RESEARCH PAPERS

IMPACT OF CEMENT DUST ON MICROBIAL FLORA ASSOCIATED WITH *Crocus sativus kashmirianus C.V.*

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Abstract

Cement dust pollution instigates alkalization of the ecosystem, and alters the chemical composition and ecological communities of soils. The present study discriminates the effect of cement dust on the associated microbial flora with saffron corms during the flowering phase. The results portray the direct impact of cement dust on microbial load particularly beneficial rhizospheric flora, which was also well supported by the results of chemical characteristics of saffron soil. Current study renders the impact of cement dust on beneficial rhizospheric flora associated with saffron corms and showed positive correlation with chemical characteristics of saffron soil

Keywords: *bacteria; cement; fungi; pollution; rhizoflora; saffron*

Introduction

Cement industry plays an important part in modifying the soil ecosystem by addition of the toxic or unwanted substances (mainly alkaline particulates) and other heavy metals (Ni, Co, Pb, Cr Fe etc) to the outside environment (Baby *et al.*, 2008). Cement dust encompasses 3-8% aluminum oxide, 0.5-0.6% iron-oxide, 60-70% calcium oxide, 17-25% silicon oxide, 0.1-4% magnesium oxide and 1-3% sulphur trioxide and is considered to be one of the main sources of pollutants that greatly affect plant growth and development, phytomass, productivity , species composition, cover and biodiversity (Ade-Ademilua and Umebese, 2007; Arul and Nelson 2015).Cement dust pollution generally causes alkalization of the ecosystem leads to chemical composition alteration vis a vis ecological communities of soil systems.. Cement dust induces the changes in the physico-chemical properties of soil, which are generally unfavorable to plant growth. The most commonly used microbial activity indicators for soil health monitoring are microbial biomass, soil respiration and soil enzyme activity. Soil microbial activity is important for the nutrient biogeochemical cycling and it is negatively affected by the cement dust pollution (Ocak *et al.*, 2004; Arul and Nelson, 2015)

In Kashmir region (J&K), there has been an expansion of some industries particularly cement industry in some agriculturally and biodiversity rich areas especially in the area of second highest saffron production in world. In this backdrop the present study is an attempt to assess theimpact of the cement dust emitted by the Saifco Cement Factory (Khrew, J&K) on soil physicochemical properties and bacterial and fungal flora associated with saffron corms during flowering period.

Methods

Experimental sites

The study was conducted in the vicinity of Saifco Cement factory (Khrew, J&K), located at 34 .02°N 74.98°E. It has an average elevation of 1,607 metres (5,272 feet a.m.s.l), west of the Srinagar, JK India. Based on area distribution within a soil-mapping unit, the sampling sites, Control (15 km), BT01 (5 km), and BT02 (1 km) away from the Saifco Cement Factory were randomly selected in saffron cultivated fields. The chimney height of the Saifco Cement Plant was 50 m. The dominant wind direction was north-west, and soil sampling was coincided with the same wind direction.

Soil sampling

Soil samples were taken from 0 to 15 cm depth (tillage layer) in the month of October 2015 during the flowering of saffron corms from the saffron field in Khrew area, J&K (India). The soil profile was dug and then the surface of profile was cleaned and the samples were taken from 5 and 15 cm depths with a disinfected spatula. Stones and plant and root debris were removed. However, the rhizosphere soil was collected as described by our previous report (Parray *et al*., 2013). The soil samples were passed through 2-mm sieves and stored at 4 °C before microbial analysis. Sub-samples of the soils were air-dried and ground to pass through a 2-mm sieve for chemical analysis.

Soil chemical characterization

Soil chemical characteristics were determined at Department of soil science, SKUAST Shalimar JK India. All the parameters were analyzed as per the standard methods available.

Microbiological analysis

To isolate bacteria and fungi, 1 g of soil sample was transferred to 90 ml distilled water and was serially diluted. Diluted suspensions were spread plated on LB agar and potato dextrose agar medium and were incubated at 28°C for 24 h. Culture plates were examined macroscopically and then colonies were enumerated and identified on these media at ambient temperature (APHA, 1984).

