J. Sci. Technol. (Dinajpur) Vol. 7: pp--- (2009)
ISSN 1994-0386

PERFORMANCE OF RED AMARANTH ON DIFFERENT INDUSTRIALLY POLLUTED SOIL

R.A. Begum[1], A.T. M.A.I. Mondol[2], M.N. Rahman[3], M.S. Islam[4] and R. Sen[2]

ABSTRACT

A pot experiments was conducted at BARI green house for two consecutive years (2001-2002) to study the performance of red amaranth. The soil used in this experiment was collected from eight industrial zone of Maona and Mouchak areas. The control (fresh) soil was collected from Mouchak area. The experiment was laid out in a completely randomized design (CRD) with three replications. Nine treatments were used in this study which were: T_1=Fresh soil, T_2=Soil polluted by Sunipon Pharmaceutical's waste water, T_3=Soil polluted by Rahim Textile's waste water, T_4=Soil polluted by Aymen Textile's waste water, T_5=Soil polluted by Shamim Textile's waste water, T_6=Soil polluted by Hydroxide Textile's waste water, T_7=Soil polluted by Apex Tannery's waste water, T_8=Soil polluted by Gomoti Textile's waste water and T_9=Soil polluted by Devine Textile's waste water. Among the nine only fresh soil showed the highest performance of red amaranth. The soils of Sunipon Pharmaceutical, Hydroxide Limited and Apex Tannery areas were highly polluted by heavy metal and red amaranth could not survive there. The order of red amaranth yield was: Gomoti Textile > Divine Textile > Ayman Textile > Rahim Textile > Shamim Textile.

***Key words**: Industrial Polluted soil, Textile'waste water, Pharmaceutical'waste water Tannery's waste water, and Red amaranth* growth

INTRODUCTION

Industrial pollution is a serious problem throughout the developing countries like Bangladesh. Rapid industrialization and indiscriminate use of wastes are the mater of concern for agricultural land. Industrial effluents like sewages, sludge's, dyeing by products, ternary wastes, pesticides and other various agro-chemicals are loading nearest water bodies of the industrial areas. These effluents contain toxic metals like Pb, Cd, Cr, Cu and Hg and increasing day by day. Metals cannot be destroyed or degraded by any process but are adsorbed by the soil clay and humus. Due to lack of irrigation water farmers are bound to use this polluted water for crop production. The uptake of heavy metals by plants from contaminated soils is of great concern because an excess of dietary intake of some of these heavy metals (e.g., Pb and Cd) might be hazardous to consumers. These metals even in trace amounts destroy enzymes of living cells (Rahman, 1993) and hence their discharge into the environment must be carefully controlled and minimized. Expansion of industries in many areas of the country and unplanned disposal of industrial wastes loaded with heavy metals and other chemicals are polluting our agricultural fields and water bodies. This in turn, directly or indirectly is affecting the soil and crop productivity and quality of agricultural products because Cadmium, arsenic, chromium, and mercury are extremely poisonous (Hellawell, 1986). Their uptake and accumulation in plant have been known to result in negative effects on plant growth (Breekle and Kahle, 1992; Trivedi and Erdei, 1992). Heavy metals may cause inhibition of plant growth by affecting different plant processes, i.e., photosynthesis (Becenrill *et al*., 1988), respiration, carbohydrate metabolism (Greger and Lindberg, 1986) and water relations (Becenrill *et al*., 1989). Farmers of different areas of Bangladesh cultivate rice around vicinity of different industries, which discharge effluents directly to the rice field. The nature and extent of damage caused by these toxic effluents are very alarming. Germination, root initiation, rate of root growth, stem growth, panicle emergence, filling of rice grain etc. are said to be greatly affected by industrial effluent (Nuruzzaman *et al.*, 1992). A systematic research work has not yet been done on soil under industrial area and its impact on crop production.

