International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(1): 1240-1244

Received: 07-11-2018
Accepted: 12-12-2018

MM Barvaliya
College of Agriculture, Navsari Agricultural Univeristy, Campus Bharuch, Gujarat, India

AP Italiya
College of Agriculture, Navsari Agricultural Univeristy, Campus Bharuch, Gujarat, India

KH Patel
College of Agriculture, Navsari Agricultural Univeristy, Campus Bharuch, Gujarat, India

TU Patel
College of Agriculture, Navsari Agricultural Univeristy, Campus Bharuch, Gujarat, India

NH Garaniya
College of Agriculture, Navsari Agricultural Univeristy, Campus Bharuch, Gujarat, India

Correspondence
MM Barvaliya
College of Agriculture, Navsari Agricultural Univeristy, Campus Bharuch, Gujarat, India

Effect of FYM, Zn and *Trichoderma* Spp. on growth, yield and quality of spinach beet grown in Cd contaminated soil

MM Barvaliya, AP Italiya, KH Patel, TU Patel and NH Garaniya

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}), 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}) using Factorial Complete Randomize Design with three repetitions. The experimental results revealed that plant height, number of leaves, leaf area, fresh weight of leaves during 1st, 2nd and 3rd cuttings and dry weight of root after 3rd cutting were significantly highest with treatment F_2 over F_1 and F_0 with a tune value of 20.14, 22.01 and 18.33 cm; 5.68, 6.04 and 7.33; 205.58, 201.52 and 230.71 cm^2; 122.79, 133.86 and 106.13 g pot^{-1}; 9.82 g pot^{-1}respectively. Similar trends in results with respect to growth and yield were found with application of Zn @ 5 mg kg^{-1}(Z_2) over Z_1 and Z_0. However, fresh weight of leaves was found significantly highest with application of *Trichoderma spp*. @ 2 kg ha-1 over T_0. The interaction effects F x Z during 1st and 2nd cutting in plant height and F x Z during 2nd cutting in leaf area was found significant. As per interaction effect F x Z is concerned, leaf area was significantly affected due to F_1Z_2 with a tune value of 220.12 cm^2, during 2nd cutting over rest of the F x Z combinations but statistically remain at par with F_1Z_1, F_2Z_1, F_0Z_2 and F_2Z_2. Significantly the highest content of fiber, nitrate and folic acid in leaves were found due to application of FYM @ 20 t ha^{-1} during the 1st, 2nd and 3rd cutting of spinach beet, however, significantly highest nitrate and folic acid content was recorded due to application of Zn @ 5.0 mg kg^{-1} during 1st, 2nd and 3rd cutting with a tune value of 34.72, 35.75, 35.41 ppm and 178.69, 179.21, 176.48 µg $100g^{-1}$, respectively.

Keywords: Spinach beet, FYM, Zn, *Trichoderma*, yield

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 fulfill 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. Cd is well known among all other highly toxic environmental element because of its higher toxicological properties and high mobility from soil to root to higher plant part and further down the food chain. Cd is considered as phytotoxic as it inhibits plant growth parameters including respiration, photosynthesis, water and nutrient uptake as well as reduces the rate of new cell production and root growth (Kau *et al.* 2006; Liu *et al.* 2004) [8]. Cd also inhibits the anti oxidative enzyme activities and induces oxidative stress in cells (Correa *et al.*, 2006; Sandalio *et al.*, 2001) [4, 13].
Farm yard manure can be a very effective amendment to reduce the accumulation of Cd and Pb in Amaranth and other crops growing on Cd and Pb contaminated soils. Application of Farm yard manure (FYM) significantly decreased Cd concentration (41 to 31%) in spinach plant grown on soil without heavy metal application and under contaminated soil conditions (Yassen *et al.*, 2007) [17].

A number of plant-associated microbes are free- living and strongly beneficial to plant. A fungus in the genus *Trichoderma spp*. can solubilize various plant nutrients, such as rock phosphate, Cu, Mn, Zn. Zinc acts in metallo-enzymes or cofactors for a large number of enzymes such as anhydrases, dehydrogenases, oxidase, peroxidases and plays an important role in regulating nitrogen metabolism and photosynthesis. Zinc fertilization inhibited Cd uptake by leafy vegetables from such limed soils with high Cd: Zn ratio (Chaney *et al.*, 2006) [2].

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

Growth and Yield: Growth parameters *viz*., plant height, number of leaves, leaf area, leaves fresh weight recorded during 1st, 2nd and 3rd cutting and dry root weight at harvest are presented in Table 1.