Results and Discussion

The present study distinguishes the effect of cement dust deposition on soil characteristics as well as on the microbial flora with respect to the distance from source that was evident from the current findings. The chemical characteristic features viz; pH, conductivity, organic carbon, available NPK determined showed a significant variation with the distance from the source. The pH of the soil samples at the cement factory was alkaline. And the microflora observed both from bulk soila as well as associated with corm roots (rhizoflora) also showed significant decline with respect to cement dust accumulation via cement factory. The pH values ranged from 7.6 at control site to 8.24 and 8.13 compared to the sites that were nearby to the cement factory at respective distances (Table 1). The electrical conductivity estimated was found almost equal at all the sites with average value of 0.05 dS/cm (Table 1). Organic-matter content was found higher in the soil contaminated with cement dust. The values range from 0.7 % at control site to 1.44% at BT01 (5 km from source) site and 2.53 % at BT02 (1 km from source) site. The high organic-matter content can be a result of increased microbial activities in the contaminated soils, thus resulting in the rapid rate of organic-matter decomposition and incorporation into the soil. The NPK values were found to have direct correlation with cement dust. The highest concentration of N 569 Kg/ha was found to be at farther site from the cement industry compared to the control site having 158 Kg/ha mean while the available K was found to be highest of about 448 Kg/ha at BT01 (5 km from source) site and it shows decline with increase in distance from source. The available P was found maximum at control site of 85 Kg/ha and at BT01 (5 km from source) site its value was 53 Kg/ha (Table. 1) This indicates the extent to which the soil was polluted by cement dust, in addition to that the pH of soil gradually increased due the effect of cement dust when compared to control soil. Alkaline nature of cement dust reduces absorption of mineral substances form the soil it leads to changes in the plant physiology and morphology (Raajasubramanian *et al.*, 2011; Maletsika *et al.*, 2015). Sustained cement impact and alkalization of the soil environment can lead to change in the availability of several plant essential nutrients particularly N and Mn concentrations. It is also mentioned that plant absorption of nutrients considerably decreased due to the high amount of Ca and K content present in the alkaline soils (Mandre, 1995; Princewill and Adanma, 2011). Photosynthesis as well as optimum quantity of mineral substances are essential for structural as well as physiological functioning of the plants. Reduction of photosynthesis affects all the physiological activities of crop one way and on the other hand absorption of mineral substances deficiency also plays most important role for changing the growth and biochemical content of plant, it leads to affect the yield of crop. Due to alkaline nature of cement dust, it affects the absorption of mineral substances from the soil (Raajasubramanian *et al*., 2011; Princewill and Adanma, 2011).

Table 1: Chemical characteristics of saffron soil contaminated with cement dust in Khrew area

Soil sample	Ph	Electrical conductivity dS/cm	Organic carbon %	Available Nitrogen Kg/ha	Available phosphorus Kg/ha	Available Potassium Kg/ha
Control	7.6±1.70	0.05±1.70	0.7±1.70	158±1.70	85±1.70	364±1.70
BT-01	8.24±1.70	0.05±1.70	1.44±1.70	324±1.70	53±1.70	448±1.70
BT-02	8.13±1.70	0.06±1.70	2.53±1.70	569±1.70	40±1.70	224±1.70

All values are mean of three replicates+SEM.
Control=non-polluted site (10 km from cement factory); BT-01=5 km from sourceand BT-02= 1 k m from source)

The data representing the microbial flora associated with saffron corms showed significant change in colony numbers from non-polluting sites to polluting areas. The bacterial flora decreases from 300 x10³ cfu/g to 200 x10³ cfu/g in bulk soil and 460 x10³ cfu/g to 130 x10³ cfu/g in rhizospheric soil from control site to the most polluted site. Similarly the fungal flora in bulk soil and rhizpspheric soil varies from 240to 100 x10⁴ cfu/g and 345 to 90 x10⁴ cfu/g respectively from control site to polluted site (Table 2).

