1. INTRODUCTION

Medicinal plants have played an important role in the development of human health, wealth and culture since prehistoric times. Awareness of medicinal plants usage is a result of many years of struggle against illness due to which man learned to pursue drugs from different parts of the plants. Over 50% of prescription drugs are derived from chemicals first identified in plants but, presently 400 medicinal plants are identified at risk of extinction from over-collection and deforestation, threatening the discovery of future cures for disease.

*Commiphora wightii* (Arnott) Bhandari, Family Burseraceae is one of the important traditionally known, medicinal plant of arid and semi arid regions of India. It is commonly known as ‘guggal’ or ‘guggulu’ in hindi (Murray 1995) and Indian bdellium tree in English (Lal and Kasera 2010). The generic name is derived from Greek word ‘kommis’ and ‘phora’ meaning gum bearer. It is a slow growing branched spiny shrub or small tree, with silvery, paper-like peeling barks (Barve and Mehta 1993). Leaves are 1 to 3 foliate, 20mm long, rhomboid-ovate, serrate near apex, entire near base, aromatic and deciduous. Young leaves appear in the month of May and June. It is polymorphic flowering plant having female, male and andromonoecious (male and bisexual flowers) plants. Flowers are tetrmerous brownish red, solitary or in fascicle of 2-3, almost sessile. Fruits are ovoid green berry like drupe, become red on ripening, 6-8 mm in diameter and appear twice in a year. It is propagated by vegetative means and by seeds setting.

The genus *Commiphora* is widely distributed in tropical region of Africa, Madagascar and Asia (Hanus *et al.* 2005). The distribution further extends to Australia and Indian Ocean and Pacific Island. Out of total 200 species globally, 5 species are distributed in southwestern and central part of India (Parnet 1972). In India, it grows wild in rocky tracts of Rajasthan, Gujarat, Madhya Pradesh, Karnataka and Orissa (Dixit and Rao 2000). A recent survey carried out by Arid Forest Research Institute, Jodhpur in all 33 districts of Rajasthan revealed that highest guggul density was in Sawai Madhopur (=74 ha$^{-1}$), followed by Jhunjhunu (=69 ha$^{-1}$) district. The
districts which were lacking natural guggul population were Bikaner, Banswara, Churu, Shri Ganganagar, Hanumangarh and Pratapgarh (Tomar 2013).

This plant has vast economic value and a wide array of medicinal importance. It is basically used for its oleo-gum resin commonly known as guggul gum, which has been a key component in ancient Indian ayurvedic system of medicine (Chakravarty 1975). Guggul gum is a mixture of many secondary metabolites, which are of potent medicinal uses mainly in arthritis, cold, bronchitis, laryngitis, obesity, heart disease, lipid disorders etc. (Jain 1991; Satyavati 1991). This is also being used in perfumery, calico-printing, fumigation, dyeing silk and cotton and as incense. The important constituents of secondary metabolites are E and Z-guggulsterones, which are extracted from the guggul gum, but the supply of guggul gum does not fulfil the demand. According to the assessment reported by Ayurvedic Drug Manufacturing Association (ADMA), less than 10% of requirement of guggul gum is currently being met from indigenous sources and remaining 90% of this material is being obtained through imports (Ved and Goraya 2007).

Unfortunately, this important plant is facing many types of threats, which are categorized into three groups viz; social, ecological and genetic threats as described below:

(A) SOCIAL THREATS:

- Encroachment, unawareness of rural people, unsustainable overexploitation, lack of management and cultivation practices lead to decrease in its population (Atal et al. 1975; Kumar 2013).

- High demand for manufacturing medicines and other commercial products, guggul plants have been subjected to excessive destructive harvesting methods (Kumar and Bhandari 1994) as a result, it has became threatened species (GEC 1994; WCMC 1994).

- The exact situation of population of this species is not well known. In IUCN’s Red Data list (2012), it comes under the category of data deficient plant. Government of India has included it under rare, endangered, threatened (RET) category (Samantaray et al. 2011).
(B) ECOLOGICAL THREATS:

- Plant is often attacked by termites, leaf eating caterpillars and white flies, particularly in summer season (Orwa et al. 2009) and some diseases like leaf spot and bacterial leaf blight also acts detrimental to it. Insect and pest management practices are lacking.
- Regeneration of C. wightii is adversely affected by invasive and dominating species like Prosopis juliflora, which is identified as frequent associate in similar habitat (Reddy et al. 2012).
- Soil erosion, low rainfall, high temperature and drought conditions also lead to loss of natural guggul population.

(C) GENETIC THREATS:

- It is slow growing in nature, has poor natural regeneration due to poor seed setting and seed germination percentage (Yadava 2011).
- Male and andromonoecious plants are extremely rare in natural population and plantations (Gupta et al. 1996; Tomar 2013). Population is dominated by female plants.
- In absence or scarcity of male plants, it evades the process of fertilization and adopted apomixis for its survival (Gupta et al. 1996). This situation may be leading the production of genetically identical plants and loss of genetic variation, which may lead to self destruction and loss of this species.

Present scenario demands an early solution in form of effective conservation strategies. Keeping all the above three aspects in consideration, following studies are essential;

1. An intensive field based population status assessment with regular monitoring and evaluation of population status at fixed time intervals is necessary to keep track of population change in different sites.
2. Proper protection of sites having high density population for In situ habitat conservation and creating awareness in the surrounding rural areas for its importance and protection.

4. Plans should be developed to encourage seedling recruitment in the small populations, especially those harbouring low genetic variation (Kulloli et al. 2013).

5. Superior genotypes for different characteristics like highly apomictic, non apomictic, high and viable seed yielder and high guggul gum producer should be selected and preserved for its improvement through breeding programmes.

6. Reproductive biology, breeding behaviour and Molecular studies are essential for designing conservation and breeding strategies and for developing base population with desired genetic characteristics.

Forest department of Rajasthan and Gujarat have already initiated many activities on the lines/ strategies described above from point 1 to 4. In the present thesis, we have tried to study some of the aspects related to point 5 and 6.

Literature survey on reproductive biology and genetic diversity revealed that most of the plants in the studied populations are females. Occurrence of male and andromonoecious plants are extremely rare (Gupta et al. 1996). They also reported non-pseudogamous apomixis, nucellar polyembryony and autonomous endosperm formation. Literature survey also revealed high variation in seed germination which ranges from less than 10% to 60%, at different locations (Dalal and Patel 1995). This study does not clarify the reasons of such significant differences. These differences could be due to genetic makeup or environmental factors.

Present study was aimed to resolve some of the genetic aspects of this species, particularly male, female and andromonoecious plants differences and breeding behaviour using molecular marker techniques.
Based on the above cited background and research gaps, following three objectives were identified for present thesis work;

1.) To study the male, female and andromonoecious plants percentage occurrence and their morphological characters in different sources/locations.

2.) Comparative analysis of variation in E and Z guggulsterone production in male, female and andromonoecious plants.

3.) To study the genetic variation in selected mother plants and their progenies using isozymes and DNA profiles.