Chapter: 1

1.1:Introduction

India is the second largest producer of fruit plants after China. Mango, banana, citrus, guava, grape, pineapple, and apple are the major fruit plants grown in India. Apart from these, other fruits like papaya, ber, phalsa, sapota, annona, jackfruit, and pomegranate and peach, apricot, pear, almond, walnut, and strawberry are also grown in a remarkable area. Propagation in fruit plants through seed is primarily done to raise rootstocks, which are required for grafted plants. Some of the fruit plants like lemon and papaya are propagated through seeds, but dormancy, poor germination, low seed viability, and adverse environmental conditions are major limiting factors (Kajla *et al.* 2013).

1.1A :Biotechnological aspects

The vegetative propagation of fruit plants hasbeen practiced for centuries, and many improvements in conventional methods have been madeover the years. Advances in biotechnological techniques like plant tissue culture provided new methods for rapid production of highquality, disease-free, and true-to-type planting material. Recently, the tissue culture technique, i.e., micropropagation, has expanded their scope and potential on commercial scale. Micropropagation is suitable for the rapid and large-scale clonal multiplication of elite germplasm.The technique not only offers a valuable alternative in fruit trees propagation studies but is also useful for virus control and management of plant genetic resources.

Biotechnological tools like *in vitro* culture and micropropagation not only offer a valuable alternative in propagation studies of fruit trees but are also useful for virus control and managementof genetic resources. The technique of *in vitro* micropropagation is employed, for rapid propagation under aseptic conditions,for mass multiplication of plants for commercial sector and *in vitro* preservation of plant germplasm.

Later on with the discovery of the hormonal control of organogenesis and finding of most commonly used tissue culture media by Murashige and Skoog (1962), the scope of Micropropagation was further extended to huge scale of plant species, including fruit and plantation crops. With the advancement in science and technology, micropropagation technique has also been standardized for many plants. Now micropropagation is perhaps the most popularand widely commercialized global application of plant biotechnology in horticulture. A large number of plants are being cloned and exploited commercially worldwide. Novel germplasm in horticultural crops, is created using various bio-technological tools, also needs to be multiplied rapidly for quick dissemination. This is possible only by integrating *in vitro* culture and molecular biology techniques.

1.1B: History of Plant Tissue Culture

In recent years plant biotechnology has made an impressive progress as one of the frontiers of biotechnology of plant tissue culture since its pioneering experiments by White (1934,1937), Laibach (1925,1929),Vanoverbeck *et al*. (1941), Loo(1945), Gautheret (1934),Skoog(1944) and Murashige and Skoog (1962) have contributed in establishing a strong foundation for the applications of this versatile technology.Soon after working out the theoretical aspects of in vitro cultivars plant scientists have made efforts to involve in the practical application of plant tissue culture technology.The important horticultural application of plant tissue culture is throughmicropropagation. Small amounts of tissue can be used to raise hundreds or thousands of plants in a continuous process.Murashige (USA) has developed standard methods of propagation of *invitro* species ranging from ferns to foliage flowers and fruit plants.The utility of this technique was soon realised by Morel (1960) for rapid propagation of orchids,*Cymbidium* and *Odontoglossum*.Use of plant tissue culture for micropropagtion was initiated by Morel (1960) and he was the first to develop commercially viable approach for orchids.

The first complete plants from tissue culture of tree species were regenerated by Winton (1968).He used leaf explants of black cotton wood (*Populus trichocarpa*) for micropropagation.Tissue culture of woody species was first reported by Gautheret way back in 1933.The progress made with trees has been rather slow as compared to herbaceous species. This is largely because fruit tree species have a distinct juvenile and an adult phase and trees especially in their adulthood are more recalcitrant to tissue culture technology. Since then several plant species have been micropropagated and protocols are now established for them.

Fruit trees may play a crucial role in managing carbon pools (terrestrial, aquatic etc.) to mitiqate the increasing concentration of atmospheric carbon dioxide. These plants can be used in agro forestry plantation. Figure 1a shows carbon sequestration pathway.

