CHAPTER-I

INTRODUCTION

Fruits are rich source of vitamins, minerals, proteins, carbohydrates etc. having vital role in balanced diet and also have significant contribution in Indian economy. In India, diverse climatic conditions fortify different varieties of fruit plants which are entirely contributing a lot in the total GDP. India is the second largest producer of fruits around the world with total production of 295 million tons of fruit in 2016-17 while 81.285 million tonnes in 2015-16 (National Horticulture Board, India, 2016). It ranks first in the production of papayas (44.03%) followed by Brazil, Indonesia, Nigeria, Mexico and Ethiopia (NHB, India).The major fruit producing states in the country includes Gujarat, Karnataka, Maharashtra, West Bengal, Chhattisgarh, Madhya Pradesh, Assam, Tamil Nadu, and Kerala.

Papaya (*Carica papaya* L.) belongs to family Caricaceae, comprising of four genera including *Carica, Facaratia, Farilla* and *Cylicomorp.* Out of these four genera, *Carica* have only one species i.e. papaya and it is native to Central and South America. It is an economically important fruit crop in India, SriLanka, Hawaii, Australia etc. Papaya is also known as Papeya (Bengali), Papita (Hindi), Pappayi and Popay (Marathi) and Erand Karkati (Sanskrit). Some of the well known cultivars of papaya are Washington, Honey dew, Coimbatore1, Coimbatore 2, Pusa Delicious, Pusa Dwarf, Sunrise Solo, Sun Up etc.

Papaya is grown in tropical and subtropical regions at 22-26°C temperature and 100-150 cm rainfall. These are frost-sensitive trees which survive in a properly drained, well aired soil having pH from 5.5-6.7 (Morton, 1987). It cannot tolerate water logged conditions and results in rotting of stem and dropping of lower leaves.The plants are generally erect, small, soft-wooded and fast-growing with a height upto 3-6 meters. Stem of the plant is unbranched with spirally arranged palmately-lobed large leaves, clustered at the crown. The plant shows apical dominance, seldom branching except when the apical meristem is removed, or is damaged.

In the axils of leaves, five-petalled flowers of papaya are of three type i.e. staminate (male), pistillate (female) and hermaphrodite with modified cymose inflorescences. The flowers are waxy, fleshy, and cream to yellow in colour with

slight fragrance. The inflorescence in the papaya trees are either long pendulous in male flower while one or two flowers in female trees at their leaf axil. Pistillate flowers have a large ovary with numerous ovules and hermaphrodite flowers bear an elongated, slender ovary.

The fruit of the papaya plant is 15-50 cm in length and 10- 20 cm in thickness. The fruit which are produced by the female is generally round or ovoid while the one produced by hermaphrodite, develops an elongated and cylindrical fruit. The immature fruit has greenish or white flesh which contains white milky latex. However, when the fruit matures, it changes to reddish-orange and contain small, black, ovoid seeds (Morton, 1987).

Papaya is good source of iron, calcium, provitamin A, vitamin B and C, carotenoids and a range of phytochemicals such as chymopapain, papain, danielone, protocatechuic acid, caffeic acid etc. The latex of the plants comprises enzymes suc as proteolytic enzymes, papain and chymopapain (Bhattacharya and Khuspe, 2001) that are widely used to cure digestive disorders. Latex of papaya has anti-bacterial and anti-fungal properties (Giordani and Siepai, 1991). It is beneficial for dyspepsia, burns and scalds (Reed, 1976). The fruits and seeds have antihelminthic and anti-amoebic activities (Okeniyi *et al*., 2007). They are also used in making ice cream, jam, salads, drinks, jelly, candied etc.

The green fruit is usually used as a vegetable or is pickled. Unripe fruit is a good source of papain, an enzyme that breaks proteins and is widely used in preparation of food, beverages, animal feed, vaccines etc. This enzyme is widely used in medications for treatment of hard skin, diphtheria, impaired digestion etc. Papain is utilized in leather and wool softening and in silk degumming. It is a necessary ingredient in beer making and meat tenderizing.

