Status and Propagation of Elm (*Ulmus wallichiana* Planchon): A Multipurpose Tree Species of Kashmir Valley

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(2003-For-01-M)

THESIS

Submitted to

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for award of the Degree of

Master of Science in Forestry

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Sher-e-Kashmir
University of Agricultural Sciences and Technology of Kashmir
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Certificate - I

This is to certify that the thesis entitled "**Status and Propagation of Elm (*Ulmus wallichiana* Planchon): A Multipurpose Tree Species of Kashmir Valley**" submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science in Forestry**, to the **Faculty of Post-graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir** is a record of bonafide research work carried out by **Mr. Gh. Mohi-ud-din Bhat (Regd. No. 2003-For-01-M)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that any help or information received during the course of investigation has duly been acknowledged.

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We, the members of Advisory Committee of **Mr. Gh. Mohi-ud-din Bhat (Regd. No. 2003-For-01-M)**, a candidate for the degree of **Master of Science in Forestry**, have gone through the manuscript of the thesis entitled, "**Status and Propagation of Elm (*Ulmus wallichiana* Planchon): A Multipurpose Tree Specie of Kashmir Valley**" and recommend that it may be submitted by the student in partial fulfillment of the requirements for the award of degree.

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ABSTRACT

Studies on **Status and propagation of Elm (*Ulmus wallichiana* Planchon): A multipurpose tree species of Kashmir valley** was carried out in the Division of Forestry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar during the year 2004 and 2005. Elm (*Ulmus wallichiana*) locally known as '**Bren**' is one of the commonly found broad leaved tree specie in Kashmir valley and is best known representative of family *Ulmaceae*. It is grown for its multifarious uses and had become a preferred tree species in the agroforestry system. Unfortunately, it has problems in its propagation which has resulted in its being endangered. Studies were therefore, undertaken with following main objectives :

a) To study status and distribution of Elm (*Ulmus wallichiana*) in Kashmir valley; and
b) To study propagation of Elm (*Ulmus wallichiana*).

Detailed survey at block level of all districts of Kashmir valley was conducted and observation with regard to its distribution, concentration its socio-economic impact and identification of oldest existing Elm trees in the areas were recorded as per questionnaire method, informal interview method and transit walk method. Further studies were undertaken on its propagation through seed and vegetatively through treated cuttings. Observations have been recorded with respect to maturity indices, dormancy of seed, seed weight, longevity of seed, raising of seedling nursery and vegetative propagation through cuttings treated with PGRs viz., IAA, IBA and NAA

@ 200, 400, 600, 800 and 1000 ppm of each. The detailed survey conducted revealed that the tree was found growing in all districts of Kashmir valley, although their concentration varied from place to place. It was naturally found growing along river banks, streams, nallas, besides farmers grow these trees on boundaries of their field and on sloppy lands, etc. The concentration of Elm trees on per ha basis varied from district to district. It was found more in southern districts of Anantnag and Pulwama where it was recorded as maximum of 78.0 and 49.75 number of trees per ha, respectively. However, it was recorded minimum in Srinagar district with 2.33 number of trees per ha of land. Socio-economic studies conducted revealed that Pulwama district had maximum average land holding of 0.70 ha per family followed by Budgam, Anantnag, Kupwara, Baramulla and Srinagar with average land holding of 0.31, 0.30, 0.29, 0.29, 0.02 hectares per family, respectively.

Studies further, revealed that the highest average income from land holding per ha of Rs. 31,980.00 was assessed in Anantnag district as against lowest of 10,680.00 in Srinagar district. The studies conducted also revealed that Elm trees contributed its share in average estimated annual income per ha of land holding depending upon average number of Elm trees grown per ha of land. In Anantnag district the income from Elm trees contributed about 6.69 per cent to the farmers average annual income as against lowest of 0.24 per cent in case of Srinagar district. Thirty-eight old growing Elm trees were identified and located in different parts of valley. They were found in all districts of valley except in Pulwama and Budgam. The average age of these trees ranged between 200-400 years, with approximate height and girth of 65.0-110.0 ft (20.0-33.84 m) and 9.75-16.25 ft (3.0-5.0 m), respectively. Among these trees, the oldest tree (about 400 years) was found at Ziyarat Sharief of Hardpora of block Achabal, district Anantnag. In order to overcome the problems in its propagation, studies were conducted on seed/vegetative propagation. The studies conducted on the maturity indices revealed that the tree *U. wallichiana* comes in flowering early in spring. Flowers are borne on leafless twigs in spring. They are minute, reddish in colour, fruit winged, peppery, 9-13 mm in diameter with a seed in centre. Most of seeds were unfilled. Studies conducted to find out optimal time, when large number of viable and germinable seeds can be collected revealed that 3rd and 4th week of March is most suitable time for collection of Elm seeds depending upon environmental conditions especially temperature, aspect and altitude. The seeds collected at maturity start germinating from third day of sowing thereby indicating that these seeds do not have any kind of dormancy and need no treatment. Seeds collected at maturity resulted in higher germination percentage of 96 per cent with MGT 1.47 and GV as 54.88. The seeds collected at maturity showed higher weight of 10.14 g/1000 seeds as against of 7.10 g/1000 seeds collected at immature stage. Seeds collected at maturity having moisture content of 49.91 per cent survived for only 30 days when stored as such at 4^{o}C. On the other hand seeds with reduced moisture content (nearly 50%) were found to be survived for 180 days of storage at 4^{O}C with reduced germination percentage of 3.0 per cent.