Carbon Sequestration Paln

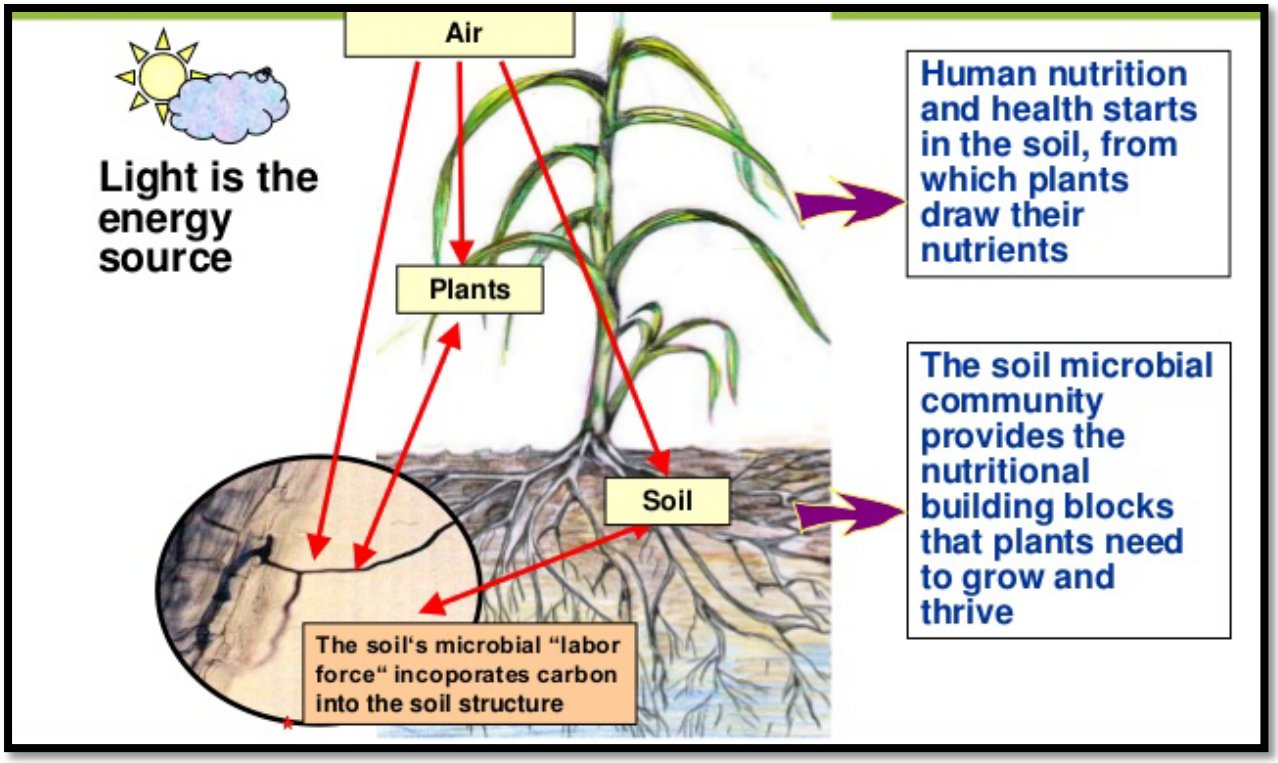

Figure 1a: Proven Carbon Sequestration.

1.1C: Problems in Tree Propagation

Breeding of tree is technically difficult and time consuming. Compared to horticultural plants research in tree species has lagged behind (Dhawan and Saxena 2004)

Constraints in vegetative propagation:

- In many tree species the cuttings lose their ability to root by the time a particular clone is evaluated for its useful traits.
- The cutting raised plants tend to form adventitious roots which unlike the tap root of seedlings do not penetrate very deep inside the ground thereby making the plant highly prone to felling by strong winds.
- Propagation through tissue culture also possesses a potential risk for spread of various systemic diseases.
- Propagation through cuttings is extremely slow and season specific.

