



## Compound Effect of Cement Dust Emitted by Closely Located Cement Plants on Soil of Nokha (Bikaner)

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### ABSTRACT

India is the second largest producer of cement in the world with an installed capacity of 330 million tones (2011-12)<sup>1</sup>. The Sarvottam, Tiger and Nokha mini-cement plants were established in 90's at Nokha tehsil (Bikaner) in the western Rajasthan. These factories have emitted cement dust in the vicinity for a long time. Therefore, to study the effect of cement dust on soil and plants eighty samples of soil were collected at surface and 15 cm depth around the factory within the radius of 3 km in four radial directions. This cement dust deposited on upper most soil contain elements like Zn, Cu, Mn, and Na well above permissible limits with higher pH, which are hazardous to plants and soil structure.

**Key words:** Cement dust, Zinc, Copper, Manganese, Sodium, pH, Soil surface, Radial direction.

### INTRODUCTION

Industrial activity including the cement production causes the atmospheric pollution on the ecosystem. The major impact of cement activity on soil and plants comes in the form of the broadcast of dust and gases. These particles gets deposited on top soil as well as enter into the soil as dry, humid or occult deposits and can effect its physiochemical properties. The main visible pollution generated by the cement industry in arid region corresponds to the dust. Infact, the cement dust can be emitted at every stage of the cement manufacturing process including crushing, grinding

the raw material like limestone, clay, iron ore and fly ash etc,<sup>2,3</sup> and mixing them in appropriate proportion. Besides mild heating is applied to drive off water and carbon dioxide available in limestone<sup>4</sup>.

Interesting quantity of dust deposited decreases sharply with increase in distance from cement plant. The main objective of this study is to assess the impact of dust given out by the nearby located cement plants on the physiochemical characteristic of the soil in their vicinity<sup>5,6</sup>. Further to check whether dust emitted from them has some compound effect on the soil in any direction.

## EXPERIMENTAL

Nokha is located within the subtropical region, with annual rainfall of about 298 mm. The temperature varies from 48 degree in summer to 1 degree in winter. The humidity is highest in August with mean daily relative humidity is 71% in morning and 52 % in the evening<sup>7</sup>. It is located between latitude 27°36' N and 73°31' E.

To study the effect of cement dust, whole area around three cement plants namely; Sarvottam cement plant located at Chakara village (Nokha); Tiger cement plant and Nokha cement plant located in RIICO industrial area at a distance 500 m from each other, whole area around the plants was divided into four radiant directions of east, south, west and north in clockwise manner<sup>8,9</sup>. Soil sample were taken at surface and 15 cm depth at 100m, 500m, 1km, 2km and 3 km distance (10 samples each) in plastic bags of ½ kg each. Prior to analysis, the samples were cleaned using wire mesh and pebbles removed. The samples were fitted using Whatman filter paper no.42. DTPA method as proposed by Lindsay and Norwal (1978) was effectively used to extract all the four cations i.e. Zn, Cu, and Mn from the soil<sup>10</sup>. Na was determined using flame photometer<sup>11</sup>.

## RESULTS

A summary of the results and chemical evaluation of micronutrients (Zn, Cu, Mn and Na) in the soils of the study area is presented in table 1-

12. Generally soil pH of unpolluted soil around the two cement plants is 8.5. The acceptable range of various elements for soil as per Central Pollution Control Board Zn (0.6 ppm), Cu(0.2 ppm), Mn(2 ppm) and Na(1.25 ppm)<sup>12</sup>.

### Sarvottam cement

Soil pH is higher in all the directions except north direction. High concentration of Zn, Cu, Mn and Na were limited within the 500m radius of the plant as the plant is located within agricultural fields.. However, Zn was found well above permissible limits in north direction of sarvottam cement works.

### Tiger cement

Soil pH, is higher in all the directions, especially in west and north direction. Likewise, high concentration of Cu, Mn and Na were limited within the 1 km radius of the plant. However, Zn was found well above permissible limits in south and west direction of Tiger cement works.

### Nokha cement

Soil pH, is high in all directions more particularly in western side of plant partly due to higher sodium. High concentration of Zn, Cu and Mn were generally limited upto 1 km periphery of cement plant. However, Zn was found well above permissible limits in all directions except east direction.

### Effect on plants

Accumulation of salts closer to the surface is a typical feature of cement dust polluted soils.

