0635

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Effect of Automobile Lead Pollution on *Cassia tora* L. and *Cassia occidentalis* L.

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ABSTRACT

The effect of car exhaust lead pollution on pollen germination and seed viability of two roadside weeds, Cassia tora *L. and* Cassia occidentalis *L., was studied. A decrease in the percentage of pollen germination and seed viability was observed in plants growing near Highway No. 8. With increasing distance from the highway pollen germination and seed viability improved, and at a distance of 60 m from the road the percentage of pollen germination and seed viability became closer to normal. The decrease in pollen germination and reduction in viability were directly proportional to the amount of lead accumulated in the plants.*

INTRODUCTION

Sixty to seventy percent of the pollution in urban environments is due solely to motor vehicles. The emission from vehicles contains oxides of sulphur, oxides of nitrogen, hydrocarbons and particulate matter which contains lead (Lynn, 1976; Parker, 1977). These pollutants have a phytotoxic effect, which may or may not be visible. The common symptoms are changes in the rates of photosynthesis and transpiration, and reduction in chlorophyll content, with a consequent reduction in yield (Stern, 1977).

Lead is added as an antiknock compound in petrol to increase the octane level. In India this addition amounts to 150–300 mg litre^{-1}, of which 80–90 % escapes in the car exhaust (Chatterjee, 1979). The lead is

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9423

accumulated in roadside vegetation, soil, animals and the human body, affecting physical and physiological parameters, including the plant reproductive cycle. It is potentially harmful even at low concentrations (Peel, 1983).

Many workers have reported the impact of car exhaust pollution on the environment. Some have recorded the deposition of lead on roadside soil and vegetation (Daines *et al.*, 1970; Ganje & Page, 1972; Smith, 1976; Rodriguez-Flores & Rodriguez-Castellon, 1982). Some work has been reported on the *in vitro* effect of SO_2 on pollen germination and pollen tube growth (Murdy, 1979; Varshney & Varshney, 1981). The present work deals with the effect of car exhaust lead pollution on pollen germination, pollen tube growth and seed viability in roadside weeds.

MATERIALS AND METHODS

The study area chosen was the Bombay–Ahmedabad Highway (No. 8) passing through Baroda (India) at 73′ 0″ and 73′ 30″ E longitude, 22′ 0″ and 22′ 30″ N latitude and 30 m above mean sea level, and with a vehicular traffic of 15 000–16 000 per day. A gradient was taken up to 60 m at right angles to the road to assess the impact of car exhaust lead pollution on both sides of the highway. Lead uptake was recorded in the two plant species, *Cassia tora* L. and *C. occidentalis* L., growing along the gradient. A control area where lead pollution was minimal was also taken for comparison. Sampling was done during the months of September and December.

Sampling

Sampling was done both in control and experimental areas. The plants are common roadside weeds and complete their life cycle within 6 months. When the plants reached flowering stage the inflorescences were removed and kept in polythene bags. These bags were brought to the laboratory immediately and pollen germination studies conducted.

Germination studies

Germination studies were carried out at room temperature (27 °C). A nutrient medium was prepared containing 10 % sucrose, 0·02 % boric acid

and 0·5 % agar and put on a slide. Pollen grains were then sprayed on to it. Humidity was provided by keeping the slides in Petri dishes containing wet filter paper. The percentage of pollen germination and growth of the pollen tube was recorded after 2 h.

When the plants were about to finish their life cycle the mature pods were removed, dried, stored for one month and then seed viability studies were conducted. Seeds were soaked in concentrated H_2SO_4, 3 min for *C. tora* and 5 min for *C. occidentalis*, and then kept in running tap water for 2 h. They were then washed with distilled water and transferred to Petri dishes containing moist filter paper for germination. Seed viability was recorded by observing them up to 48 h. The germination studies were repeated 4 times.

Chemical analysis

The amount of lead accumulated in the plant and soil was estimated to establish the correlation between the amount of lead accumulation in the foliar tissues and the impact on the reproductive cycle of the plants. During the flowering stage the middle-aged leaves were removed, washed, oven-dried at 60 °C for 24 h and powdered. Soil samples collected from the upper layer (up to 5 cm) from all the points along the gradients (2, 20, 40 and 60 m from the source and control) were oven-dried. Powdered samples of leaf and soil were sieved through a 100 μm sieve and digested with a mixture of H_2SO_4, HNO_3 and $HClO_4$ (1:5:1). Lead was estimated using a Varian Tectron 1200 atomic absorption spectrophotometer (Brooks, 1972).

RESULTS

The impact of lead uptake by these plant species is given in Tables 1–4.

As can be seen from Table 1, the level of lead accumulation was inversely proportional to the distance from the highway. The percentage of pollen germination, pollen tube growth and percentage of seed germination were directly proportional to the concentration of lead as well as to the distance from the highway (Tables 2, 3 and 4).

Although the amount of lead accumulated and the germination studies showed a well-marked gradient, there was a difference between the two species: *C. tora* showed severe injury even with low concentrations of

TABLE 1
Lead Concentration ($\mu g\, g^{-1}$ dry wt)

Source of lead	*Control*	*Distance from the highway (m)*			
		2	*20*	*40*	*60*
Cassia tora	18	208	90	55	20
Cassia occidentalis	18	303	97	68	22
In soil	36	500	312	112	46

Readings mentioned in Tables 1–4 are an average of 4 replicates.

TABLE 2
Percentage of Pollen Germination

Source	*Control*	*Distance from the highway (m)*			
		2	*20*	*40*	*60*
Cassia tora	67	10	17	30	57
Cassia occidentalis	72	20	37	47	62

TABLE 3
Length of Pollen Tube (μm)

Source	*Control*	*Distance from the highway (m)*			
		2	*20*	*40*	*60*
Cassia tora	375	30	90	165	235
Cassia occidentalis	720	300	405	495	570

TABLE 4
Percentage of Seed Germination

Source	*Control*	*Distance from the highway (m)*			
		2	*20*	*40*	*60*
Cassia tora	66	13	20	33	46
Cassia occidentalis	86	13	33	40	53

lead, whereas *C. occidentalis* showed some resistance. The levels of lead in the control plants of both species were the same (Table 1).

DISCUSSION

Meteorological parameters such as wind direction and speed, and distance from the source, influence the impact of lead pollution from motor vehicles. The response of plants to different concentrations of pollutant is variable. In the present study there was an evident difference between *C. tora* and *C. occidentalis* in percentage pollen germination, pollen tube growth and seed viability. Besides these parameters a reduction in the life cycle period of the plants growing near the highway was observed as compared with the control by 15–20 days.

The lead accumulation was very high in plants growing near the highway, compared with the control. This accumulation decreased with increasing distance of the plants along the gradient (Table 1).

The effect of lead pollution reported here might be caused by the synergistic effect of various pollutants, but for the present investigation only lead uptake and its influence on the reproductive cycle of the plant species have been studied. A good correlation has been obtained between lead levels and the effects on the plants.

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