# Impact of Cement Dust on the Morphology of Saffron Plant (*Crocus sativus*) and Three Species of Horticultural Trees

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## ABSTRACT

Impact of cement dust on various parts of saffron plant (*Croccus sativus*) and on some selected species of horticultural trees was studied at some selected sites situated at different distances from the emission source. The highest sensitivity to dust impact was recorded in the content of chloroplast pigments, pH of leaf wash, pH of leaf extract, fresh and dry weight of leaves, length of leaves and length of saffron flower. The deleterious effects of the dust on the morphology of the leaves were expressed by the reduction in size of the leaf, damaged leaf margin and change of colour.

***Keywords:*** Cement dust, chloroplast, morphology, leaf extract

## INTRODUCTION

Air pollution has become a major threat to the survival of plants in the industrial areas (Gupta and Misra, 1994). The cement industry also plays a vital role in the imbalances of the environment and produces air pollution hazards (Stern, 1976). In comparison with gaseous air pollutants, many of which are readily recognized as being the cause of injury to various types of vegetation, relatively little is known and limited studies have been carried out on the effects of cement dust pollution on the growth of plants. Reduction in the number of flowers and yield of black gram (*Vigna mungo* L. Nipper) due to cement dust pollution was observed by Prasad and Inamdar (1990). Gupta and Misra (1994) have also reported the toxic effect of cement dust on the stomatal clogging of *Iphonia grantoides*. Lerman and Darley, (1975) have observed a marked reduction in the growth of poplar trees, 1 mile from a cement plant when cement production was more than doubled.

Stratmann and Van Ttaut (1966) dusted plants with quantities of dust ranging from 1 to 48 g/m$^2$ per day and observed that dust falling on the soil caused a shift in pH to the alkaline side, which was unfavourable to oats but favourable to pasture grass. Darley *et al.*(1966) noted that plants were stunted and had few leaves in the heavily dusted portion of an alfalfa field downwind from a cement plant. Brandt and Rhoades (1972) observed significant

changes in structure and composition of the seedling, sapling, shrub and tree strata when they compared to dusted and non-dusted forest communities in the vicinity of limestone quarries and processing plants.

The present paper presents an assessment of the impact of cement dust pollution on the saffron (*Croccus sativus*) and on three species of horticultural trees like almond (*Prunus amygdalus*), walnut (*Juglans regia*) and apricot (*Prunus armanica*) in the vicinity of a cement factory established in 1982 under the banner of Jammu and Kashmir Cements Limited in Khrew area of Pampore in Kashmir.

## STUDY AREA

Khrew is situated 20km to North-east of Srinagar city at an altitude of 1680m ASL. In 1982, a large cement factory with a capacity of 600 tons of cement production per day, was set up at Khrew under the name of Jammu and Kashmir Cements Limited. The main raw materials used for the production of cement include limestone, clay, sandstone, bauxite and gypsum. Cement dust, oxides of sulphur and nitrogen are the main pollutants of cement industry. It has been studied during the field study that the total area affected by cement industry is about 2 $km^2$. The north and northeastern area is covered by mountain ranges while on the other sides it is surrounded by flat arable land of karewas. Due to prevailing topographic and meteorological condition in the area pollutants are deposited in the east and southeast of the factory. It is because of the presence of comparatively higher mountain range north-eastern side from where the wind moves down towards the south-eastern side of the factory. Site 1 was adjacent to the cement factory and was in receipt of heavy dust pollution. Site 2 was located 0.5 km away from the cement factory, while the site 3 was about 1 km away from it. Site 4 was located about 1.5 km away from the factory; site 5 was located about 2 km away from the cement factory. Site 6, which was located at Pampore, was used as a control site.

## MATERIAL AND METHODS

Collection of samples of vegetative parts of the saffron plant and horticultural trees was performed at each study site during 2004 and 2005 on seasonal basis. The samples were analysed for physico-chemical parameters of chloroplast pigment, pH of leaf wash, pH of leaf extract, fresh and dry weight of leaves and length of saffron flower. The chloroplast pigments were determined in accordance with the methods given by Arnon (1949).

## RESULTS AND DISCUSSION

The results presented in Table 1 revealed that chlorophyll *a* fluctuated from 0.11 to 0.51 mg/g, chlorophyll *b* from 0.02 to 0.21 mg/g and total chlorophyll from 0.13 to 0.72 mg/g at site 1 and at control site in case of saffron plant. A significant reduction in chlorophyll contents of the foliage was observed at all the polluted sites. Earlier also the decrease in the chloroplast pigments due to cement dust pollution (Shukla et al., 1990 and Misra et al., 1993) stands recorded. The reduction in the chlorophyll content might have been caused by the

highly alkaline nature of cement dust which might have degraded the chlorophyll molecules or by shading as has also been reported by Borka (1980). Lerman (1972) suggested that continuous application of cement clogs the stomata so interfering with the gaseous exchange. This may lead to increased leaf temperature which may retard chlorophyll synthesis (Mark, 1963; Singh and Rao, 1981).

pH of leaf wash was fairly higher (9.2) in dusted plants at site closest to the source of pollution as compared to 7.63 of control site. Same was true for pH of leaf extract which was 7.18 at site 1 and 6.69 at control site. With the 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 aluminum in the leaf tissue probably increasing pH of the leaf extract.