**Table 1: Levels of various elements in east direction of Sarvottam Cement, Charkara (Nokha)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	9.41	1.08	0.22	3.20	1.25
100 m (d)	9.13	1.04	0.24	1.95	1.20
500 m(s)	9.44	0.44	0.24	2.88	1.10
500 m(d)	8.98	0.48	0.22	1.80	1.00
1 km (s)	8.91	0.24	0.22	1.36	1.00
1 km (d)	8.62	0.34	0.18	1.44	0.90
2 km (s)	8.76	0.24	0.22	1.50	0.95
2 km (d)	8.55	0.22	0.12	0.86	0.90
3 km (s)	8.76	0.38	0.12	0.74	0.90
3 km (d)	8.53	0.22	0.16	0.68	0.85

**Table 2: Levels of various elements in south direction of Sarvottam Cement, Charkara (Nokha)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	9.34	0.62	0.33	2.26	1.85
100 m (d)	9.23	0.52	0.22	2.10	1.55
500 m(s)	9.22	0.46	0.22	0.96	1.25
500 m(d)	9.21	0.44	0.27	0.80	1.45
1 km (s)	9.00	0.32	0.18	0.81	1.60
1 km (d)	9.10	0.38	0.14	0.78	1.45
2 km (s)	8.98	0.36	0.12	0.75	0.95
2 km (d)	8.75	0.31	0.12	0.56	0.975
3 km (s)	7.98	0.36	0.12	0.32	0.95
3 km (d)	7.88	360	429	0.30	0.12

s= surface, d= 15 cm depth

**Table 3: Levels of various elements in west direction of Sarvottam Cement, Charkhada (Nokha)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	9.34	0.60	0.20	3.60	1.55
100 m (d)	9.13	0.78	0.22	4.90	1.50
500 m(s)	9.10	0.56	0.18	3.04	1.45
500 m(d)	8.91	0.39	0.16	5.34	1.65
1 km (s)	8.90	0.30	0.15	2.50	1.50
1 km (d)	8.85	0.33	0.14	2.22	1.45
2 km (s)	8.80	0.25	0.12	3.00	0.90
2 km (d)	8.78	0.27	0.12	1.24	0.75
3 km (s)	8.80	0.31	0.12	0.50	0.80
3 km (d)	8.78	0.33	0.12	0.38	0.90

**Table 4: levels of various elements in north direction of Sarvottam Cement, Charkhada (Nokha)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	8.95	0.68	0.25	3.66	1.50
100 m (d)	8.71	0.73	0.18	5.62	1.45
500 m(s)	8.84	0.61	0.15	3.30	0.88
500 m(d)	8.70	0.50	0.16	4.70	0.95
1 km (s)	8.35	0.60	0.14	1.88	0.90
1 km (d)	8.65	0.31	0.12	1.76	0.90
2 km (s)	8.61	0.38	0.11	1.61	0.80
2 km (d)	8.70	0.27	0.12	1.54	0.85
3 km (s)	8.52	0.35	0.12	1.70	0.85
3 km (d)	8.44	0.24	0.10	1.65	0.85

s= surface, d= 15 cm depth

**Table 5: Level of various elements in east direction of Tiger Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	9.20	0.74	0.45	2.46	2.30
100 m (d)	8.97	0.74	0.35	4.22	1.75
500 m(s)	8.85	0.62	0.28	2.34	1.25
500 m(d)	8.75	0.56	0.18	4.30	0.98
1 km (s)	8.70	0.42	0.17	1.70	1.00
1 km (d)	8.63	0.33	0.13	1.50	1.10
2 km (s)	8.58	0.36	0.12	1.70	1.10
2 km (d)	8.45	0.28	0.12	1.64	1.20
3 km (s)	8.41	0.25	0.11	1.46	1.00
3 km (d)	8.40	0.21	0.12	1.21	0.98

**Table 6: Level of various elements in south direction of Tiger Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	9.85	1.50	0.58	4.66	1.00
100 m (d)	9.62	0.78	0.37	2.70	0.90
500 m(s)	9.50	1.40	0.56	4.18	0.98
500 m(d)	9.20	1.11	0.35	2.52	0.95
1 km (s)	8.93	0.76	0.40	3.04	1.00
1 km (d)	8.90	0.94	0.34	3.60	0.95
2 km (s)	8.88	0.98	0.49	0.72	0.95
2 km (d)	8.85	0.82	0.16	0.72	0.98
3 km (s)	8.80	0.83	0.21	0.70	0.98
3 km (d)	8.75	0.78	0.18	0.68	0.90

**Table 7: Level of various elements in west direction of Tiger Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	10.40	4.30	0.58	14.40	13.50
100 m (d)	10.10	1.60	1.04	7.20	12.50
500 m(s)	9.80	2.40	0.46	6.00	4.05
500 m(d)	9.22	3.60	0.47	3.20	3.50
1 km (s)	9.10	1.11	0.41	6.20	2.30
1 km (d)	8.99	1.20	0.30	2.60	1.70
2 km (s)	8.80	1.30	0.12	1.40	1.20
2 km (d)	8.73	1.20	0.08	1.06	1.00
3 km (s)	8.51	1.30	0.12	0.84	1.00
3 km (d)	8.10	0.94	0.80	0.84	1.10