Plant height: The plant height, measured at first, second and third cutting of spinach beet which was significantly affected due to individual effect of different levels of FYM, *Trichoderma* and Zinc (Table 1). The plant height measured at 1st, 2nd and 3rd cuttings was significantly higher with treatment F_2 over F_1 and F_0 with a tune value of 20.14, 22.01 and 18.33 cm, respectively. In case of *Trichodermaspp*. application, plant height was significantly affected due to application of *Trichodermaspp*. (T_1) over control (T_0) during 1st and 2nd cutting except 3rd cutting. However, significant increase in magnitude of plant height was 3.47 and 5.28 per cent over T_0 during 1st and 2nd cutting, respectively. Among the three levels of Zinc, application of Zinc @ 5 mg kg^{-1}(Z_2) significantly influenced the plant height over Z_1 and Z_0 during 1st, 2nd and 3rd cutting. As per interaction effect F x Z is concerned, plant height was significantly affected due to F_2Z_2 with a tune value of 21.78 and 25.31 cm during 1st and 2nd cutting, respectively over rest of the F x Z combinations (Table 2).

Leaf Area: The data pertaining to leaf area found during the 1st, 2nd and 3rd cutting of spinach beet shown in table 1. The results revealed that leaf area recorded during 1st, 2nd and 3rd cutting was significantly affected due to different levels of FYM, *Trichoderma* and Zinc. The highest leaf area was significantly found due to application of FYM @ 20 t ha^{-1} over F_1 and F_0 during 1st, 2nd and 3rd cutting with a tune figure of 205.58, 201.52 and 230.71 cm^2 respectively. However, leaf area significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) except during 1st and 2nd cutting with the magnitude of significant increase in leaf area during 3rd cutting was 7.01 per cent over T_0. Significantly highest leaf area was recorded 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 205.91,201.52 and 230.71 cm^2 during 1st, 2nd and 3rd cutting, respectively. As per interaction effect F x Z (Table 2) is concerned, leaf area was significantly affected due to F_1Z_2 with a tune value of 220.12 cm^2, during 2nd cutting over rest of the F x Z combinations but statistically remain at par with F_1Z_1, F_2Z_1, F_0Z_2 and F_2Z_2.

Number of Leaves: The results (Table 1) revealed that significantly highest number of leaves was found due to application of FYM @ 20 t ha^{-1} over F_1 during 1st, 2nd and 3rd cutting with an increase in magnitude of number of leaves was 9.44, 20.08 and 11.57 per cent over F_0 during 1st, 2nd and 3rd cutting, respectively. However, number of leaves significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1}(T_1) over no application (T_0) except during 1st and 3rd cutting. However, the magnitude of significant increase in number of leaves during 2nd cutting was 7.32 per cent over T_0 with a tune value of 5.72. Significantly highest number of leaves was found due to application of Zinc @ 5 mg kg^{-1}(Z_2) with corresponding value of 5.75, 6.05 and 7.26 during 1st, 2nd and 3rdcutting, respectively over Z_1 and Z_0.

Fresh and dry weight of leaf: The fresh weight of leaves recorded during 1st, 2nd and 3rd cutting was significantly affected due to individual effect of FYM, *Trichoderma* and Zinc. The significantly highest fresh weight of leaves was found due to application of FYM @ 20 t ha^{-1} over F_1 and F_0 during 1st, 2nd and 3rd cutting with a tune figure of 122.79, 133.86 and 106.13 g pot^{-1}, respectively. In case of *Trichoderma spp.* T_1 recorded significant increased in magnitude of fresh weight of leaves were with a tune value of 4.45, 3.17 and 5.45 per cent over T_0 during 1st, 2nd and 3rd cutting, respectively. Among the different Zinc treatments, application of 5.0 mg kg^{-1}(Z_2) produced significantly higher fresh weight of leaves with corresponding values of 121.32, 112.86 and 104.84 g pot^{-1} during 1st, 2nd and 3rd cutting, respectively. As compared to control, the extent of increase in magnitude with Z_2 was 16.00, 10.43 and 16.79 per cent over Z_0, respectively.

Dry weight of root: The data pertaining to dry weight of root found after 3rd cutting of spinach beet shown in table 1. The data further revealed that dry weight of root recorded after 3rd cutting was significantly affected due to different levels of FYM except the levels of *Trichoderma* and Zinc. The highest dry weight of root was significantly found due to application of FYM @ 20 t ha^{-1} over F_0 after 3rd cutting with a tune figure of 9.82 g $pot^{-1}$and remain statistically at par with $F_1$with corresponding value of 9.21 g pot^{-1}.

