CHAPTER I

INTRODUCTION
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Man and forest have always co-existed since time immemorial. Increasing realization of the fact that forests not only provide multiple benefits to mankind but also helps in conserving the environment has thus created global concern for their outstanding protection and preservation, destruction and degradation of forest resources may have detrimental effects on soil, water and climate and ultimately on human and animal growth. But the condition of our forests today is extremely poor, India's human and animal population is increasing at an alarming rate and rapidly increasing mankind population along with rising growth of animal kingdom, has been fatally responsible for subsequently decreasing forest/tree cover.

Forest, at present occupy about 76.8 m km² (63.7 m km² forest cover) constituting 23.4% (19.4% of forest cover) of the total geographic area of the country. Dense forest in India is only 11.48 percent. Where as they constitute only 2 percent of the world's forest area, they have to support over 15% of the human population and nearly 14% of the cattle population. Besides this, Indian forester are neither uniformly stocked nor equitably distributed. The average annual production of wood per ha is 0.7 cum, which compares poorly with the world average of 2.5 cum.

In the last 10 years there has been a deterioration of about 2.5 percent in the forest cover area. Natural regeneration is either absent or inadequate in 52.8 % of the forest in country (FSI, 1987). Some of the more accessible areas have already been over exploited leading to serious soil erosion and environmental degradation. The per capita availability of land is decreasing rapidly in an inverse proportion to the increasing population of the country, which has already exceeded the carrying capacity of the land. The land scarcity and demographic pressures are the major driving forces responsible for the present situation, leading to the conversion of forest and natural grasslands for urbanization, industrial and agricultural areas.
To meet the challenges of over increasing demand for fuel, fodder, timber and various other forest based product on one hand and to avoid environmental deterioration on the other, the central as well as state governments have launched various afforestation schemes. Large areas are to be planted annually, which requires raising millions of seedlings in nursery. Huge demands for nursery stock, however, make it difficult to ensure good quality, form and vigor of seedlings.

The need of the hour is a quantum jump in existing afforestation targets in India. The plan is to afforest wasteland at a rate of five million hectare per annum. Such large scale plantations will demand a large amount of planting material and in order to achieve higher yields it is important that these planting materials are of good quality (Ramachandran, 1988). Hence, there is a need to go vertical and raise plantations based on high yielding quality materials which once identified can be multiplied on a large scale through the clonal propagation (Khoshoo, 1988). The regeneration of tree species through vegetative means has been gaining much importance from last decade. Earlier, the technique has been largely employed for tree improvement programme. Vegetative propagation in exercised through several methods viz; grafting, budding, layering, stem cutting, tissue culture and their various forms nevertheless, stem cutting is most common, simple and cheapest one.

The use of wood biomass for energy has many positive aspects compared to the use of fossil fuels. There benefits include the reduced use of non-renewable fuels, less dependency of foreign fuel stabilization of income in rural areas, and reduced emission of carbon dioxide and other green house gasses. It is being observed that the developing world is today encountered with near crises situation, both economic and environmental. Due to increasing population there is a large gap between the production and demand of petroleum products also. India consumes about 111 m tones of petroleum product annually. Of this, only 33 m tones are produced in the country as crude oil. Meeting less than 30 percent of the needs from domestic sources. India’s consumption of natural gas has risen faster
than any other fuel in recent years. The consumption of natural gas was 0.6 trillion cubic feet (Tcf) and 0.8 Tcf per year in 1995 and 2000, respectively. The country’s domestic natural gas supply is not likely to keep pace with the increasing demands. Another energy source, coal is the dominant commercial fuel in India, satisfying more than half of India’s energy demand but increased coal consumption over the past four decades has led to nine-fold increase in energy related carbon emissions.

The economic development of any developing country depends on its self-reliance in energy needs. Economic and industrial development made by man had been closely associated with the substitution of one form of energy with another. The ever increasing demand of petroleum fuel in transport industry and agriculture sectors and the frequent price hikes, besides contributing to pollution at an alarming rate compelled the developed and developing countries to give top priority research for alternative source of energy which is renewable, safe and non polluting. In recent years, research has been directed to explore ‘biofuels’ that is plant based fuel sources, as a supplement or substitute of fossil fuels.

Bio fuels are renewable liquid fuels coming from biological raw material and have been proved to be good substitute for oil in the transport sector. Biofuels are gaining importance in light of increasing demand, especially fossil fuels which are now renewable. Biofuels are renewable, biodegradable, non-hazardous and safer for air, water and soil and its use reduces the emission of green house gases. As such biofuels- ethanol and biodiesel are gaining worldwide acceptance as a solution to environmental problem, energy security, reducing imports, rural employment and improving agricultural economy As compared to petrodiesel, biodiesel significantly reduces the lifecycle of carbon dioxide emissions. On an average, it reduces emission of particulate matter by 40-65 percent, unburned hydrocarbons by 68 percent, carbon monoxide by 44-50 percent, sulphates by 100 percent and the carcinogenic nitrated polycyclic aromatic hydrocarbons by 90 percent. Its higher cetane number improves the combustion.
According to the report of the committee on development of biofuel constituted by Planning Commission, Government of India out of a large number of oil seed bearing tree species *Pongamia pinnata* (karanj) would be very suitable for Indian conditions (Singh, 2003). *Pongamia* is the promising species as a source of biodiesel.