1.1D: Plant Tissue Culture Techniques

Tissue culture is used in its broadest sense to include the aseptic culture of plant parts of widely different organizational complexities, including organs, tissues, tissues, isolated cells and protoplasts under controlled conditions (Gamborg and Phillips, 1996). Tissue culture technique has been exploited to increase the number of desirable stock or germplasm available to the breeder, to create genetic variability for plant improvement programmes and to improve the state of health of the planting materials. In-vitro techniques for the culture of protoplast, anther, microspore and ovule have also been used to create new genetic variation in the breeding lines. Cell culture methods also produce somaclonal and gametoclonal variants with crop improvement potential. The culture of single cell meristems can be effectively used to eradicate pathogens from planting materials and there by dramatically improve the yield of established cultivars (Brown and Thorpe, 1995). However, one of the major applications of tissue culture techniques is in the area of clonal propagation (Berbee and Hilderbrant, 1972; Evans, 1990). The clonal propagation is an asexual method of reproduction for genetically uniform plants that

are originated from a single individual, through explants. The clonal propagation of plants through such techniques is popularly called micropropagation in other words; micropropagation is an in vitro clonal propagation of plants from shoot tips or nodal explants, usually with an accelerated proliferation of shoot during subculture.

.

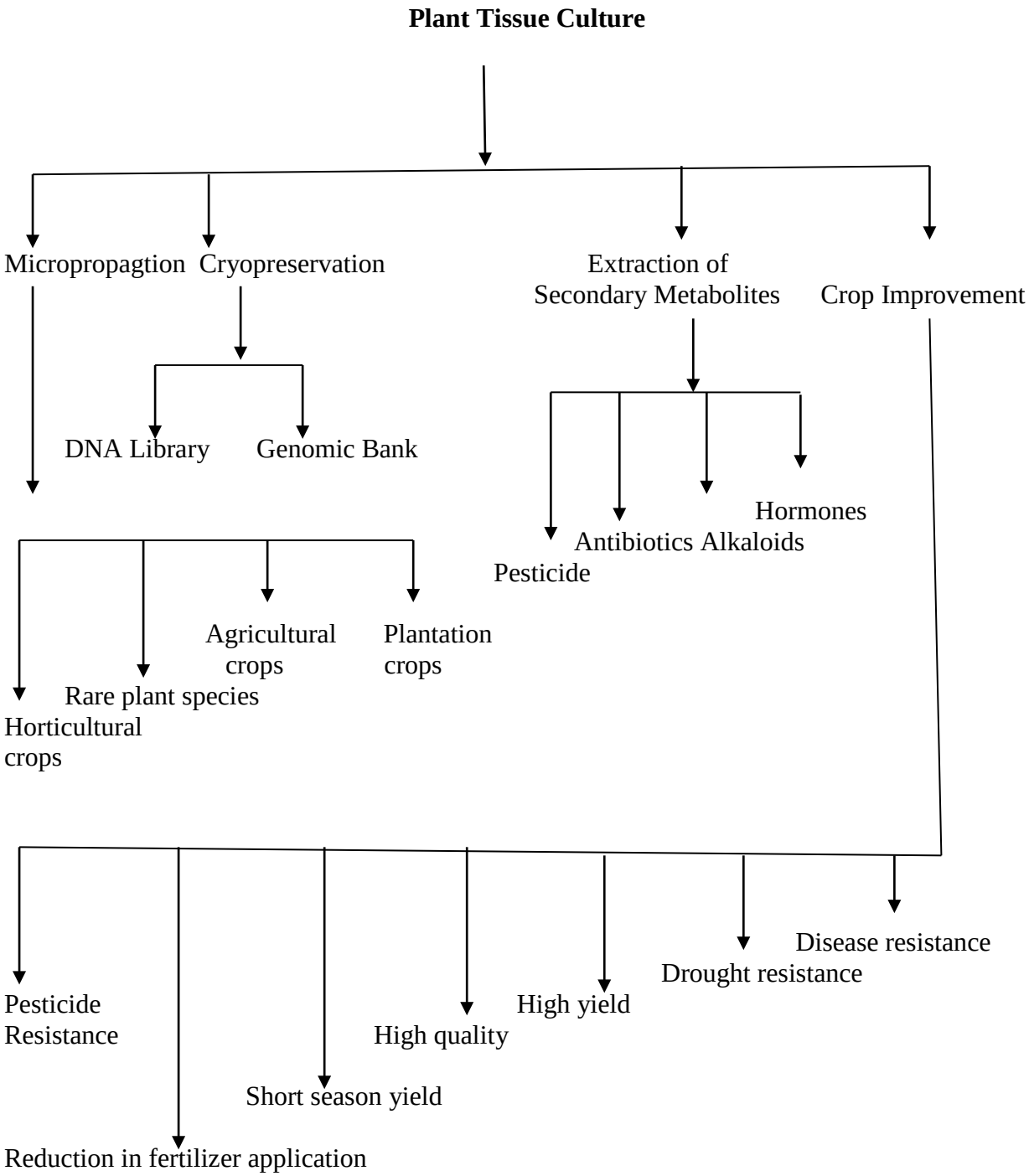

Figure1b : Showing the possible uses of plant tissue culture technology to the developing world.