Quality parameters of spinach beet

Quality parameters *viz*., content of fiber, nitrate and folic acid were recorded in leaves during 1st, 2nd and 3rd and results pertaining to quality parameter of spinach beet are presented in Table 3.

The data presented in table 3 revealed that fiber content did not differ significantly due to individual effect of different

levels of FYM, Trichoderma and Zinc during 1st, 2nd and 3rd cutting. The nitrate from leaves of spinach beet as significantly affected by different levels of FYM and Zinc during the 1st, 2nd and 3rd cutting of spinach beet. The significantly highest nitrate content was recorded with application of FYM @ 20 t ha^{-1} over F_1 and F0 during 1st, 2nd and 3rd cutting with a tune figure of 36.66, 36.93 and 36.91ppm, respectively. Among the different Zinc levels, application of zinc @ 5.0 mg kg-1 (Z_2) produced significantly higher nitrate content in leaves with corresponding values of 34.72, 35.75 and 35.41 ppm during 1st, 2nd and 3rd cutting, respectively and statistically remains at par with Z1 with a tune value of 34.59, 35.32 and 34.73 ppm, respectively.

The folic acid measured at 1st, 2nd and 3rd cuttings was significantly higher with treatment F2 over F1 and F0 with a tune value of 181.76, 179.96 and 177.07 µg 100g-1, respectively. The data further showed that F2 was statistically remaining at par with F1 with a tune value 178.46 and 174.33 µg 100g-1 during 1st and 3rd cutting, respectively. Among the three levels of Zinc, application of Zinc @ 5 mg kg-1(Z2) significantly influenced the folic acid content over Z1 and Z0 during 1st, 2nd and 3rd cutting. The significant increment in folic acid due to treatment Z2 during 1st, 2nd and 3rd cutting was 1.58, 1.96 and 4.78 percent over Z1, however, it remain at par with Z2 and 2.29, 3.61 and 3.33 per cent over Z0, respectively.

Discussion

Growth and Yield of Spinach beet

The plant height measured at 1st, 2nd and 3rd cutting was significantly higher with F_2 (20.14, 22.01 and 18.33 cm) as compared to F_1 (17.67, 18.41 and 17.36 cm), respectively. Here, F_2 recorded 13.98, 19.55 and 5.59 per cent higher plant height over the F_1, during 1st, 2nd and 3rd cutting, respectively. In the case of number of leaves, treatment F_2 registered significantly higher number of leaves of spinach beet (5.68, 6.04 and 7.33) over F_1 (5.38, 5.51 and 6.90) during 1st, 2nd and 3rd cutting, respectively. The leaf area was recorded at 1st, 2nd and 3rd cutting of spinach beet and an extent of increase in leaf area at 1st, 2nd and 3rd cutting of spinach with F_2 as compared to F_1 was 4.89, 1.46 and 11.81 per cent, respectively. The significant growth and yield response to increasing level of FYM may partly be due to the beneficial effect of organic manure, however, application of organic manure was useful not only in terms of nutrient supply but also improve physical and biological fertility of soil. This is in line with the report of Ajakaiye (1971) [1] that organic manure also improves soil physical and biological conditions. The obtained finding is in good harmony with Piramonti *et al.* (1997) [12]. Organic lettuce production reported that inorganic fertilizers resulted in lower yields compared to organic manures in lettuce production (Masarirambi *et al*., 2010; Maqueda *et al*., 2010) [11, 10]. Similar result was reported by Xu *et al.* (2005) [16] that vegetables grown with organic fertilizers grew better and resulted in a higher total yield than those grown with chemical fertilizers. Since chemical fertilizers do not Posses good characteristics of aggregating the soil particles. However, yield attributing characters *viz*., number of leaves and leaf area increased which resulted in increase in yield. The above results are in conformity with that of Jana *et al*. (1999) [7] in Palak.

