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Effect of Cement Dust Deposition on Heavy Metal Content of Soil Around Cement Industry in Guntur District of Andhra Pradesh

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ABSTRACT

A study was conducted to investigate the concentration of heavy metals in soil around the cement industry in Satrasala village, near Macherla in Guntur district. A total of 160 soil samples were collected during the months of August (Before sowing of crop) and December (After harvest of crop) 2017 at various distances from cement industry *viz.,* 250, 500, 1000, 2000 m and at the distance of 2250, 2500, 3000 and 4000 m away as check area. The results revealed that the mean concentration of heavy metals like chromium, cadmium and lead before sowing of crop ranged from 14.83 to 7.68, 7.97 to 1.36 and 8.95 to 4.76 mg kg^{-1} respectively and after harvest of crop ranged from 14.73 to 7.69, 7.97 to 1.35 and 8.90 to 4.73 mg kg^{-1} respectively from 250 to 2000 m from cement industry. The heavy metal content in the soil samples did not differ much before sowing and after harvest of crop and were found to decrease as the distance from the cement industry increases. The present investigation revealed that study area soils were affected by dust emissions from the cement industry as indicated by very high concentration of heavy metals in soils of near the cement industry (250 m) and very low concentration in check area.

Key words: *Heavy metals, cement dust, chromium, cadmium, lead.*

Indian cement industry is the second largest in the world after China, comprising of 210 large and more than 350 mini cement plants. Out of 210 cement plants located in India, 77 are situated in the states of Andhra Pradesh, Rajasthan and Tamil Nadu with a cumulative installed capacity of over 350 million tonnes during the year 2016. The cement production capacity of India is nearly 425 million tonnes during the year 2017. India's cement production capacity is expected to reach 550-600 million tonnes by 2025 because of the government's focus on infrastructural development (www.ibef.org. 2016-17). Andhra Pradesh occupies second place among the cement producing states of India. Cement Industries are major source of pollution in the country. The cement industries have been categorized as highly polluting industries by the Central Pollution Control Board (CPCB). The main pollutants emitted from cement industries are Particulate matter, sulphur dioxide (SO_2) and nitrogen dioxide (NO_2).

Cement production requires huge amount of non renewable resources like limestone and fossil fuels. It is estimated that 5-6 percent of carbon dioxide is generated from cement industries. Cement industries emit pollutants in the form of dust and gases which find their way into the soil and environment. The exhaust from a cement factory contains nitrogen oxides, carbon dioxide, water, oxygen, small quantities of dust, chlorides, fluorides, sulphur dioxide, carbon monoxide, smaller quantities of organic compounds and heavy metals. Dust from cement industries leads to accumulation of emitted metals in soil which may affect both the composition and physiological processes of microorganisms leading to a reduction in microbial biomass and enzymatic activity which ultimately leads to degradation of soil quality.

MATERIAL AND METHODS

A total number of 160 soil samples were collected at the rate of 80 samples at each time (Before sowing of crop and after harvest of crop). Probable affected area -60 samples (15 at each distance *viz.,* 250, 500, 1000 and 2000 m) and Check area-20 samples (5 at each distance *viz.,* 2250, 2500, 3000 and 4000 m) were collected. The soil samples were then air-dried and ground with wooden hammer. The soil was then sieved through 2 mm sieve and again transferred to air tight polyethylene bags and were labelled. Heavy metals in the soil samples were analysed by the method given by Gupta (2004). One gram of air dried sample was taken in to 100 ml conical flask and 5ml of triacid was added. The samples were digested at 80^{o}C on hot plate till dryness. Double distilled water was added and filtered through whatman No.42 filter paper and subsequently diluted to 50 ml. Cr, Pb and Cd were determined by acetylene-air flame Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

The results revealed that the lead, cadmium and chromium contents were increased significantly with the decrease in the distance from the industry. The chromium content (Table 1) before sowing of crop

Table 1. Effect of cement dust deposition on chromium content (mg kg^{-1}) of soil