Studies conducted on raising of seedling nursery of Elm (*Ulmus wallichiana*) revealed that seedlings raised in open beds were much superior than those grown in

root trainers in terms of germination, survival percentage, plant height and collar diameter. However, root trainer studies needs to be further investigated and can not be ignored. Studies conducted on vegetative propagation of Elm (*Ulmus wallichiana*) through cuttings revealed that treated hardwood dormant cuttings with plant growth regulators viz., IAA, IBA and NAA at lower concentration of 200 ppm gave significantly better results in terms of rooting percentage, average root number, root length, plant height and collar diameter. On the basis of studies conducted and considering various combinations and parameters, it was concluded that IBA @ 200 ppm is the best plant growth regulator to be used for vegetative propagation of Elm (*Ulmus wallichiana*) under existing conditions. However, softwood cuttings did not respond to the plant growth regulators treatments.

Key words: Elm (*Ulmus wallichiana* Planchon), distribution, dormancy, longevity, maturity indices, nursery raising, oldest growing Elm trees, seed weight, vegetative propagation.

Signature of Student Signature of Major Advisor

Dated:_____ Dated:_____

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Dedicated

To

The Memory of

Late Engineer Sheikh Aijaz

and

Late Engineer Wani Ab. Rashid

"May God rest their souls in rest and peace"

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CHAPTER-1

INTRODUCTION

Forests in India occupy about 678333 sq. km (20.64%) of the total geographical area comprising both conifers and broad leaved tree species (Anonymous, 2005). In Jammu and Kashmir, they are spread over an area of 25063 sq. km in the provinces of Jammu, Kashmir and Ladakh (Anonymous, 2005). The State has distinct agroclimatic zones comprising subtropical, intermediate temperate and cold arid zone. The valley of Kashmir falls under temperate zone and the forests consist mostly of evergreen conifers and broad leaved tree species occupying an area of 8128 km^2, whereas Jammu and Ladakh has 12066 and 36 km^2 of forests, respectively (Anonymous, 2002-03). Among conifer species *Cedrus deodara* (Deodar), *Pinus wallichiana* (Kail), *Abies pindrow* (Fir), *Picea smithiana* (Spruce) and *Cupresus* spp. are dominant one, while as Populus spp. (Poplar), *Salix* spp. (Willow), *Ulmus* spp. (Elm), *Aesculus indica* (Horse chestnut), *Prunus* spp. (Wild Apricot) etc., are common broad leaved species. Elm (*Ulmus wallichiana*) locally known as 'Bren' is one of the commonly grown broad leaved tree species in valley and is best known representative of family *Ulmaceae* and genus *Ulmus.* This genus has numerous species viz., *Ulmus wallichiana, U. villosa, U. lancifolia, U. parvifolia, U. compestris*, etc. and is most widely distributed of all the genera in the tribe *Ulmeae.* It is essentially a north

temperate assemblage though three species extend into tropics. It occurs throughout Europe as far as north as Scotland, Southern Finland and North Central Asia, Turkey, Lebanon, Israel, Iran, Afghanistan and Himalayas. In the Far East, it is wide spread in China, Korea and Japan. On the Asian main lands, it extends to northwards to the Soviet Far East. The Southern Kurile Islands are its northern limits in the islands of Far East. In the South East Asia, it extends through Malaya to Sumatera, Sulawesi and Flores. In North America, Elms are native in eastern states (Anonymous, 1976 and 1983).

