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Effect of Cement Dust Deposition on Soil Microbial Properties

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A B S T R A C T

A study on "Effect of cement dust deposition on soil microbial properties" was conducted at Department of Environmental Sciences, Advanced Post Graduate Centre, Lam, Guntur during 2017-2018. A total of 160 soil samples were collected around cement industry in Satrasala village, near Macherla in Guntur district 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 showed that the microbial population *i.e.*, bacteria and fungi was influenced by the cement dust deposition. The minimum population of bacteria 27.1 and 26.9 x 10^5 CFU g^{-1} was recorded before sowing and after harvest of crop at 250 m and population increased to 87.1 and 89.1 x 10^5 CFU g^{-1} with increase in distance up to 2000 m distance from cement industry. Similar trend was observed in case of fungal population also. Minimum population of 10.4 and 9.3 x 10^3 CFU g^{-1} was recorded before sowing and after harvest of crop at 250 m from cement industry and population increased to 26.1 and 25.5 x 10^3 CFU g^{-1} with increase in distance up to 2000 m from cement industry.

Introduction

Cement is the most widely used building material throughout the world. With the increase in demand for cement the number of factories producing cement is increasing each year and both consumption and production of cement has increased greatly in recent years. Indian cement industry is the second largest in the world after China and accounts for 6.9 per cent of world's cement output. India is having 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 lime stone and fossil fuels. It is estimated that 5-6 % 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 kiln 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.

Materials 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.

Enumeration of microbial load

The enumeration of total fungi and bacteria in the soil samples was carried out by following the standard dilution plate count technique. The procedure includes, ten grams of soil was taken in a conical flask to which 100 mL of sterile saline was added aseptically. The sample was agitated for 15 minutes on an orbital shaker and serial dilutions of soil suspensions were prepared. An aliquot of 0.1 mL of respective dilutions were spread on the surface of sterile agar medium (Nutrient agar for bacteria, Rose Bengal agar medium for fungi) contained in sterile petri plates. Then the petri plates were incubated at room temperatures ($28^0C \pm 2^0C$) for 24-72 h in a bacteriological incubator. After incubation colonies formed were counted using digital colony counter. Fungi count was taken after 24h; while bacteria count was taken after 72h and the population was expressed as CFU x dilution factor per gram (Aneja, 2001).

Results and Discussion

Bacterial population

The data on the bacterial population of soil around the cement industry as influenced by cement dust deposition before sowing and after harvest of crop are presented in Table 1.

Before sowing of crop the bacterial population of soil at 250, 500, 1000 and 2000 m from cement industry ranged from 15 to 36, 32 to 62, 51 to 89 and 73 to 103 x 10^5 CFU g^{-1} with the mean values of 27.1, 45.9, 66.4 and 87.1 x 10^5 CFU g^{-1} respectively, whereas, after harvest of crop the bacterial population ranged from 17 to 35, 32 to 63, 54 to 84 and 76 to 109 x 10^5 CFU g^{-1} with the mean values of 26.9, 46.3, 68.8 and 89.7 x 10^5 CFU g^{-1} respectively.

The bacterial population of soil in check area before sowing of crop at 2250, 2500, 3000 and 4000 m from cement industry ranged from 120 to 159, 156 to 179, 153 to 186 and 178 to 204 x 10^5 CFU g^{-1} with the mean values of 142.4, 167.4, 176.0 and 190.2 x 10^5 CFU g^{-1} respectively, whereas, after harvest of crop the bacterial population ranged from 122 to 158,

157 to 184, 162 to 196 and 173 to 209 x 10^5 CFU g^{-1} with the mean values of 143.2, 171.2, 178.0 and 188.6 x 10^5 CFU respectively.

The above data showed that maximum bacterial population of soil before sowing of crop was found to be ranged from 142.4 to 190.2 x 10^5 CFU g^{-1} in check area (2250 to 4000 m) and population followed a decreasing trend with decrease in distance up to 250 m, it recorded the least bacterial population of 27.1 x 10^5 CFU g^{-1} and after harvest of crop the maximum bacterial population was also recorded in check area which ranged from 143.2 to 188.6 x 10^5 CFU g^{-1} and minimum population of 26.9 x 10^5 CFU g^{-1} was found at 250 m from cement industry. Dust from cement factories leads to considerable change in pH and accumulation of emitted metals in soil which may affect both the composition and physiological processes of microorganisms (McCarthy, 2003 and Biyik *et al.*, 2005).

Fungal population

The data on the fungal population of soil around the cement industry as influenced by cement dust deposition before sowing and after harvest of crop are presented in Table 2.