Sample number	Soil samples collected before sowing of crop				Soil samples collected after harvest of crop			
	Distance from cement industry (m)				Distance from cement industry (m)			
	250	500	1000	2000	250	500	1000	2000
1	14.96	12.14	9.62	8.32	15.09	12.12	9.58	8.24
2	15.58	13.64	10.65	8.63	15.49	13.64	10.61	8.61
3	14.45	10.74	11.65	9.64	14.44	10.76	11.68	9.65
4	12.58	12.59	9.37	8.32	12.28	12.47	9.41	8.37
5	15.67	9.01	10.12	9.07	15.46	9.06	10.12	9.11
6	17.12	11.95	8.94	9.67	17.08	11.92	8.86	9.58
7	14.43	11.25	10.47	8.65	14.39	11.28	10.38	8.69
8	17.55	11.92	9.41	5.44	17.46	11.88	9.48	5.43
9	17.12	13.25	9.72	8.31	17.05	13.27	9.76	8.35
10	15.05	12.63	11.76	6.29	15.06	12.61	11.82	6.31
11	12.55	12.23	10.38	8.11	12.25	12.21	10.43	8.16
12	15.94	13.45	10.12	6.83	15.54	13.49	10.14	6.82
13	14.42	11.71	9.43	6.02	14.43	11.71	9.48	6.09
14	12.72	13.06	12.46	6.28	12.74	13.19	12.57	6.24
15	12.31	10.61	10.41	5.64	12.25	10.76	10.47	5.63
Mean	14.83	12.01	10.3	7.68	14.73	12.02	10.32	7.69
Min	12.31	9.01	8.94	5.44	12.25	9.06	8.86	5.43
Max	17.55	13.64	12.46	9.67	17.46	13.64	12.57	9.65
Chromium content (mg kg^{-1}) of soil samples collected from check area								
	2250	2500	3000	4000	2250	2500	3000	4000
1	3.86	3.54	2.16	2.18	3.89	3.52	2.19	2.49
2	4.14	4.08	3.08	3.05	4.15	4.07	3.08	3.06
3	2.57	2.37	2.24	2.19	2.46	2.32	2.27	2.15
4	3.81	2.78	2.62	2.53	3.89	2.74	2.62	2.51
5	4.35	3.69	3.53	2.89	4.38	3.61	3.51	2.85
Mean	3.75	3.29	2.73	2.57	3.75	3.25	2.73	2.61
Min	2.57	2.37	2.16	2.18	2.46	2.32	2.19	2.15
Max	4.35	4.08	3.53	3.05	4.38	4.07	3.51	3.06

increased from 2.57 mg kg^{-1} at 4000 m to 7.68 mg kg^{-1} at 2000 m and kept on increasing to the maximum value of 14.83 mg kg^{-1} at 250 m, whereas after harvest of crop it increased from 2.61 mg kg^{-1} at 4000 m to 7.69 mg kg^{-1} at 2000 m and to the maximum of 14.73 mg kg^{-1} at nearest distance of 250 m. The chromium levels were above the permissible limits of 0.5 mg kg^{-1} as per APAU (1967-95). Similar results were observed by Isikli *et al.* (2003) in Eskisehir-Turkey and Princewill and Adanma (2011) in Nigeria. The high concentration of chromium in the surface soil around the cement industry might be due to linings of the rotaries contain chromium, which could be liberated by wear and friction during cement production, results were in agreements with Ziadat *et al.* (2006).

The lead content (Table 2) before sowing of the crop increased from 2.83 mg kg^{-1} at 4000 m to 4.76 mg kg^{-1} at 2000 m, and kept on increasing to the maximum value of 8.95 mg kg^{-1} at nearest distance of industry and after harvest of crop it was 2.75 mg kg^{-1} at 4000 m which was increased to 4.73 mg kg^{-1} at 2000 m and kept on increasing as going nearer to the industry to the maximum of 8.90 mg kg^{-1} at 250 m distance. The lead content was above the permissible limit of 0.5 mg kg^{-1} as per APAU (1967-95). Al-Omran *et al.* (2011) also reported similar results in Al-Hasa Oasis, Saudi Arabia. Cadmium content (Table 3) before sowing of crop increased from 0.51 mg kg^{-1} at 4000 m to 1.36 mg kg^{-1} at 2000 m and kept on increasing to the maximum value of 7.97 mg kg^{-1} at 250 m, whereas,