Papayas have been propagated by seed (Fernando *et al*., 2001) despite the pollination causes considerable and rapid genetic drift in dioecious cultivars (Litz, 1986). The time difference between the seed sowing and harvesting is usually 8–9 months with the fruit is marketed all over the year (Chan and Paull, 2008). The seeds present in the fuit are higher in number but seed germination is relatively slow i.e., 2-4 weeks and sporadic (Perez *et al*., 1980) after sowing. The papaya seeds are sown more in number because the sex is not revealed up to 6 months after germination. Seeds obtained from reprosuction, yield a mix of male, female and hermaphroditic plants. Fruit production outcomes are decided by self-pollination or cross-pollination among the genotypes.

Cross-pollination causes heterogeneity which can be a disadvantage. Numerous pathogens and pests are home to papaya and which lowers the plant vigour and influence fruit quality. The major pests includes fruit flies, spider mite, papaya whitefly (*Trialeuroides varibilis*), and nematodes that attack the papaya leaves, fruit and roots (Morton, 1987; Nishina *et al*., 2000). The insect deposits its eggs in the papaya fruit and the larvae appear which feeds on seeds and internal portions of the fruit. Diseases and environmental stresses are commonly much more important factors limiting the food production around the world. The inherent heterozygosity, dioecious nature and susceptibility to papaya ring spot virus inhibit the cultivation of this plant (Bhattacharya and Khuspe, 2001). Therefore alternate propagation strategy is required for the production of specific sex types, disease free and true-to-type planting material. Clonal propagation is an urgent necessity for improvement of papaya.

Papaya genome size is of 372Mb (Arumuganathan and Earle, 1991) with 9 pairs of chromosomes and a generation time of 9 months. It is a polygamous diploid (2n = 18) plant with a dioecious and gynodioecious forms (Storey, 1953). The genotype and climatic conditions affects the sex expression in papaya i.e., male and hermaphrodite flowers often undergo sex reversal. Also, when plants are produced by tissue culture, it is essential to assess the genetic variations in micropropagated plants. The use of molecular markers like RAPD and ISSR are very common method to assess the same. Therefore the testing of genetic fidelity of *in vitro* plants is must for successful micropropagation work.

Papaya trees exhibit sexual polymorphism and the sex of plant can be determined only after inflorescence stage. The identification of sex type in papaya will benefit farmers, decreasing their money consumption on resources. This resulted in more production of fruits. Hence, sex determination in papaya (Storey, 1976) could be studied more for efficient fruit production. Molecular markers are now used for determination of sex at seedling stage to enhance papaya production (Deputy *et al*., 2002).

Phenotypic variation among papaya varieties can be vary from small fruits to somewhat large fruit and spherical in female trees while cylindrical from hermaphrodite trees (Samson, 1986). The genetic variations in the germplasm could be used to study the genetics of the crop and thus used for breeding or conservation programmes (Sakiyama, 2000).

For plant improvement, the crop selected must be analysed with the variations present and their causes, to be exploit for further improvement. Papaya variability and short generation time have made it a valued fruit tree, which could be used for genomic and genetic diversity analysis.

A molecular study involves in the detection, characterization and evaluation of genetic diversity of desired genotype. The technique offers several advantages over conventional techniques and has become an essential tool for the study, conservation and improvement of plant species. The study of genetic diversity are done by DNA-based markers for identification, development of genotypes (Smith *et al*., 2000).

Keeping the above points in view, the present investigation is planned with the following objectives:

1. To develop an efficient micropropagation protocol for papaya and testing the genetic fidelity of micropropagated plants
2. To assess genetic diversity amongst different Genotypes of *Carica papaya*
3. Determination of sex in different genotypes of *Carica papaya* using molecular markers