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EFFECT OF INDUSTRIAL AIR POLLUTION ON SOME FRUIT TREES

SUMMARY OF THE
THESIS SUBMITTED TO
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Baroda (Vadodara) Urban area lies between 73° and 74° 13' longitude and 21° and 23° north latitude, in Gujarat State, India. After the discovery of oil and natural gas in the vicinity in sixities, a major industrial complex has come up on the north-west of Baroda City. This comprises a Fertilizer Complex, an Oil Refinery Petrochemicals, Alkalies and Chemicals and various medium and small scale chemical industries (209) at Nandesari Industrial Estate. These sources are emitting various noxious air pollutants, toxifying the ambient environment, adversely affecting economic plants, general vegetation and other organisms including human beings.

MAJOR OBJECTIVES OF THE STUDY

(i) There is a huge lacuna in our knowledge about the interaction, effects and sensitivity level of indigenous economic tree species to air pollution. This study was conducted with an aim to partially fill this lacuna and enrich the scientific knowledge.

(ii) In the vicinity of the industrial source, there is often heavy damage to the vegetation. It is difficult to pinpoint the source and causative agent. Thus, to provide an authentic data and methodology to trace the causative agent and the source of damage.

(iii) To monitor the extent of pollution with help of damaging pattern of vegetation, phytochemical analysis coupled with meteorological parameters.

(iv) To study the effect of known concentration of specific pollutant i.e. sulphur dioxide on plants under laboratory condition.

(v) To initiate some experiments to minimize the pollution damage to plants by antidote, to further line of research in pollution abatement effects.

This study has been presented in the thesis under the following five Chapters:

Chapter 1. Introduction
Chapter 2. Materials and Methods
Chapter 3. Results
Chapter 4. Discussion
Chapter 5. Conclusion.

The investigation was carried out in three phases.

I. FIELD SURVEY

1.1. Field survey of general vegetation near a fertilizer complex - A gradient study (East - west):

A gradient near a fertilizer complex in the winward direction was studied and the plant species present at 0.5,

1•5 and 2•5 Km•, from the source were recorded• Observations for the nature of visual symptoms, degree of damage and species frequency were noted• The herbaceous species exhibited more species diversity as well as increased frequency and density with increasing distance form the source•

1•2• Study on the trees growing along National Highway No• 8 - A gradient study (North-South):

The combined effect of autoexhaust and industrial air pollution on trees viz•, Dalbergia sissoo Roxb• and Syzygium cumini Skeels growing along the National Highway No• 8 (Baroda - Ahmedabad) was studied• Among the seven sectors studied, trees growing in the sector four, where a fertilizer complex is located, showed severe damage in various growth parameters, frequency and density•

1•3• Field survey of selected fruit trees:

This investigation was carried out to determine the extent of air pollution damage to some economically important tropical fruit trees most common around the industrial complexes viz•, Mangifera indica L• (mango) Manilkara hexandra Dubard• (rayan) and Syzygium cumini Skeels (jamun)• Detailed morphological,biochemical and yield observations were made• The villages surveyed were Koyali, Bajwa, Dumad, Angadh, Ranoli, Dhanora, Ankodia, Undera, Chhani, Sankarda, and Ampad• Samiyala (least polluted) was taken as control•

The morphological observations especially the pattern of damage to tree canopy coupled with meteorological parameters provided the clue for the direction of pollution source. Among the three tree species, mango exhibited severe damage in all the parameters investigated and also accumulated higher concentration of pollutants derivatives i.e. sulphur and chloride. Jamun exhibited relatively high tolerance to air pollution. In jamun sulphur accumulation was comparatively less in the pollution zone as compared to control. Rayan trees exhibited intermediate sensitivity to air pollution.

Based on the plant damage, the observation stations were classified into three groups. All the three species growing at Angadh, Bajwa, Ranoli and Dhanora exhibited high degree of damage in all the parameters.

Mango trees growing at Koyali, Sankarda, Dumad, Chhani, Undera and Ankodia showed medium degree of damage and low damage at Ampad which was often close to the control.

In rayan trees medium damage to various parameters was recorded at Koyali, Sankarda, Chhani and Undera whereas low degree of damage was noticed at Ankodia, Dumad and Ampad.