Table 2. Effect of cement dust deposition on lead content (mg kg^{-1}) of soil

Sample number	Soil samples collected before sowing of crop				Soil samples collected after harvest of crop			
	Distance from cement industry (m)				Distance from cement industry (m)			
	250	500	1000	2000	250	500	1000	2000
1	11.06	8.24	5.38	5.08	10.16	8.28	5.35	5.01
2	9.31	6.34	6.71	4.23	9.32	6.35	6.68	4.22
3	9.05	9.17	5.64	5.45	9.05	9.19	5.62	5.41
4	8.13	5.31	5.25	6.18	8.14	5.15	5.24	6.15
5	8.04	5.75	6.29	4.98	8.08	5.08	6.26	4.95
6	8.27	5.14	7.34	5.67	8.24	5.19	7.34	5.63
7	11.04	7.48	5.07	3.08	11.05	7.46	5.12	3.12
8	10.08	5.44	5.01	3.19	10.07	5.41	5.05	3.21
9	9.14	7.08	6.67	4.51	9.15	7.08	6.63	4.56
10	9.13	9.07	7.09	3.21	9.12	9.05	7.04	3.17
11	9.24	6.34	5.61	5.18	9.29	5.32	5.56	5.12
12	8.34	4.16	6.01	6.18	8.32	4.14	6.05	6.22
13	7.08	7.64	6.03	5.62	7.09	7.43	5.95	5.54
14	8.23	5.14	4.45	3.94	8.24	5.15	4.41	3.85
15	8.12	7.08	5.62	4.84	8.13	7.07	5.56	4.79
Mean	8.95	6.63	5.88	4.76	8.9	6.49	5.86	4.73
Min	7.08	4.16	4.45	3.08	7.09	4.14	4.41	3.12
Max	11.06	9.17	7.34	6.18	11.05	9.19	7.34	6.22
Lead content (mg kg^{-1}) of soil samples collected from check area								
	2250	2500	3000	4000	2250	2500	3000	4000
1	4.98	3.67	3.56	2.92	4.99	3.58	3.71	2.92
2	3.89	3.89	3.54	2.78	3.85	3.92	3.28	2.85
3	3.26	3.65	3.32	3.74	3.22	3.74	3.31	3.24
4	2.89	2.59	2.68	2.35	2.83	2.55	2.62	2.36
5	2.84	2.57	2.82	2.35	2.89	2.51	2.82	2.39
Mean	3.57	3.27	3.18	2.83	3.56	3.26	3.15	2.75
Min	2.84	2.57	2.68	2.35	2.83	2.51	2.62	2.36
Max	4.98	3.89	3.56	3.74	4.99	3.92	3.71	3.24

after harvest of crop cadmium content was 0.51 mg kg^{-1} at 4000 m which was increased to 1.35 mg kg^{-1} at 2000 m and kept on increasing to the maximum of 7.97 ppm at 250 m distance from the industry. The Cd content was above the permissible limits of 0.10 mg kg^{-1} as per APAU (1967-95). The results were in corroboration with Solgi (2015) in Iran.

The high concentration of Pb and Cd metals in soils can be related to the combustion of leaded fuel by machineries involved in different activities around the industry coupled with cement production, mechanism, process that releasing dust containing Cd, Pd *etc*. Banat *et al.* (2005), Li and Huang (2007) and ETPI (2007) asserted that high quantity of Cd release in to the environment by fuel burning process, similar findings reported by Schuhmacher *et al.* (2004), Krishna and Govil (2005) and Mandal and Voutchkov (2011).

Table 3. Effect of cement dust deposition on cadmium content (mg kg^{-1}) of soil