Table 2: Microbial population (*CFU/g) in saffron soil contaminated with cement dust in Khrew area

	Bulk soil		Rhizospheric soil	
Sites	Bacteria* X 10^3 (CFU/ g)	Fungi *X 10^4 (CFU/ g)	Bacteria* X 10^3 (CFU/ g)	Fungi *X 10^4 (CFU/ g)
Control (10 km)	300±1.70	240±4.76	460±1.53	345±3.70
BT-01 (05 km)	220±1.84	170±1.08	290±1.61	183±4.56
BT-02 (01 km)	200±2.02	100±2.36	130±2.56	90±3.09

**Microbial populations measured in terms of colony forming units (CFU/g). All values are mean of three replicates per plate±SEM.*
Control=non-polluted site (10 km from cement factory); BT-01=5 km from source and BT-02= 1 k m from source

We found that microbial flora isolated from rhizospheric soil was found most prone to cement pollution stress and among the bacterial and fungal flora, the latter was most susceptible to cement dust pollution (Raajasubramanian *et al*. 2011). Due to the alkaline dust accumulation in soil, increasing soil pH values will decrease microbial biomass and, as a consequence, will reduce organic matter decomposition and element cycling in cement dust-affected areas (Hasenekoglu and Sulun 1991; Sadhana *et al*. 2013). The decrease in microfungi and rhizoflora surrounding the saffron corms is directly correlated to with the decrease in available P content in the soil. The current study gives us the clear picture about impact of cement dust on microflora and it forms the base to help us to screen out the specific rhizoflora that are affected by the cement dust. The principal component analysis (PCA) of microbial load with respect to the sites and physico-chemical properties was examined (Fig 1a-d).

