CHAPTER VI

GENERAL DISCUSSION
Forests constitute one of the most important natural resources which play an important role in the economic development of the country. The impact of human activities has resulted in the gradual extinction of natural forest from large areas resulting in the scarcity of forest product eg. timber, pulp, fuel etc. which are utilized directly or indirectly by human population throughout the world. Degradation of forests is also observed in the forests of Sagar and surrounding areas where the forest cover has been reduced from 3,000 sq. km. to approximately 2,000 sq. km. during the past few decades.

From the times immemorial, man is involved with forestry. His involvement with forest trees has been of love-hate one. He grew and propagated useful trees for fruits, spices, timber and rubber etc. but at the same time has been unsparing with the axe. Such type of adverse consequences have been observed in a number of forests, e.g. the forests of Scandinavian countries which were burnt long ago to boil brine for salt, the mediterranean forests were consumed by the ship, building, industries of the ancient Greeks and Romans and the Cedars of the Lebanon went to the temple and mummy care buildings trade (Kumar, 1981). In a developing country, such as India, wood is still an important source of fuel, timber and pulp and will remain so for many decades to come.
The present investigations are an addition to present knowledge of nursery practices to revive plants stock for large scale afforestation and reforestation programmes. So far scientific information about the nursery practices adapted for raising seedling was lacking. An attempt has been made to study different forest nurseries around Sagar and methods adopted by forester to raise seedlings. In following discussion the same is being presented.

Five different nurseries around Sagar were considered for these studies based on easy approach and nearness to make frequent visits. Periodic visits to these nurseries revealed that nearly all the important dominant species of the local forest are raised through seeds by foresters. Germination time taken by different species for completion of germination was variable in different species. Transplantation age was also variable depending on number of factors. Such survey of forest nurseries were made for disease incidence by Jaiswal (1989). The survey concluded during present study was not made earlier by any other worker at least in this area. The results gave an idea of the area of nursery, method of sowing of seeds, preparation of beds and the number of plants raised in different nurseries.

Ten most commonly raised forest tree species (Table 10) in the nurseries around Sagar were
investigated for different parameters viz. number of seeds per kilogram, time of seed collection, treatment before germination, sowing time and any other speciality if any. No. of seeds per kilogram were highest in *Anogeissus pendula*, while *Cassia fistula* had biggest seeds and numbering only about 498 seeds per kilogram. Seed collection time was variable in different species. In *Acacia catechu*, *Albizzia lebbek*, *Anogeissus pendula*, *Cassia fistula*, *Dalbergia sissoo*, *Emblica officinalis* and *Tectona grandis*, the seeds were collected during winter from December till February-March, while in *Terminalia arjuna* and *Terminalia tomentosa* the seeds were collected during March-April i.e. summer months. It can be inferred that seeds of the above species should be collected at the right stage of maturation for raising seedlings in the nurseries. Similar conclusion were derived by Hedegart (1975) and Seeber and Agpoa (1976) that seeds collected during the later period of maturation, presuming that such seeds are most viable. During seed collection it must be kept in mind that the knowledge of ripening period of seeds, time of maturity and ability to recognise mature and ripe seeds are very essential for collection of good quality seeds of different species.

The most important pretreatment before sowing was soaking in water for 24 hours in nearly all the species except *Tectona grandis* where the seeds were soaked in solution for 4 months because, their seeds have
very hard seedcoats. Similar soaking procedure was adopted by Ghosh et al. (1974) in Pinus petula (Pinus caribaea) and Chandra and Sharma (1977) in a number of tree species.

The sowing time for different species varied. For Acacia catechu, Cassia fistula, Dalbergia sissoo, Emblica officinalis, Tectona grandis, Terminalia arjuna and Terminalia tomentosa, the sowing time was from March to June while for Dendrocalamus strictus it was September and for Albizzia lebbek and Anogeissus pendula it was February.

