Chapter - 1

1. INTRODUCTION

At present floriculture has gained importance for exploiting it commercially. Some of the floriculturally important plants can be raised from seeds but some cannot be propagated rapidly from seeds to meet the growing demands.

Civilization is largely based upon men's ability to propagate and grow specific kinds of plants which can be used for food and shelter, clothing, recreation, and aesthetic fulfilment. Plant propagation may be defined as the controlled reproduction of plants by men to perpetuate selected individuals or groups of individual plants which have specific value to him.

Economic aspects of ornamental horticulture are as important as the aesthetic ones. The floricultural products of economic importance mainly consist of cut flowers and ornamental foliage plants. The world trade in flowers is estimated to be around $ 13 billion in 1981. Developed countries account for more than 90 per cent of the total world trade in floricultural products. The majority of imports are taken by the European countries in the recent times and the major exporting countries have been the developing ones.

India is endowed with natural wealth such as flora and fauna of which flora occupy a place of importance and significance. A large number of these native Indian species have been extensively used for improvement of various flowers in other countries. Some of these Indian flora have been compiled and described. These basic genetic materials need to be preserved and effectively utilized in the improvement of floriculture in India.

Dahlia, rose, *Chrysanthemum*, azalea (*Rhododendron*) and *Mussaenda* are some of the most important floricultural plants. Besides growing in family gardens they are also cultivated on commercial basis. *Dahlia* and *Chrysanthemum* are generally annual erect herbs. Rose, azalea and *Mussaenda* are generally shrubs and bear a number of coloured flowers (but in Mussaenda flowers are not actual flowers, so called flowers are modified sepals).

All of them cannot be propagated through the seeds and only *Dahlia* and *Chrysanthemum* (certain varieties) can be propagated through seeds. These processes depend on nature (soil and weather) and viability of seeds and it takes time. Moreover, to maintain the quality and easy rapid cultivation they must be propagated vegetatively by using cuttings. Now-a-days many bioregulators including plant growth regulators and their commercial formulations are in use. This has necessitated the screening of wide spectrum of bioregulators on rooting on cuttings of floricultural plants under laboratory conditions.

Almost all the vegetative parts of plants may be used for the purpose of obtaining cuttings. Not only stems, but leaves, root and stolons can also be rooted. The royal Horticultural society Dictionary of Gardening defines a cutting as "any portion of a plant, stem, leaf or bud which is separated from the plant and has been induced to form roots of its own".

However, the organs most commonly used for this purpose are the stems. This is due to high response of cuttings to root forming substances, and their easy convenience of handling. Induction of root formation in stem cuttings by the application of plant hormones and other chemicals has now become a common practice in the field of floriculture and forestry. In this method of propagation true-to-type offspring's are obtained. Further, this method helps in rapid multiplication of many plants from a single individual, thereby increasing the production of cuttings at a comparatively short span of time than those raised from seeds (Mahlstede and Harber, 1957). This scientific method of propagation is of immense practical and economic importance. At present average nurseryman depends very largely upon propagation from cuttings.

Stem cuttings can be classified according to the plant from which they are obtained viz. hard wood stem cuttings, semi-hard wood stem cuttings, soft wood stem cuttings and herbaceous stem cuttings. **Hard wood** cutting is one of the least expensive and easiest methods of vegetative propagation. They require no special preparation. The cuttings are usually prepared during dormant season. A few fruit species such as mulberry, grape, pomegranate and some deciduous ornamental shrubs are rooted by this method e.g. forsythia, wisteria, honey suckle etc.

Semi-hard-wood cuttings are generally taken during summer months from new shoots just after a flush of growth has taken place and the wood is partially matured. Many ornamental shurbs such as *Camellia, Evonymous* the evergreen azaleas fall under the semi-hard wood group.

Soft-wood-stem cuttings generally root easily and quickly than the other types but require more attention and equipments. Softwood cuttings produce roots in a fairly short time 1-3 or 4 weeks in most cases. They also generally respond markedly to treatments with root promoting substances. Many ornamental woody shrubs can be propagated by softwood cuttings e.g. *Forsythia, Magnolia,* rose, *Eveigela* and some are made from succulent herbaceous plants such as *Geranium, Chrysanthemum, Dahlia, Coleus* and Cornations. Most floricultural plants are propagated by herbaceous cuttings which root easier under suitable conditions. Under proper conditions, rooting is rapid and in high percentage.

Stem cuttings of some plants readily form adventitious roots when put in the soil. Rooting is promoted when buds and leaves are present. This is expected because leaves and buds are known to produce auxins. Auxins so produced move basipetally and accumulates at the base of the cutting where root initiation takes place. Cutting of such plants which do not readily form abundant roots, when treated with PGRs like indole butyric acid (IBA) and Napthalene acetic acid (NAA) are called difficult-to-root plants.

Growth hormones (Bioregulators) have been implicated by several workers in the formation of adventitious roots on stem cuttings. Exogenous application of some known growth substances greatly modify the rooting potential of stem cuttings (Hartmann 1976). Stimulation of root formation by auxin has been established (Jarvis 1986). The presence of all the known growth hormones i.e. auxins, gibberellins, cytokinins, ABA and ethylene have been shown in the roots of many species (Torrey 1976). The effect of auxin in early stages of root initiation on cuttings has been established (Heide 1965, Ericksen 1973-74, Mohammed and Ericksen 1974).

