Chapter 1

Introduction
INTRODUCTION

Much has been said of man's contamination of his environment and the threat it poses to the very existence of the ecosystem as well as to its biotic and abiotic components, crops, natural resources, forests, biota, cultural assets, and other necessities. The growth of human population, industry, agriculture, urbanization, industrial expansion, and improper and ill-managed uses of natural resources are at the heart of the main aspects of the pollution. The problem of pollution as a consequence of industrialization is by now a well-known phenomenon. Pollution and its consequent adverse effects have now become household topics.

The presence of any pollutant in the environment influences not only the abiotic but also the biotic components of ecosystem by way of making certain visible and/or subtle changes in the functioning of their normal life systems. Vegetation on the earth surface is constantly exposed to pollutants pervades not only cities but also the sub-urban and rural areas as well.

The relationship between plants and pollution is complex. Plant's response to a pollutant is an integrated response, influenced by a number of components of the soil, disease, insects, climates, etc. Many
different types of pollutants have been identified and their effects on the living system have been studied in detail by many workers all over the globe. Pollutants are usually discussed as being the additional or abnormal components of the environment in which the plants have evolved or grown.

The life cycle of the plants is normally adapted to the environmental conditions. They live as the most appropriate forms, both evolved and survived under the conditions of natural stresses. The inability of plants to comply with the conditions of changed environment leads to the pollution damage. Vital life functions of the plants are affected adversely by the pollutants to the extent to cause a retardation in the growth, the reproduction and the life span of the individuals. The air pollutants, in general, are known to damage the plants and to decrease the agricultural productivity (Rao, 1981, 1985; Carlson, 1983; Godzik and Krupa, 1984).

The heavy metals and their salts are potent environmental pollutants as these are active metabolic inhibitors and exert toxic effects on both, the terrestrial and the aquatic, flora and fauna. They spread and seep into the soil by sewage sludge being used as a fertilizer or via air-borne pollution. The higher
plants take up and concentrate these metal ions resulting in the toxic effects on the plants grown in a polluted environment (Jastrow and Koepppe, 1980).

The heavy metals are the integrated components of the biosphere and thus occur naturally in soils and plants. A heavy metal is classically defined as a metal precipitable in acid solutions by hydrogen sulphide. Though, there is no universally acceptable definition of a heavy metal, generally those with a density [or specific weight] of five or more or atomic number greater than twenty-three [or twenty, as considered by some others] are labelled as heavy metals (Passow et al, 1961). Passow et al (1961) have listed thirty-eight elements with density greater than five. The heavy metals are non-degradable, persist in nature and are toxic to living organisms at a fairly lower concentrations (Mhatre, 1991).

The heavy metals are heterogeneous group of elements which greatly differ in their chemical properties and biological functions. According to Tiller (1989), heavy metals are considered as environmental pollutants. All heavy metals are toxic at relatively higher concentration.

The heavy metals are ubiquitous, and are persistent pollutants present mainly in a myriad of
industrial effluents. These are found in soil and street
dust (Day et al, 1975; Solomon and Hartford, 1976;
Harrison, 1979; Carey et al, 1980; Harrison et al, 1981;
Magrath et al, 1988; Hewitt and Candy, 1990), and also in
the water sources (Jana and Chaudhary, 1980; Hewitt and

The heavy metals are rapidly becoming the
environmental pollutants, particularly in the densely
industrialized areas and near the sites of smelting of
heavy metals, and where there is a heavy road traffic
(Lagerwerff and Specht, 1970). The classical example for
this was the occurrence of the human sickness "Itaï-itai"
in Japan caused by cadmium released from industrial areas
and passed at least in part from the soil into the food
chain via plants (Yamagata and Shigematsu, 1970).

Among the common heavy metals are mercury,
copper, lead, zinc and cadmium. Cadmium and mercury are
phytotoxic even in small amounts (Vallee and Ulmer,
effluents containing cadmium, mercury, and lead. It is
not improper to say that a damage by heavy metal is the
damage both by the water pollution and the soil
pollution. Most of the heavy metal pollution of river
water, and consequently of soil strata, is caused by the
industries and the domestic waste water (Ray Chaudhari
and Gupta, 1977). The heavy metals, when present at the
elevated levels in soil, are generally toxic and can ultimately cause the death of plants.

The presence of excessive amounts of heavy metals in the growing medium causes the damage to plant cells, the degree and extent of injury being dependent on the concentration of metal present. A heavy metal interferes with the normal functioning of the plant body which is due to the stress and may finally result in the less productivity often leading to the death of plant (Chaphekar and Shetye, 1989). When the toxic metals come in a contact with the living protoplasm, a great variety and number of biochemical reactions occur depending upon the particular heavy metal and its mode of action (Singh and Shrotriya, 1989); the order of toxicity of metals (mercury > copper > cadmium > zinc > lead) closely followed the electronegativity of metals.

The increased introduction of cadmium in the environment (Nodberg, 1974) and the potent phytotoxic potential of this trace element has greatly stimulated the research on the responses of plant to this metal. Most research papers and articles are exclusively concerned with the uptake and phytotoxicity of cadmium as this metal is particularly toxic for most crop species as compared to lead, nickel, mercury, or chromium.
Reports of the use of zinc as a nutrient in plant fertilizers appeared in the literature as early as 1912. Brenchley (1914) described the zinc deficiency in the higher plants. That zinc is essential to plant life was established by Somers (1977). Zinc deficiency is now the most common micronutrient deficiency in the USA. The use of zinc fertilizers to improve crop growth is also well established. Crops that are sensitive to the zinc deficiency are citrus and deciduous tree fruits, pines, grapes, soyabean, lima beans, and onions.