Germination percentage of ten (Table 11) species under investigation sown at five different nurseries around Sagar were recorded. It is observed that the percentage germination in polythene bags and beds were different in different nurseries in a species. This difference in germination percentage was varying within a narrow limit which may be due to local conditions, seed quality and other minor variables. This may also be ascribed to depth of sowing which may vary slightly from nursery to nursery.

Table 12 indicates the effect of sowing depth on percentage germination in ten different species. The seeds were sown at surface, 2 cm., 4 cm., and 6 cm. depth. It appears that the sowing depth has a significant effect on germination, of course the seed size was also
important in relation to sowing depth. In majority of the species the best sowing depth was 4 cm. for optimum germination. In *P. strictus* the highest germination percentage was achieved at a maximum depth of 6 cm., which is difficult to explain. These results are in agreement with the findings of Chandra and Ram (1980), Singh *et al.* (1973, 1975) have also observed similar results in their studies and found that the germination percentage in *Pinus wallichiana* and *P. smithiana* seeds decreased as the depth of sowing increased and similarly the deeper sowing delayed the emergence period. Ghosh *et al.* (1976) have made similar studies on three species of *Pinus* and pointed out that the suitable depth of sowing varied from species to species. Bahuguna *et al.* (1989) have pointed out in *Albizia frucortia* the best sowing depth was between higher and lower sowing depth which he used.

The non-germination of seeds at greater depth below 6 cm. as observed in the present case, may be explained on the basis of non-availability of light as well as the fact that most of the dormancy breaking mechanism in the form of soil, microbes, chemical action of organic acid and inorganic acid, mechanical action of soil particles, temperature fluctuation etc., are better operative in the upper layer of soil (Shanker, 1968). Russel (1937) has reported that microbes differ in different layers of soil. They are usually higher in
number in upper layers where as in deeper layers their number decreases. The higher germinative capacity of the seeds, down to a depth of 0.0 to 6.0 cm., may be attributed to the profilic microbial activity. Chakravarti and Verma (1968) have concluded that non-germination of seeds beyond a depth of 10 cm., may be on account of lack of aeration and presence of the mechanical proem of the soil surface, further it may be concluded that the germination of seeds is directly related to their size and soil depth.

Data on the effect of method of sowing on germination percentage in different forest tree species are presented in Table 13. It was observed that the percentage germination was not significantly in different when seeds were sown by broadcast, strip and pit sowing method in majority of the species. When the seeds were sown by dibbling method the percentage germination dropped significantly in all the species except Cassia fistula. Bahuguna et al. (1987) also recorded highest germination in the seed sown by broadcast method. Maithani et al. (1988) observed lower germination percentage with dibbling method which is in agreement with present findings.

Studies on the effect of potting media on germination behaviour and growth performance is shown in Table 14-23. Six different potting media were used. The
germination percentage was highest in the medium containing soil, sand and manure (1:1:1 ratio) in all the species and similarly the shoot length was also highest in this medium. The results of the present studies find support in the previous reports (Purohit, 1977 and Jindel, 1977) where also, the shoot growth has been reported to be maximum under loam soil. Le Barron (1944) concluded that germination response to different potting medium corresponds to the moisture holding capacity and texture of the medium. The germination percentage was generally poor in sand + manure media which may be due to depletion of oxygen and excess of water which may result in suppression of the physiological activities (Pollock and Roos, 1972; Mackay, 1972). The germination of seeds are also affected by the availability of moisture and aeration in the potting medium as evident by large variation in the seed germination of some tree species in different soil media. The moisture and aeration generally depend on soil, water retaining and water supply in the beds, type containing different media (Le Barron, 1944; Palace, 1955 and Heinsetmen, 1957). Funk (1971), Seth and Shrivastava (1972) reported poor performance of root and shoot in the media containing either 100% sand or sand mixed with soil, because these media remain too compact to allow the normal development of the roots. Rawanski et al. (1980) also stressed the importance of soil media for root development. Soil or potting media is one of the
most important and essential environmental factors which play an important role in seedling establishment. By matching species to its suitable soil the growth and production of plants can be optimised (Stevens and Werts, 1971). Gupta (1992) reported better growth performance of seedlings of *Dalbergia sissoo*, *Albizia lebbek* and *Prosopis cineraria* in a mixture of tank silt, farm yard manure and sand.