When auxin is applied to the cuttings, root primordia originate by the division of the cells of phloem parenchyma or the pericycle. The root primordium so initiated emerges out through the cortex. Usually, roots emerge on the lower most part of the cutting but some times higher up when a high concentration of auxin is used (Krishnamoorty 1981). After all a combination of auxins is more effective. In general, cuttings of herbaceous plants readily respond to auxins while those of woody perennials like *Rhododendron* fail to respond to auxin application. Many plant cuttings and graftings develop roots quickly on application of IBA. Sinha *et al.* (1962) studied the rooting effects of different auxins on *Psidium guyava* and found that treatment of IBA followed closely by IAA proved superior as compared to others. NAA and its commercial formulations have also proved to be effective in inducing rooting on cuttings.

In some plants, **ethylene** treatment also promotes the formation of secondary roots and root hairs. Often, excised flower also shows root formation with ethylene application (Krishnamoorty 1981). But it also reported that ethylene may not be very important for rooting.

In the past, gibberellins were considered to have little or no effect on root growth (Cleland 1969) but a careful survey of recent literature reveals many conflicting reports (Burstrom 1960). Most reports indicate that gibberellins inhibit root growth (Stowe and Yamaki 1957) or had no effect (Blakely *et al.* 1972) but a few indicate to the contrary (Richardson 1957). The stimulation of rooting by GAs was often related to light/dark treatments of stock plants such as pea (Leroux

1967) and *Helianthus tuberosus* (Gautheret 1969). Root formation was stimulated when plants were grown at low irradiance or dark. So, there is a need to assess the efficiency of GAs on induction of rooting.

An extensive study on the physiological factors controlling rooting response of branch cuttings (Nanda 1975) provided considerable basic information. It was found that environmental factors like season, light (Hansen *et al.* 1987, Moe and Anderson 1989) temperature and humidity have permanent role to play on root initiation. The other factors like juvenility of the mother tree, size of cuttings, presence of leaves and vegetative buds and the change in the content of carbohydrates (Hartmann *et al.* 1990, Reuveni and Raviv 1981) have direct effect on rooting the branch cuttings.

The effectiveness of externally applied auxin is not always the same in all seasons (Nanda 1975, Nanda and Sethi 1979). Thus it has been reported that treatments of the cuttings with auxins inhibited rooting during certain seasons when untreated cuttings root profusely. In certain seasons, when the control cuttings do not root or only negligibly, the external application of auxins enhances number of roots formed (Nanda *et al.* 1968). This has been ascribed to the fact that during period of active growth the endogenous level of auxin was high due to high meristematic activity (Nanda 1970, Nanda and Anand 1969, Adarsh *et al.* 1969).

Presence of apical buds and leaves on the cutting has a direct influence on the rooting behaviour. Sachs (1882) stated that leaves are essential for root formation as they supply certain root forming substance, whereas Went (1938) suggested that leaves supply carbohydrates and other root promoting substances. Ericksen (1973) stated that sprouting bud is very effective on development of adventitious roots, hence a effective correlation exists between presence of active root meristem and formation of roots on cuttings. **Water** also plays an important role in root formation. Plant propagation often emphasizes the desirability of taking plant material in a turgid condition (Hartmann 1976).

Temperature and **light intensity** play a great role in rooting (Hartmann *et al.* 1990). Extreme light and low temperature cause a delay in rooting and ultimately result in the death of cuttings (Dore 1965, Gautheret 1969).

The origin of preformed root initial is similar to wound induced adventitious root formation (Lovell and White 1986). In general root initials lie dormant until cuttings are made and placed under environmental conditions favourable for further development and emergence (Lovell and White 1986). Adventitious roots in herbaceous plants usually originate just outside the vascular bundles (Preistley and Swingle 1929), but the tissue involved at the site of origin can vary depending upon the kind of plant (Hartmann *et al.* 1990). In woody perennial plants, adventitious roots in stem cuttings usually originate from living parenchyma cells, primarily in the young secondary phloem, but they sometimes arise from vascular rays, cambium, phloem, lenticels or pith (Lovell and White 1986, Ginzburg 1967).

The role played by different bioregulators on rooting on cuttings is not fully understood. Reports pouring in from different laboratories on the action of

IBA, NAA, gibberelins, ethylene on induction of rooting on cuttings do not support the views expressed by one group or the other. Hence, it was felt to have a deeper insight into the problem by applying IBA, NAA, gibberellin, ethylene or their commercial preparation at different concentrations on the stem cuttings of *Dahlia*, *Chrysanthemum*, rose, azalea, *Mussaenda* plants.

The trade names of commercial rooting agents which are commonly used today are Rootex, Rootone (0.1% IBA and 0.2% NAA) etc. For the comparative studies of induction of early rooting Rootex and Rootone also are proposed to be used in this investigation. They are available in the powder form and can be applied at the base of the cuttings. But dip or quick dip methods with concentrated solution of both the compounds can also be used.

Under the circumstances it was considered pertinent to examine the responses of certain herbaceous (easy-to-root) and difficult-to-root plant species to plant growth regulators viz. IBA, NAA, GA_3, GA_{4+7}, ethylene (2-chloroethyl phosphonic acid ethrel) and to assess their performance on rooting on cuttings. It was also considered urgently necessary to follow the anatomical changes brought about by the bioregulators in initiation of roots.