The plant height, number of leaves and leaf area of spinach beet were significantly affected due to application of *Trichoderma* @ 2 kg ha^{-1} over the control (T_0) during 1st, 2nd and 3rd cutting of spinach beet (tables 1). Significantly highest plant height (18.50, 19.75 and 17.55 cm), number of leaves (5.49, 5.72 and 7.03) and leaf area (195.11, 192.61 and 211.68 cm^2) were recorded with treatment T_1 over T_0, during 1st, 2nd and 3rd cutting, respectively. In mark (2002) who stated that *T. harzianum* and other *Trichodermaspp*. Could increase in yield of plant about 36% when compared to the control. The reasons why the yield could increase that can be explained by Suwan *et al*. (2004) [15] who reported that *T. harzianum* could elucidate to produce trichotoxins promoting plants. *Trichoderma* are known to produce a number of antibiotics such as trichodermin, trichodermol, polyketides, peptaiboils, sesquterpenes and steroids. They are frequently associated with both biocontrol activity and promotion of plant and root growth (Chen *et al.*, 2006, Harman *et al*., 2004) [3, 6]

Like FYM and *Trichoderma*, the effects of Zinc levels were also found to be significant on the growth parameters *viz.*, plant height, number of leaves and leaf area during 1st, 2nd and 3rd cutting of spinach beet. The addition of Zn enhanced the DMY of spinach by reducing its content in the soil, thereby reducing its uptake. Similar results were also obtained by Singh and Nayyar (1994) [14] in corn; Sarkunan *et al.* (1996) in rice; Georgieva *et al.* (1997) [5] in radish, pea and peeper and wheat. Foliar application with yeast extract and Zinc treatments improved seed yield of faba bean plants due to increasing flower formation and the reduction of flowers and pod shedding as well as increasing their ability to accumulate more bio constituents.

However, the leaves fresh weight as well as root dry weight significantly affected due to different levels of FYM, *Trichoderma* and Zinc with similar trend was found as in case of growth parameters (Table 1). Here, significantly highest the leaves fresh weight of spinach beet was recorded in F_2 with a tune value of 122.79, 113.86, 106.13 g pot^{-1} during 1st, 2nd and 3rd cutting, respectively. Similar trend was observed in case of dry weight of root in case of different levels of FYM.

With respect to interaction effects are concern with respect of growth parameters, interaction F x Z found to be significant with respect to plant height during 1st and 2nd cutting as well as leaf area during 2nd cutting (Table 2). The results presented in table 2 revealed that significantly highest plant height was found with F_2Z_2 during 1st and 2nd cutting with a tune value of 21.78 and 25.31 cm, respectively than rest of the F x Z combinations. In case of leaf area the same interaction effect was found significant during 2nd cutting. However, F_1Z_2 recorded significantly highest leaf area with a corresponding value of 220.12 cm^2 and remain at par with F_0Z_2, F_1Z_1, F_2Z_1 and F_2Z_2.

Quality parameters

Response of applied of FYM, *Trichoderma* and Zinc to fiber, nitrate and folic acid content in leaves of spinach beet during 1st, 2nd and 3rd cutting are concern, it was found to be significant with an exception of fiber content in leaves during 1st, 2nd and 3rd cutting with different levels of FYM, *Trichoderma* and Zinc as well as nitrate and folic acid content during 1st, 2nd and 3rd cutting with the application of *Trichoderma*. However the highest content of fiber, nitrate and folic acid in leaves were found due to application of FYM @ 20 t ha^{-1} during the 1st, 2nd and 3rd cutting of spinach beet. In case of folic acid content the F2 was stastically remain at par with F_1 (174.22 µg $100g^{-1}$). The content of total carotenoids increased significantly with increasing levels of FYM and inorganic nitrogen. Increased carotenoids content could be assigned to elevation in the content and activity of chlorophyll and associated light absorbing pigments following

the application of FYM. Similar results were also reported by Dufault (1987).

The significantly highest nitrate and folic acid content was recorded due to application of Zn @ 5.0 mg kg^{-1} during 1st, 2nd and 3rd cutting with a tune value of 34.72, 35.75, 35.41 ppm and 178.69, 179.21, 176.48 µg $100g^{-1}$, respectively. In case of nitrate content, application of Z_2 during 1st, 2nd and 3rd cutting was statistically remain at par with Z_1 with a tune value of 34.59, 35.32 and 34.73 ppm, respectively. However, the folic acid content in Z_1 remain at par with Z_2. FYM significantly increased, while inorganic nitrogen tented to decrease vitamin C content besides increase the content of Fe and Zn in leaves of spinach beet this will results in increase the folic acid content in leaves of spinach beet. This may be due to the fact that the greater amount Fe in FYM which results in increase the synthesis of folic acid content in leaves (Salisbury and Ross, 1991).