Sample number	Soil samples collected before sowing of crop				Soil samples collected after harvest of crop			
	Distance from cement industry (m)				Distance from cement industry (m)			
	250	500	1000	2000	250	500	1000	2000
1	9.58	4.69	2.81	1.65	9.55	4.64	2.84	1.69
2	7.62	5.48	3.42	0.86	7.64	5.47	3.49	0.67
3	8.94	5.67	1.92	1.18	8.91	5.61	1.98	1.19
4	6.58	6.97	2.49	1.46	6.57	6.94	2.51	1.38
5	8.03	5.12	3.48	1.58	8.04	5.15	3.43	1.67
6	5.64	4.49	3.37	1.17	5.68	4.35	3.34	1.15
7	7.94	6.68	2.43	1.47	7.98	6.67	2.42	1.39
8	6.75	6.19	2.91	1.38	6.79	6.11	2.89	1.49
9	9.59	4.18	2.42	1.85	9.61	4.09	2.51	1.81
10	8.98	5.74	3.52	1.06	8.95	5.74	3.49	0.93
11	9.27	6.36	2.34	1.82	9.28	6.34	2.39	1.89
12	7.47	4.64	3.47	0.99	7.43	4.69	3.42	0.97
13	6.28	5.73	2.41	1.68	6.24	5.74	2.37	1.66
14	8.77	4.82	2.85	0.92	8.73	4.86	2.92	0.95
15	8.11	6.63	2.34	1.34	8.09	6.61	2.34	1.37
Mean	7.97	5.56	2.81	1.36	7.97	5.53	2.82	1.35
Min	5.64	4.18	1.92	0.86	5.68	4.09	1.98	0.67
Max	9.59	6.97	3.52	1.85	9.61	6.94	3.49	1.89
Cadmium content (mg kg^{-1}) of soil samples collected from check area								
	2250	2500	3000	4000	2250	2500	3000	4000
1	0.98	0.82	0.74	0.59	0.94	0.82	0.75	0.58
2	1.74	0.57	0.57	0.47	1.74	0.55	0.51	0.45
3	0.77	0.76	0.52	0.32	0.75	0.77	0.54	0.35
4	1.14	0.95	0.83	0.65	1.18	0.91	0.85	0.62
5	1.12	0.73	0.54	0.51	1.19	0.74	0.58	0.53
Mean	1.15	0.77	0.64	0.51	1.16	0.76	0.65	0.51
Min	0.77	0.57	0.52	0.32	0.75	0.55	0.51	0.35
Max	1.74	0.95	0.83	0.65	1.74	0.91	0.85	0.62

CONCLUSION

From the present study, it was concluded that higher concentrations of heavy metals were found at 250 m from cement industry and with increasing distance from cement industry the concentration was decreased. The lowest concentration was noticed at control site. All heavy metals were above the permissible limits of APAU (1967-95). The significant effects were concentrated within the distance of 500 m from the cement industry and minor changes were observed up to 2000 m from cement industry. Therefore, mitigation strategies should be performed for Pb, Cd and Cr remediation.

LITERATURE CITED

Al-Omran A M, El-Maghraby S E, Nadeem M E A, El-Eter A M and Al-Qahtani S M I 2011 Impact of cement dust on some soil properties around the cement factory in Al-Hasa Oasis, Saudi Arabia. *American-Eurasian Journal of Agriculture and Environmental Science,* 11 (6): 840-846.

APAU 1967-95 Annual reports of All India coordinated research project on micro and secondary nutrients and pollutant elements in soils and plants, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad.

Banat K M, Howari F M and Al- Hamad AA 2005 Heavy metals in urban soils of Central Jordan. *Environmental Research,* 97: 258-273.

ETPI (Environmental Technology Program for Industry) 2007 Responding to the Environmental challenge: A survey of Pakistan's manufacturing and industrial Sector, cement industry, Karach, Pakistan.

Gupta P K 2004 Methods in environmental analysis, water, soil, and air, *Updesh Purohil for Agrobios* (India).

Isikli B, Demir T A, Urer S M, Berber A, Akar T and Kalyoncu C 2003 Effects of chromium exposure from a cement factory. *Environmental Research*, 91: 113-118.

Krishna, A.K and Govil, P K 2005 Heavy metal distribution and contamination in soils of Thane-Belapur industrial development area, Mumbai, Western India. *Environmental Geology,* 47 (8):1054-1061.

Li X and Huang C 2007 Environmental impact of heavy metals on urban soil in the vicinity of industrial area of Baoji city, China. *Environmental Geology*, 52 (8) 1631-1637.

Mandal A and Voutchkov M 2011 Heavy metals in soils around the cement factory in Rockfort Kingston Jamaica. *International Journal of Geosciences*, 2: 48-54.

Princewill C O and Adanma N N 2011 Metal concentration in soil and plants in abandoned cement factory. *International Conference on Biotechnology and Environment Management,* 18:146-150.

Schuhmacher M, Domingo J L and Garreta J 2004 Pollutants emitted by a cement plant: health risks for the population living in the neighbourhood. *Environmental Research,* 95:198-206.

Solgi E 2015 An investigation on Cd and Pb concentrations of soils around the Kurdistan cement factory in Western Iran. *Journal of Chemical Health Risks,* 5 (3): 179-191.

www.ibef.org, 2016-17. https://www.ibef.org/ industry /cement-india.aspx.

Ziadat A H, Batarseh M, El-Hassan T and Berdanie B W 2006 Chemical and mineralogical characteristics of dry deposition in the surrounding of a cement factory in Jordan. *Journal of Environmental Forensics*, **7**:169-174.

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