Medicinal plants are occupying the main role in the traditional systems of medicines all over the world, especially India. “Traditional Indian Medicines” (TIM), include Siddha, Ayurveda, Unani, Yoga and Naturopathy. The majority of the medicinal preparations in these systems contain chemical constituents, which are derived from the medicinal plant sources. Ancient Siddha and Ayurvedic system of medicines are predominantly based on plant Materia medica, which are making the use of most of the native medicinal plants. India is sitting on a gold mine of well-recorded and well-practiced knowledge of traditional herbal medicine. In ancient literatures like ‘Rig-Veda’ and ‘Atharva-Veda’, Later, the texts like ‘Charak Samhita’ and ‘Sushruta Samhita’ were documented in about 1000 years B.C., where use of plants and polyherbal formulations was highlighted for health multidirectional care. Plant-based remedies for health care through day-to-day life experiences are a part of cultural heritage of India. More than 80% of people in Asia are still depending on traditional and folk remedies for their daily medicinal needs. India being one of the twelve megadiversity centers has immense biotic wealth marked by remarkable ecosystem, species and genetic diversity. This rich biological diversity is matched equally by rich cultural diversity and health traditions. Over 7,000 species out of an estimated 17,000 angiosperms recorded from India are reportedly used for medicinal purposes (Groombridge, 1992).

Many herbal remedies individually or in combination with different formulations have been recommended in various medicinal treatises for various diseases. The modern medicines have evolved from folk and traditional system of medicines after the thorough chemical and pharmaceutical screening. Researches on the medicinal properties of the plants were prompted by the information of tribal people using them for treating various diseases. In fact, there is revival of interest throughout the world in natural plant products, as they are biologically more compatible with human system and less toxic than synthetic drugs.
Plants have their medicinal value due to various chemical constituents of their tissues. Plant metabolites, primary as well as secondary, are the major source of pharmaceuticals, food additives, fragrances, pesticides, herbal cosmetics, etc. The great variety of chemical constituents, their quality and quantity depend upon the genome of the plant, effect of environment and interaction of genome and environment. Interspecific variations are common in plants and one can find a number of species with varieties, races and strains, etc. that differ from each other in one or more characters. Traditionally used medicinal plants produce a variety of phytochemicals of known therapeutic properties (Iyengar, 1976; Harborne, 1989; Chopra et al., 1992). Production of bioactive compounds of plants used in ethnomedicine has increased the role of these medicinal plants in health care (Morales et al., 2008). Numerous chemopreventive agents have been identified in the epidemiological, experimental, preclinical and clinical observations.

The trend of using natural products is increasing. Herbal remedies have attained much more popularity in the treatment of minor ailments, due to increasing awareness of personal health maintenance through natural products. Indeed, the market and public demand has been so great that there is a great extinction risk to many medicinal plants and obviously the loss of genetic diversity. Habitat destruction and indiscriminate over collection from wild are the major threats that menace native plant population. Though India has rich biodiversity and one among the twelve mega diversity centers, the growing demand is putting a heavy strain on the existing resources causing a number of species to be either threatened or endangered category. The overall pressure on phytomass diversity has brought several medicinal plants under the endangered category. About 90% of medicinal plants used by the industries are collected from the wild. Less than 20 species of medicinal plants are under commercial cultivation. Majority of the plant collections involve destructive
harvesting because of the use of parts like roots, bark, wood, stem and the whole plant in case of herbs. This poses a definite threat to the genetic stocks and to the diversity of medicinal plants, if biodiversity is not sustainably used. To ensure the sustainable supply of standard plant material, and to reduce the load on wild forms, there is need to mark out better chemotypes and to standardize their cultivation practices.

India has vast and inexhaustible resources of plant based drugs. The systematic investigations of these drugs on modern scientific lines started after Independence. A number of important medicinal plants prescribed by Vaids and Hakims have been thoroughly investigated from every point of view. But for majority of plant resources, especially medicinal plants the information is not satisfactory. *Eclipta alba*, one such plant belonging to the family Asteraceae or Compositae, is vernacularly known by many names as *Bhringraj, Bhringaraja, Kesara, Bhangra, Babri, Kesuti, Maka, Keshrangana, Kesarda and Kalobhangro, Yerba de Tajo, False daisy,Trailing Eclipta, Han Lian Cao, Congalala, Cangulala*, etc. depending upon different regions. The Sanskrit word *Bhringraj* literally means that which bestows hair the splendid black colour like that of a grand humming bee. *Eclipta alba* is commonly known as *safed bhangra* (Hindi) when in flower and as *Kalobhangro* when in fruit.

