to kill the aphids in one set. From the other set of the plants aphids were transferred to another set of healthy plants. This process was repeated for 10 days to test for non-persistent or persistent virus transmission.

Seventy per cent of mechanically inoculated opium poppy plants showed mosaic symptoms 9–10 days after inoculation (figure 1) and veinal necrosis after 18–20 days, which led to premature death of the plants. Only 5% of the plants inoculated by insect transmission exhibited symptoms of the disease, and the virus transmission was non-persistent[1-3].

Host range of the virus was very limited. However, *Sonchus asper* L. and *Argemone mexicana* L. showed severe systemic symptoms after inoculation. *Chenopodium amaranticolor* Coste & Reyn and *C. quinoa* Willd. produced pale chlorotic lesions 5 days after inoculation. Thermal inactivation point of the virus was 50–55°C; the virus retained infectivity for up to 50 h at 30–35°C and showed pathogenicity at dilutions up to 10^{-3}.

Electron microscopic examination of leaf-dip preparations revealed that the virus is a flexible rod, about 765 nm long. Infected cells exhibited numerous scrolls and a few pin-wheel inclusion bodies. Turnip mosaic virus, a member of the potyvirus group, has been reported on opium poppy from Hungary[2]. Bean yellow mosaic virus has also been reported to naturally infect opium poppy in Bulgaria[4]. A strain of turnip mosaic virus causing mosaic disease of radish has, however, been reported to be mechanically transmitted to poppy[5]. A viral disease of opium poppy has also been reported to be caused by a spherical virus[1]. The present virus differs significantly in particle morphology[6], biological properties and symptomatology[7] from the above reports[1,7]. On the basis of host range, biological properties, insect transmission and electron microscopic studies, the present isolate appears to be a member of the potyvirus group. A perusal of the literature indicates that this is the first report of occurrence of a potyvirus on opium poppy in India[7,9].

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RAPID EFFECTS OF LEAD ON WATER HYACINTH (*EICHHORNIA CRASSIPES* SOLMS) PLANTS FOLLOWING SINGLE EXPOSURE DETECTED BY PHOTOACOUSTIC SPECTROSCOPY

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LEAD is a biologically nonessential metal. It is well known for its toxicity to plants and animals[1,2]. Even 10 ppm of lead in solution can stop root growth completely in certain plants[3]. It inhibits the activity of many enzymes that have key roles in cellular metabolism and in biosynthesis of some important compounds such as haem and chlorophyll[1,2,4]. Incubation of *Anacystis nidulans* thylakoids with Pb^{2+} (0.5 mM) for 30 min at 4°C removes 60% of the Mn pool. Only 0.5 mM of Pb^{2+} reduces oxygen evolution to zero[5]. Many sources of lead are responsible for contamination of the environment. Lead mining, industrial use of lead and combustion of petrol containing lead additives are the main causes of lead pollution. Urban areas and rural areas near major roads are more likely to be subjected to contamination by these sources. Plants growing in these places are highly exposed to lead, which gets deposited in various plant tissues and becomes a

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potential causal factor in plant pathology[1,6]. Lead taken up by plants becomes a source of lead poisoning for animals.

The present study was carried out with a view to find out the rapidity of post-exposure effects of lead on water hyacinth (*Eichhornia crassipes* Solms) plants by using the sensitive technique of photoacoustic spectroscopy. These plants were chosen for the study because they absorb metals very rapidly. They can absorb 65% of lead from the surrounding medium within an hour of exposure to 10 ppm[6].

The plants were collected from a pond in a botanical garden. A lead nitrate solution of 100 ppm with 62.5 ppm of Pb^{2+} was prepared in 16 l of pond water in a big plastic bowl. Four similar plants were kept in the solution. Four other similar plants were kept in the same amount of pond water in a second bowl as controls. Every 24 h a single plant was picked up from each of the bowls and washed with tap-water to remove lead nitrate deposited on the surface. A photoacoustic (PA) spectrum of one leaf of both exposed and control plants was taken immediately after removal without allowing them to dry. Spectra were recorded at 24, 48 and 72 h of exposure. All the spectra were taken with a modulation frequency of 80 Hz on a single beam PA spectrometer (model OAS 400, EDT Research, London) with a 300 W xenon lamp. The PA spectra were measured under identical conditions of illumination and corrected using the same carbon black reference sample.

