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Impact of cement industry pollution on physio-morphological attributes of mango tree (*Mangifera indica*) around industrial belt Sarla Nagar, Maihar, Satna (M.P.)

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Abstract
Survival of plants in the vicinity of industrial areas is being threatened by particulates. This study was aimed to know the effect of cement industries dust on various parts of Mango tree growing at different distances from the cement industrial belt Sarla Nagar, Maihar, Satna (M.P.). Sampling was done at different distances ranging from 0.5-2.0 kms from the point source. The chlorophyll, carotenoid pigments, pH of leaf wash, pH of leaf extract and leaf size (length) were reduced in dustexposed plant species as compared to control site Uchehra (15 km away from the cement factories). Increased concentration of cement dust pollutants causes invisible injuries like progressive decline in photosynthetic ability and closure of leaf stomata and thus affect the growth and productivity of Mango tree. Besides the deleterious effects of the dust were expressed by the reduction in size of the leaf, damaged leaf margin and change in colour. Overall study shows that Mango trees growing near cement industries were adversely affected physiologically.

Keywords: Cement dust, Chlorophyll, Pollution, Mango Tree

1. Introduction
Cement industry is one of the most boomed up industry in India. It is second largest cement producer in the world after china. Cement industry is the one of the 17 most polluting industries listed by Central Pollution Control Board. During the last decades, the emission of dust from cement factories has increased alarmingly due to expansion of existing cement plants to meet the requirement of cement materials for construction work. In comparison with gaseous air pollutants, many of which are readily recognized as being the cause of injury to various types of vegetation (Gupta and Mishra, 1994 and Iqbal and Shafig, 2001) [1, 2], relatively limited studies have been carried out on the effect of cement dust pollution on vegetation especially in Jammu and Kashmir.

Cement dust pollution severely affects the growth and morphology of plants. It might be in the form of visible markings on the foliage such as chlorosis, necrosis, veinal deformities, mottling etc. Ade-Ademilua *et al*. (2008) [3] reported a significant reduction in shoot length, total leaf area and dry weight of plants affected by cement dust pollution. A significant delay in germination of seeds which was followed by growth retardation in terms of plant height and leaf area, number of leaves, length of petiole, number of flowers and fruits, fresh and dry weight were also seen by Katiyar *et al.*(2015) [4]. Reduction in growth parameters are due to the cumulative effects of the causal factors on the physiological processes necessary for plant growth and its development Schutzki and Cregg (2007) [5]. Dust deposition reduces diffusive resistance and increases temperature of leaf, making the tree more likely to be susceptible to drought. It also causes slight decrease in transpiration rate, stomatal conductance while increasing the leaf temperature.

Photosynthetic pigments mainly- chlorophyll and carotenoid contents, are affected by a variety of stress factors. As these are the dominant photosynthetic pigments in green plants and assessment of their concentrations in foliage provide an estimate of potential photosynthetic capability (Gitelson and Merzlyak, 1996 and Carter 1998) [6, 7]. Chlorophyll 'a' is being more severely affected than chlorophyll 'b'. Chlorophyll 'a' is degraded to phaeophytin through replacement of Mg^{+2} ions in chlorophyll molecules, while chlorophyll 'b' forms chlorophyllide 'b' through the removal of phytol group of the molecule (Rao and Blane, 1966) [8].

All the atmospheric pollutants retained by leaves are transformed inside the plant and affect its photosynthesis and respiration. This damage appears in the form of chlorotic and necrotic lesions at leaves level (Landis and Yu, 1995) [9]. Analysis of photosynthetic pigments may provide insight into the physiological status of vegetation (Moran, *et al.* 2000) [10]. The present study was undertaken with the objective to assess the impact of cement industries dust on the physiological and morphological attributes of Mango (*Mangifera indica*) planted in the vicinity of cement industries in Sarla Nagar, Maihar, Satna (M.P.).