1.1E: Commercialisation of Plant Tissue Culture

Commercial micropropagation is an exciting and challenging field and a new industry that seems set to alter radically the method of plant production for a number of important crops.Commercial micropropagators are essentially producers of young plants and operate in one of the most demanding and competitive horticultural markets. Annual production of micropropagated plants exceeds 50 million but the market could probably absorb nearer to 250 million.A huge range of genera and species is micropropagated.

The objective of commercial propagation is to reproduce either sexually or asexually copies of an original parent plant.The controlled aspects of micropropagation permit the rapid propagation of individuals from a single plant.Multiplication rates can be very high since plants in culture can theoretically be multiplied at an exponential rate by consecutive subculturing. A multiplication rate of fourfold in cultures subcultured every four weeks will theoretically produce over one million plants in ten months.

Tissue culture protocols are available for most of the fruit crop species, although continued optimization is still required for many crops, especially woody plants. These techniques are being increasingly used by number of research workers and commercial firms.

Large-scale micropropagation laboratories are producing millions of plants for the commercial ornamental market and the agricultural clonally-propagated crop market. Advancement in commercialization of plant tissue culture and acceptance of tissue cultured plants by the commercial sector have led to continued exponential growth within the industry in terms of new units as well as number of plants.

Micropropagation of plants is a multibillion dollar industry being practiced in hundreds of small and large nurseries and commercial laboratories throughout the world. Microrpropagation of ornamental and medicinal plants fruit and forest trees offers not only means for the mass multiplication of existing stocks of germplasm for biomass energy production but also for the conservation of important elite and rare species that are threatened with the danger of extinction. Conventional propagation techniques are time consuming and labour intensive thus making the availability of a large number of plants for plantation or afforestation a difficult and challenging task (Batra *et al.* 2000).

Clonal fidelity is a major consideration in commercial micropropagation using in vitro tissue culture methods.Micropropagation of fruit crops offers a rapid means of producing clonal planting stock for forestation programmes,woody bio-mass production and conservation of elite and rare germplasm.

1.1F: Need for tissue culture for fruit trees

Trees have comparatively long generation cycles so breeding and conventional improvement programmes are tedious and take a long duration compared to that of annual crop species.In many of the tree species there is a very low fruit setting because of heavy flower drop due to strong wind or fungal infestation. As many of the tree species are cross pollinated selfing followed by selection is not possible.The heavy deforestation resulted in loss of genetic diversity of many of the fruit trees. Raising the trees by convetional seed propagation methods is not relied because

- The seedling trees are slow glowing
- Late in bearing flowers and fruits
- The cross pollination will results in loss of unique characteristics
- The occurrence of wide variability among the seedling populations

Conventional propagation methods through vegetative means are not always successful and many a time cause the destruction of the mother plant. In this context improvement of fruit and forest species using in vitro techniques is more relevant (Karnosky, 1981)

1.1G: Tissue culture of Fruit Trees

Indian tissue culture units are mainly involved in propagation of fruit crops and ornamentals for export market. However, the production for domestic market has been increasing from 10 to 40% in recent years.

The greatest use of tissue culture plants has been in fruit trees for the production of clonal rootstocks (particularly peaches in Europe). Self rooted cultivars hold great promise for the future if early field evaluation results are confirmed by longer term evaluations (Zimmerman, 1986).

Considerable work has been carried out on temperate fruit trees using in vitro methods leading to improvement in quality and yield. Limited progress has been achieved in case of Citrus, Fig, Artocarpus and few other tropical fruits (Rao, 1981). Comparative studies are therefore a matter of urgency in tropical fruit trees. Considerable progress has been achieved over recent years in the clonal propagation in vitro of many fruit trees (Skirvin, 1981).