Data on studies on the effect of irrigation interval on different parameters in the ten species under investigation is presented in Table 24-33. The seeds of majority of these species failed to germinate in water logged conditions. Similarly seeds did not germinate when irrigation frequency was maintained at a level of once a week. Such detrimental effects of water logging have been reported for a number of plant species such as *Mullugo cerviana* (Bakshi and Kapil, 1954), *Cassia tora* and *C. obtusifolia* (Mall, 1957), and *Alternanthera sessilis* (Kaul, 1973). The best germination in majority of the species was obtained in seedling watered daily. The growth of seedlings indicated a decreasing trend with decreasing water regimes. This trend was found common for almost all the species studied, Kramer (1949) observed that soil moisture affects root growth not only directly but indirectly. Holch (1931), and Kramer (1949) reported larger ratio of root to shoot in decreased water supply. It is very interesting to record that the increase in
root length caused by drought condition, was quite significant. Similar results have also been reported in Helianthus annus (Purohit, 1977), Solanum melongene (Jindal, 1977). Misra and Puri (1954), while dealing with water in relation to the structure and growth of plants have mentioned that the development of root system also depends upon the amount of moisture present in the soil, although in most of the cases it is governed by the heredity characters. Kolesnikov (1971) also reported an increase in root length as a consequence of the lack of water, till the soil moisture reaches a wilting coefficient point. Their finding has been similar to the results of present studies. Poor growth of seedlings in decreasing soil moisture has been associated with increased respiration and decreased photosynthesis resulting in depletion of sugar and starch (Wadleigh et al., 1943; Thut and Loomis, 1944), decreased protein synthesis (Nightingale and Farnham, 1936) and reduced permeability of roots (Kramer, 1949).

Results of the effects of different light conditions on germination and growth can be categorised into two groups viz. A. catechu, D. sissoo, D. strictus, E. officinalis and T. grandis where best germination percentage was under semishady conditions while in A. lebbek, A. pendula, C. fistula, T. arjuna, T. tomentosa it was better in full sunlight conditions in the open. Growth of seedlings also exhibited more or less
similar trend with few exceptions. It appears that some species belong to the category of sciophytes i.e., shade loving, while others belong to the category of heliophytes i.e., sun loving. It is well known that light, controls the photosynthetic activity of the plants, hence directly influences fresh and dry matter production, is naturally, a factor of prime importance for the vegetative growth of seedlings. Light is associated with the level of endogenous hormones in the plants. Thus it indirectly influence the growth and development of seedlings and has a profound influence on their structure and physiognomy. It has been reported that extension in growth is generally not favoured by high intensities of sunlight (Shirley, 1932; Lokhart, 1963; Whitehead, 1969 and Singh, 1975) but overall growth is favoured by high light intensities (Ashby and Oxley, 1935; Singh, 1971 and Singh, 1975). Findings on seedlings of various forest tree species indicate that best shoot root growth attained by seedling was under sunlight. While diffused light produced an inhibitory effect on shoot root length. However, seedlings of a few species (viz. A. catechu, D. sissoo, D. strictus, E. officinalis, T. grandis) showed stimulatory effect on shoot length in diffused light condition. It is presumed that they may be shade loving plants. Dark condition proved weak and etiolated seedlings with minimum shoot root length ratios probably due to less amount of photosynthate available
for transporation and consequent growth of tissues (Cf Friend et al., 1965).