Principle Scientific Officer[1], Senior Scientific Officer[2], Scientific Officer[4], Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur, Assistant Professor[3], Department of Soil Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur

The present study was under taken using the polluted soils collected from and designed considering the farmer's field situated at Maona of Sreepur and Mouchak of Kaliakair of Gazipur district and conducted in the green house of Soil Science Division, Bangladesh Agriculture Research Institute (BARI), Gazipur, Bangladesh. The objective of the study was to study the growth and yield of red amaranth using industrial polluted soil.

MATERIALS AND METHODS

A Pot experiment was conducted at BARI greenhouse for two consecutive years (2001-2002) to study the performance of red amaranth on eight polluted soils with a control (fresh) soil. The soil used in this experiment was collected from eight spots of polluted industrial zone of Maona and Mouchak areas. The control (fresh) soil was collected from Mouchak area. Moreover, eight industrially polluted soils were also collected from those areas. The chemical properties of the experimental soils are presented in Table-1, 2, 3 and 4. The experiment was laid out in a completely randomized design (CRD) with three replications. Nine treatments were used in this study which were T_1=Fresh soil, T_2=Soil polluted by Sunipon Pharmaceutical's waste water, T_3=Soil polluted by Rahim Textile's waste water, T_4=Soil polluted by Aymen Textile's waste water, T_5=Soil polluted by Shamim Textile's waste water, T_6=Soil polluted by Hydroxide Textile's waste water, T_7=Soil polluted by Apex Tannery's waste water, T_8=Soil polluted by Gomoti Textile's waste water and T_9=Soil polluted by Devine Textile's waste water. Each treatment consists of three pots accommodating forty plants in each pot. Three pots for each treatment were treated as three replications since numbers of treatments were nine. Therefore, the total number of pots was 27. The red amaranth cv. BARI Lalshak-1was used in this experiment was.

Irrigation and other intercultural operations were done as and when necessary. Thirty five days after sowing, Lalshak (Red Amaranth) was harvested. The following data were collected: Number of plants pot^{-1}, Plant height, Stem diameter, Number of leaves plant^{-1} and 10 plant weight Yield pot^{-1} and were subjected to statistical analysis i.e., analysis of variance (ANOVA). Mean separation was done following DMRT (Steel and Torii, 1960).

Table 1. Physical characteristics of the experimental soil of Maona

Soil depth (cm)	Soil separates (%)			Soil Texture	Bulk density (g/cm^3)	Particle density (g/cm^3)	Soil water content (cm)		
	Sand	Silt	Clay				Field capacity	Wilting point	Av. water
0-10	13.2	43.8	43.0	Silty Clay	1.42	2.55	6.22	2.30	3.90
11-20	11.0	42.5	46.5	Silty Clay	1.48	2.59	6.51	2.35	4.16
21-30	10 5	40.0	49.5	Silty Clay	1.52	2.61	6.94	2.41	4.53
31-40	9.8	42.2	48.0	Silty Clay	1.59	2.63	7.30	2.46	4.84
41-50	6.0	56.0	38.0	Silty Clay	1.62	2.66	7.42	2.71	4.71
51-60	6.2	53.8	40.0	Silty Clay	1.68	2.70	7.81	2.78	5.03

Table 2. Physical characteristics of the experimental soil of Mouchak

Soil depth (cm)	Soil separates (%)			Soil Texture	Bulk density (g/cm^3)	Particle density (g/cm^3)	Soil water content (cm)		
	Sand	Silt	Clay				Field capacity	Wilting point	Average water
0-10	12.5	41.8	45.7	Silty Clay	1.38	2.53	6.45	2.29	4.16
11-20	11.0	42.6	46.4	Silty Clay	1.46	2.57	6.61	2.42	4.19
21-30	9.8	41.6	48.6	Silty Clay	1.48	2.61	6.92	2.58	4.34
31-40	9.5	42.3	50.2	Silty Clay	1.51	2.65	7.31	2.64	4.67
41-50	8.0	56.2	35.8	Silty Clay	1.56	2.68	7.44	2.70	4.74
51-60	11.0	54.8	34.2	Silty Clay	1.64	2.70	7.60	2.72	4.88