1.1H: AM Fungi

One of the most successful strategies is the ability of root systems to establish mutualistic and reciprocally beneficial symbiotic relationships with microorganisms is mycorhizae.It is association of roots with specific fungal groups.The word mycorrhizae were coined by Frank in 1885.Among the several kind of mychorrhizal associations AM fungi are the most predominant type. AM fungi belongs to the class zygomycotina which are obligate symbionts and hence cannot be cultured on synthetic media without any host(Mosse and Hepper 1975). AM are thought to be ecologically important to most vascular plants are harbouring mycorrhizal fungi as an integral and normal component of their root systems and benefited from it. AM are

characterised by the formation of unique structures such as vesicles and arbuscles.AM fungi is known to increase nodulation and nitrogen fixation in legumes (Kumar *et al*. 2002).

1.1I: Role of Endomycorrhiza in tissue culture raised plants

Recently, attention has turned to the possible beneficial effects of microorganism *in vitro* plant cultures. It has been observed that mycorrhiza enhances the survival percentage of *in vitro*-raised plant. Mycorrhization in micropropagation, particularly the use of arbuscular mycorrhizal fungi (AMF), is now gaining momentum due to a demonstrated positive impact on posttransplant performance of *in vitro* grown plants (Lovato *et a*l. 1996; Rai 2001).

Inoculation of AM fungi during early stages of acclmitazitation may be an alternative strategy for improving plant growth.Potential of AM fungi as biofertilisers and bioprotectors to enhance micropropagated plantlets is recognised but not well exploited with because of the current agronomic practices with their implication for environment.

1.2: Lemon

Acid lime (*Citrus aurantifolia*christm.)Swingle is the third important fruit after mandarins and sweet oranges. India is perhaps the largest producer of acid lime in the word. It is cultivated in almost all the states of country, Andhra Pradesh, Maharashtra, Tamilnadu, Karnataka, Gujarat, Bihar and Himachal Pradesh are being major producing states. Beside acid lime, sweet lime (*Citrus limettioides*), Tahiti limes (*Citrus latifolia*) and Ranapur lime (*Citrus limonia*) are also cultivated on a limited scale in India.

1.2A: Taxonomy: Lemon belongs to family is Rutaceae. Identification of Scientific Name of Lemon is done by considering its genus and species. Species having similar characteristics are placed in a particular genus. Lemons are placed under *Citrus* genus. All fruits belonging to a particular species are ecologically same. Lemon belongs to *C. limon* species.

1.**2B: Distribution :** The fruits of lemon are a type of berry called a hesperidium. They grow in sub-tropical and tropical areas. They were originally from Southeast Asia between south China and northeastern India near the Himalaya. They were brought to Europe about the time of the Crusades. An Italian navigator, Cristopher Columbus, brought lemon seeds to America and lemons were well established in Florida. The first commercial lemon orchards were planted in the late 1800's in the United States. Now the lemons are produced in India, Mexico, Brazil, Iran, Turkey, Egypt, Argentina, Spain, Italy and the United States. The world's three leading lemon producing countries are Argentina, Spain and the United States. The lemon is very rich in vitamin C, so it is used in many ways such as food, beauty products and so on.

1.2C:Description:*Citrus limon* L. (Lemon) a member of Rutaceae is an important evergreen and aromatic small tree.Lemon trees are fruit trees that produce small, oval, yellow citrus fruits (Plate 3.1 A,B). They reach 3 to 6 meters in height. They have thorny twigs and large, pointed leaves, which are reddish when young and become dark-green above and light-green below. The leaves are about 6-12 cm long with wings on the petioles. Buds are red, and the flowers have 4 or 5 petals which are 2 cm and have about 20 to 40 stamens. The lemons are about 7 to 12 cm long. The peels are yellow and 6 to 10 mm thick. Lemons have a bulge at one end. The interior of the fruit includes eight to ten segments, which contain the pulp, juice, and seeds. Some lemons do not have seeds inside. The yellow outer part has many tiny glands that contain fragrant oils.