Pila bhangra is the name given to closely related plant *Wedelia chinensis* (Anonymous, 1952; Bhargava and Seshadri, 1972) which is considered as adulterant of this species as it is morphologically similar with *Eclipta*.

The generic name *Eclipta* has been derived from a Greek word meaning “deficient” in reference to absence of bristles and awns on the fruits. The specific epithet *alba* means “white” that refers to the colour of the flowers. *Eclipta alba* has different synonyms viz. *Eclipta prostrate* (L.) L., *Eclipta erecta* L., *Eclipta puncatata* L., *Verbesina alba* L., *Verbesina prostrata* L. Its several forms exist in nature which differs strikingly in many morphological features either growing in populations or
colonizing at new places. Some of the variable forms have even the merit of
taxonomic recognition. It is erect, partly erect or prostrate and is described as variable
species by taxonomists.

_Eclipta alba_, a worldwide weed frequently encountered in the tropical and
subtropical parts of the world (Asia, Australia, Brazil, Egypt, Iraq, Mexico), is
adaptable to changing habitat and also found in some temperate parts of the world.
However, it prefers warm climate with a temperature range of 25 °C to 35 °C for its
good growth and yield. _Eclipta alba_ (L.) Hasskarl, have an original geographic
distribution in North and Central America but now it has became a cosmopolitan
weed by western colonization activity. In India, _E. alba_ ascend up to 1,800 m in the
Himalayas and other mountains (Duthie, 1905). The plant inhabits in the poorly
drained wet areas, in the wastelands, lawns, along streams, ditches and canals, saline
conditions and paddy fields but it occasionally occurs in drier areas. A wide range of
habitat is indicative of the ability of the species to colonize newer areas.

_E. alba_ is a common plant in Indian folklore medicine. In Ayurveda, _Eclipta_ is
said to be the best drug for the treatment of liver ailments such as cirrhosis and
infective hepatitis and other conditions involving hepatic enlargement. The herb,
called “The King of Hair”, is widely used in the preparation of hair care herbal
products like hair oils and shampoos. Medicinal value of Bhringraj has been
discussed in "Bhavaprakash"-the ancient Indian classic (Fig. I). Fresh juice of leaves
is rubbed on the scalp for promoting growth of hair. Bhringraj is bitter, hot fattening,
alterative anthelminticum and alexipharmic. It is useful in mental disorders, anaemia,
headaches, earaches, insomnia, dysentery, fevers and as a mild laxative. It
is a
classical rejuvenative for preventing ageing and slowing signs of old age. Bhringraj
works as a general antiseptic, astringent, oral mouth wash for infected gums and loose
teeth. It also helps to maintain and rejuvenate teeth, bones, sight, hearing and
memory. Externally it can also used on minor cuts or injuries, athlete foot, eczema
and dermatitis. It is used as a tonic in hepatic and spleen enlargement. It is applied with sesame oil in elephantiasis. The juice of plant with honey is given to infants with castor oil for expulsion of worms and to new born babies suffering from catarrh. It may be used to prevent habitual abortion and miscarriage. It is considered beneficial for relief in piles. The plant is used as a dyeing herb in tattooing. Leaves are used as vegetable in Java and in some part of India in chutneys. Decoction of the plant is used to invigorate the liver, to prevent premature graying of the hair and to stop bleeding, especially from the uterus (Chevallier, 1996).