Elm (*Ulmus wallichiana*) is commonly distributed in Western Himalayas, Indus to Nepal at an altitude of 900-3000 m (Anonymous, 1976).The species is scattered from Central Nuristan (Afghanistan) along the Himalayas through Kashmir and into Nepal. In India, the specie is reported to occur in H.P., U.P., Uttranchal and Jammu & Kashmir. In H. P., the specie is found in Choot near Nichar, Narkanda and Sidpur Nalla, Western Himalayas, Himalaya National Park Kullu, old Manali villages and Kangari Jangal near Solang Nalla. In U.P., it is found in Deota, Konain and Khandra etc. In Uttranchal, it is found in Pangot and Kailakhan (Nanital), Yamnotri forest divisions, Nanital (Melvile and Heybroek, 1971, Phartyal *et al.*, 1997, Singh and Mehra, 1997).

In Kashmir, this tree specie is predominantly found in Dachigam, Tangmarg, Babareshi, Pahalgam, Chandanwari and Verinag (Melville and Heybroek, 1971).

Elm (*Ulmus wallichiana*) is a deciduous tree found upto 33 m tall and 2.7 m in girth. It has spreading crown, bark is very rough, exfoliating in diamond shaped flakes. Branches sub-erect, roughly pubescent leaves elliptic, 6-15 cm long, serrulate, acuminate. Fruit is winged, flat, rounded peppery, 10-13 mm across, with a seed in centre. The perfect flowers are usually borne in spring before the leaves. The Samara (fruit) ripens few weeks later in April-May (Anonymous, 1976).

In Kashmir, Elm (*Ulmus wallichiana*) is grown for its multifarious uses and has become a preferred tree specie in our agroforestry system. It is often planted around villages, along banks of streams, on dry ridges and on sloppy lands, etc. It is also grown around boundaries of fields in some places. Elm has been found to be suitable under moisture stress conditions of Kandi areas in Kashmir valley.

Elm timber is suitable for light construction, planking, packing cases, furniture, handles for agriculture tools (Gamble, 1922, Pearson and Brown, 1932).Its leaves are valued as good fodder and bark for sandals and ropes (Anonymous, 1976). The bark also contains 0.76 per cent of tannin (Singh, 1958). Its branches are used as firewood. Elm bark is also used in a recipe for an ointment to heal broken bones and has been reported to be used also for treatment of cuts in Mussoorie (Melville and Heybroek, 1971). Considering its multifarious uses, it has become one of the best multipurpose tree specie and has been heavily exploited for various uses resulting it being endangered.

U. wallichiana plant has been given the status of an endangered specie (IUCN, 1978) and some of the reasons for its being endangered are:

1) Heavy lopping for fodder and also for fuel wood, thereby making the fruit setting in the tree difficult.

2) It is hard to root and so can not be regenerated easily through stem cuttings.

3) Absence of natural regeneration because of high incidence of empty seeds.

4) Seeds being low in viability can not be stored for long time and as such artificial regeneration through seed is difficult.

5) Steady increase in the concisions, rights, privileges on the forest without any responsibility towards the well being of the forest by the beneficiaries.

In nature the Elm is propagated through seeds, however, seeds of *Ulmus wallichiana* are scarcely available for afforestation due to high incidence of empty seeds and low longevity.

Since Elm is one of the important multipurpose tree specie of valley having problems in its propagation which has resulted in its being endangered, the present research project entitled **Status and propagation of Elm (*Ulmus wallichiana* Planchon): A multipurpose tree species of Kashmir valley** was proposed to study its status,

distribution and address the problems of propagation with following main objectives:

a) To study status and distribution of Elm (*Ulmus wallichiana*) in Kashmir valley, and

b) To study propagation of Elm (*Ulmus wallichiana*).

CHAPTER-2

REVIEW OF LITERATURE

The Elm (*Ulmus* spp.) is essentially a north temperate assemblage though three species extend into tropics. It occurs throughout Europe as far as north as Scotland, Southern Finland and north Central Asia, Turkey, Lebanon, Israel, Iran, Afghanistan and Himalayas. In the Far East, it is wide spread in China, Korea and Japan. On the Asian main lands it extends northwards to the Soviet Far East. The southern Kurile Islands are its northern limits in the islands of Far East. In the South-East Asia it extends through Malaya to Sumatera, Sulawesi and Flores. In North America Elms are native in eastern states (Anonymous, 1983).

The Elms (*Ulmus* spp.) are placed in family *Ulmaceae,* genus *Ulmus.* This genus has numerous species viz., *Ulmus wallichiana, U. compestris, U. parvifolia, U. pumila, U. villosa, U. lancifolia, U.procera, U. Americana, U. levigata* etc. and is widely distributed of all the genera in the tribe *Ulmae* (Anonymous, 1976 and 1983).