Table 1: Effect of FYM, *Trichoderma* and Zinc on plant height, leaf area, number of leaves, leaves fresh weight and root dry weight of spinach beet

Treatment	Plant height (cm)			Leaf area (cm^2)			No of leaves			Leaves fresh weight (g pot^{-1})			Root dry weight (g pot^{-1})
	Cutting			cutting			Cutting			Cutting			At harvest
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	
FYM													
F_0	16.77	17.35	16.07	180.17	170.81	177.90	5.19	5.03	6.57	105.24	102.08	90.00	8.81
F_1	17.67	18.41	17.36	196.00	198.62	206.34	5.38	5.51	6.90	113.48	107.86	95.99	9.21
F_2	20.14	22.01	18.33	205.58	201.52	230.71	5.68	6.04	7.33	122.79	113.86	106.13	9.82
S.Em.±	0.20	0.27	0.29	1.80	3.40	3.74	0.08	0.08	0.09	1.79	1.00	1.32	0.22
C.D.@5%	0.58	0.79	0.82	5.17	9.74	10.74	0.24	0.22	0.25	5.13	2.88	3.77	0.63
Trichoderma													
T_0	17.88	18.76	16.96	192.72	188.01	198.09	5.35	5.33	6.84	111.36	106.25	94.79	9.16
T_1	18.50	19.75	17.55	195.11	192.61	211.88	5.49	5.72	7.03	116.31	109.62	99.96	9.40
S.Em.±	0.17	0.22	0.23	1.74	2.77	3.06	0.07	0.06	0.07	1.46	0.82	1.07	0.18
C.D.@5%	0.48	0.64	NS	NS	NS	8.77	NS	0.18	NS	4.19	2.35	3.08	NS
Zinc													
Z_0	16.85	17.47	16.08	166.12	158.22	178.34	5.08	5.10	6.59	104.59	102.20	89.77	9.08
Z_1	18.47	18.82	17.15	205.91	196.38	202.05	5.41	5.43	6.95	115.60	108.75	97.51	9.24
Z_2	19.25	21.48	18.53	209.72	216.35	234.57	5.75	6.05	7.26	121.32	112.86	104.84	9.53
S.Em.±	0.20	0.27	0.29	1.80	3.40	3.74	0.08	0.08	0.09	1.79	1.00	1.32	0.22
C.D.@5%	0.58	0.79	0.82	5.17	9.74	10.74	0.24	0.22	0.25	5.13	2.88	3.77	NS
C.V.%	4.76	6.04	7.02	3.94	7.57	7.75	6.51	5.95	5.23	6.67	3.94	5.73	9.98

Table 2: Effect of F x Z on plant height and leaf area of spinach beet

Interaction	Plant height (cm)						Leaf area(cm^2)		
	1st cutting			2nd cutting			2nd cutting		
FXZ	Z_0	Z_1	Z_2	Z_0	Z_1	Z_2	Z_0	Z_1	Z_2
F_0	15.93	16.88	17.48	16.12	16.82	19.12	141.32	160.88	210.23
F_1	16.69	17.82	18.49	16.89	18.32	20.02	162.35	213.38	220.12
F_2	17.93	20.69	21.78	19.39	21.34	25.31	170.98	214.87	218.70
Source	**S.Em.±**	**C.D.@5%**		**S.Em.±**	**C.D.@5%**		**S.Em.±**	**C.D.@5%**	
FXZ	**0.35**	**1.01**		**0.48**	**1.36**		**5.88**	**16.87**	

Table 3: Effect of FYM, *Trichoderma* and Zinc on leaf quality of spinach beet.

Treatment	Fibre content (%)			Nitrate (ppm)			Folic acid (µg $100g^{-1}$)		
	Cutting			cutting			Cutting		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
F_0	6.98	7.16	7.08	31.70	33.87	32.94	169.08	171.84	167.14
F_1	7.03	7.22	7.16	33.14	33.96	33.88	178.46	176.14	174.22
F_2	7.10	7.34	7.28	36.66	36.93	36.91	181.76	179.96	177.62
S.Em.±	0.06	0.06	0.06	0.72	0.47	0.48	1.10	0.68	1.19
C.D.@5%	NS	NS	NS	2.07	1.35	1.38	3.15	1.94	3.42
T_0	7.00	7.22	7.12	33.25	34.87	34.16	175.74	175.23	172.27
T_1	7.07	7.26	7.22	34.42	34.97	34.99	177.12	176.73	173.71
S.Em.±	0.05	0.05	0.05	0.59	0.39	0.39	0.90	0.55	0.97
C.D.@5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Z_0	6.95	7.18	7.11	32.18	33.69	33.59	174.69	172.96	170.80
Z_1	7.04	7.24	7.13	34.59	35.32	34.73	175.91	175.77	171.70
Z_2	7.12	7.30	7.27	34.72	35.75	35.41	178.69	179.21	176.48
S.Em.±	0.06	0.06	0.06	0.72	0.47	0.48	1.10	0.68	1.19
C.D.@5%	NS	NS	NS	2.07	1.35	1.38	3.15	1.94	3.42
C.V.%	3.61	3.55	3.68	9.05	5.73	5.89	2.64	1.63	2.93

