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EFFECT FYM ON MITIGATING THE HAZARDOUS EFFECT OF ARSENIC ON, YIELD OF SPINACH AND AVAILABILITY OF ARSENIC

F.M. PRASAD, MEETU SINGH, PREETI PARASHAR, R. ARNOLD[1], M.R. THOMAS, C.S. NURA[2] AND S. PRASAD[3]

St. John's College, Dr. B.R.A.University, Agra - 282 002 (U.P.)

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ABSTRACT

A greenhouse experiment was conducted at Agra during winter seasonof to study the effect of FYM to minimize the hazardous effect of arsenic on spinach and availability of arsenic Results revealed that application of As at higher levels tremendously reduced the yield of spinch even in the presence of FYM indicating no effect of FYM on As toxicity at higher levels of As. Application of FYM responded well to enhance the N content in spinach but As addition did noy show any beneficial effect on N content in crop. Increasing levels of As increased P content significantly over no As addition.Potassium S and Zn content in spinach leaves increased significantly with the FYM levels but As application tended to reduce the contents of these elements significantly over control. Arsenic concentration in spinach crop increased with its application significantly and declined to great extent by addition of FYM. The higher doses of FYM were more effective in mitigating the adverse of As in spinach leaves. The available As in post harvest also reduced with the higher FYM levels.

Keywords: FYM, arsenic, yield spinach, available arsenic

INTRODUCTION

The presence of arsenic in soil is a threat to environment quality dueto toxic properties. Arsenic is highly hazardous to human and animal health. As small as 0.1 g of arsenic trioxide (As_2O_3) can prove lethal to humans (Smedley and Kinniburgh 2002). In recent years, the toxic effect of arsenic present in contaminated ground water used for drinking purpose in several parts of the world (Mandel *et al*. 1996, Sanyal, 2005). Very little work has been done to explore the influence of arsenic contaminated ground water used as irrigation source on soil, crop system. Thus, the danger of entry of arsenic into the food chain along with its possible biomagnifications through crop uptake deserves urgent research attention. It has been realized that organic manure must also be a part of manual schedule to maintain the productivity of soils. Organic manure application in soil play a vital role in maintenance of physiochemical, biological and biochemical properties of soil beside supplementing macro and micronutrients. Water holding capacity of soil is also increased by organic matter. Organic matter serves as a reservoir of nutrients that are essential for plant growth, upon decomposition it produces organic acids and carbon dioxide, which helps to dissolve minerals and makes them more available to growing plants. Meager information is available on the response of organic matter (FYM) to mitigate the adverse effect of arsenic yield and absorption of nutrients in spinach crop. The present study was therefore, conducted to evaluate the effect of FYM in mitigating the adverse effect of arsenic on yield of spinach arsenic.

MATERIAL AND METHOD

A green house experiment was conducted during the winter season of 2008 at green house of Department of Chemistry, St. John's College Agra in order to see effect of organic matter (FYM) to mitigate the adverse effect of arsenic on foliage yield of spinach and availability of nutrients. The soil had pH 8.3, organic carbon 3.1 g kg^{-1}, available N 125 kg^{-1}, available P 12.0 kg^{-1}, available K 115.0 kg hac^{-1}, available S 8.5 (mg kg^{-1}), available Zn 0.55 mg kg^{-1} and available As 0.29 mg kg^{-1}. The treatments consisted four levels of FYM 0, 0.5, 1.0 and 2.0 percent and four levels of Arsenic (0.20, 40 and 80 mg kg^{-1}) were laid out in complete randomized block design with three replications. The whole amount of FYM as per treatment was applied in the soil used. The earthern pots with polythene lining were filled with 10 kg soil each. Recommended doses of fertilizers were applied and 10 seeds of spinach were sown on 15 Oct. 2010 and thinnes to six plants after germination. The plants were irrigated with water. The crop was grown upto 45 days and yield data for fresh leaf and dry matter were recorded. These plants samples were analyzed for nitrogen. The Arsenic was determined in plant leaves by AAS coupled with hydride generator.

