1. INTRODUCTION

1.1 Airborne Lead Pollution and Its Effects on Environment and Human Health

With rapid urbanization and expansion of population, environmental quality tends to get degraded. One of these problems involves environmental lead pollution. The sources and distribution of lead emissions come from many sources. One of the most important sources of lead is from petrol engines. Since 1924 lead compounds began to be added in petrol as an anti-knock additive and its use increased rapidly each year. In 1975, the U.S.A. EPA showed that the highest lead emissions in the environment were caused by petrol combustion. Lead from petrol-fueled motor vehicles takes the form of both organic and inorganic lead. Most additives are tetramethyllead (TML) and tetraethyllead (TEL) that are added in petrol to improve its octane rating. Most of the lead added into petrol for this purpose is eventually discharged into the atmosphere from the exhausts of motor vehicles (Purves, 1985). The consequences of this source of pollution are largely unpredictable and are far-reaching. Motor vehicle exhausts have now become a major source of atmospheric lead pollution.

Lead has been used by humans for many thousands of years and can be regarded as a long-standing environmental contaminant. The World Health Organization (1973) classified lead as a member of the group of very toxic metals. Many studies have shown that lead causes adverse effects to the environment and to humans. Heavy contamination of lead can cause the inhibition of growth and metabolism of some plants and even the death. Since the 1970's there is voluminous literature dealing with the problems created by lead contamination of the environment (Zimdahl and Arvik, 1973; McLaughlin and Sfopps,

1973; Simpson *et al.*, 1979; Johnson and Eaton, 1980; Forni and Sciame, 1980; Voors and Johnson, 1982), and enhancement of lead levels caused by pollution has been reported in the bodies of earthworms (Ireland, 1979), small mammals (Getz *et al.*, 1977; Roberts and Johnson, 1978), song birds (Getz *et al.*, 1977), feral pigeons (Hutton and Goodman, 1980) and sheep (Ward and Brooks, 1978).

Significantly, lead can enter the body of humans by many pathways and cause long-term adverse effects. The most profound effects of lead poisoning are undoubtedly those associated with severe damage to the central nervous system(Harrison and Laxen, 1981). Research has shown that infants and children are particularly susceptible to lead toxicity as a result of physiological and behavioral factors (Barltrop 1972). Laporte and Talbott (1978) have reported that even relatively low levels of lead exposure can produce a massive disruption of learning ability while not affecting either morbidity or mortality (Laporte and Talbott, 1978). Yule and Lansdowne (1983) found in a pilot study in the UK on children with blood lead levels <30 μg/dl that even at this low level of exposure there were measurable effects on cognitive functions. So environmental lead pollution is a health risk to children because of its effects on mental and behavioral development.

1.2 Bioindicators for Monitoring of Lead Air Pollution

It has become important to monitor the level of lead in the environment. A number of research studies on monitoring lead pollution in the air have been conducted. In recent years increasing concerns with airborne lead has resulted in the search for simple, non-

destructive monitoring techniques. Among various airborne lead monitoring methods, the biological one is effective and practical.

Bioindicators are generally defined as organisms, such as plants, animals, and micro-organisms, that have the ability to simply indicate or show the presence or absence of any particular factor, in this case airborne lead pollution caused by petrol-powered vehicles.

Clements in 1920, was one of the first scientists to clarify and describe in detail the use of plants as indicators of environmental conditions (Martin and Coughtrey, 1982). More recently Ellenberg *et al.* (1991) defined bioindicators as " a related group or community of organisms or easily observed behavioral traits whose presence or absence can be so closely correlated with certain environmental conditions that it can be utilized as a pointer or quantitative test." This represents the interrelationship between the environment and it's indicators within the context of an ecosystem in an easily understandable manner.

Biological monitors provide monitoring capabilities in the context of complex ecological condition which are unlikely to be interpreted easily with physico-chemical measurements in a given field condition. For example, the effects of a certain pollutant may vary in the presence or absence of other stresses on the whole biological systems and may be antagonistic, additive, or synergistic. Physico-chemical methods provide data on specified chemicals measured at a particular time and location with laboratory calibrated instruments. Such data are required to examine the level of contaminants with regards to standards for air and water quality which are established for human health. Such data generally represent the fluctuations of contaminants in the atmosphere, but do not give an

indication that organisms will be effected (Burton, 1986). In addition to this, collection and retention properties go with these biological monitors, which are more representative of the field conditions which accounts for additional advantages over physical monitoring devices such as deposit gauges or high volume air samplers.

Some characteristics of plants make them good monitors of air pollution (Martin and Coughtrey, 1982). They are: (1)plants are excellent receptors of airborne heavy metals; (2) heavy metals on and in plant parts can be physically and chemically analyzed to obtain quantitative results; (3) plants provide continuous and integrated results; (4) plants can be used to determine the location of the pollution source and also the pattern of distribution of deposition; (5) plants are relatively cheap; (6) plants are independent of the power source during the exposure period which provides researches with greater flexibility in the number and geographical sitting of sample points and (7) biological material gives greater reality in assessing deposition to an ecosystem.

Among various kinds of plants showing in urban and rural areas, trees are the most usual but not the best indicators for air pollution monitoring. In recent years the most popular plants for such monitoring studies have been lichens and mosses because of their ability to receive and accumulate chemical substances predominantly from the surrounding atmosphere. Lichens and mosses are rare in urban areas with much pollution, however, trees are the major plant type found in these areas. Therefore, pollution monitoring studies should be directed towards using trees as biological indicators (Sawidis *et al.*, 1995).

1.3 Necessity of Airborne Lead Monitoring

The Japanese Society for the Promotion of the Sciences' environmental conference in 1993 reported that Bangkok has the worst air quality in the world. This is because of uncontrolled increases in motor vehicles which also cause dense traffic. Investigation of air quality along roads in Bangkok during 1988 and 1991 (Department of Pollution Control and Department of Health, 1992) revealed that lead levels in ambient air vary with the number of motor vehicles. This finding was also associated with the report on blood lead levels in 6-13 year old children in Bangkok (22.0±7.5μg/dl) which was significantly higher than that of children in the same age group who lived in Kanchanaburi (16.2±6.8μg/dl). Chiang Mai, the second largest city in Thailand, is now having the same problem. Without effective measures to solve these problems, the present situation of air pollution in Bangkok will occur in Chiang Mai in the near future. The Thai Government has not completely ignored this severe problem. A policy was issued in January 1992 to decrease ambient lead by several measures including promoting the use of unleaded petrol (initially in Bangkok) and targeted to have lead-free petrol in all areas of Thailand in 1994. This means unleaded petrol is sold throughout Thailand, however, but is not used by all cars. There has not been any specific study to assess the impact of this policy on airborne lead in Chiang Mai. This study aims to assess the present situation of environmental lead in Chiang Mai and to find out practical methods to regularly monitor variations of atmospheric lead. Five common plant species were collected from 13 different high traffic areas in Chiang Mai City. The hypothesis of this study is that concentrations of lead in plants from sites with higher amounts of lead in the air and roadside dust will be higher than those from sites with less traffic. Species which have the highest accumulation of lead will be used as bioindicator(s) for monitoring atmospheric lead pollution.

1.4 Aims and Objectives of This Study

This study has three main objectives:

(1) Determine the accumulation level of lead in five different plants at major cross roads with heavy traffic in Chiang Mai City.

(2) Screen the best species for further monitoring of lead pollution.

(3) Find out seasonal effects on the content of lead in plants.