Conclusion

Application of FYM @ 20t ha^{-1} and Zn @ 5 mg kg^{-1} along with trichodema @ 2 kg ha^{-1} advisable to get higher yield of spinach beet in Cd contaminated soil with better leaf quality of spinach beet.

References

1. Ajakaiye MB. Organic manure on vegetables. Samaru Agricultural Newsletter. 1971; 13:9-36.
2. Chaney RL, Filcheva E, Green CE, Brown SL. Zn deficiency promotes Cd accumulation by lettuce from biosolids amended soils with high Cd: Zn ratio. J Residual Sci. Technol. 2006; 3:68-75.
3. Chen I, Viterbo A, Brotman Y, Lousky T. Enhancement of plant disease resistance by biocontrol agent Trichoderma. Life Science, 2006. URL:http://www.weizmann.ac.il/.
4. Correa AD, Rorig R, Verdineli LR, Cotelle MA, Ferard S, Radetski CM. Cd phytotoxicity: quantative sensitivity relationships between classical end points and antioxidative enzyme biomarkers. Sci. total Environ. 2006; 357:120-127.
5. Georgieva V, Tasev C, Senalevitch G. Growth, yield, lead, Zn and Cd content of radish, pea and pepper plants as influenced by level of single and multiple contamination of soil. III Cd. Bulg. J Plant Physiol. 1997; 23:12-23.
6. Harman GE, Howell CR, Viterbo A, Chet I, Lorito M. *Trichoderma* species-opportunistic, av/irulent plant symbionts. Nat. Rev. Microbiol. 2004; 2:43-56.
7. Jana JC, Thapa U, Maity TK. Green and seed yield of alak as affected by nitrogen fertilizeration and cutting management. Veg. Sci. 1999; 26(1):61-63.
8. Kau CY, Wong RH, Lai JC, Lee H. accumulation of chromium and nickel metals in lung tumors from lung cancer patients in Taiwan. J Tox. Environ. Health. 2006; 69:1337-1344.
9. Lui WJ, Zhu YG, Smith FA, Smith SE. Do iron plaque and genotypes affect arsenate uptake and translocation by rice? J Exp. Bot. 2004; 55:1707-1713.
10. Maqueda C, Herencia JF, Raiz JC, Hidalgo MF. Organic and inorganic fertilization effects on DTPA- extractable Fe, Cu, Mn and Zn and their concentration in the edible portion of crops. J Agr. Sci. 2010; 149:461-472.
11. Masarirambi MT, Hlawe MM, Oseni OT, Sibiya TE. Effect of organic fertilizers on growth, yield quality and sensory evaluation of red lettuce 'VenezaRoxa'. Agriculture and Biology Journal of North America. 2010; 1(6):1319-1324.
12. Piramonti F, Stringari G, Zorzi G. Use of compost in soilless cultivation. Compost Science and Utilization. 1997; 5:38-46.
13. Sandalio LM, Dalurzo HC, Gomez M, Romero-Puertas MC. Del Rio LA. Cd-induced changes in the growth and oxidative metabolism of pea plants. J exp. Bot. 2001; 52:2115-2126.
14. Singh SP, Nayyar VK. Accumulation characteristics of cadmium in selected forage species. J Ind Soil Sci. 1994; 42:96-100.
15. Suwan S, Isobe M, Kanokmedhakul S, Lourit N, Kanokmedhakul K, Vassilev A. Cadmium- induced changes in chloroplast lipids and photosystem activities in barbey plants. Biologia Plantarum. 2004; 48:153.
16. Xu HL, Wang R, Xu RY, Mridha MAU, Goyal S. Yield and quality of leafy vegetables grown with organic fertilizations. Acta Horticulture. 2005; 627:25-33.
17. Yassen AA, Nadia BM, Zaghloul MS. Role of some organic residues as tools for reducing heavy metals hazards in plant. World Journal of Agricultural Sciences. 2007; 3(2):204-209.