INTRODUCTION
Cotton is recognized as "White gold" and it is the world's most important commercial crop. It is considered to be the backbone of the widespread network of agro-based industries in the world. As the world's leading textile fiber plant, cotton forms a vital part of global agriculture. It is cultivated in an area of 34.20 m ha with the production of 25.30 m MT and productivity of 739 Kg/ha.

In India cotton is cultivated in an area of 9.13 million hectares, which is largest among all the cotton growing countries. However, the production of 4.60 million tons and productivity of 502 kg per hectare is less compared to the two other largest cotton-growing countries namely China and USA (Anonymous, 2006).

Cotton belongs to the family Malvaceae and the genus Gossypium, which includes 50 species distributed in arid to semi arid regions of the tropic and sub-tropics (Fryxell, 1992). Among them four species viz., Gossypium arboreum L., G. herbaceum L. (desi cottons), G. hirsutum L. and G. barbadense L. (American cottons) are commonly cultivated. It is an important fiber and food crop in more than seventy countries but India has the unique distinction of commercially growing all the four species of Gossypium. About 90 per cent cotton production of the world is from cultivation of G. hirsutum, a tetraploid widely cultivated species (Wendel and Cronn, 2003).
Though, India ranks first in terms of area under cotton cultivation, it slides down to second position in terms of production. The dismal productivity figure of 502 Kg/ha shows that India is far behind many cotton-growing countries. Though USA and China have larger area they reveal much higher production than what is seen in India.

Cotton is grown in nine major states in India and among them Gujarat, Maharashtra and Andhra Pradesh are the prominent cotton growing states. Karnataka ranks 7th in area and 8th in production, where it is grown over an area of 3.56 lakh hectares with 7 lakh bales of production and productivity of 334 kg/ha (Anonymous, 2006). Productivity of cotton in Karnataka is much lesser than national and world average.

It has higher employment generating potential as compared to any other crop and hence occupies a vital position in the over all development, especially in the predominantly agrarian developing country like India. It has a wide range of products, having variety of industrial end uses. Commercial status of the cotton crop has been key in Indian agriculture for revenue and employment generation. Indian textile industry predominantly uses 75 per cent cotton as its raw material. Cotton and textile exports account for nearly one-third of total foreign exchange earnings of India, crossing Rs.60, 000 crores. India has achieved significant breakthrough in cotton yarn exports besides increasing its global market share in cotton textiles and apparels.

1.1 Changing Scenario: Increasing prominence of hirsutum

At the time of independence 97 per cent cotton area was under desi cottons and 3 per cent of the area was under hirsutum cottons, with the
popularization of hirsutums there was a systematic encroachment of desi cottons by American cottons. After 60 years of independence 72 per cent of the area is occupied by hirsutum based cotton while 14 per cent and 7 per cent by arboreum and herbaceum cottons respectively (Singh and Mohan, 2005). The era of hybrids brought revolution in the history of cotton.

India holds the distinction of being pioneer in the world in development and commercial cultivation of cotton hybrids. Development of intra-hirsutum hybrid "H-4" (Patel, 1971) and inter-specific hybrid, "Varalaxmi" (Katarki, 1972), were milestones in the history of cotton improvement not only in India but also in the world. Since then intra and inter-specific hybrids have been developed and cultivated in both tetraploid and diploids. The advent of hybrids in seventies brought a sea change in the quantity and quality of cotton in India (Basu, 1983). More than 40 hybrids have been released for commercial cultivation in different cotton growing states (Singh and Singh, 1999). Farmers accepted hybrids and the area under commercial hybrids increased substantially. Presently hybrids produced by both public and private seed sector industry occupy nearly 50 per cent of area contributing to 60 per cent of the total production (Singh and Mohan, 2005). Apart from higher productivity, hybrids are endowed with better fiber quality fetching higher price and thus profitable to farmers.

1.2 Exploitation of CGMS system

The conventional hybrid cotton seed is produced mainly through the labour intensive technique of hand emasculation and pollination that increases the cost of the hybrid production making the seeds of conventional
hybrids are expensive and are beyond the reach of marginal and poor farmers. In addition to this, generally the selfed seeds of female parent get mixed with hybrid seeds reducing the genetic purity of the seeds.

With a view to reduce the cost of hybrid seed and increase the genetic purity, efforts were made to develop hybrids using genetic male-sterile (GMS) or cytoplasmic genetic male-sterile lines (CGMS). In recent years with the advent of male sterility in cotton, exploitation of heterosis became much easier by reducing 50 per cent of the cost of hybrid seed production (Basu and Paroda, 1995). Stable cytoplasmic source of male sterility in cotton is contributed by *G. harknessii*, which was first reported by Meyer, 1973. Restoration of male sterility was found to be governed by two gene pairs (Meyer, 1975, Weaver and Weaver, 1977), which are under incomplete dominance. Later, Davis (1978) reported good prospects of producing cheaper hybrid seed by using *G. harknessii* cytoplasm.