Table.1 Effect of cement dust deposition on soil bacterial population (1 x 10^5 CFU g^{-1})

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	18	46	62	85	22	45	68	85
2	20	38	79	73	21	39	75	76
3	15	34	65	92	17	36	67	101
4	19	48	67	86	20	45	79	86
5	29	41	59	79	28	44	62	82
6	25	32	51	83	22	36	54	89
7	27	52	67	103	29	54	72	109
8	25	41	63	95	26	43	59	95
9	32	46	66	93	35	49	69	87
10	36	37	75	99	32	32	73	96
11	28	59	54	86	27	57	58	93
12	29	46	58	88	32	42	67	91
13	36	53	63	78	33	58	62	82
14	32	62	78	81	29	63	84	85
15	35	54	89	85	31	52	83	89
Mean	**27.1**	**45.9**	**66.4**	**87.1**	**26.9**	**46.3**	**68.8**	**89.7**
Min	15	32	51	73	17	32	54	76
Max	36	62	89	103	35	63	84	109
Soil samples collected from check area								
	2250	2500	3000	4000	2250	2500	3000	4000
1	120	174	185	204	122	182	196	209
2	139	179	186	197	139	184	172	199
3	152	165	184	189	158	157	183	181
4	159	163	172	183	148	172	177	181
5	142	156	153	178	149	161	162	173
Mean	**142.4**	**167.4**	**176**	**190.2**	**143.2**	**171.2**	**178**	**188.6**
Min	120	156	153	178	122	157	162	173
Max	159	179	186	204	158	184	196	209

Table.2 Effect of cement dust deposition on soil fungal population (1 x 10^3 CFU g^{-1})

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	5	12	18	23	6	10	15	21
2	8	15	22	29	6	13	18	25
3	11	9	16	24	9	9	17	27
4	10	15	24	32	8	14	22	30
5	12	10	20	34	10	11	17	35
6	9	12	18	27	9	12	15	31
7	10	19	13	21	11	15	10	25
8	8	15	22	19	9	17	18	17
9	10	16	17	32	8	16	20	31
10	10	19	16	26	11	18	16	22
11	9	21	22	21	9	22	21	20
12	13	15	16	19	12	17	17	16
13	15	11	23	24	10	14	20	23
14	17	16	23	29	12	19	22	26
15	9	11	20	31	9	12	21	34
Mean	**10.4**	**14.4**	**19.3**	**26.1**	**9.3**	**14.6**	**17.9**	**25.5**
Min	5	9	13	19	6	9	10	16
Max	17	21	24	34	12	22	22	35
Soil samples collected from check area								
	2250	2500	3000	4000	2250	2500	3000	4000
1	45	65	54	74	38	61	58	79
2	49	64	65	79	45	69	62	74
3	52	61	69	61	51	65	67	63
4	43	58	76	73	44	56	75	78
5	61	78	73	69	69	73	72	58
Mean	**50**	**65.2**	**67.4**	**71.2**	**49.4**	**64.8**	**66.8**	**70.4**
Min	43	58	54	61	38	56	58	58
Max	61	78	76	79	69	73	75	79

Before sowing of crop the fungal population of soil at 250, 500, 1000 and 2000 m from cement industry ranged from 5 to 17, 9 to 21, 13 to 24 and 19 to 34 x 10^3 CFU g^{-1} with the mean values of 10.4, 14.4, 19.3 and 26.1 x 10^3 CFU g^{-1} respectively, whereas, after harvest of crop the fungal population ranged from 6 to 12, 9 to 22, 10 to 22 and 16 to 35 x 10^3 CFU g^{-1} with the mean values of 9.3, 14.6, 17.9 and 25.5 x 10^3 CFU g^{-1} respectively. The fungal population of soil in check area before sowing of crop at 2250, 2500, 3000 and 4000 m from cement industry ranged from 43 to 61, 58 to 78, 54 to 76 and 61 to 79 x 10^3 CFU g^{-1} with the mean values of 50.0, 65.2, 67.4 and 71.2 x 10^3 CFU g^{-1} respectively, whereas, after harvest of crop the fungal population ranged from 38 to 69, 56 to 73, 58 to 75 and

58 to 79 x 10^3 CFU g^{-1} with the mean values of 49.4, 64.8, 66.8 and 70.4 x 10^3 CFU respectively.

The above data showed that highest fungal population of soil before sowing of crop was found to be ranged from 50.0 to 71.2 x 10^3 CFU g^{-1} in check area (2250 to 4000 m) and population followed a decreasing trend with decrease in distance up to 250 m, it recorded the least fungal population of 10.4 x 10^3 CFU g^{-1} and after harvest of crop the highest fungal population of soil was also recorded in check area which ranged from 49.4 to 70.4 x 10^3 CFU g^{-1} and minimum population of 9.3 x 10^3 CFU g^{-1} was found at 250 m from cement industry. The difference in the fungal population of soil around cement industry was due to greater lime content of soil. The results obtained were in conformity with the observations recorded by Mlitan and Hack (2014) in Libya and Ocak *et al.,* (2004) also reported similar results in Turkey.

The microbial population *i.e.,* bacteria and fungi was influenced by the cement dust deposition. The minimum population of bacteria 27.1 and 26.9 x 10^5 CFU g^{-1} was recorded before sowing and after harvest of crop at 250 m and population increased to 87.1 and 89.1 x 10^5 CFU g^{-1} with increase in distance up to 2000 m distance from cement industry. Similar trend was observed in case of fungal population also. Minimum population of 10.4 and 9.3 x 10^3 CFU g^{-1} was recorded before sowing and after harvest of crop at 250 m from cement industry and population increased to 26.1 and 25.5 x 10^3 CFU g^{-1} with increase in distance up to 2000 m from cement industry. The bacterial and fungal population did not differ much before sowing and after harvest of crop and the lowest population was recorded in study area (< 2000 m) over the check area (> 2000 m).

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