INTRODUCTION
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Medicinal plants are of great significance today, and with the new GATT agreement, it is important to conserve this natural resource of our country. Since modern health care systems are becoming more and more expensive, therefore, we need to develop a technology to introduce and integrate herbal medicine system into our health care.

The traditional Indian system of medicine, namely Ayurveda, which involves dispensing of herbal products in various forms, such as powders, extracts decoctions etc., dates back to the Vedic period. First mention of diseases and drugs is found in the Rigveda and Yajurveda (i.e., circa 2,000 B.C.), and the earliest comprehensive description of Ayurveda is available in the Atharvaveda (i.e., 1,600-1,000 B.C.), which contains *inter alia* descriptions of human anatomy, rudiments of classification of diseases and reference to herbal medicines.

Recent past has witnessed an upsurge in the popularity of the herbal medicines. In the developing countries, about 80% of the people depend upon the traditional system of medicines and 95% of the industrial need is met through indiscriminate collection of widely growing medicinal plants. Over half a million tons of dry plant raw material is indiscriminately collected that has led to considerable genetic erosion and loss of biodiversity including the plants of medicinal properties.

There are more than 45,000 plant species in India out of which 7,000 species are medicinal and aromatic plants serving as raw material to pharmaceutical and other plant based industries. About 1,000 genera and more
Introduction

than 2,500 species are used in indigenous system of medicine, which largely consists of Ayurveda.

There is a wide spread belief that “Green” drugs are healthier than synthetic products. In most of the industrialized countries, the use of medicinal plants has increased dramatically in the last decade. Medicinal plants continue to provide health security to rural people in primary health cares. According to WHO, over 80% of the people in developing countries depend on traditional medicines for their primary health needs. In India, the coverage of rural population by the modern health system varies from 3 to 30%, thus 4 to 500 million people are bound to use traditional medicines as the only feasible alternative. According to 1994 UNDP report, the annual value of medicinal plants derived from developing countries is approximately 32 billion US Dollars (Sharma, 2004).

The availability of medicinal plants is already under serious threat because 95% of the medicinal plants used by the Indian pharmaceutical industry are collected from the wild. Less than 30 species of the plants are under commercial cultivation. Over 70% of the plant collections involve destructive harvesting because of the use of the parts like roots, bark, wood, stem and the whole plants (in case of herbs). This poses a definite threat to the diversity of medicinal plants. Conservation of medicinal plant species is possible preferably through ex-situ means, so that these species come under cultivation practices and can be made available as and when required for the benefit of human race.

The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been
widely observed. Furthermore, an increasing reliance on the use of medicinal plants in industrialized societies has been traced to the extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used herbal remedies. Moreover, in these societies, herbal remedies have become more popular in the treatment of minor ailments and also on account of the increasing costs of personal health maintenance. Indeed, the market and public demand has been so great that there is a great risk that many medicinal plants today may face either extinction or loss of genetic diversity (Hamilton, 2004).

Genetic biodiversity of traditional medicinal plants is under a continuous threat of extinction as a result of growth-exploitation, environment unfriendly harvesting techniques, loss of growth habitats and unmonitored trade of medicinal plants. It is estimated that the global trade in medicinal plants is US$ 800 million per year. The botanical retail market inclusive of herbs and medicinal plants, in the USA, is estimated at approximately US$ 1.6 billion per year. China with exports of over 120,000 and India with 32,000 tones p.a. dominate the international markets. There has been a continuous resurgence in the consumption and demand for medicinal plants. These plants are in high demand for finding use in pharmaceutical, nutraceutical, cosmetic and food supplement industries.

India has a rich biodiversity and the growing demand is putting a heavy strain on the existing resources. Though the demand for medicinal plants is growing, some of them are being increasingly threatened in their natural habitats. For meeting the future needs, cultivation of medicinal plants has to be encouraged and promoted. According to an all India ethnobiological survey carried out by the Ministry of Environment and Forests, Government of India,
there are over 8,000 species of plants which are being used as a source of medicine by the people of India.