**Table 8: Level of various elements in north direction of Tiger Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	11.18	1.20	1.60	5.10	1.65
100 m (d)	10.74	0.74	1.60	1.00	1.35
500 m(s)	9.95	0.86	1.70	4.18	1.55
500 m(d)	9.85	0.64	1.60	1.06	1.00
1 km (s)	9.10	0.56	0.21	4.44	0.95
1 km (d)	9.05	0.30	0.16	1.10	0.95
2 km (s)	8.89	0.42	0.10	3.14	0.88
2 km (d)	8.86	0.42	0.12	0.88	0.75
3 km (s)	8.85	0.48	0.12	0.32	0.88
3 km (d)	8.88	0.54	0.08	0.94	0.85

s= surface, d= 15 cm depth

**Table 9: Level of various elements in east direction of Nokha Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	10.14	0.84	0.53	3.43	2.00
100 m (d)	9.25	0.71	0.45	2.91	1.35
500 m(s)	9.20	0.67	0.31	2.39	1.25
500 m(d)	8.98	0.61	0.25	2.54	1.20
1 km (s)	8.95	0.55	0.22	2.13	1.20
1 km (d)	8.85	0.43	0.18	1.82	1.20
2 km (s)	8.82	0.34	0.16	1.47	1.20
2 km (d)	8.80	0.29	0.13	0.93	1.00
3 km (s)	8.78	0.26	0.11	0.81	1.00
3 km (d)	8.75	0.20	0.10	0.89	0.80

**Table 10: Level of various elements in south direction of Nokha Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	9.95	1.29	0.68	3.27	1.65
100 m (d)	9.40	0.75	0.59	4.09	1.55
500 m(s)	9.30	0.91	0.44	2.58	1.25
500 m(d)	9.20	0.89	0.35	1.75	1.20
1 km (s)	8.98	0.79	0.28	1.61	0.95
1 km (d)	8.89	0.64	0.19	0.98	0.98
2 km (s)	8.85	0.61	0.18	0.84	0.90
2 km (d)	8.79	0.53	0.14	0.75	0.90
3 km (s)	8.70	0.48	0.12	0.67	0.85
3 km (d)	8.67	0.37	0.12	0.53	0.80

**Table 11: Level of various elements in west direction of Nokha Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	9.99	2.60	0.37	7.89	3.95
100 m (d)	9.50	1.22	0.29	6.15	3.85
500 m(s)	9.12	1.15	0.31	3.20	3.75
500 m(d)	8.89	0.92	0.24	1.40	3.80
1 km (s)	8.78	0.84	0.18	1.69	4.65
1 km (d)	8.75	0.63	0.14	0.88	5.75
2 km (s)	8.70	0.52	0.12	0.74	4.30
2 km (d)	8.67	0.48	0.10	0.62	2.80
3 km (s)	8.60	0.44	0.09	0.68	2.35
3 km (d)	8.53	0.41	0.09	0.71	2.10

**Table 12: Level of various elements in north direction of Nokha Cement (Nokha) (in ppm)**

Distance	pH	Zn	Cu	Mn	Na
100 m (s)	10.83	1.12	0.98	3.88	3.75
100 m (d)	10.57	0.96	1.09	4.45	2.80
500 m(s)	10.10	0.71	0.85	4.18	2.80
500 m(d)	9.40	0.83	0.74	3.17	2.95
1 km (s)	9.32	0.65	0.62	2.29	1.70
1 km (d)	9.10	0.52	0.36	1.80	1.85
2 km (s)	9.05	0.61	0.28	1.32	1.75
2 km (d)	8.89	0.49	0.21	0.94	1.70
3 km (s)	8.89	0.42	0.17	0.76	1.65
3 km (d)	8.45	0.36	0.13	0.63	1.60

s= surface, d= 15 cm depth

Zinc, copper and manganese are toxic to plant leaves in excessive state. Cement dust when fall on nearby *Prosopis cineraria* leaves hinders photosynthesis and respiration, hence, leaf chlorosis, leaf tip burning, stunted growth and no flowering and sangery (fruit) yield. *Prosopis cineraria* plants in the nearby area show growth only when their leaves are washed with natural rain. Pearl millet and clusterbean grown in the surrounding field show poor growth due to excessive sodium and other salt present in soil.

## CONCLUSION

Therefore, it is concluded that cement dust emitted from these plants has led to high concentration of salts viz. Zn, Cu, Mn, and Na more precisely in 1 km radius of plants. This is particularly true for south western direction which may be attributed to most prevailing direction of wind year round. Soil pH has also increased more significantly upto 1 km radial direction. Since elements studied were mobile, therefore, their distribution was not much effected by soil depth.

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