0.41	0.33	0.33	0.034	0.045	0.038	0.1045	0.1013	0.1121
Z_1	4.40	5.32	2.58	0.46	0.42	0.40	0.042	0.052	0.045	0.1326	0.1219	0.1281
Z_2	5.13	6.21	2.95	0.53	0.51	0.48	0.050	0.059	0.052	0.1622	0.1460	0.1489
S.Em.±	0.11	0.12	0.06	0.01	0.01	0.01	0.001	0.001	0.001	0.0037	0.0029	0.0033
C.D.@5%	0.32	0.34	0.16	0.02	0.03	0.03	0.003	0.003	0.002	0.0106	0.0083	0.0094
C.V.%	10.65	9.64	9.12	7.21	11.50	10.48	9.50	7.67	6.22	11.79	9.99	10.66

Table 6: Effect of FYM, *Trichoderma* and Zn on Cd uptake by leaves and root of spinach beet

Treatment	Cd uptake by leaves (g pot^{-1}) Cutting			Cd uptake by root (g pot^{-1}) At harvest
	1st	2nd	3rd	
F_0	0.0504	0.0487	0.0580	0.21
F_1	0.0513	0.0484	0.0597	0.21
F_2	0.0548	0.0492	0.0612	0.19
S.Em.±	0.0011	0.0007	0.0011	0.01
C.D.@5%	0.0033	NS	NS	NS
T_0	0.0514	0.0491	0.0593	0.21
T_1	0.0529	0.0484	0.0600	0.20
S.Em.±	0.0009	0.0006	0.0009	0.01
C.D.@5%	NS	NS	NS	NS
Z_0	0.0494	0.0485	0.0571	0.21
Z_1	0.0529	0.0487	0.0602	0.20
Z_2	0.0541	0.0491	0.0616	0.20
S.Em.±	0.0011	0.0007	0.0011	0.01
C.D.@5%	0.0033	NS	0.0030	NS
C.V.%	9.24	6.36	7.51	14.41

Discussion

Nutrient Content: The content of N, P, K, Fe, Mn, Zn, Cu and Cd in leaves during 1st, 2nd and 3rd cutting and Cd in root after third of spinach beet were significantly affected due to individual effects of FYM, *Trichoderma* and Zinc. The F_2 level of FYM recorded significantly higher content of N, P, K, Fe, Mn, Zn, Cu and lower content Cd in leaves during 1st, 2nd and 3rd cutting as well as in root after 3rd cutting than F_1 and F_0. The major and micro nutrients content in leaves and lowest Cd content in leaves as well as in root were significantly affected by the application of *Trichoderma* @ 2 kg ha^{-1} during 1st, 2nd and 3rd cutting of spinach beet except in K content in leaves during 2 cutting, Fe during 2nd and 3rd cutting, Mn and Zn in all cutting, Cu in 2nd cutting and Cd in1st and 3rd cutting. In case of Cd content in leaves Z_1 was statistically at par with Z_0 during 1st cutting with a tune vale of 5.81 ppm Cd. However, significantly lowest Cd content in root was found with T_2 over T_0 with a tune value of 21.59 ppm. Significantly the highest major and micro nutrients content in leaves were recorded with the application of Zn @ 5.0 mg kg^{-1} during 1st, 2nd and 3rd cutting respectively. Data further revealed that significantly lowest Cd content in leaves with a tune value of 5.56, 5.10 and 6.59 ppm during 1st, 2nd and 3rd cutting, respectively and 21.26 ppm in root of spinach beet after 3rd cutting were recorded under Z_2 treatment. The application of organic matter increased N, P and K content and uptake as compared with the control under polluted soil. These results are agreement with Ciecho *et al.* (2004) [2] who reported that a serious accumulation of nitrogen was observed in the grain and straw of *Zea maize* as a result of compost application. Cd concentration of the shoot also decreased upon the addition of FYM. However, the combined effect of FYM and Zn reduce the Cd content most than the single application of both. Sarkunan *et al.* (1996) [9] reported that addition of compost reduced the Cd content in rice. According to Kuo *et al*. (1985) [8] organic matter had little effect on Cd availability in soil. Soil amended with the FYM showed more reduction in availability of heavy metals because of high organic C content of the soil. Organic C present in the FYM is responsible for the release of negatively charged ions that attract the positively charged heavy metals and consequently results into more retention of heavy metals in the soil with lower availability to the plant. Clemente *et al.* (1991). Singh *et al.* (2007) [10] have also found FYM application to the soil to be an effective measure for reducing Cr toxicity to spinach plants in Cr- contaminated soils at farm, PAU, Panjab, India. Increase in concentration of iron and zinc was observed particularly when zinc and iron were applied in combination.

Nutrient uptake: The individual levels of FYM was significantly increased the major and micro nutrients uptake by leaves of spinach beet during 1st, 2nd and3rd cutting. The significantly highest uptake of N (0.318 g pot^{-1}), P (0.0235 g pot^{-1}), K (0.387 g pot^{-1}), Fe (6.11 mg pot^{-1}), Mn (0.53 mg pot^{-1}), Cu (0.0601 mg pot^{-1}), Zn (0.1543 mg pot^{-1}) and Cd (0.0612 mg pot^{-1}) by leaves as well as Cd (0.19 mg pot^{-1}) by root were recorded with treatment of F_2 *i.e* 20 t ha^{-1} over the application of F_1 @ 10 t ha^{-1} and control. The data further revealed that N, P, K, Fe, Mn, Cu and Zn uptake by leaves was affected significantly due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) during 1st, 2nd and 3rd cutting. Significantly highest Fe, Mn, Cu and Zn content by leaves was found during 1st, 2nd and 3rd cutting due to application of Zinc @ 5 mg kg^{-1}(Z_2) over Z_1 and Z_0 with corresponding value of (5.13, 6.21 and 2.95 mg pot^{-1}), (0.53, 0. 51 and 0.48 mg pot^{-1}), (0.050, 0.059 and 0.052 mg pot^{-1}) and (0.1622, 0.1460 and 0.1489 mg pot^{-1}) during 1st, 2nd and 3rd cutting, respectively. However, Cd uptake by leaves during 1st and 3rd cutting was significantly affected due to Z_2 over Z_1 and Z_0 with a tune value of 0.0541 and 0.0616 mg pot^{-1}, respectively without any significant effect on Cd uptake by root of spinach beet. FYM application significantly influenced Cd uptake by buckwheat. Notably, the application of FYM to Cd-contaminated soil mitigated toxicity by immobilization of Cd besides providing better physical and biological fertility which helps in increased the availability of all major as well as micronutrients to the growing crop. The observed effect could be clearly ascribed to the role of non- contaminated FYM as a sink for Cd (Bolan *et al.*, 2003) [1]. He and Singh (1993) [5] attributed the decreased Cd concentration in plant with higher levels of organic matter addition was predominantly due to the effect of increasing CEC in soil. The addition of FYM might cause an increase of soil CEC that have increased the ability of soils to adsorb Cd and Pb ions. The uptake of micro nutrients in microbial inoculated plants was also noticed higher due to direct or indirect effects of inoculations which are also noticed by Kothari *et al.* (1991) [7].

Conclusion

Application of FYM @ 20t ha^{-1} and Zn @ 5 mg kg^{-1} along with *Trichoderma* @ 2 kg ha^{-1} advisable to get better content and uptake of major as well as micro nutrients by leaves of spinach beet in Cd contaminated soil besides reducing significant content and uptake of Cd by leaves and root of spinach beet at harvest which positively reflected on higher yield.

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