It is estimated that 70-80% of people worldwide rely chiefly on traditional, largely herbal, medicines to meet their primary healthcare needs. The global demand for herbal medicine is not only large, but still growing. The market of Ayurvedic medicines, is estimated to be expanding at the rate of 20% annually in India, while the quantity of medicinal plants obtained from just one province of China (Yunnan) has grown by 10 times in the last 10 years (Farnsworth and Soejarto, 1991; Pei Shengji, 2001; and Hamilton, 2004).

In terms of the number of species individually targeted, the use of plants as medicines represents the biggest human use of the natural world. Plants provide the predominant ingredients of medicines in most medical traditions. Estimates for the numbers of species used medicinally include: 35,000-70,000 (or on an average 53,000) world wide; 10,000 – 11,250 in China; 7500 in India; 2572 traditionally by North American Indians; and 2237 in Mexico (Farnsworth and Soejarto, 1991; Toledo, 1995; He and Gu, 1997; Xiao and Young, 1998; and Hamilton, 2004).

The family Asteraceae (Compositae), the largest family of flowering plants comprises about 900 genera and over 30,000 species. It is cosmopolitan in distribution and has a wide range of habitats. In India, it is represented by about 138 genera and 708 species occurring chiefly in Himalayas and mountains of Southern and Western India, ascending upto about 6,000 meters above sea level and about 52% of the species are endemic in nature. The family plays an important role in the vegetation of the areas ranging from arctic region upto the tropics. In the tropics, it avoids the rainforest but occurs in arid zones
Introduction

and mountains. The family is of great economic importance and a large number of plants are ornamental as for example *Helianthus annus*, *Tagetes* spp., *Chrysanthemum coronarium*, *Dahlia variabilis*, *Zinnia elegans* are some of the ornamental plants. Some members are important source of human food (Lettuce, Artichoke and Endive). Other are medicinal plants *Anthemis nobilis*, *Calendula officinalis*, *Filaga germanica*, *Eclipta alba*, *Tanacetum vulgare*, *Vernonia anthebiuntica*, *Solidaga* spp., *Blumea lecera*, *Lactuca sativa*, *Taranacum officinale* and *Sonchus oleraceus*.

Plant Description:

**Binomial name**: *Eclipta alba*

**English name**: Trailing eclipta

**Indian name**: Bhangra, Bhringraj

**Family**: Asteraceae

**Part used**: Whole plant

**Botanical Description**: Perennial herb, erect or prostrate, 30-40 cm tall, stems green or purple, bristly, thickened at the nodes. Leaves opposite, subsessile, lanceolate oblong, denticulate, hirsute on both sides. Flowers white in axillary or terminal head; the female flowers are radiated and the bisexuals are at the centre. Achene 3-angled, slightly flattened.

**Habitat**: It is a common weed in moist situations growing throughout India, at all elevations in waste places and on the road sides.

**Propagation**: It is propagated by seeds and sometimes by vegetative methods.
**Chemical Constituents:** It contains mono, di, and trithiophene acetylenes together with α-terthienyl. The petroleum ether extract of aerial parts contains a terthienyl aldehyde, ecliptal, besides stigmasterol and β-sitosterol; the aerial parts also contain 2-an-geloyloxy methylene-5'-dithiophene, 5'-isovaleryloxy methylene-2-dithiophene. The roots are very rich in thiophene acetylenes. They contain the dithiophene derivatives 5'-seneocioyl oxymethylene-2-dithiophene and 5' tigloyloxymethylene-2-dithiophene in addition to 2-5-thiophene (Prajapati et al., 2003).

**Therapeutics:** The plant is bitter, acrid, thermogenic, alterative, anti-inflammatory, anthelmintic, anodyne, vulnerary, ophthalmic, digestive, carminative, haematinic, diuretic, aphrodisiac, trichogenous, deobstruant depurative and febrifuge, and is useful in hepatosplenomegaly, elephantiasis, inflammations, vitiated conditions of vata, gastropathy, anorexia, helminthiasis, skin diseases, wounds, ulcers, ophthalmopathy, debility, hypertension, strangury, leprosy, pruritus, fever, jaundice, odontalgia, otalgia and cephalalgia (Prajapati et al., 2003).