Table 3. Chemical constituents like pH, EC, OM, N, P, K and Na of soil samples collected from different industrial areas

Sample No.	pH	EC (µS cm^{-1})	OM (%)	Total N (%)	Available P (mg/kg)	Total K (me/100g)	Total Na (me/100g)	Ca (me/100g)	Mg (me/100g)	S (mg/kg)	Zn (mg/kg)
1	7.31	1267	1.76	0.37	34	4.06	9.86	9.59	7.13	111	107
2	6.55	852	1.61	0.26	27	2.47	5.73	6.11	5.66	74	80
3	5.42	806	1.36	0.24	23	2.49	5.68	5.48	5.17	71	78
4	6.81	891	1.68	0.29	28	2.56	5.78	6.16	5.83	73	83
5	6.22	649	1.32	0.23	19	2.12	4.50	5.61	4.76	75	64
6	6.30	1018	1.87	0.30	28	4.48	8.07	9.02	9.19	95	96
7	5.81	756	1.67	0.23	22	2.31	5.50	5.30	4.73	67	75
8	7.13	737	1.61	0.21	21	2.11	5.19	5.88	4.83	67	78
Min.	5.42	649	1.32	0.21	19	2.11	4.50	5.30	4.73	67	64
Max.	7.31	1267	1.87	0.37	34	4.48	9.86	9.59	9.19	111	107

Note: 1. Sunipon Pharmacutical Industry, Molaid, Maona, 2. Rahim Textiles, Mouchak , Safipur, 3. Ayman Textile and hossiary, Chandura , 4. Shamim Textiles, Mouchak , Safipur,5. Hydroxide Ltd., Mouchak, 6. Apex Tennary, Mouchak, Safipur, 7. Gomoti Textiles, Chandura , 8. Devine textile, Chandura

Table 4. Chemical constituents (B, Fe and Cu Mn, As, Pb, Cr, Co, Ni and Cd) of soil samples from different industrial areas

Sample No.	B (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Total Mn (mg/kg)	Total As (mg/kg)	Total Pb (mg/kg)	Total Cr (mg/kg)	Total Co (mg/kg)	Total Ni (mg/kg)	Total Cd (mg/kg)
1	1.86	154.82	198	255	22.6	113	363	94	109	6.6
2	1.98	109.82	191	189	19.4	74	879	89	92	2.6
3	1.45	96.31	179	181	16.8	69	511	76	78	2.5
4	1.38	91.28	187	176	16.4	55	501	71	74	2.4
5	1.24	88.47	189	172	15.9	45	526	65	71	2.4
6	1.29	86.86	185	169	15.4	44	517	60	67	2.1
7	1.24	84.49	181	165	15.0	48	514	58	66	2.0
8	1.16	73.82	170	133	14.4	36	266	48	52	1.5
Min.	1.16	73.82	170	133	14.4	36	266	48	52	1.5
Max.	1.98	154.82	198	255	22.6	113	879	94	109	6.6

Note: 1. Sunipon Pharmacutical Industry, Molaid, Maona, 2. Rahim Textiles, Mouchak , Safipur, 3. Ayman Textile and hossiary, Chandura, 4. Shamim Textiles, Mouchak , Safipur,5. Hydroxide Ltd., Mouchak, 6. Apex Tennary, Mouchak, Safipur, 7. Gomoti Textiles, Chandura, 8. Devine textile, Chandura

RESULTS AND DISCUSSION

Performance of red amaranth (number of plants pot^{-1}, plant height, stem diameter and number of leaves $plant^{-1}$) on different industrially polluted soil are presented in Table 5 and discussed below:

Number of plants pot^{-1}: Polluted soil had remarkable effect on the performance of red amaranth. Highest number of plants (76 in 2001 and 88 in 2002) was observed in control (fresh) soil. After maintaining proper spacing control (fresh) soil contained 40 plants in both the years. Number of amaranth plant grown on five moderately polluted soil are in following order: Gomoti Textile (34.33 in 2001 and 33.67 in 2002) >Divine Textile (31.67 in 2001 and 30.33 in 2002) >Aymen Textile (29.33 in 2001 and 25.67 in 2002) >Rahim Textile (23.00 in 2001 and 19.67 in 2002)> Shamim Textile (18.00 in 2001 and 15.33 in 2002). Red amaranth could not survive on three extremely polluted soils namely Sunipon Pharmaceuticals, Hydroxide Limited and Apex Tannery due to contained higher amount of Pb, Cr, Cu, As, Mn, Ni and Co toxic elements. The above toxic elements exerted toxic effect on red amaranth which was supported by Nuruzzaman *et al.*, (1992) that germination, root initiation & rate of root growth greatly hampered by industrial polluted soil.

Plant height: Plant height of red amaranth was significantly influenced by different polluted soils. Highest plant height (27.27 cm in 2001 and 24.47 cm in 2002) was obtained from control (fresh) soil. Plant heights of red amaranth on five moderately polluted soils are in the following order: Gomoti Textile (8.93 cm in 2001 and 8.43 cm in 2002) > Divine Textile (8.07 cm in 2001 and 7.57 cm in 2002) > Rahim Textile (7.13 cm in 2001 and 7.30 cm in 2002) >Aymen Textile (7.43 cm in 2001 and 6.83 cm in 2002) >Shamim Textile (7.83 cm in 2001 and 6.67 cm in 2002). Red amaranth failed to grow on three extremely polluted soils namely; Sunipon Pharmaceuticals, Hydroxide Limited and Apex Tannery.

Stem diameter: Stem diameter of red amaranth was significantly influenced by different polluted soil. Highest stem diameter (1.61 cm in 2001 and 1.53 cm in 2002) was obtained in control (fresh) soil. Stem diameter of red amaranth grown on five moderately polluted soils was in the following order: Gomoti Textile (1.29 cm in 2001 and 1.21 cm in 2002) > Divine Textile (1.22 cm in 2001 and 1.15 cm in 2002) >Aymen Textile (1.16 cm in 2001 and 1.10 cm in 2002) >Rahim Textile (1.06 cm in 2001 and 1.02 cm in 2002) >Shamim Textile (1.00 cm in 2001 and 0.92 cm in 2002). Red amaranth failed to grow on three extremely polluted soils namely; Sunipon Pharmaceuticals, Hydroxide Textiles and Apex Tannery. Root initiation, rate of root growth, stem growth, are said to be greatly affected by industrial polluted soils (Nuruzzaman *et al.*, 1992).

Number of leaves $plant^{-1}$: Number of leaves $plant^{-1}$ of red amaranth was significantly influenced by different polluted soils. Highest number of leaves $plant^{-1}$ (8.23 in 2001 and 7.77 in 2002) was obtained in control (fresh) soil. Number of leaves $plant^{-1}$ of red amaranth grown on five moderately polluted soils is in the following order: Gomoti Textile (6.13 in 2001 and 5.57 in 2002) >Divine Textile (5.73 in 2001 and 5.37 in 2002) >Aymen Textile (5.27 in 2001 and 4.97 in 2002) >Rahim Textile (4.73 in 2001 and 4.43 in 2002) >Shamim Textile (4.50 in 2001 and 4.23 in 2002). Red amaranth failed to produce any leaves on three extremely polluted soils namely Sunipon Pharmaceuticals, Hydroxide Textiles, Apex Tannery.