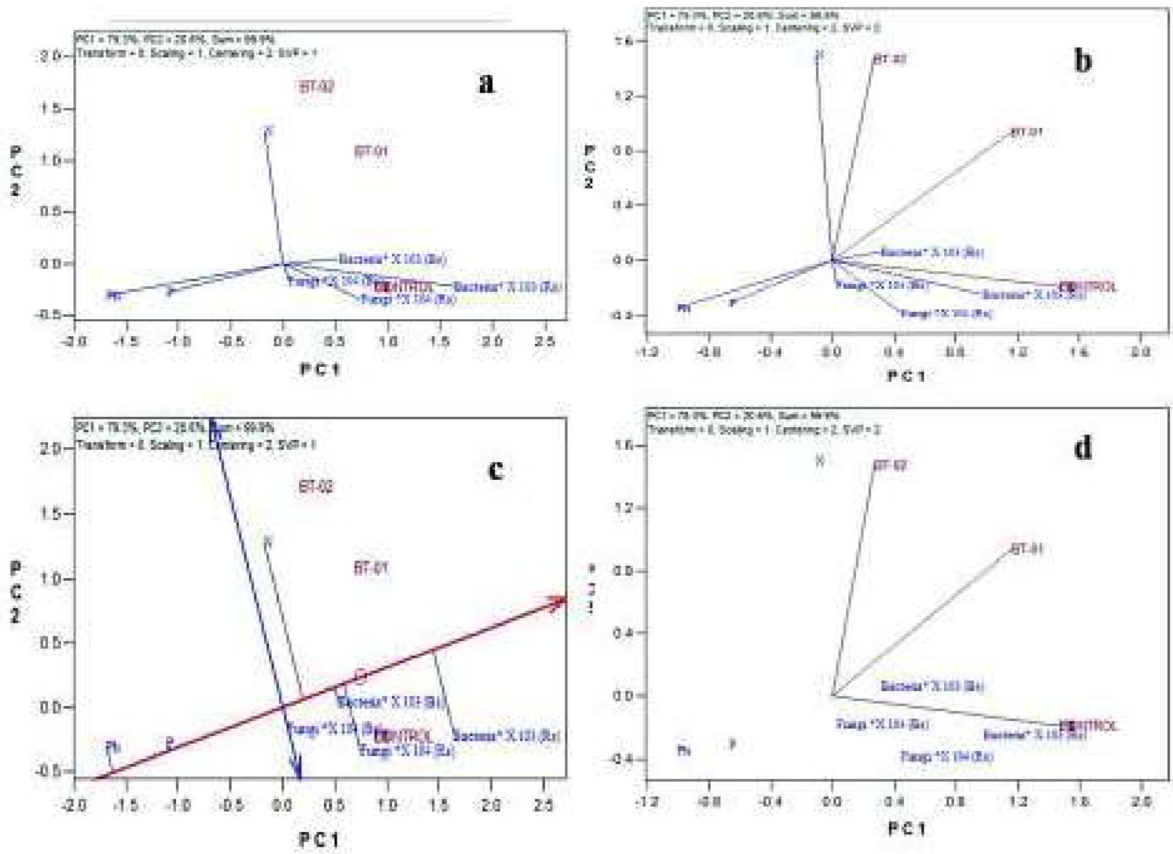

Fig. 1a-d: PCA analysis of microbial load with respect to the sites and physiochemical properties of saffron soil.

It was observed that as we move from the control site towards the cement factory, the microbial load decreases and it was directly correlated with chemical characteristics of soil as well. The N content was observed maximum at affected site while as pH and P content were shown to have direct impact on microbial flora of saffron plant.

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References

1. Ahiamadjie, H. and Adukpo, O. K. (2011). Determination of the Elemental Contents in Soils around Diamond Cement Factory, Aflao. *Research Journal of Environmental and Earth Sciences* **3(1):** 46-50.
2. Arul, A. and Nelson, R. (2015). Effect of Cement Dust Pollution on Morphology and Photosynthetic Pigments of Some Legume Plants Grown in Ariyalur District, Tamil Nadu. *Int. J. Adv. Multidiscip Res* **2(12):** 59-65
3. Baby, S., Singh, N. A., Shrivastava, N. S. R., Kumar, S.S., Singh, D. and Vivek, K. (2008). Impact of dust emission on plant vegetation of vicinity of cement plant. *Environ. Engineering and Management* **17(1):**31-35.
4. Hasenekoglu, I. and Sulun, Y. (1991) Erzurum Aşkale çimento fabrikasının kirlettiği toprakların mikrofungus florası üzerine araştırma. *Turk J Bot* **15:** 20-27.
5. Maletsika, P.A., Nanos, G.D. and Stavroulakis, G.G. (2015). Peach leaf responses to soil and cement dust pollution. *Environ Sci Pollut Res Int.* **22(20):** 15952-60.
6. Mandre, M. (1995). Physiological and biochemical responses of coniferous trees to alkaline dust impact. *Inst.of Ecol. Pub. Tallinn*, 44-65.
7. Ocak, D., Sulun, Y. and Hasenekoglu, I. (2004). The effect of cement dust emitted from Gaziantep Cement Plant on Micro fungus Flora of Surroundings Soils, Turkey. *Trakya Univ J Sci*. **5:**107-115.
8. Parray, J. A., Kamili, A.N., Reshi, Z.A., Hamid, R. and Qadri, R.A. (2013). Screening of beneficial properties of rhizobacteria isolated from Saffron (*Crocus sativus* L.) rhizosphere. *African J. Microbiol Res.* **7(23):** 2905-2910.
9. Princewill, C., Adanma, N.N. (2011). Metal concentration in soil and plants in abandoned cement factory. *IPCBEE*. **18:** 146-150
10. Raajasubramanian, D., Sundaramoorthy, P., Baskaran, L., Sankar, K., Ganesh, A.L., Chidambaram, A. and Jeganathan, M. (2011). Cement dust pollution on growth and yield attributes of groundnut (*Arachis hypogaea* L.) *International Multidisciplinary Research Journal.* **1(1):** 31-36.
11. Sadhana, C., Ashwani, K. and Anand, D.G .(2013). Cement Dust Pollution and Morphological Attributes of Groundnut (*Arachis hypogaea*). *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*. **4(1):** 20-25