Out of numerous species Elm (*Ulmus wallichiana* Planchon) is distributed in Western Himalayas for Indus to Nepal and India at an altitude of 900-3000 m (Anonymous, 1976). The specie is scattered from

central Nuristan (Afghanistan) along the Himalayas through Kashmir and into Nepal. In India the species is found in H.P., U.P., Utranchal and Jammu & Kashmir (Melville and Heybroek, 1971). In Kashmir the species is predominantly found in Dachigam, Tangmarg, Babareshi, Pahalgam, Chandanwari and Verinag (Melville and Heybroek, 1971).

Elm (*Ulmus wallichiana*) is a deciduous tree upto 33 m tall and 2.7 m in girth. It has spreading crown, bark is very rough, exfoliating in diamond shaped flakes. Branches sub-erect, roughly pubescent, leaves elliptic, 6-15 cm long. Flowers borne on leafless twigs in spring in groups of 15-30, anthers are red, ovary densely hirsute. Samara (fruit) is winged, flat, rounded, peppery, 10-13 mm across with a seed in centre (Anonymous, 1976 and 1986).

Elm (*U. wallichiana*) is preferred over most of other tree species for use as fodder for cattle, sheep, goats and cows (Anonymous, 1986).

Elm timber is suitable for light construction, planking, packing cases, furniture, handles for agriculture tools (Gamble, 1922, Pearson and Brown, 1932). The bark contains 0.76 per cent of tannin (Tej Singh, 1958). Elm bark is also used in a recipe for an ointment to heal broken bones and has been reported to be used for treatment of cuts in Mussoorie (Melville and Heybroek, 1971).

Because of its multipurpose uses the tree specie has been exploited very extensively used and exhausted. Accordingly it has been given the status of an endangered species by International Union for

Conservation of Nature and Natural Resources (IUCN, 1978) on account of following reasons:

- Heavy lopping for fodder and also for fuel wood, thereby making the fruit setting in the tree difficult.
- It is hard to root and so can not be regenerated easily through stem cuttings.
- Absence of natural regeneration because of high incidence of empty seeds.
- Seeds being low in viability can not be stored for long term and as such regeneration through seed is difficult.
- Steady increase in the concisions, rights, privileges on the forest without any responsibility towards the well being of the forest by the beneficiaries.

In nature, the Elm is propagated through seeds, however, seeds of *Ulmus wallichiana* are scarcely available for afforestation due to high incidence of empty seeds and low longevity. They should be sown immediately as they germinate within few days. The natural regeneration of species is very poor (Anonymous, 1986 and Phartyal *et al.*, 1997).

The literature scanned does not show much work on its propagation nor much information is available on Elm seed and its collection whereas maturity indices studies are very important and has been conducted in other species. The knowledge of exact stage and time of seed maturity is essential for collection of abundant quantity of

healthy and vigorous seeds (Troup, 1921). Besides, seeds collected when fully ripe retain viability longer than the seeds collected when immature (Harrington, 1970, Stein *et al.,* 1974). Immature seeds are low in viability and often produce low vigour, deformed seedlings (Heit, 1961, Suchbest, 1956). Reproduction development of plant begins with formation of flower buds and progress through anthesis, fruit development and accumulation of storage materials in the seed and ends with the physiological maturity, when seeds reach its maximum dry weight (Tekrony and Egli, 1977). Seeds of some species are capable of germinating a few days following anthesis (Gill, 1938, McAlister, 1943, Hume, 1984). It has been noticed that immature seeds die if they are allowed to dry out (Harrington, 1972). Maturity may be reached several weeks earlier on hill tops than in nearby valleys (Cobb, 1959). Thus, fruit collection should be started only when the seeds are sufficiently mature. Therefore, indicators of maturity for individual specie is a must, so that collection is made right in time, otherwise immature collection of seeds will result in loss of time, money and failure of plantations. Similarly collection after dispersal is difficult and it is time consuming and not much seeds can be collected from identified mother trees, however, those seeds which are large in size can only be collected after dispersal.

The seeds of *U. wallichiana* are weak and light so need to be collected, when they are sufficiently mature. If allowed to ripe fully these may be carried away by winds. Colour change in fruit provides a simple and in some species reliable criteria for judging seed maturity

(Willan, 1985). A relationship is often established between maturity and their colour, which is then used to identify physiological maturity of tree seeds such as in *Liquidampar styraciflua* and *Platnus occidentalis* (Bonner, 1972) and in *Quercus* species (Bonner, 1974, 1976). In such species colour changes are usually from green of the immature fruit to various shades of yellow, brown or grey and this may be accompanied by the hardening of pericarp. In case of *U. wallichiana* the seeds are minute reddish in colour at the time of maturity. The change in fruit colour is by far the best available criteria for judging the maturation of seeds as shown in *Carissa opaca* and *Ficus benjamina* (Maithani *et al.*, 1987).