Ten plants weight: Ten plants fresh weight of red amaranth was significantly influenced by different polluted soils. Maximum ten plant weight (87.67 g in 2001 and 83.00 g in 2002) was (Table 6) obtained in control (fresh) soil. Ten-plant weight of red amaranth grown on five moderately polluted soils is in the following order: Gomoti Textile (55.33 g in 2001 and 54.33 g in 2002) > Divine Textile (51.33 g in 2001 and 48.33 in 2002) > Aymen Textile (45.00 g in 2001 and 42.67 g in 2002) > Rahim Textile (39.00 g in 2001 and 37.33 g in 2002) > Shamim Textile (35.33 g in 2001 and 33.33 g in2002). Red amaranth failed to grow on three extremely polluted soils namely Sunipon Pharmaceuticals, Hydroxide Textiles and Apex Tannery. Heavy metals may cause inhibition of plant growth by affecting different plant processes, i.e., photosynthesis(Becenrill *et al.*, 1988), respiration, carbohydrate metabolism (Greger and Lindberg, 1986).

Table 5. Performance of red amaranth on different industrially polluted soil

Treatment	No. of plants pot^{-1}		Plant height (cm)		Stem diameter (cm)		No. of leaves $plant^{-1}$	
	2001	2002	2001	2002	2001	2002	2001	2002
Control soil	40.00a	40.00a	27.27a	24.47a	1.61a	5.13a	8.23a	7.77a
Sunipon Phar.	-	-	-	-	-	-	-	-
Rahim Textile	23.00c	19.67de	7.13b	7.30b	1.06bc	1.02bc	4.73d	4.43bc
Aymen Textile	29.33b	25.67cd	7.43b	6.83b	1.16bc	1.10bc	5.27cd	4.49bc
Shamim Textile	18.00c	15.33e	7.83b	6.67b	1.00c	0.92c	4.50d	4.23c
Hydroxide Textile	-	-	-	-	-	-	-	-
Apex Tannery	-	-	-	-	-	-	-	-
Gomoti Textile	34.33b	33.67b	8.93b	8.43b	1.29b	1.21b	6.13b	5.57d
Devine Textile	31.67b	30.33bc	8.07b	7.57b	1.22bc	1.15bc	5.73bc	5.37b
F-test	**	**	**	**	**	**	**	**
LSD	8.01	8.76	4.34	4.39	0.33	0.34	1.13	1.24
CV (%)	10.5	12.3	15.1	16.6	10.5	11.4	7.6	8.9

Table 6. Performance of red amaranth on different industrially polluted soil

Treatment	10 plant weight (g)		Yield pot^{-1} (g)			
	2001	2002	2001	% decrease	2002	% decrease
Control soil	87.67a	83.00a	329.67a	-	318.33a	-
Sunipon Pharma.	-	-	-	-	-	-
Rahim Textile	39.00de	37.33cd	80.00d	75.73	71.33d	77.59
Aymen Textile	45.00cd	42.67cd	113.00c	65.72	96.33c	69.74
Shamim Textile	35.33e	33.33d	58.67e	82.20	45.33e	85.76
Hydroxide Textile	-	-	-	-	-	-
Apex Tannery	-	-	-	-	-	-
Gomoti Textile	55.33b	54.33b	158.00b	52.07	153.60b	51.94
Divine Textile	51.33bc	48.33bc	143.00b	56.62	136.00b	57.28
F-test	*	*	*	-	*	-
LSD	7.73	10.86	17.25	-	17.42	-
CV %	8.1	12.0	6.4	-	7.0	-

Yield pot^{-1}

Yield pot^{-1} of fresh red amaranth was significantly influenced by different polluted soils. Maximum yield pot^{-1} (329.67 g in 2001 and 318.33 g in 2002) was recorded (Table 6) in control (fresh) soil. Yield pot^{-1} of red amaranth grown on five moderately polluted soils is in the following the order: Gomoti Textile (158.00 g in 2001 and 153.00 g in 2002) > Divine Textile (143.00 g in 2001 and 136.00 g in 2002) > Ayman Textile (113.00 g in 2001 and 96.33 g in 2002) > Rahim