It is good for blackening and strengthening of the hair; for stopping haemorrhages and fluxes; and for strengthening the gums. Bhringraj oil obtained from the plant is applied to scalp before bed time, in insomnia. The leaves are used as vegetable in Java; in chutneys in some parts of India. In the recent years, there has been an increased interest in the cultivation of medicinal and aromatic plants to meet the requirements of cosmetic, flavoring, perfumery and pharmaceutical industries and also to earn foreign exchange by way of export (Saily et al., 1994, Ray et al., 2000).
Nematodes comprise a large and ubiquitous group of invertebrates which are highly diversified and have representatives in almost every kind of environment. They occur in unimaginable number and have a wide range of species, size, and structure. A large number of nematode species are parasites of different kinds of plants and animals. Some species are macrophagus, others are saprophagus, and many species are herbivores or phytovores obtaining nourishment directly from plant tissues. It has been estimated that one acre of land can harbour as many as three billion nematodes. The growing awareness about phytoparasitic nematodes being limiting factor in agriculture productivity has led to a tremendous upswing in the interest, in a period of last six decades.

The root-knot nematode, a common name collectively given to the species of *Meloidogyne* (Chitwood, 1949), causes the formation of knots or galls on the roots of a wide variety of plants. It is of great concern in sub-temperate, sub-tropical and tropical regions, and is considered to be the number one nematode problem of agricultural crops and medicinal plants in most developing nations. The root-knot nematodes are sedentary endoparasites of underground parts of the host plants. They complete their life cycle within 30 days. The second-stage juvenile, earlier known as larva, is the infective stage of *Meloidogyne*. *Meloidogyne incognita* is an important and most prevalent nematode pest of *Eclipta alba* in Western Uttar Pradesh, India (Khan and Khan 1985; Khan et al., 1987).

The earliest host response in root-knot nematode infection is the formation of discrete galls on the roots of host plant. Schuster and Sullivan (1960) reported that galls were induced in tomato roots by larvae of *M. incognita* without actual entry of larvae into the roots. They concluded that the stylet penetrated the root surface and secreted materials that stimulated host
Introduction
tissues to form galls. Molliard (1900) reported gall formation on the root of melon, *Coleus, Begonia*, arrest of root tip growth and frequent development of lateral roots. The size of gall on the roots of infected plants varies depending upon the intensity of infection as well as on the plant species. Large galls were observed by Steiner *et al.*, (1934) at the base of stem of *Thumbergia laurifolia* and rhubarb, with a diameter of about two feet.

At infection sites in the roots of *Zingiber officinalis*, the cells of endodermis and pericycle were suberized and lignified (Huang, 1966). Division of stele in galled roots of *Lycopersicon pimpinellifolium* infected with *M. incognita* was observed by Farooq (1973). Siddiqui *et al.*, (1974) observed the formation of abnormal xylem in the roots of *Lagenaria* infected with root-knot nematode. The plant and nematode interactions caused morphological, anatomical and physiological changes of the affected tissues, or death of the cell by removal of their contents, or the host cells adapted to nematode by enlarging or increasing their metabolic activities, or the cells underwent growth and multiplication; these effects of plants have been termed as destructive, adaptive and neoplastic, respectively (Dropkin, 1980). Pasha *et al.*, (1987) noticed irregular scattering of vascular elements especially the vessels. Discontinuity of vascular tissues, significant reduction in vessel element dimensions, hypertrophy, hyperplasia, thickening of cell walls, granulation of cytoplasm, and enlargement of nuclei and nucleoli were the most commonly occurring events in the tissue around the nematode head.

The second-stage juveniles usually penetrate the roots and establish their feeding sites in vascular parenchyma. In response to feeding activity, some parenchyma cells become enlarged and multinucleate, and are generally known as “giant cells”. The term giant cell refers to a multinucleate transfer cell
usually induced by root-knot nematode, in which the multinucleate condition results from repeated endomitosis (Endo, 1987). The formation of giant cells (or syncytia) through the dissolution of cell walls and the coalescing of their contents was reported for root-knot infections on *Nicotiana* hybrids by Kostoff and Kendall (1930) and was supported by other workers.