Figure 1 shows PA spectra of a control sample and of samples taken from lead-exposed plants after 24, 48 and 72 h. A strong PA signal is seen in the wavelength range 200–400 nm whereas a weak one is seen in the range 400–800 nm. This is attributed to the presence of the cuticle, which is transparent to visible light but presents a thermal barrier to the diffusion of heat generated in the underlying material following absorption of visible light[7]. But the cuticle itself absorbs in the wavelength range between 200 and 400 nm and the heat generated following this ultraviolet absorption faces no thermal barrier.

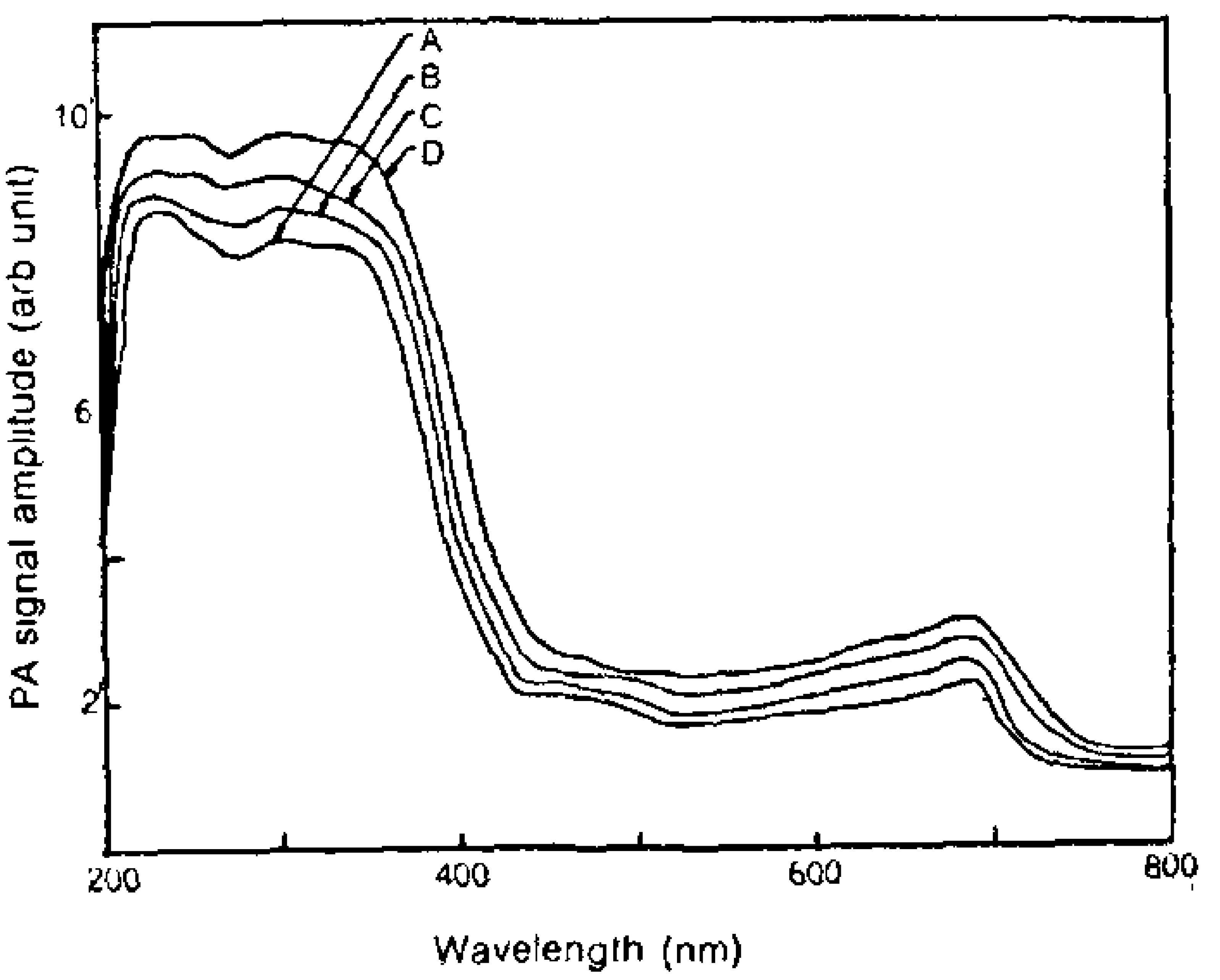

Figure 1. Photoacoustic spectra of water hyacinth leaves. A, control; B, 24 h exposure of plant to lead nitrate; C, 48 h exposure; D, 72 h exposure.

An enhancement in PA signal amplitude all along the spectral range was observed following the lead exposure, and signal amplitude increased with increase in exposure time (curves B, C and D of figure 1). Lead being a heavy cation, most of the absorbed lead gets deposited in the root system of the plant. Wolverton and McDonald[6] observed by atomic absorption spectroscopy that lead gets deposited in the ratio 71:1 in roots and stem. The large amount of lead in the roots could have impaired the entire root system, seriously affecting absorption of water. As a result, the water content of the upper parts of the exposed plants could have been reduced owing to natural dehydration, causing a reduction in specific heat and density of leaf material and thickness of the cuticle. This could have resulted in an increase in the heat diffusion through various layers of the leaf including the cuticle. Because the thermal diffusivity is defined as $\alpha = k/\rho c$, where, k is the thermal conductivity, ρ, the density of leaf material and c, the specific heat, increased diffusivity would mean accelerated heat flow through various layers and probably also partial failure of the cuticle to function as a thermal barrier. Hence an increase in PA signal was observed. Rosencwaig and Pines[8] also reported a