In the first CGMS based cotton hybrid, developed on *G. harknessii* cytoplasm was released for commercial cultivation is PKV.Hy-3 (Anonymous, 1993a). However, yield of this hybrid was 10-15 per cent lower than conventional hybrid developed by using the same parents. There are several problems associated with male-sterile based hybrids such as smaller flower size, low productivity, smaller boll size, reduced ginning outturn and yield and quality characters (Meyer, 1965 and 1971; Murthy and Weaver, 1974; Shroff, 1980 and Sethi et al., 1988).
1.3 The option of New A x R crosses

There is a limited genetic diversity available among A and R lines used in developing hybrids. This happens because only available R-lines are repeatedly used for making new hybrid combinations with available A-lines. There is a need for creating recombinational variability and obtain diverse male and female lines. The use of CGMS source is limited for want of better CMS lines and potential restorers. Therefore, the scope of CGMS system will be greater through genetic diversification leading to the development of divergent A-line and R-lines. Restorer genes for the harknessii cytoplasmic background are not available among the hirsutum varieties. Hence breeders are transferring the restorer genes first to the hirsutum lines especially with the fertile cytoplasmic background. This is a tedious process because of which very limited restorer lines are available for use in developing CGMS based hybrids. To have potential new R lines a novel approach of utilizing sterile cytoplasmic base was followed. In an earlier study multiple crosses of CGMS based hybrids was made and new R lines based on male sterile cytoplasm were derived. Similarly some new A lines were developed by utilizing potential hirsutum lines. In this study the possibility of increasing potential of MS based hybrids was examined by considering one of the options namely utilizing new potential A lines and R lines derived through recombination breeding.

1.4 The option of B x R crosses

In the option described earlier (A x R) the choice of female and male parents is restricted to the available A and R lines even though they may be newly developed. It is always felt that if parental lines are selected without
imposing such restriction (based on restoration status) in choosing them as parents, greater genetic diversity is available by virtue of which the exploitation of heterosis can be more effective. In this study an attempt is made to utilize the newly developed ‘R’ lines with potential new varietal lines, as these hirsutum lines are maintainer types (maintainer lines who’s ‘A’ versions are not yet developed). This gives scope for examining whether when such newly developed diverse ‘B’ lines are used, the magnitude of heterosis can be more than that observed in A x R crosses. Thus in this option the restriction on using available A lines is removed (B x R) to examine if this can enhance heterosis level of the crosses.

1.5 Stability parameters

Stability analysis helps in understanding the genotypic adaptation of environmental changes and use of adaptable cotton genotypes is important for stabilizing crop production over seasons and regions. Varietal adaptability has been studied in cotton (Tuteja, 2006). In this study an attempt is made to assess stability parameters of cotton hybrids developed through different approaches.

1.6 Gametophytic study of parental genotypes

Evaluation and characterization of genotypes is normally done for different quantitative and qualitative characters studied based on field evaluation. In recent years greater emphasis is laid on the need for characterizing and evaluating genotypes for traits measured at gametophytic level. It has been realized recently that pollen/gamates play an important role in crop improvement (Shivanna, 1998; Ravikumar and Patil, 2002). In maize
it has been shown that gametophytic performance can be used to predict combining ability (Ottaviano et al., 1980) and a positive correlation between pollen competitive ability (in terms of pollen tube growth rate) and sporophytic growth and vigor has been demonstrated in cotton, vigna and wheat (Ter-Avanesian, 1978). Pollen selection plays an important role, therefore it is essential to develop in vitro pollen germination medium and to study response of pollen in terms of germination and tube growth rate in parental lines.

1.7 Molecular characterization of genotypes

The verification of varietal identity is an important element in seed quality control and rigorous genetic purity tests have to be applied to maintain supply of genetically pure seeds. Presently grow out test has been followed to verify the genetic purity of varieties and hybrids that involves time, money and effort (Smith and Smith, 1992). The morphological characters have been used so far for varietal identification and verification of crosses, but at times they are less reliable in discriminating genotypes and additionally they are more cumbersome (Patterson and Whatherup, 1984; Smith et al., 1991). DNA finger-printing studies to assess genetic purity, to measure genetic diversity and/or genetic relationship with RAPD have already been conducted in cotton (Soregaon, 2004, Mehetre et al., 2005 and Yin et al., 2006). In the present study efforts have been made to characterize hybrids and their parents through RAPD technique. The priority areas of research in cotton described above are embedded to form the following objectives:
Chapter 1

Introduction

1. To develop new A and R lines based on G. harknessii cytoplasm.

2. To compare groups of A x R and B x R crosses representing levels of restriction on choice of parents based on restoration status.

3. To evaluate combining ability status of A, B and R lines utilized in different groups of crosses.

4. To determine stability parameters in different groups of crosses.

5. To study *in vitro* pollen characterization of parental lines.

6. To make DNA fingerprinting of selected parents and hybrids through RAPD analysis.