The giant cell cytoplasm becomes dense and granular as the giant cells become older. The shape of giant cells as noticed by Christie (1936) varied in appearance depending on the tissues from which they were derived. Initially the newly developed giant cells had large clear areas separated from one another by the strands of cytoplasm. The anatomy of the galled roots is drastically changed, hypertrophy and hyperplasia are the main causes of gall formation. These two mechanisms alter the arrangement of the tissues, specially vascular strands in the affected parts.

*Meloidogyne incognita* infection interferes in the physiology of the host plant leading to the development of characteristic symptoms which are reflected on the shoots and the roots. Hussey (1985), Melakeberhan *et al.* (1985) and Molinari (1996) have reviewed the physiology of nematode-infected plants. Plant water relations are affected due to root-knot nematode infection leading to non-specific symptoms like wilting, chlorosis and stunting. These may be caused due to anatomical changes; damage of epidermis, cortex and the stelar elements as a result of nematode migration; physical interruption of the transpiration stream causing embolism (occurrence of air-pockets interfering water conductance); and the resultant dysfunction of the vascular system. Respiration of galled tissues varies with host species, varieties and physiological age of the plant. In cucumber and tomato the rate of respiration in root knot-infected tissues was three times higher than uninfected tissues.
However, young infected tomato plants respired at a lower rate while older plants at a higher rate than uninfected plants.

The interactions between fungal antagonists and nematodes have been known to occur in agricultural soils for many years (Mankau, 1962; Barron, 1977). Nematode-destroying fungi of diverse biology and affinities are ubiquitous in most soils and undoubtedly, in many instances, play an important role in regulating nematode population dynamics. Fungi possessing the capacity to destroy or deleteriously affecting nematodes vary considerably in both their biology and taxonomic relationships. They range from obligate, endoparasitic forms (many of which are zoosporic) to predacious trap-forming species and opportunistic fungi that colonize reproductive structures, such as cysts and eggs. The fungus *Paecilomyces lilacinus* (Thom.) Samson has been reported as a potential biocontrol agent for root-knot nematode (Jatala *et al.*, 1979; Jatala, 1982, 1986; Adiko, 1984).

Pollution the direct resultant effect of industrial development is a necessary evil and the pollutants are the by-products of various developmental processes. Air pollution is an important segment of overall environmental pollution and has emerged as a serious problem in different parts of the world. It has entered into agriculture as a new crop damaging factor which has been recognized in different parts of the world. Air pollutants originating from various kinds of industries fall into two categories *viz.*, gaseous and particulate. Sulphur dioxide (SO$_2$), oxides of nitrogen (NOx), carbon monoxide (CO), ammonia (NH$_3$), chlorine (Cl$_2$), ethylene (C$_2$H$_4$), hydrogen fluoride (HF), ozone (O$_3$) and peroxyacetylene nitrate (PAN) are the gaseous pollutants. Coal dust, fly ash, cement dust, soil dust particles etc. are major particulate air pollutants. Primary air pollutants like NOx, SO$_2$ after coming in contact with
Introduction

Atmospheric water result in acid rain. Acid rain is an acute and severe consequence of air pollution problem in developed countries, while the particulate air pollutants is major problem in developing countries. In India, sulphur dioxide and fly ash are the most prevalent air pollutants as both are emitted after burning of coal which is abundantly used as energy source to run the industries. Concentrations of SO$_2$, for industrial areas, have been recommended as 0.042 $\mu$g m$^{-3}$ by the Central Pollution Control Board, India. But, in many areas the concentration usually exceeds the prescribed safe limit. Some air pollutants such as SO$_2$, CO, NO$_x$, NH$_3$, HF are called primary air pollutants while others such as O$_3$ and PAN as secondary air pollutants depending upon their origin (Wood, 1968; Khan, 1996).

The optimum levels of environmental factors and air quality help in proper growth and maintain plant health, as over 90% biomass of green plants is derived from atmosphere. Plant growth and yield are adversely affected, directly or indirectly by air pollution (Mudd and Kozlowski, 1975; Heck et al., 1982). Adverse effects of air pollution on agriculture crops are being assessed in different parts of the world. The Environmental Protection Agency (EPA), in USA estimated that in 1976 annual loss to agriculture production due to air pollution was around 2.9 billion dollars. Since then pollution load has increased substantially. Yield losses due to air pollution have been found in a large number of crop plants including soybean, peanut, cotton, tobacco, vegetable crops, medicinal and ornamental plants.