1.2D: Acid lime varieties (Sour lime, Mexican lime, key lime, west Indian lime)

Commonly grown lime is the acid lime called kagzi lime. There is not much variation among lime trees. They all have been multiplied sexually, because of the well-known phenomenon of polyembryoni. The improved varieties are:-

1. **Pramalini**: It bears fruit in clusters of 3-7 and yields 30% more than the normal kagzi lime. The fruits have 57% juice, which is higher thanVikram (53%) and normal lime (52%).

2. **Vikram**: This also bears fruits in clusters of 5-10 and some off-season fruits during September, May and June. It gives 30-32% more yield over the normal lime.
3. **Chakradhar**: It is seedless strain of acidlime. The plants are erect, compace and dense in habit. Fruits are round, with thin papery rind, containing 60-66% juice and almost seedless compared with 52-62% juice and 6-8 seeds/fruits in others. Bearing starts by fourth year of plating. It bears fruits during January-February, June-July and September-October.
4. **PKM 1**: Its fruits are round, medium to large-sized, with an attractive yellow skin, and 52.31% juice. It is high yielder than the local strains.
5. **Selection 49**: It is a prolific-bearer, producing better-sized quality fruits. It has a tendency for bearing summer crop and tolerance to canker, tristeza and leaf-minor.
6. **Seedless lime**: It is new selection of lime. Fruits are obolong, skin thin, primrose coloured, prolific- bearer, yields double that of normal lime but late.
7. **Tahiti (persain) lime**: The large-fruited limes of Tahiti group are different in many characters from the true limes. The trees are larger, spreading and more resistant to cold, nearly thornless, leaves much larger, and of different shapes; fruits much larger and almost seedless. It is a tripod. There are no varieties of this lime being grown in India.

   Acid lime is propagated commercially through seeds. It can be propagated by cuttings, layering and budding owing to high intensity of polyembryony (90-100%) and has least chance of contamination of viral diseases.

1.2E: Cultivation: Citrus fruits grow best between a temperature range of 13ºC to 37ºC. Temperatures below – 4ºC are harmful for the young plants. Soil temperature around 25ºC seems to be optimum for root growth. High humidity favours spread of many diseases. Frost is highly injurious. Hot wind during summer results in desiccation and drop of flowers and developing fruits. Barring these limitations citrus is grown in all subtropical and tropical areas of the world. The sub-tropical climate is best suited for citrus growth and development. Khasi and Darjeeling

mandarins are grown in high altitudes upto 2000 m as it is adapted to a cooler climate. Citrus plants are grown in a wide range of soils ranging from sandy loam or alluvial soils of north India to clay loam or deep clay loam or lateritic/acidic soils in the deccan plateau and north-eastern hills. Citrus orchards flourish well in light soils with good drainage properties. Deep soils with pH range of 5.5 to 7.5 are considered ideal. However, they can also be grown in a pH range of 4.0 to 9.0. High calcium carbonate concentration in feeder root zone may adversely affect the growth.

Availability of quality planting material is of utmost importance in citrus cultivation. Citrus plants are very sensitive to various biotic and abiotic stresses. Therefore selection of an ideal rootstock is a continuing challenge for the citrus industry of India. Currently used rootstocks viz. rough lemon and Rangpur lime have gone through a lot of variation over the last five decades. Therefore ideal selections developed from the conventional rootstocks by National Research Centre for Citrus (NRCC), Nagpur and at other places under State Agriculture Universities may be obtained for propagating quality planting material.

For budwood selection, disease free mother plants developed from the elite progeny of known pedigree through shoot tip grafting method available at NRCC, Nagpur may only be used. Primary nursery beds are prepared on light fertile soils or in the HDPE trays under shade net structures. Selection of nucellar seedlings is done by eliminating weak seedlings, off types and non uniform seedlings in 2-3 stages in the nursery beds. Secondary nursery seedlings may be raised in polythene bags also as they become ready for plantation in the main field after attaining the height of about 30-40 cm after one year.

1.2F: Uses

Its fruit are important source of vitamin C for human nutrition.They contain volatile oils,limonene,α-terpinene, α-pinene, β-pinene,citral,coumarins,bioflavanoids,vitamins and

mucilage.They also act as an antiseptic,antirheumatic,antibacterial and antioxidant.Lemon juice, rind, and zest are used in a wide variety of foods and drinks. Lemon juice is used to make lemonade, soft drinks, and cocktails. Lemon juice is also used as a short-term preservative on certain foods that tend to oxidize and turn brown after being sliced (enzymatic browning), such as apples, bananas, and avocados, where its acid denatures the enzymes.