A phosphorous-induced zinc deficiency has been widely reported; application of phosphate fertilizers and high phosphorous level in the soils have been linked to the zinc deficiency. The presence of phytin, the main storage of phosphorous in cereals grains and other seeds, seems to be casually responsible for low zinc availability (Reinhold et al, 1973).

The toxicity of an excess zinc to plants is now well established. The toxic amounts of zinc usually occur in acidic soil or in contaminated areas such as mine spoil banks, industrial areas, and waste disposal sites.

Fluorine belongs to a group of elements which includes chlorine, bromine, and iodine, collectively called the halogens, from the Greek word meaning 'the
Fluorides, the salts of element fluorine, make up almost 0.17% of the earth's crust. Under the natural conditions, fluoride is present as a compound in soil, rocks, and minerals such as apatite, cryolite, topaz, mica and hornblende.

Pure fluoride compounds are used as catalysts and fluxes in a large number of industrial processes during the production of ceramics, phosphorous chemicals, fertilizers, aluminium, steel, etc. Fluoride compounds are produced from burning fuel and waste (Bennett and Freeman, 1969).

The fluorides are found to pollute air, soil, and water. Fluoride passes to and from the atmosphere in water, soil, and rocks and living organisms due to both the natural phenomena or man's activities. These are accumulated in plants, enter the food chain through herbivores and pass into the soil and animal waste.

Guderian (1971) has shown that several grass and fodder species could accumulate toxic levels of fluoride and this was of great relevance to herbivorous animals. Dental and skeletal fluorosis would have been induced in livestock through the ingestion of fluoride containing vegetation that may otherwise appear normal.

The intake of fluorides has increased markedly over the past quarter century. Fluorides are added to
number of consumer products such as toothpaste, mouth rinse and gels in order to try to reduce teeth decay in children. Even very low levels of fluoride in water and air are harmful to certain species of plants. High doses are well known to be poisonous to animals and humans indeed. Exposure to fluoride in doses beyond 1 ppm, which is permissible limit in potable water, results in skeletal and dental fluorosis.

The Indian earth crust is rich in the fluoride-containing minerals. Fluoride is present in the ground water, major sources of drinking water in most Indian villages, and in several food stuffs. It has been estimated that the fluoride level in water in India range from 2-39 ppm.

One of the serious health problems, as India is facing today, is the prevalence of endemic fluorosis in some states, involving a population of about 20 million. The hazards of fluoride to crops, livestock, and to human beings have been recognized since at least a hundred years.

In the State of Gujarat, five districts namely, Mehsana, Sabarkantha, Banaskantha, Bhavnagar, and Amreli, as well as Chhota Udepur in Vadodara district, have fluorides in their drinking water as high as 7.75 ppm. Food crops like bajra, jowar, wheat, potatoes, sugar
cane, etc. are found to contain appreciable amounts of fluoride. This has resulted in an acute fluorosis, both skeletal and dental, in the human population.

Ahmedabad is the sixth biggest city of India; it is an industrial capital of Gujarat having about sixty textile mills, forty different processing houses, a coal-fired thermal power station, and more than one thousand types of small-scale industries within or near the city limits. Many of these have the hydrogen-fluoride manufacturing plants, super-phosphate plants, brick works, glass factories, and copper smelters emitting many different pollutants in high amounts. In addition to these, there are about more than 150,000 vehicles consuming about 200,000 litres of petrol and about 45,000 litres of diesel daily. All of these sources discharge their waste products into the environment causing both air and water pollution. Near such industries are the crop fields, the crops being constantly exposed to many different pollutants.

The increased exposition of plant to pollutant such as heavy metal and fluorides is the consequence of environmental contamination by industry, mining, or sewage disposal. Industrial waste and discharge have been recognized as one of the major sources of toxic chemicals present in environment.
With this background, the present study was undertaken to investigate the effects of zinc and cadmium (heavy metals) and fluoride on the mung plants. Mung or green gram (*Phaseolus aureus* Roxb) is one of the important pulse crops and is indigenous to India. It is a fast-growing, warm-season, dry-land pulse crop. It is generally consumed whole or split after decoration. The tender young pods and the green shelled beans are eaten as vegetables. The haulms are used as a fodder and husk and broken pieces of seeds constitute a useful livestock feed. Green gram seeds are small, globular, and usually olive green in colour. Seed coat is a testa with fine wavy ridges, sometimes very faint but never lacking. Cotyledons are yellow not becoming pasty on chewing (Kochhar, 1981). The parched and dehusked beans are ground into flour which is used in the preparation of variety of dishes typical of India. Being a leguminous crop, green gram can also be used as green manure.
OBJECTIVES

The major objectives of the present investigations were:

1. To study the growth and the metabolic events of the green gram seedlings grown in the presence of heavy metals and fluoride under the laboratory conditions, and,

2. To examine the effects of heavy metals and fluoride on the growth, the metabolic events, and the yield of the mung plants raised under the field conditions.