Fly ash, a particulate air pollutant has shown great potential in enhancing productivity through soil amendments where it acts as a source of trace elements. Application of low amount (2%) of fly ash favoured growth of Beta vulgaris and improved yield (Singh et al., 1994). Khan and Khan (1996)
observed that the plants grown in the ash-soil mixture showed luxuriant growth and had bigger and greener leaves. Enhancement in plant growth, yield, carotenoids and chlorophyll was 40-80% in fly ash amended soil. At 100% fly ash level, yield was considerably reduced. The most economic level of fly ash incorporation was 40%, which improved the yield and market value (mean weight) of tomato fruits by 81 and 30%, respectively.

Several workers have reported about the promising effects of fly ash on different plants. Mishra and Shukla (1986) reported increase in plant height, dry weight, metabolic rate and photosynthetic pigments of maize (*Zea mays*) and soybean (*Glycine max*) by dusting fly ash at low rate. Enhancement in seed germination and growth of *Brassica parachinenesis* at low levels of fly ash (3 to 6%) has been reported by Wong and Wong (1989). High fly ash concentration suppresses plant growth and causes deterioration of soil properties (Hodgson and Holliday, 1966; Adriano *et al.*, 1980). Rapid industrialization of nations throughout the world has caused a substantial and sustained increase in pollution of air, land and water. This “development with destruction” has been responsible for the rapid decline in the health of our ecosystems that may lead gradually to their total degradation.

Efforts have been made to modify the properties of agricultural soil by addition of fly ash, thus improving the soil fertility and crop yield. Currently, about 2% of the total fly ash produced is effectively utilized. Since a large amount of fly ash is generated each year, a great deal of research has been conducted to determine the feasibility of its utilization in agriculture.
Plan of Work:

The present study was carried out:

(i) To study anatomical changes in *Meloidogyne incognita* infected roots of *Eclipta alba* leading to gall formation.

(ii) To investigate cytological changes leading to the development of giant cell and giant cell complex.

(iii) To find out any role of phloem in formation, development, and maintenance of giant cell.

(iv) To trace structural abnormalities in xylem and phloem elements.

(v) To study the effect of different inoculum levels of *M. incognita* on growth and yield of *E. alba*, reproduction of nematode, and internal structure of infected roots.

(vi) To study the effect of different inoculum levels of *M. incognita* on plant growth, chlorophyll pigment, protein and oil contents of *E. alba*.

(vii) To study the effect of *Paecilomyces lilacinus* and root-knot nematode (*M. incognita*) on the disease development and growth of *E. alba*.

(viii) To study the effect of fly ash on the plant growth, yield, chlorophyll pigment, protein and oil content of *E. alba*.

(ix) To study the effect of fly ash on development of root-knot nematode and growth of *E. alba*.
The experiments were divided into three sections. The aim of the experiments was to establish the facts about host parasite relationship between *E. alba* and *M. incognita*. For managing the disease a biocontrol agent was used; its efficacy was tested on *E. alba*. The fly ash amended soil was assessed to ascertain the role of ash on plant and *M. incognita*.

**SECTION-I**

Experiment 1: Histopathological responses of *Eclipta alba* towards *Meloidogyne incognita*.

Experiment 2: Effect of different inoculum levels of *Meloidogyne incognita* on the growth and yield of *Eclipta alba*, reproduction of the nematode and internal structure of the root.

Experiment 3: Effect of different inoculum levels of *Meloidogyne incognita* on plant growth, chlorophyll pigment, protein and oil content of *E. alba*.

**SECTION-II**

Experiment 4: Histology of the interaction of *Paecilomyces lilacinus* with *Meloidogyne incognita* on *Eclipta alba*. 
SECTION-III

Experiment 5: Effect of fly ash amended soil on the plant growth, yield, chlorophyll pigment protein and oil content of *Eclipta alba*.

Experiment 6: Effect of fly ash amended soil on the development of the root-knot nematode (*Meloidogyne incognita*) and growth of *Eclipta alba*.