Temperature is the most important environmental factor that regulates the time of germination partly due to climatic adaptation (Hartman *et al.*, 1990). Germination rate has been low at low temperature but increases gradually as temperature rises (Koller, 1972). Above an optimal level, where the rate is most rapid, a decline occurs as the temperature approaches a lethal limit, where the seed is injured. The temperature points (minimum, optimum and maximum) varying with species are usually designated for seed germination (Edwards, 1932). The optimum germination temperature has been found to vary between 24 to 30^{O}C (Hartman *et al.*, 1990). International Seed Testing Association (ISTA, 1976, 1985, 1993) published rules for testing seeds of a variety of species and mentioned optimum temperature for germination, media and requirement of light. ISTA (1993) has recommended alternating temperatures of 20^{O} and 30^{O} and a constant

temperature of 20^{O}C on the top of paper for germination of *Ulmus* seeds. Phartyal and workers (1997) have worked out optimum conditions of seed germination in *Ulmus wallichiana* and reported 25^{O}C temperature as optimum under laboratory condition besides, germination on top of paper resulted in significantly higher germination than between paper and sand media. The maximum temperature for the germination of seeds of a few species may be relatively high e.g. *Prosphis farcata*, 40^{O}C (Dufni and Negbi, 1978), *Sesbania drummondii,* 40^{O}C (Eastin, 1984).Germination and survival are best at 25^{O}C compared to 10, 20, 30, 35^{O}C in *Ulmus americana* (Staub, 1967). Light stands recognized as a germination controlling factor since the mid of 19th century (Crocker, 1930). Recent research demonstrated that light acts in both dormancy induction release and in a mechanism that adapts plants to specific niches in environments after interacting with temperature (Hartman *et al.*, 1990).

In modern forestry, seed storage has become a practical necessity for artificial regeneration, which requires a regular and sustained seed supply through years of poor seed production. Elm (*Ulmus wallichiana*) seeds are generally low in viability besides a large number of seeds are empty. It seeds in spring and seeds are weak and recalcitrant (Bonner, 1984), therefore, are difficult to store under ordinary conditions. Seeds being recalcitrant should be sown immediately.

Moisture content is probably the most important single factor in determining seed longevity and all seeds that remain viable for more than one (1) year can withstand considerable drying without injury.

Many orthodox seeds can be spread for long periods at ambient temperature provided that moisture content is low. Complete desiccation is injurious to most seeds and the degree of drying can be injurious was shown by Barton (1935).

Harrington (1960) proposed his so-called thumb rule, which related seed moisture and temperature to seeds life span. Harrington's, 1972 rule stated that:

1) Life of the seed is halved for each 1 per cent increase in seed moisture.

2) If the seed moisture is below 14 per cent, no ice crystals form at freezing temperature so storage of dry seeds at sub-zero temperature should increase longevity.

Baldwin, 1955 has suggested different moisture levels for cold storage e.g. Pine 7-9 per cent, Abies 11 per cent, Picea 6-7 per cent, *Ulmus* 3-7 per cent, Thuja 8 per cent, Betula 1-5 per cent. Moisture content of 4-8 per cent is considered safe for long term storage for genetic conservation (IBPGR, 1976).

Elm seeds ordinarily remain viable for a few weeks but at 3 per cent moisture content and 25^{O}F, high viability has been maintained for 15 years (Barton, 1961).

Germination of seed is the initial and under some circumstances critical step in afforestation by natural or artificial means. Seeds of different species and of the same specie from different provenances

behave differently in their germination response and knowledge of same is very essential for understanding plantations programmes. Similarly a specie may be found in a wide variety of climatic regions, but the germination behaviour may differ according to provenance. This is seen in *Tsuga canadensis,* where distinct ecological types can be recognized.

Maithani *et al.* (1990) studied on standardization of nursery technique viz., Method of seed sowing, optimum irrigation schedule of *Dalbergia sisoo* and concluded that line sowing method with twice a day irrigation (morning and evening) enhance germination of seeds, gives higher germination and survival.