Lemon juice and rind are used to make marmalade, lemon curd and lemon liqueur. Lemon slices and lemon rind are used as a garnish for food and drinks. Lemon zest, the grated outer rind of the fruit, is used to add flavor to baked goods, puddings, rice, and other dishes.The leaves of the lemon tree are used to make a tea and for preparing cooked meats and seafoods.The juice of the lemon may be used for cleaning Lemons were the primary commercial source of citric acid.Lemon oil may be used in aromatherapy

1.2G: Need of tissue culture in Lemon

Citrus cultivation in India is plagued with various problems due to limiting growing conditions, limiting water resources and high incidence of pests and diseases warranting great care from planting till the plants come to bearing in order to sustain a productive life of a minimum of 15-20 years. There is growing interest/awareness among the citrus growers for adoption of latest technologies for commercial cultivation of citrus.

Citrus are generally propagated through budding,cutting or layering.Propagation is therefore limited to period when buds are available.These conventional techniques are also not free from risk of in born pathogens.However in vitro propagation can overcome this problem improving citrus cultivation ie.fruit quality and resistance to diseases and environmental stresss (Rathore *et al.* 2007).

The demands for elite rootstock material are continuously increasing for fruit production and to fulfill such demands application of *in vitro* propagation techniques is one of the successful alternative particularly in case of citrus crops (Singh *et a*l. 2012).

1.3: FIG

Fig (*F.carica*) is under cultivation since ancient times. Morphologically it is called "Syconium", which is a vegetative, fleshy tissue, with tiny true fruits enclosed inside (Plate 4.5 A-D). Fig is a gynodioecious species and some female types need pollination while other set fruits parthenocarpically. Pollination is effective by a wasp, which develops inside the synconium of a male fig. This symbiotic relationship is a classical case of coevolution between plant and insect. Fig fruits are often consumed as dried or canned. As a fresh fruit, it has a luscious taste. Fruits have been prized over centuries for the medicinal and dietary properties. Its cultivation is mostly confined to western parts of Maharashtra and Gujarat, Uttar Pradesh (Lucknow and Saharanpur), Karnataka (Bellary, Chitradurga and Srirangapatna) and Tamil Nadu (Coimbatore).

Fig is highly nutritious fruit. It is rich in calories (269), proteins and calcium (higher than milk), iron and highest fiber content. Fig has nutritive index of 11, as against 9,8 and 6 for apple, raisin and date respectively. The chemical composition and flavour of fig varies with cultivar. The total sugar content of fresh fig is 16% and of dried is 52%. The edible portion of dried fig (100gm) supplies protein (4gm), carbohydrate (69gm), fat (1gm), calcium (200gm), iron (4gm), vitamin A(100IU) and thiamine (0.1mg). Fig is valued for its laxative properties and is used in the treatment of skin infection. The fruit help to maintain acid-alkali balance of the body. Latex is useful to coagulate milk.

Table 1.1: Characteristics of different varieties of Fig

Type	Popular varieties	Flower type	Mode of pollination	No. of crops	Listed varieties	Other features
Edible fig	Poona Conardia Mission Kadota Brown Turkey	Long styled pistillate flowers	Fruit develops parthinocarpically*	1	470	Seed are hollow without inner kernels and the embryo. Some varieties produce a small breba or first crop in addition to main or second crop.
Smyrna (Lop injir)	Calimyrna (sari lop) Zidi Taranimt	Long styled pistillate flowers	Female wasps emerging from the spring caprifig enter Smyarna fig for oviposition and in the process effect pollination	1	116	Originated from the caprifig. The fertile seed contribute to the excellent fruit quality.
San pedro	King Gentile San pedro Dauphine Lampeiria	Long styled pistillate flowers	First (breba) crop fruit develops without pollination but not	2	21	Commercially not very important, some white, large fruited types are grown in mediterramean countries for drying.

			second(main) crop			
Wild fig Caprifig (male or goat fig)	Roeding 3 Samson Stanford Brawley	Short styled pistillate flowers and functional staminate flowers near the ostiole	Self-fertile (persistant) syconia	3	20	A primitive type-fruits have almost no edible value, but serves as adobe for fig wasp and smyarna and san pedro figs.