![Fig. I: Shloka in Bhavaprakasha describing medicinal value of Bhringraj](image)

_Eclipta alba_ is widely used in pharmaceutical and cosmetic industry. In pharmaceutical industry it is the most widely used plants in hepatoprotective formulations. Other pharmaceutical Ayurvedic formulations include Abana (Heart care), Geriforte (Stress care), Pilex (Vein care), Purim, (Homo care), Talket, Blood purifier capsules and syrups, Galactin Vet, Geriforte Aqua, Geriforte Vet, Liv. 52 Protec and health supplements. _Eclipta alba_ is also an important ingredient of many popular Ayurvedic Herbal formulations like shampoos, protein conditioner and revitalizing hair oils. Large number of cosmetic and health products containing Bhringraj are commercially available in the market (Fig. II). It is known to be the best remedy for hair fall and grey hair.
Fig. II: Health and cosmetic preparations containing *Eclipta alba*
*E. alba* is one of the important medicinal plants required by Indian pharmaceutical industries and of global interest (Pushpangadan, 2006). Its consumption in 1999 by Indian pharmaceutical industries was 500 tonnes (Subrat *et al.*, 2002). Estimated annual consumption of *Eclipta* is found to be 3351 ±100 MT/year. This requirement is increasing sharply in view of the popularity of the Ayurvedic herbal formulations having *Bhringraj* as an important ingredient. *E. alba* is one of the medicinal plant species traded in high volumes (≥ 100 MT/year) sourced mainly from wastelands (Ved and Goraya, 2007). Its sources of supply are MP, UP, TN Maharashtra, W Bengal and collected as wild. According to Ved *et al.* (2002) on an average *Eclipta* gives a yield of 6000 Kg/Ha of dry herbage/year. The whole plants are being sold at a price range of Rs.15-40/kg in the Hyderabad, Mumbai, Delhi and Bangalore markets. The Calcutta market has quoted a price of only Rs.6/per Kg. The leaves of *Eclipta alba* are sold at a price of Rs. 8-10/kg in the Chennai market. According to Ministry of Health and Family Welfare Government of India (2001), in India, the retail market price- Powder: Rs. 60/ kg (2000); Bhringraj ghanvati (solidified aqueous extract): Rs. 510/kg (1999). According to report of the Task Force on Conservation and Sustainable use of Medicinal Plants, Government of India Planning Commission March 2000, average requirement of crude drugs (tons/annum) of *Eclipta alba* by some Indian pharmacies is 76.275. According to ICS UNIDO (International Centre of Science and High Technology United Nations Industrial Development Organization) the plant is cultivated in the OAS (The Organization of the American States) project, experimental cultivation started by SOLIGON, S.A. in Panama.

The great importance of systematic collection and cataloging of available germplasm of various economic plants has been emphasized (Harlan, 1956; Frankel and Soule, 1981). A systemic survey can reveal different cytotypes/ecotypes of promising genetic variability in respect to chromosome complements, mutations and
Introduction

modes of reproduction (Roy, 1995). The renowned wealth of India has seldom been subjected to genetic scrutiny. Knowledge of the genetic diversity is also a prerequisite for *in situ* and *ex situ* conservation scheme (Hamrick *et al.*, 1991). Some of these species may, however, need cultivation to conform to quality standards, especially in cases where more than one equivalent species are freely traded as one botanical. The biochemical differences within taxa with respect to chemism are the result of spontaneous processes in nature. The importance of existence of variability in the medicinal plants has been well recognized by traditional physicians and vaids of yester years. They used to collect herbs of certain morphological attributes (flower, fruit, leaves, etc.) and preferred plant parts especially root drugs of specific colour, smell, size, fibrous content, itching quality, etc. obviously from locations best known to them. It is also not surprising that curative properties of plants change according to seasons and developmental stages and hence medicine men of yester years prefer to collect required plants or their parts during certain periods only (Bharat, 1997).

The knowledge about medicinal potentials of different cytotypes, ecotypes, gene complexes, interspecific hybrids within medicinal plants is the need of the hour. Keeping in view all of these facts there is a need to explore the medicinal plants from cytomorphological and phytochemical parameters. *E. alba* holds great promise to be investigated in detail owing to the morphological variability. The present work was undertaken with an aim of screening of North Indian *E. alba* germplasm for phenotypic (morphological, biochemical) and genotypic (cytological, molecular) variability. Attempt has also been made to induce variability utilizing *in vitro* techniques. Impact of agronomic inputs on growth of *Bhringraj* was also studied.