RESULTS AND DISCUSSION

Yield

Data (Table 1) indicated that application of FYM reduced the toxic effect of lower levels of arsenic and increased the yield of green foliage of spinach over control. But application of FYM failed to prevent the toxic effect 0 K 40 and 80 mg kg^{-1} applied arsenic on spinach production. The higher levels of FYM were more effective in reducing the adverse effecf of As at each level than that of its lower doses as evident from significant interaction. The green foliage yield was not affected significantly with 20 mg As kg^{-1} level but higher levels of As (40

1. *Government Science College, Rewa (M.P.)*
2. *SHIATS, Allalabad (U.P.)*
3. *Prentiss Girl's College Etah (U.P.)*

and 80 mg kg^{-1}) reduced the green foliage yield of spinach significantly even in the presence of FYM over control. The maximum green foliage of spinach was recorded at 2% FYM + no As treatment. These results are in close conformity with the findings of Mukhopadhyay *et al.* (2002).

Table 1: Interactive effect of arsenic and FYM levels on green foliage yield of spinach (g/ pot)

As level (mg kg^{-1})	FYM levels (%)				Mean
	0.0	0.5	1.0	2.0	
0	8.55	9.63	11.25	12.05	10.37
20	8.00	9.10	11.00	12.00	10.02
40	6.00	7.50	9.00	10.75	8.31
80	2.90	4.00	6.50	7.90	5.32
Mean	6.36	7.56	9.44	10.67	
CD (P= 0.05)	As 0.64		FYM 0.64	As x FYM 1.28	

Composition of spinach leaves

Nitrogen: The nitrogen content of spinach leaves increased upto 20 mg kg^{-1} of arsenic level thereafter declined at 40 and 80 mg As kg^{-1} as compared to control. The magnitude of decline in N content was due to increasing concentration of As levels indicating an antagonistic effect on N absorption by plants. The minimum value of N content in spinach leaves was noted at 80 mg As kg^{-1}. The highest value of N content was noted with 2% FYM level. The N content in spinach leaves enhanced from 2.09% at no FYM to 2.58% with 2% FYM level. The increasing N content with addition of FYM may be attributed to increased availability of N in soil. Similar finding were also observed by Jain and Tiwari (2001).

Phosphorus: Data (Table 2) indicated that phosphorus content in spinach leaves increased with the rise in arsenic levels upto 80 mg kg^{-1}. This increase in P content in spinach leaves due to As addition may be attributed to competitive interactions of P and As (Melamad *et al.*1995). On an average, FYM also intereased the P content of spinach leaves significantly over control. The higher levels of FYM were more effective in iproving the P content in spinach leaves as compared to lower levels Mullins. The P content in spinach leaves enhanced from 0.37% at No FYM to 0.51% with 2% FYM.

Potassium: Data (Table 2) reveal that the application of As tended to decrease the level of K in leaves of soinach. On an average arsenic application had a detrimental effect on the K content of the leaves and the lowest value of K, content was recorded at the highest dose of As (80 mg kg^{-1}). On the contrary, FYM application had a beneficial effect on the concentration of K in leaves. The K content in leaves increased from 1.75% at control to the extent of 1.96% at 2% levels of FYM. All the levels of FYM proved significantly superior over control in respect of K content in spinach leaves. This increased in K content may be due to increased availability of K in soil with FYM addition. The interaction effect of As and FYM on K content was non-significant.