Qaisar, K. N. (1997) studied on the response of treatments on germination and early seedling growth with regard to seed weight/size of *Celtis australis* and recommended that for raising the quality planting stock of *Celtis australis* the best treatment of Giberellic acid @ 200 ppm may be given to seeds prior to sowing in polythene bags for 48 hours regardless of size weight factor. Other pre-sowing treatments like stratification + GA_3 200 ppm, GA_3 100 ppm and only stratification may also be adopted. He recommended to select the large seeds for uniform and quality seedling stock of *Celtis australis.*

Effect of seed weight, nitrogen source and split application on the grown of *Celtis australis* was studied by Mohammad Saleem *et al.* (1994) and reported that low seed weight gave the better germination whereas seedling raised from heavy seed weight were healthy and having better growth.

Misra and Jaiswal (1993) reported maximum survival, collar diameter, plant height, in the bigger size of polybags used. Sutherland and Day (1988) reported increase in seedling growth with increase in volume of container. Hellum (1978) and Preisig *et al.* (1979) reported that root system of both containerized seedlings bare root stock differ substantially from those of naturally regenerated seedlings (Carlson and Nairn, 1977). McMinn (1978) and Segaran *et al.* (1979) reported that seedlings reared in non-ribbed container were found frequently having spiraled root system and early root development.

Mughal (1996) reported that *Cupressus torulosa* and *Cedrus deodara* attain optimum shoot and root development when grown in open nursery in beds, while as seedlings grown in poly-packs do not exhibit better growth in terms of height and root development. Roots of poly-packs show even deformities and confinement in immediate vicinity.

Vegetative or asexual propagation is used to produce a plant identical in genotype with the mother plant. It is most convenient, easiest and economical method of propagation for some important crops (Hartman *et al.,* 1993). Although Elm (*Ulmus wallichiana*) is not vegetatively propagated commonly, however workers from time to time have tried to propagate it vegetatively with moderate success. Grafting has given better results than budding in *Ulmus* species (Greguss, 1972). Elk (1973) found that hardwood cuttings of *Ulmus* cultivar cut in January, February and treated them with growth substances and then planted after end of March gave promising results. Best results in terms

of rooting, survival and establishment in the field after transplanting were obtained when cuttings of *U. hollandica* were dipped in 1500 ppm, IBA for 15 minutes and inserted in compost in heated bins (Whalley, 1975). Effect of growth regulators in rooting performance of stem cutting of some shrub species of Western Himalayas was studied by Chauhan *et al.* (1994) and reported that all shrub species recorded better results with regard to sprouting, callusing and rooting under prolonged dip treatment in IBA and NAA for 24 hours as compared to a quick dip.

Rooting was obtained under intermittent mist conditions on soft wood cuttings taken in May from 12 year old *Ulmus americana* trees, soaked in 2 per cent solution of Benomyl for five minutes and dipped in a 10:1 mixutre of hormodin (0.3 per cent IBA) and captan (Schrebler and Kawose, 1975). Tissue culture in *Ulmus* species has also some received attention. Chalupa (1975) obtained whole tree from unorganized callus. Propagation of *U. americana* from callus, derived from cell suspension cultures has also been successfully reported by Durzan and Lopwashanski (1975). *Ulmus pumila* has been successfully propagated by using soft wood cuttings from the crown and twig grafting was also found to be successful. Graft propagation was necessary to ensure plant survival and optimum growth in colder areas (Schreiber and Main 1976). *In vitro* culture of American Elm (*U. americana*) anthers has been obtained by Redenbugh *et al.,* 1977. Bud grafting and layering has also been found to be successful for vegetative propagation of Elm species by Koster (1977). Saul and Zsuffa (1978) obtained Dutch Elm disease resistant individuals through vegetative propagation where by they used

green cuttings. Sharma and associates (1991) found that double slash cut responded to rooting upto 16.66 per cent, whereas different concentrations of IAA, NAA and IBA were most effective when cuttings were dipped for 24 hours. Kanwar *et al.* (1996) tested one year old branches of twenty five years old trees under nursery conditions, under the effect of auxins, season and cuttings position for rooting potential of *U. lavigala* and reported that growth regulators enhanced rooting. Kobert (1979) obtained good results on vegetative propagation of *U. procera* and found that rooting pre cent to be high for shoots of young mother trees and rooting decreased with increasing age of mother trees. Effect of auxin on rooting cutting of *Skimma laureola* was studied by Badola and Goel (1990) and observed that per cent callusing and rooting was higher in July and August, lower in September and cuttings fail to root in October. He also reported that *Skimma laureola* can be vegetatively propagated by root cuttings and August is the best month, also 150 ppm IAA was optimum treatment for obtaining best results.

CHAPTER-3

MATERIALS AND METHODS

Investigations conducted on **Status and propagation of Elm (*Ulmus wallichiana* Planchon): A multipurpose tree species of Kashmir valley** were carried out in the Division of Forestry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, during the year 2004 and 2005. The details of techniques followed and materials used during the course of investigations are described below as per the objectives of the project.