The present results are in agreement with the results of Pathak et al. (1983), they have found that the seedlings of Leucaena leucocephala grown under 45% light conditions showed better height and greater dry matter. Similarly Robert (1971) found the tallest seedlings of Quercus rubra L. grew in 30% of full light, except the dry weight was comparatively lesser then that of absolute light. The observation of poor growth of seedlings under 20% light condition may be attributed indirectly to inadequate nutrition. This finding is in agreement with Robert (1971) who concluded that heavy shade lead to higher concentration of nutrients in the foliage. This suggests that these nutrients could not have been utilized for growth and probably this has resulted in poor growth of seedling. The growth under 100% light conditions was also not found satisfactory and it might have an adverse effect on the growth of seedlings due to increased temperature and decreased moisture in the soil as many earlier workers (Troup, 1921; Bhargava, 1951 and Mathur, 1956) have indicated the essentiality of partial or lateral shade in the earlier stage of seedlings of this species to protect them from drought. However, while comparing the present results with that of Blackman and Black (1969), on several shade tolerant plants, it appears that this tree species is partially shade loving.
during earlier phases of growth. After attaining sapling stage it can grow well in sunny habitat (Troup, 1921).

Studies on the effect of different concentrations of Ammonium nitrate on shoot and root length on different species showed better growth of shoot and root at a percentage of 0.5% of ammonium nitrate in general, however, there are some aberrations in some species. Stimulatory effect of nitrogen on vegetative growth has been reported for a number of plant species including *Alternanthera sessilis* (Kaul, 1973) and *Asphodelus tenuifolius* (Singh, 1972), but is was also observed that higher doses of ammonium nitrate had a depressing effect on growth of shoot (viz. *A. catechu*, *A. lebbek*, *C. fistula*, *D. sissoo*, *E. officinalis*, *T. grandis*, *T. arjuna*).

The promotive effect of increasing nitrogen supply may probably be due to increased chlorophyll synthesis (dark green colour of leaves indicated this) which brings about more carbohydrate synthesis. Carbohydrates are rapidly converted into proteins and protoplasm, at high nitrogen supply. Shrivastava et al. (1976) reported that external nitrate supply resulted in higher protein and alcohol soluble nitrogen by 6th day of seedling growth in maize. Findings on growth of seedlings of various forest tree species are in confirmations with the above reports.
Studies on the effect of phosphate application on shoot and root growth indicates that different species had different requirements of phosphate. Some showed better growth at 0.5%, while others showed better growth at 1.0% and 2.0% super phosphate concentration. In comparison to the effect of nitrogen, the effect of phosphorus was more pronounced. The supply of phosphorus was able to enhance vegetative growth to the extent it was not produced by nitrogen application. Stimulatory effect of phosphorus on plant growth has been reported from a number of plant species such as barley (Marinos, 1963) and *Asphodelus tenuifolius* (Singh, 1972). Stimulatory effect of phosphorus has been observed during present investigations.

Studies on the effect of different concentrations of IAA indicated that it had a stimulatory effect on growth of shoot, however, after a certain concentration of IAA the stimulatory effect tapers off. More or less similar trend was observed with the treatment of IPA and IBA in all the species under investigation. In many species there was no definite trend in shoot/root ratio in response IPA and IBA concentrations.

The presence of auxin in plants was indicated by Boysen-Jeysen (1910, 1911, 1936) and Went (1933) and their isolation was achieved by Kogl and Haagen-Smit
(1934) and Thimann (1935). From this it appears that many phases of plant growth are initiated and regulated by auxins. According to Van Overbeek (1935) the genetically dwarf races of maize had much less auxin than plants of normal height, indicating that auxin was related to the growth in stem length. A number of morphological and physiological changes due to varying auxin levels have been studied by a number of workers (Mitchell and Martin, 1937; Dostal and Hosek, 1937; Skoog, 1939; Zimmerman, 1941). Auxin treatment at higher doses brings about accelerated stem growth and retarded root growth in plants (Thiman, 1937). This work was mostly confined to either stem tips, coleoptiles and embryos (Raghvan, 1964) or root initiation (Thimann and Wert, 1934). Rooting responses of stem, cuttings including T. grandis by auxins was given by Nanda et al. (1968). Seed presoaking treatment with IAA< IPA and IBA produced slight stimulatory responses at low concentration (Baines, 1980). Sinnott (1960) showed that effect of auxins is different in different species of plants.