*Rarely in some environmental complex pollination is required. Pollinated figs are large sized with coarse pulp.

Fig is classified as a climacteric fruit and to a little extent ripening countinues once the fruit is harvested. After picking, figs are carefully sorted. The diseased and damaged ones are culled. Fruits are graded for size as 50gm, 40-50 gm and 30-40gm. They are packed in a corrugated box carton of 3 ply having 12 holes for ventilation. They are arranged in the carton in 2 layers, each of 28 (4 rows of fig in a line). Fig leaves are used for cushioning. Owing to perishable nature of fruits, growers produce in local markets. Figs can be held for a short period (7-10 days), at 0˚C and 85-90% relative humidity.

Figs are one of the first fruit to be preserved by drying. Apart from drying and canning, figs are processed into paste and jelly.

1.3A: Distribution: Warm temperate or sub-tropical small fig trees or shrubs to 30 ft; trained to stout, wide-headed trees in California. Plants thrive in hot, arid climates – a true Mediterranean fruit crop; can grow in Gulf States, Texas, but commercially in California only. Several tropical countries grow figs, like Central America, Bermuda, and the Caribbean islands, Venezuela, Chile and Argentina.

1.3B:Morphology: *Ficus carica* is a gynodioecious (functionally dioecious), deciduous tree or large shrub, growing to a height of 7–10 metres with smooth white bark. Its fragrant leaves are 12–25 centimetres long and 10–18 centimetres across and deeply lobed with three or five lobes. The complex inflorescence consists of a hollow fleshy structure called the syconium, which is lined with numerous unisexual flowers. The flower itself is not visible from outside the syconium, as it blooms inside the infructescence. Although commonly referred to as a fruit, the fig is actually the infructescence or scion of the tree, known as a false fruit or multiple fruit, in which the flowers and seeds are borne. It is a hollow-ended stem containing many flowers. The edible fruit consists of the mature syconium containing numerous one-seeded fruits (druplets). The fruit is 3–5 centimetres long, with a green skin, sometimes ripening towards purple or brown. *F.carica* has milky sap (laticifer). The sap of the fig's green parts is an irritant to human skin.

1.3C: Cultivation: Fig being a deciduous and sub tropical tree , prefers areas having arid or semiarid environment, high summer temperature, plenty of sunshine and moderate water. Although the plants can survive temperature as high 45°C, the fruit quality deteriorates beyond 39°C. Though the mature tree can withstand low temperature up to 4°C, it makes good growth when the temperature is above 15 - 21°C. The sizes, shape, colour of the skin and pulp quality are markedly affected by climate. But quality figs are produced in the region with dry climate especially at the time of fruit development and maturity. High humidity coupled with low temperature usually results in fruit splitting and low fruit quality.

Fig is one of the most salt and drought tolerant crops. It can tolerate a fairly high level of sulphate or chloride salt. Medium to heavy, calcareous, well drained, deep (about 1 m) soil having pH of 7-8 is ideally suitable cultivation of fig. Fig is propagated by cuttings. Cuttings of about 25 cm in length having 3-6 nodes from the wood of previous season are usually used as

planting material. Fig is planted in square system of planting at a spacing of 5 x 5 m accommodating about 160 plants per acre. Pits of 0.6cu.m are dug for planting the cuttings. The planting is generally done during June to September. Fig can sustain heat and drought. However, for commercial production timely irrigation is necessary. Flood irrigation at an interval of 10-12 days during summer is ideal. However, if drip irrigation is adopted 15-20 litres of water/day/plant needs to be provided.

1.3D: Need of tissue culture in Fig

The planting of species occurs predominantely with vegetatively propagated plants especially by the rooting of cuttings.This fact contribute significantly to the dissemination of pathogens which affect the yield potential of the crop. Through micropropagtion of fig tree it is possible to obtain pathogen free plantlets and this is one of the basic requirements for its successful commercial propagation.The technique will be useful for large scale production providing plantlets whenever needed (Pasqual and Ferreira 2007).