2. Material and Methods

Maihar is located at 24.27°N 80.75°E. It has an average elevation of 367 metres (1204 ft). According to the locals of Maihar, the warriors Alha and Udal, who had war with Prithvi Raj Chauhan, were very strong followers of Sharda Devi. It is said that they are the first ones to visit the goddess in this remote forest. They called the mother goddess by the name 'Sharda Mai', and henceforth she became popular as 'Mata Sharda Mai'. Alha worshiped for 12 years and got the amaratva with the blessings of Sharda Devi. Behind the temple and downhill is Alha Pond. At a distance of 2 km from this pond is situated an 'akhara' (wrestling ring) where Alha and Udal used to practice *kushti* (wrestling). The people of Maihar believe that Alha is still alive and comes at 4 am in the morning to worship the Goddess Sharda.

In the present study only Mango plantations were studied for their response against heavy particulates emitted from cement industries. Collection of samples of vegetative parts of the Mango tree was performed at each site during 2015 and 2016 on seasonal basis. The samples were analysed for physicochemical parameters of chloroplast pigment, Carotenoids, pH of leaf wash, pH of leaf extract, Leaf size (cm). Chlorophyll and carotenoids were extracted in 80% acetone and readings were measured at 645,663,510 and 480 nm and calculations were made according to Arnon (1949) [11] using absorption coefficient. The leaf wash pH was determined following Pawar *et al.*, (1988) [12]. Leaf extract pH was estimated by method recommended by Singh and Rao (1983) [13]. Leaf size estimation was carried out using planimeter.

3. Results and Discussion

The impact of cement dust on Chlorophyll pigments and leaf length of Mango at various study sites around cement industrial area Sarla Nagar Maihar are given in Table 1. The data reveals that chlorophyll a concentration fluctuated from 0.346 to 0.398mg/gm, chlorophyll b from 0.046 to 0.191mg/gm and total chlorophyll from 0.392 to 0.589 mg/g at site III and at control site in Mango tree. The chlorophyll and carotenoid concentration increases as the age of plant and the distance from industry. The lowest concentration of both (chlorophyll and carotenoid) is found at site III which receives highest dust fall from all industries. Similar results regarding the chloroplast damaged by cement dust on leaf causing reduction in chlorophyll concentration in different plants were reported by Lerman (1972) [15]; Singh and Rao (1978) [16]. The shading effect of such layer could lead to suppression of chlorophyll a synthesis (Peirce, 1910 and Czaja, 1962) [17, 14].

Table 1: Chlorophyll pigments and leaf length of Mango at various study sites around industrial belt Sarla Nagar Maihar from (2015-2016).

S.No.	Parameter	Site- I	Site- II	Site- III	Site- IV
1.	Chlorophyll 'a' mg/g	0.357±0.007	0.362±0.04	0.345±0.004	0.397±0.005
2.	Chlorophyll 'b' mg/g	0.051±0.003	0.054±0.0015	0.045±0.003	0.191±0.003
3.	Carotenoids mg/g	0.814±0.004	0.852±0.006	0.795±0.007	0.890±0.008
4.	pH of leaf wash	9.15 ±0.025	8.72±0.060	9.64±0.121	7.04±0.03
5.	pH of leaf extract	7.61±0.055	7.50±0.404	7.93±0.050	6.53±0.045
6.	Leaf size (cm) (length)	5.4±0.100	5.5±0.020	5.3±0.200	6.1±0.251

Carotenoid pigments found in mature leaves are often not obvious because of the masking presence of chlorophyll. When chlorophyll is not present, as in autumn foliage, the yellows and oranges of the carotenoids are predominant. For the same reason, Carotenoid colours often predominate in ripe fruit after being unmasked by the disappearance of chlorophyll. Significant change was observed in Carotenoid concentration of trees nearest to the cement factories.