Table 2: Effect of arsenic and FYM levels on nutrient content in spinach level

Treatment	Nitrofen (%)	Phosphorus (%)	Potassium (%)	Sulphur (%)	Zinc	Arsenic
Arsenic (mg kg^{-1})						
0	2.37	0.42	1.93	0.37	32.3	0.39
20	2.40	0.43	1.90	0.35	30.3	6.04
40	2.33	0.44	1.82	0.32	26.9	10.88
80	2.28	0.46	1.76	0.29	23.4	15.09
CD (P= 0.05)	0.49	NS	0.14	0.03	2.84	0.43
FYM (%)						
0	0.09	0.37	1.75	0.28	24.9	8.47
20	2.29	0.42	1.81	0.31	27.2	8.25
40	2.43	0.46	1.90	0.35	29.4	8.03
80	2.58	0.51	1.96	0.39	31.4	7.54
CD (P= 0.05)	0.49	0.05	0.14	0.03	2.84	0.43

Sulphur: The application of arsenic tended to decrease the content of sulphur in spinach leaves over untreated crop. The magnitude of decrease was greater at higher levels of As than that of its lower level. Sulphur content in spinach leaves decreased from 0.37% to 0.29% at 80 mg As kg^{-1}. FYM application enhanced the S content of spinach leaves and the maximum value of S content (0.39%) was recorded at 2% FYM levels. The interaction of As and FYM did not influence the S content in leaves significantly.

Table 3: Interaction effect of arsenic and FYM levels on arsenic content (mg kg^{-1}) in spinach level

As level (mg kg^{-1})	FYM levels (%)			
	0.0	0.5	1.0	2.0
0	0.45	0.42	0.39	0.32
20	6.05	6.00	5.90	5.78
40	11.50	11.10	10.88	10.05
80	15.90	15.50	14.95	14.00
CD (P= 0.05)				0.86

Zinc: Table 2 contains data on zinc content of spinach leaves.As application reduced the zinc content in leaves of spinach having a minimum value of Zn content (23.4 mg kg^{-1}) at 80 mg kg^{-1}. The result showed that As addition had an antagonistic effect on Zn absorption by the plants. Zinc content in spinach leaves increased significantly with the application of FYM over No FYM treatment. The interactive effect of As and FYM on zinc content in leaves was non significant.

Table 4: Interaction effect of arsenic and FYM levels on arsenic content (mg kg^{-1}) in post harvest

As level (mg kg^{-1})	FYM levels (%)			
	0.0	**0.5**	**1.0**	**2.0**
0	0.26	0.26	0.24	0.20
20	1.98	1.94	1.89	1.68
40	4.92	4.88	4.52	3.95
80	12.86	12.0	11.15	10.00
Mean	5.00	4.77	4.45	3.96
CD (P=0.05)	As 0.78		FYM 0.78	As x FYM 1.56

Arsenic: Data indicated that there was a gradual and significant increase of As content in spinach leaves with its increasing levels. The application of 80 mg As kg^{-1}increased the As content to the greater extent. Application of FYM, on the other hand tended to decrease the As content in leaves of spinach over No FYM. This reduction in As content in leaves with FYM levels was statistically significant over untreated crop. Arsenic content in spinach leaves reduced to the extent of 8.47 mg kg^{-1} at No FYM and 7.54 mg kg^{-1} observed with 2% FYM addition. The interaction effect between As and FYM was found significant.

Available As

The extractable As content was found to be higher in the soil with the addition of As irrespective of FYM addition (Table 4). The magnitude of increase was greater at its higher levels. Amount of arsenic increased from 0.24 mg kg^{-1} at control to 17.50 mg kg^{-1} with /0 mg As kg^{-1} application. Naik *et al.* (2010) also reported an increase in arsenic content in soil with its addition. Application of FYM tended to reduce the content of arsenic from 5.00 to 3.96 mg kg^{-1} with 2% level. FYM application led to significant reduction in arsenic release into the soil solution after harvest of spinach crop. This suggests that FYM tends to serve as a binding agent in holding As to the soil matrix. These results are in accordance with the findings of Mukhopdhyay *et al.* (2002) who reported on the sorption of As (As 111 and V) by humic soil. The humic soil was observed to act as a anion exchanger in which the basic anion functional group seems to be involved in retaining the acid group. Mukhopadhyay *et al.* (2002) and Das *et al.* (2014) reported thatFYM addition to soil helps to mitigate As toxicity in plants. Interaction effect of FYM and As on As availability in soil was found to be significant.

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