A. Status, distribution and concentration of *Ulmus wallichiana* in Kashmir valley

This objective was achieved by conducting detailed survey at block level of all the districts of Kashmir valley and observations with regard to status, distribution, concentration and identification of old existing Elm trees in the area were recorded. Besides, information was also collected for its socio-economic impact.

The data was collected from randomly selected four blocks in each district which accounted for about 28.5-100 per cent of the total sampling area. In each block, four villages and subsequently four sites in each village were selected randomly for taking observations. Information was collected from below mentioned places surveyed:

S. No.	Name of district	Blocks in the district	Blocks selected randomly	Percentage of blocks surveyed	Villages selected randomly
1.	Srinagar	1. Srinagar 2. Ganderbal 3. Lar 4. Kangan	1. Srinagar	100 %	1. Dara 2. Dood Mohalla, Shalimar 3. Firdous Abad, Batamaloo 4. Burzahama
			2. Ganderbal		1. Khulmulla 2. Check Fatehpora 3. Bandy Bagh 4. Shuhama
			3. Lar		1. Yanhama 2. Lar 3. Khranihama 4. Tulmulla
			4. Kangan		1. Kachnambal 2. Tangpora 3. Tangchetar Akhal 4. Punzen
2.	Budgam	1. Budgam 2. Khag 3. Chadoora 4. Narbal 5. B.K. Pora 6. Khan Sahib 7. Beerwah 8. Magam 9. Nagam	1. Budgam	44 %	1. Juhama 3. Yechgam 4. Patwaw 5. Sheikhpora
			2. Chadoora		1. Chadoora proper 2. Darbagh 3. Panzipora 4. Panzan

			3. Khan Sahib		1. Khan Sahib 2. Hariwanum 3. Krumshora 4. Latter Chadoora
			4. Nagam		1. Nagam 2. Badipora 3. Chari Sharief 4. Nowpora
3.	Anantnag	1. Anantnag 2. Achabal 3. Shangus 4. Kulgam 5. D.H.Pora 6. Quimoh 7. Breng 8. Qazigund 9. Khovripora 10. Dachnipora	1. Quimoh	40%	1. Kolodurng 2. Kujar 3. Howar Mishipora 4. Wanipora
			2. Dachnipora		1. Kushroy Kalan 2. Mehind 3. Khirm 4. Nowshera
			3. Kulgam		1. Khudwani 2. Larm Gangipora 3. Malpora 4. Khrewan
			4. Shangus		1. Shangus 2. Matipora 3. Dethoo 4. Buchan
4.	Baramulla	1. Baramulla 2. Pattan 3. Tangmarg 4. Uri 5. Boniyar	1. Pattan	28.5%	1. Shirpora 2. Golipora Sherabad 3. Buran 4. Hanjiwara

		6. Sopore 7. Wagora 8. Ruhama 9. Rafiabad 10. Sumbal 11. Hajan 12. Bandipora 13. Zanigheer 14. Gurez			
			2. Bandipora		1. Ashtingo 2. Putshahi 3. Leharwalpora 4. Gund Kasircheck
			3. Zanigheer		1. Mandghi 2. Harwan 3. Botingu 4. Dooru
			4. Ruhama		1. Sodipora 2. Lorihama 3. Logriwalpora 4. Nodihal
5.	Kupwara	1. Kupwara 2. Langate 3. Sogam 4. Trehgam 5. Kralpora 6. Rajwar 7. Tangdar 8. Ramhal	1. Langate	50%	1. Langate 2. Kultoora 3. Kharipora 4. Kohru
			2. Kralpora		1. Trehgam 2. Gugloosa 3. Shumnag 4. Hiri

			3. Sogam		1. Voovora
					2. Kanthpora
					3. Khurhama
					4. Khodi
			4. Rajwar		1. Baghatpora
					2. Zachaldara
					3. Khirman
					4. Gujerpati Buderkal
6.	Pulwama	1. Tral	1. Tral	66%	1. Gudpora
		2. Kakapora			2. Chursoo
		3. Keller			3. Pinglish
		4. Pulwama			4. Nadir
		5. Pampore			
		6. Shopian			
			2. Pampore		1. Lethipora
					2. Kanji Nagh
					3. Chandihara
					4. Kadalbal
			3. Pulwama		1. Malangpora
					2. Tehab
					3. Pulwama
					4. Ratnipora
			4. Shopian		1. Killora
					2. Losedenow
					3. Sedew
					4. Alliyalpora
	Average sampling area			54.75%	

The information was collected from surveyed areas through following methods:

a) ***Questionnaire method***

A questionnaire (Annexure-I) prepared for the purpose was filled on spot during interaction with farmers. Questionnaire consisted of both open ended and close ended questions.

b) ***Informal interview method***

Information was also collected during informal interviews with the farmers, old and respectable citizens of the concerned areas. Generally open ended questions were asked for getting the information.

c) ***Transit walk***

Information was collected during transit walk of the villages. Transit walk gave more scope to discuss with farmers freely in their farm lands while walking through their farms. Problems and prospects of agroforestry farming were discussed.