There was significant reduction in both fresh and dry weight of the leaves (leaves of four plants and four leaves from each plant at each site) of saffron plant. The fresh weight ranged between 48mg at cement dust polluted site 1 and 68mg at control site 6 whereas the dry weight ranged between 12mg and 27mg for each site respectively. Such reductions may be due to reduced photosynthesis, through a combination of factors such as reduced interference with the gaseous exchange of foliage due to clogging of stomata, interception in the incident light due to cement encrustation on the leaf surface, pigment degradation and intra or inter-cellular changes in the leaves (Shukla *et al.*, 1990). A reduction of 0.40cm in the average length of the saffron flower was recorded between site 6 and site 1. In general, it was also observed that change in the floristic characters of the saffron plant was more in the second year than the previous year.

**Table 1. Mean impact of dust deposition on the chloroplast pigments, biomass and length of saffron leaves during 2004 2005**

| Variables | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 |
|---|---|---|---|---|---|---|
| Chlorophyll 'a' (mg/g) | 0.11 | 0.22 | 0.29 | 0.32 | 0.39 | 0.51 |
| Chlorophyll 'b' (mg/g) | 0.02 | 0.05 | 0.07 | 0.08 | 0.10 | 0.21 |
| Total chloroplast(mg/g) | 0.13 | 0.27 | 0.36 | 0.40 | 0.49 | 0.72 |
| pH of leaf wash | 9.22 | 9.12 | 8.93 | 8.72 | 8.01 | 7.63 |
| pH of leaf extract | 7.18 | 7.16 | 7.09 | 7.02 | 7.o1 | 6.69 |
| Fresh weight of leaves (mg) | 48 | 52 | 56 | 60 | 61 | 68 |
| Dry weight of leaves (mg) | 12 | 13 | 16 | 19 | 24 | 27 |
| Length of leaves (cm) | 5.9 | 6.1 | 6.2 | 6.4 | 6.5 | 7.00 |
| Length of flower (cm) | 6.9 | 7.00 | 7.10 | 7.14 | 7.21 | 7.30 |

Analysis of vegetative samples of some selected horticultural trees almond (*Prunus amygdalus*), walnut (*Juglans regia*) and apricot (*Prunus arminiaca*) from the six sites showed a marked reduction in the chloroplast pigments as one moves towards the polluted site. The chlorophyll *a* exhibited a low value of 0.104 mg/g at site 1 in case of leaves taken from an almond tree and a high value of 0.44 mg/g at site 6. Similar trend was observed in the walnut and apricot with minimum values of 0.096 and 0.345 mg/g at site 1 and maximum values of 0.42 and 0.398 mg/g at site 6 respectively.

Table 2 Chloroplast pigments and leaf length of horticultural trees at various study sites in cement industry area

| Variables | Almond | | | | | | Walnut | | | | | | Apricot | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S-1 | S-2 | S-3 | S-4 | S-5 | S-6 | S-1 | S-2 | S-3 | S-4 | S-5 | S-6 | S-1 | S-2 | S-3 | S-4 | S-5 | S-6 |
| Chlorophyll (mg/g) | 0.104 | 0.116 | 0.119 | 0.21 | 0.32 | 0.44 | 0.96 | 0.112 | 0.117 | 0.118 | 0.29 | 0.42 | 0.345 | 0.349 | 0.352 | 0.362 | 0.392 | 0.398 |
| Chlorophyll (mg/g) | 0.159 | 0.162 | 0.168 | 0.182 | 0.192 | 0.198 | 0.310 | 0.313 | 0.321 | 0.332 | 0.352 | 0.372 | 0.047 | 0.051 | 0.054 | 0.062 | 0.0092 | 0.192 |
| Carotenoids g/g) | 0.259 | 0.258 | 0.272 | 0.283 | 0.292 | 0.293 | 0.298 | 0.538 | 0.542 | 0.568 | 0.598 | 0.613 | 0.790 | 0.812 | 0.813 | 0.869 | 0.892 | 0.898 |
| pH of leaf wash | 9.25 | 9.16 | 9.03 | 8.72 | 8.32 | 7.33 | 9.22 | 9.10 | 9.03 | 8.92 | 8.32 | 7.72 | 9.68 | 9.18 | 8.72 | 8.13 | 7.79 | 7.03 |
| pH of leaf extract | 7.63 | 7.32 | 7.03 | 7.01 | 6.93 | 6.92 | 7.82 | 7.63 | 7.16 | 7.01 | 6.63 | 6.16 | 7.92 | 7.63 | 7.59 | 7.10 | 6.93 | 6.52 |
| Leaf size (cm) | 5.2 | 5.6 | 5.9 | 5.9 | 6.1 | 6.2 | 15.5 | 15.5 | 15.8 | 15.88 | 15.92 | 16.4 | 5.3 | 5.4 | 5.49 | 5.5 | 5.57 | 6.1 |



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Similarly, for chlorophyll *b* the values of 0.159, 0.310 and 0.047 mg/g were recorded for the leaves taken from almond, walnut and apricot at site 1 which were fairly low as compared to those of 0.198 mg/g; 0.372 and 0.112 mg/g at the control site for the three corresponding horticultural trees. The pH of leaf wash and pH of leaf extract showed an increase in the values i.e., towards the alkalinity with maximum value in case of site 1 and minimum value at the farthest site or site 6. The leaf size showed a significant decline from 5 6 cm at site 1. A clear signature of cement dust pollution on the horticultural trees especially located in saffron fields in the vicinity of cement factory was observed in respect of the leaf size. The size of the horticultural trees was fairly smaller in the close vicinity of the factory as compared to those of the sites farthest away from the source.

In general, the growth and development of plants was found to be affected negatively by cement dust, which may be due to the presence of different toxic pollutants in the cement dust.

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