Textile (80.00 g in 2001 and 71.33 g in 2002) > Shamim Textile (58.67 g in 2001 and 45.33 g in 2002). In contrast to fresh soil, yield pot^{-1} of red amaranth decreased in the following order: Gomoti Textile (52.07 % in 2001 and 51.94 % in 2002) < Divine Textile (56.62 % in 2001 and 57.28 % in 2002) < Aymen Textile (65.72 % in 2001 and 69.74 % in 2002) < Rahim Textile 75.73 % in 2001 and 77.59 % in 2002) < Shamim Textile (82.20 % in 2001 and 85.76 % in 2002).

The soils which were collected from the pharmaceutical and textiles industries led to nutrient imbalances on the growth of red amaranth. The excessive enrichment of the elements N, Zn, Pb, Cr, Cu, As, Mn, Ni and Co creates eutrophication and decrease the quality of soil water. The pharmaceutical site has created some problems with organics in soil and water bodies. The high level of some elements adversely affected red amaranth during its establishment. The effluent produced from the Sunipun Pharmaceutical specially producing raw materials for antibiotics are rich in inorganic nutrients such as N, K, and very rich in total organic carbon. The present findings correlates with the findings of Grunhage and Jager, (1985) where they stated maximum amount of heavy metals (Cu, Co, Cd, Zn, Ni and Cr) were absorbed in the leaves, stems and roots of red amaranth grow and depressed the growth and yield.

CONCLUSION

Three extremely polluted soils collected from of Sunipon Pharmaceutical, Hydroxide Limited and Apex Tannery area showed adverse effect on the growth of red amaranth. Red amaranth grows partially on five moderately polluted soils in the following order: Gomoti Textile > Divine Textile > Ayman Textile > Rahim Textile > Shamim Textile. To the conclude, soils should be treated for the better crop production and to maintain crop health.

REFERENCES

Becenrill JM, Gonzales-Ruedes A, Gonzales-Murua C and De Felipe MR. 1989. Changes induced by cadmium and lead in gas exchange and water. Biochem. 27: 913-918.

Becenrill JM, Munoz-Rueda A, Aparicio-Tejo P and Gonzales-Murua C. 1988. The effects of cadmium and lead on photosynthetic electron transport in clover and lucerne, Plant Physiol. Biochem. 26(3): 357-363.

Breekle SW and Kahle H. 1992. Effect of toxic heavy metals (Cd, Pb) on growth and mineral nutrition of bean (*Fagus sylvatical*) Vegetatio. 101: 43-53.

Greger M and Lindberg S. 1986. Effects of Cd^{2+} and DTPA on young sugar beets (*Beta vulgaris*), I. Cd^2+ uptake and sugar accumulation, Physiol Plant. 66: 69-74.

Grunhage L and Jager H. 1985. Effect of heavy metals on growth and heavy metal content of *Allium porrum* and *Pisum sativum*. Angew Botanik. 59: 11-27.

Hellawell JM. 1986. Biological indicators of freshwater pollution and environmental management, Elsvier Applied Science Publisher, London.

Nuruzzaman M, Ullah SM, Islam A, Rahman S and Rashid H. 1992. Effects of industrial waste on soil properties and crop growth. Regional workshop on "Environmental impacts from fertilizers, Agrochemicals and industrial wastes. Under the project Chemcial *Research and Environmental Needs* (REN)".

Rahman MM. 1993. Irrigation water quality and its impact on the physico chemical parameters of Shahzadpur soil. M.Sc. (Ag.) thesis, Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensigh.

Steel RCB and Torii JH, 1960. Principles and procedures of statistics, Mc Graw Hall Book, New York. U. S. A. pp. 377-398.

Trivedi S and Erdei L. 1992. Effects of cadmium and lead on the accumulation of Ca^{2+} and K^+ and on the influx and translocation of K^+ status. Physiol Plant. 84: 94-100.