*Pongamia pinnata* Vent. Syn. *Derris indica* Bennet, commonly known as karanj belongs to family Leguminosae, sub-family Papilionaceae. It is a moderately sized evergreen tree of about 8 m height and diameter of more than 50 cm. Bark smooth, grey and thin. Leaves imparipinnate, leaflets opposite, stipellate, 5 to 9 in number, ovate to ovate-elliptic, shortly acuminate, glabrous, bright green. Petiole 4.5 cm long. Pods obliquely oblong, 4x3 cm, woody, compressed, indehiscent. The chromosome number of this species (2n) is 20, 22, (GOI, 1983). It is found almost throughout India but is native to humid and sub tropical environments. It thrives in areas having an annual rainfall ranging from 500 to 2500 mm. In its natural habitat, the maximum temperature ranges from 23 to 38 °C and minimum from 1 to 16 °C. It resist drought and can withstand water logging and slight frost. The species grows to elevations of 1200 m, but in the Himalayan foothills is not found above 600 m.

The species is very important as fuel wood with calorific value of 4600 Kcal per kg. Opinions vary on the usefulness of this species as a fodder. According to Singh (1982) the leaves contain 43% dry matter, 18% crude protein, 62% neutral detergent fibre, 40% acid detergent fibre and in vitro dry matter digestibility of 50%. The species is in focus and generating more attention due to non-edible oil obtained from the seeds. A thick yellow-orange to brown oil is extracted from seeds. The oil is being promoted as biofuel in addition to its other important uses as a lubricant, water paint binder, pesticide, in soap making and in tanning industries.

The natural regeneration of the species is through seed (Prakash, 1991). It also coppices well and sends out root suckers in natural conditions. It starts
flowering from the 4th or 5th year of planting. The flowers appear in April to July. There is a positive correlation between the mean display rank and percent flowers turning into galls. The seeding season is April - May and the seed yield per tree ranges from about 10 kg. The natural regeneration of the species is suffering on account of collection of seed for extraction of edible oil. In the current situation, the species along with other species producing non edible oils are being encouraged for large scale plantations, may be either as block plantations or in different agro forestry systems. The main factor behind the promotion of this species is for its importance as bio-fuel or bio-diesel.

At present no clonal seed orchard is advisable for P. pinnata. In most of the tree species application of synthetic auxins induced adventitious roots in branch cuttings. (Nanda and Kochhar, 1984). In addition season of collection plays a significant influence on rooting. Another important factor is the number of roots produced on the cutting which determines the field establishment of the propagules which has not been studied so far. The objective of present study is to develop the vegetative propagation techniques for P. pinnata for the establishment of clonal seed orchard and there by improve the productivity.

A successful rooting method would overcome different problems related with seedling regeneration and will allow stocking with genetically superior clones. Literature reveals several attempts by different researchers for initiating rooting in cuttings of different tree species (Nanda, 1970; Lahiri, 1979; Reuveni and Roebar, 1990 and Nautiyal et al., 1991) yet the final outcome spells out the same conclusion that rooting potential varies with species, age, nature of cutting, growth regulating substances used, season of treatment and planting. It implies that a thorough investigation of these factors is essential for standardizing optimum rooting condition for each tree species.

An insight into the foregoing section reveals that there is an urgent need to explore propagation through stem cuttings for large scale multiplication of this species. Vegetative propagation by cuttings has helped in speeding up production
of large superior seedlings from vegetative propagation mainly cuttings. Cuttings, after the application of root inducing hormones, are allowed to root in sterilized sand inside temporary polythene tunnels as well as green house/ misting chamber where appropriate growth factors like required temperature and humidity are provided. In forestry vegetative propagation involves the multiplication of a desired tree having superior characters. This type of propagation helps to produce plants identical in genotype with the source plant. Large genetic advance can be made in a single step by selecting a single unique superior tree from a population of seed producing tree and reproducing it asexually by a vegetative propagation.

*Pongamia pinnata* Pierre is one of the commercially important tree species provides seed oil which is utilized in tanning industry and medicinal purposes and the wood is used for agricultural implements. Vegetative propagation is an indispensable component for tree improvement programme ensuring quick genetic grains by mass multiplication of superior genotypes and help in establishing clonal seed orchard, breeding population and afforestation programmes.

To achieve the targets of afforestation programmes, there is a need to raise quality planting stock of the desired tree species. Therefore, there is a need to develop a programme for clonal propagation of the suitable tree species for all the regions. Keeping in view the need for complete package of practices for developing multiplication technologies of the species, the present study was therefore undertaken with the following objectives-

**Objectives:**

1. To study the effect of season on vegetative propagation through stem cutting.
2. To standardize cutting size and type of cutting for vegetative propagation.
3. To study biochemical changes occurring during rooting.