Jamun trees growing at Koyali, Sankarda, and Chhani exhibited medium damage in morphological, biochemical and yield parameters. At other stations i.e. Ankodia, Undera, Dumad and Ampad low damage was recorded.

Foliar epidermal observations showed, that plants growing in pollution zone exhibited variation in their foliar epidermal traits. The stomatal frequency, stomatal index and size of stomatal aperture were reduced at pollution zone as compared to control. The thickness of the cuticle and trichome density increased at pollution zone. This shows, that plants may be able to reduce the entry of gaseous pollutants into the foliar tissues by these adaptations.

Soil study showed that no significant variation in soil parameters (pH, conductivity, chloride, sulphur, nitrogen and organic matter content) at different observation stations. Soil observations did not show remarkable correlation with ambient air pollutants concentration except at the highly polluted stations like Angadh and Ranoli.

II. FIELD EXPOSURE STUDY OF EXPERIMENTAL POTTED PLANTS (mango, rayan and jamun saplings)

This investigation was carried out to determine the seasonal response of three tree species under investigation at different stations in the pollution zone. One year old

fruit tree saplings in experimental pots containing humus rich garden soil were exposed to ambient air at the following stations: Bajwa, Koyali, Omkarpura, Ranoli, Padamla, Sankarda, Fajalpur, Damapura, Angadh and control in the University arboratum. Same edaphic and cultural practices were maintained except exposure to different ambient air environment.

The seasonal changes in growth parameters (shoot length, number of leaves/plant, total leaf area, injury index) and various biochemical parameters (photosynthetic pigments, ascorbic acid, protein, total free aminoacids, soluble sugars and sulphur content) were recorded. The results were compared with control and correlated with the ambient air concentration of major pollutants like SO_2, NOx and SPM (Data obtained from VUDA generated by National Institute of Occupational Health) at stations in windward and leeward direction during different seasons.

This study revealed, that the change in wind direction influenced the extent of damage to the plants, but at Damapura and Angadh the plants exhibited severe damage in all the three seasons regardless of the season. This was due to the closer proximity of the source i.e. Nandesari Industrial Estate which discharges high concentrations of mixture of pollutants into the ambient air. Jamun plants comparatively exhibited good recovery than rayan and mango

during the favourable spell. Recovery mechanism was intermediate in rayan and least in mango saplings.

III. ARTIFICIAL FUMIGATION STUDY ON MANGO, RAYAN AND JAMUN

To study the impact of specific pollutant i.e. sulphur dioxide, obe year old saplings of mango, rayan and jamun were exposed to 0.5 ppm of SO_2 in $1m^3$ fumigation chamber for two hours, with two days intervals upto 180 days. Among the three species, mango was observed to be highly sensitive to SO_2. This study revealed that exposed SO_2 concentration (60 $ppmh^{-1}$ accumulative SO_2 dose) caused visible damage to mango saplings, whereas subtle injury in rayan and jamun saplings.

AMELIORATION OF SO_2 EFFECT BY ASCORBIC ACID TREATMENT

A study was also conducted to mitigate the deleterious effect of SO_2 by treating SO_2 exposed plants with 10 and 100 µmoles of ascorbic acid as weekly foliar spray. This preliminary study on the abatement of SO_2 effect on plants clearly indicated that ascorbic acid treatment mitigated the SO_2 effect on plants. In mango, the mitigating effect was comparatively more with 10 µmoles ascorbic acid concentration, while in rayan and jamun more amelioration was observed with 100 µmoles ascorbic acid treatment.

SOME HIGHLIGHTS OF THE INVESTIGATION

1. Among the three fruit trees studied, mango is found to be sensitive to pollution and gets damaged severely. Jamun is resistant and also exhibited good growth in the pollution zone. Rayan exhibited intermediate sensitivity.

2. In this study, foliar sulphur content in all the three species was observed higher than control at all the stations in pollution zone. This indicates, SO_2 is the major pollutant in the ambient air at all the stations.

3. Foliar chloride was recorded very high at Ranoli, in all the three species. This indicates chlorine is the major pollutant localized at this station (from Gujarat Alkalies and Chemicals plant).

4. The biochemical observations especially pollutant accumulation coupled with pattern of damage and meteorological parameters can be used for monitoring the extent of pollution, source and causative agent of pollution damage can also be established.

5. This study shows that ascorbic acid can be used as a mitigating agent against sulphur dioxide pollution damage.