A number of conflicting reports have been put forward by various workers to explain the mechanism of auxin action. Although there is lack of information yet the primary mechanism of auxin action can be understood in terms of effects on chemical composition of cell wall. In the present investigations, the effect of auxins on
shoot length showed more pronounced effect in comparison to roots.

Suppressive effect of auxins at higher concentrations as observed in present study and in concordant with several workers (Dunlop, 1948; Nickerson and Hewitson, 1963; Shukla, 1977 and Baines, 1980).

Effect of GA indicated an increase in length of shoot but the concentration up to which the length increased was different for different species. Bhatnagar and Talwar (1978) have observed better growth in seedlings of P. caribaea at higher ppm of GA. Application of Gibberellic acid was reported to have accelerated plant height (Seth and Mathanda, 1959). Many workers have shown Gibberellic acid to promote germination of seeds (Chandra and Chauhan, 1976; Krishnamurthy, 1973; Vanator, 1972).

Since their discovery, hormones have been found to play a major role in growth promoting in agriculture, of these much attention has been focussed on auxins. However, since their discovery gibberellins have been well known for their properties of growth promotion. The initial works of Brian (1958, 1959) and Brian et al. (1960, 1962 and 1964) on the growth promoting effects of gibberelins led to the work in several countries on many plant species. A large number of workers reviewed the stimulation of growth processes as a result of GA treatment (Bukovac and Wittwer, 1956; Martha et al.,
1956; Lang, 1957; Rappaport, 1957; Thimann, 1963; Mukherjee and Dutta, 1964; Blesa and Gomez, 1966; Nanda and Krishnamurthy, 1967; Nanda et al., 1967; Katsumi, 1970; Konishi, 1967; Jones, 1973; Shukla, 1977; Mehrotra, 1978 and Baines, 1980). According to Russel (1973), GA3 are a class of hormones distinct from auxins, as these bring about normalisation of genetic or physiological dwarfs which auxins do not. The stimulating effects of GA3 on extension growth of normal plants has been reported by many workers on a variety of species including wheat (Brian et al., 1954; Blesa and Gomez, 1966), corn (Phinney, 1956), pea (Brian et al., 1954), soybean (Nanda et al., 1967) Lens esculantus (Mall and Ghurde, 1962), Impatiens balsamina (Nanda et al., 1968), Salmalia malabarica (Nanda and Purohit, 1964) and Abies balsamea (Little and Loach, 1975).

It was observed that the seedling of different forest tree species, which were transplanted directly from seed bed to another place/site showed poor survival in comparison to seedlings which were transplanted from polythene bags. It appears as a matter of fact due to disturbed root system especially tender root hairs during uprooting or digging the seedlings from beds and in many cases they are unable to make up for the loss due to a number of factors.
Various transplantation methods were tested for transplantation of seedlings of different forest tree species. From the observation it was concluded that when seedlings lifted with soil, showed best survival of seedlings in comparison to transplantation with bare roots.

Studies on the effects of transplantation side on one and two year old seedlings indicate varying trend depending on species and site of transplantation. Fresh biomass was variable from site to site in different species, similarly leaf area per seedling per transplant \((\text{Cm}^2)\) was also variable. It can be concluded that this depends on the microclimatic factors of the site including grazing, humidity, availability of shade during early seedling stage etc. Similar results have been recorded by Khan and Tripathi (1989) in *Alnus nepalensis*, *Quercus griffithii* and *Schima khasiana*. 