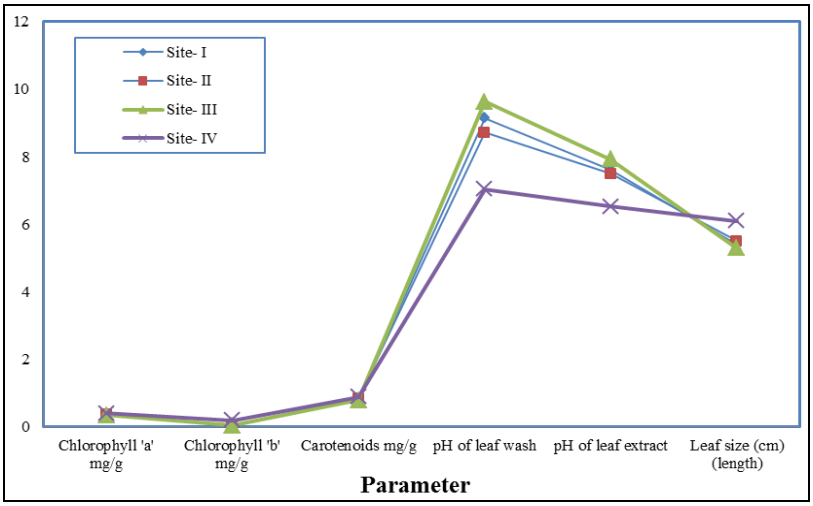

Fig 1: Chlorophyll pigments and leaf length of Mango at various study sites around industrial belt Saria Nagar Maihar from (2015-2016).

pH of leaf wash and leaf extract are important parameters and used as indicators of air pollution in the area. The pH of leaf

wash and pH of leaf extract showed an increase in the values i-e., towards the alkanity with maximum value in case of site III, followed by site I, site II and minimum value at the farthest site (site IV).With increase in cement dust concentration there was a progressive increase in pH of leaf wash and extract. The rise in pH could be due to the formation of hydroxide of almunium in the leaf tissue probably increasing pH of the leaf extract. The leaf length of studied Mango showed a significant decline of 0.8 cm (site III) as compared to control site. The size of Mango tree was fairly smaller, in the close vicinity of the industry as compared to those of the sites away from the source. Cement dust pollution severely affects the growth and morphology of plants. It might be in the form of visible markings on the foliage such as chlorosis, necrosis, veinal deformities, mottling etc. Ade-Ademilua *et al*. (2008) [19] reported a significant reduction in shoot length, total leaf area and dry weight of plants affected by cement dust pollution. A significant delay in germination of seeds which was followed by growth retardation in terms of plant height and leaf area, number of leaves, length of petiole, number of flowers and fruits, fresh and dry weight were also seen by Katiyar *et al.* (2015) [18].

In the present study also stunned growth in highly polluted zone and decrease in leaf area could be seen. Overall growth of the test plant was reduced.

4. Conclusion

The present study has shown that the deposition of cement dust has an effect on vegetation characteristics and natural communities that may alter the competitive balance between plant species. The physio- morphological characters of Mango tree were studied at different distances from the industry and compared with the control plant. The data obtained from different sites indicate that chloroplast pigment, carotenoids, pH of leaf wash, pH of leaf extract, Leaf size were affected by cement industry pollution. The Mango trees growing in control site were healthy than the trees growing near the cement factories. As the distance from the industry increases the plant growth also improves. Exposure to particulate deposition may alter plant growth and its physiology without physical damage to the plant. Moreover, accumulation of dust particulates on studied plant leaves could be a major problem in their production. It was proposed that the pigment content of the light harvesting complex is an important aspect related to the tolerance of plants to dust pollution. Chlorophyll content is essential for the photosynthetic activity and reduction in chlorophyll content has been used as an indicator of air pollution since it is fairly sensitive to air pollutants. Very fine particles (<1.0μm) present in cement dust closes the stomata thereby interfering with gaseous exchange resulting in detrimental changes in the leaf physiology. In general, the growth and development of plant was found to be affected negatively by cement dust, which may be due to the presence of different toxic pollutants in the cement dust. It clearly indicates that the cement industry pollution affect the photosynthetic activity and chlorophyll content adversely. Therefore, it is suggested that adequate green belt should be developed in and around the industrial area Sarla Nagar Maihar in order to restrict spreading of cement dust.

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