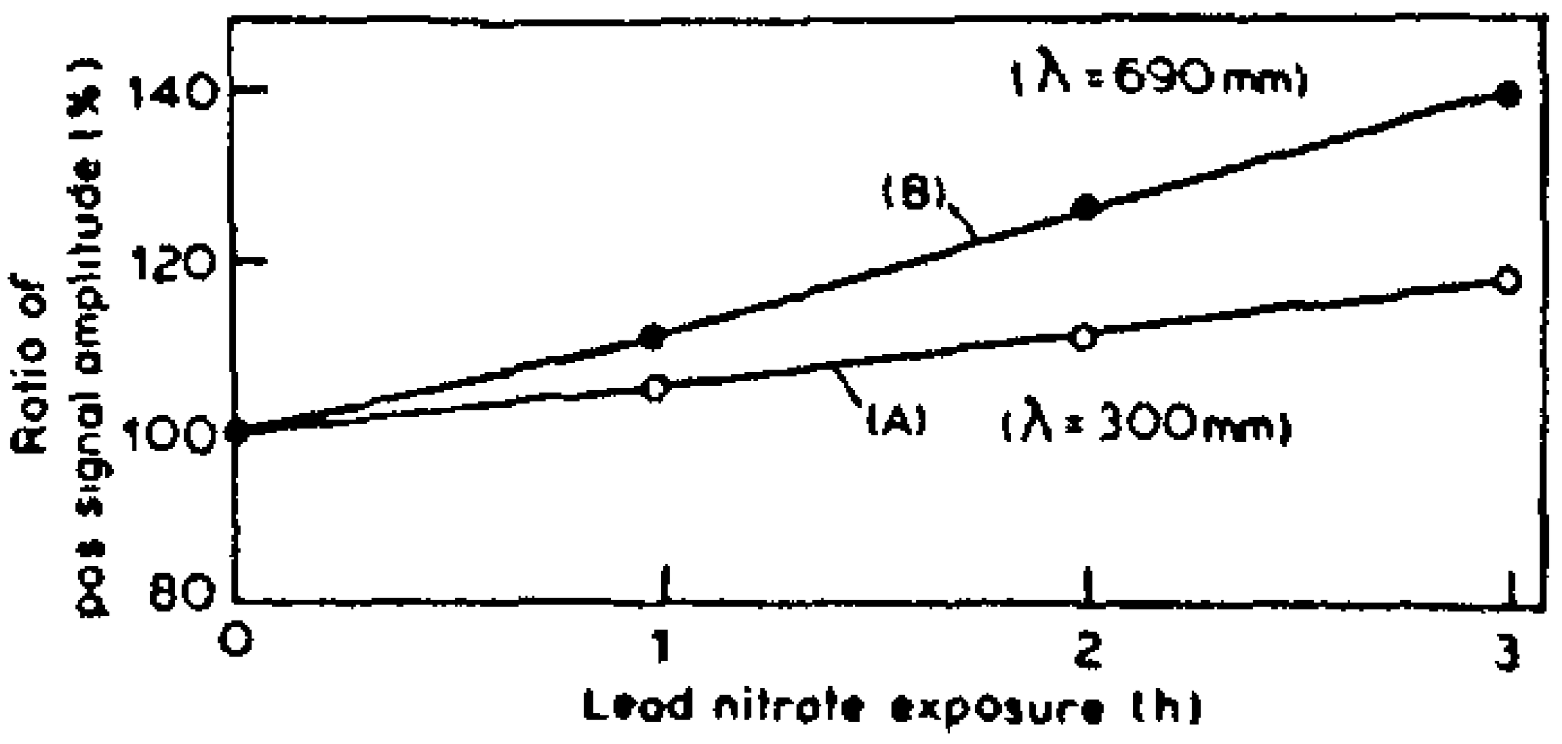

Figure 2. Ratio of signal amplitude at two wavelengths of PA spectra of leaves from lead-exposed plants to the signal amplitude of spectra of control sample as a function of duration of exposure.

similar relationship between PA signal and water content of sample in experiments with rat stratum corneum. Figure 2 shows plots of ratio of signal amplitude versus time of exposure for two wavelengths, 300 and 690 nm. It can be seen that the ratio of signal amplitude at 690 nm increases rapidly compared to that at 300 nm. This suggests that there may be effects in addition to those mentioned above. The extra enhancement of signal at 690 nm could be due to inhibition in photosynthesis caused by lead, and reduction in photosynthesis causes reduction in photochemical energy loss, making more absorbed light energy available for nonradiative relaxation[9]. Lead affects biosynthesis of chlorophylls and haem through inhibition of δ-aminolaevulinate dehydratase[2]. It still remains to be seen in what way lead exposure affects photosynthesis.

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TRATHALA FLAVO-ORBITALIS CAMERON (ICHNEUMONIDAE)—PARASITE OF *LEUCINODES ORBONALIS* GUEN. FROM BIHAR

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LEUCINODES ORBONALIS Guen. has been reported as a serious pest of brinjal shoot and fruit throughout India[1]. Investigations were carried out to record its parasitoids for biocontrol in Bihar.

A mass collection of *L. orbonalis* was made and the insects were reared in the laboratory from August 1986 to July 1988 all over Bihar in different seasons. The parasitoids that emerged from puparia of *L. orbonalis* in the course of rearing were identified as *Trathala flavo-orbitalis* Cameron (Ichneumonidae: Cremastinae). Pupal period of parasitized *L. orbonalis* was longer, 11 to 18 days, compared to 6–14 days for normal pupae. The parasitoids are 8±1 mm in length and 9.5±1 mm in width across the wings. They bear a long ovipositor of 3±1 mm and antennae of 5±1 mm. The wings are hyaline with stigma. Colour is pale brown, and the head dark brown (figure 1). Adults are thelyotokons. Adult parasitoids lived for 4–7 days.

Figure 1. Adult females of *Trathala flavo-orbitalis*.