B. To study propagation of Elm *(Ulmus wallichiana)*

The study was undertaken to determine (a) maturity indices (b) dormancy of seed (c) seed weight (d) longevity of seed (e) raising of seedling nursery and (f) vegetative propagation through cuttings.

a) ***Maturity indices***

The optimal time to harvest is when a large amount of viable, germinable seeds can be collected. In order to determine the best time for collection of seeds, the seeds were collected weekly from ten phenotypically superior trees situated at Shalimar and Harwan. The

seeds were picked with effect from middle of March, 2004 till their maturation. Bold and sound seeds were selected for germination test and were placed in Petri plates. The plates were then kept in incubator at $20\pm1^{O}C$ using double fold germination paper at the bottom. The test period was run through for 21 days. Germination was recorded daily after third day of seed placement. Seeds were considered to have germinated and counted as soon as radical emerged. The germination percentage, mean germination time (MGT) and germination value (GV) were calculated as per following standard method:

i) Germination percentage $= \dfrac{\text{Number of seeds germinated}}{\text{Total number of seeds}} \times 100$

ii) Mean germination time (MGT) = $\sum$ (Daily germination * days / No. of seeds sown

Bonner (1983)

Ungerminated seeds at the end of test were given value of n+1, where n = number of days in the test and these values were included in the calculation of means.

iii) Germination value (GV) $= \dfrac{\sum \text{DGS}}{\text{N}} * (\text{GP} * 10)$

Where DGS = Daily germination speed = cumulative germination per cent/ No. of test days.

GP = Germination per cent at the end of test.

N = Frequency or number of DGS during the test.

[Djavanshir and Pourbeik (1976)]

Note: The above methods were applied in the course of studies as and when required.

b) ***Dormancy of seed***

Seeds collected at maturity were subjected to germination test in incubator at 20±1^{O}C and dormancy if any was determined.

c) ***Seed weight***

Seed weight of 100 bold and filled seeds was recorded, using 10 replications with the help of sensitive top pan balance and finally transformed into 1000 seed weight.

d) ***Longevity of seed***

Moisture content of seed and storage temperatures are two main factors that determine the longevity of seed during storage.

Accordingly moisture percentage of Elm seeds was determined by using hot air oven on fresh weight basis. Seeds were oven dried for 16±1 hours at 30^{O}±2^{O}C as per ISTA recommendations with little modifications. Thereafter moisture content was calculated by the formula.

$$\text{Moisture percentage} = \frac{\text{Fresh seed weight} - \text{Dry seed weight}}{\text{Fresh seed weight}} \times 100$$

Considering the light and soft nature of Elm seeds, the temperature of the oven was modified and reduced to 30±2^{O}C instead of 103±2^{O}C as recommended by ISTA (1993).

After determining the moisture content, it was reduced to about 50 per cent by using silcagel in desiccators. Two sets of seed (250 g each) were prepared, one with original moisture content and other with

approximate 50 per cent reduced moisture content and were sealed in polybags and stored at 4±1^{o}C in refrigerator. The germination test of seeds stored was conducted fortnightly in the laboratory following standard methods described earlier, so as to determine the longevity of seeds during storage and effect of moisture thereof.

e) ***Raising of seedling nursery***

The seedling nursery of Elm (*Ulmus wallichiana*) was raised from bold and filled seeds in nursery beds as well as in root trainers at forest nursery SKUAST (K), Shalimar. Open beds of size (1m x 1m) were prepared, mixed with sand and dalweed. 400 seeds were sown in last week of March, 2004 and the beds were irrigated as and when required. The sowing in root trainers was also carried at same time. The root trainers were filled with mixture of soil, dalweed and sand mixed in the ratio of 2:1:1, respectively. Three hundred bold and filled seeds were sown in 12 root trainers with capacity of 150cc of 25 holes each. The performance of seedling nursery in both cases in terms of germination, survival, height and collar diameter during one growing season was monitored and recorded.

f) ***Vegetative propagation of Elm (Ulmus wallichiana) through cuttings***

Vegetative or asexual propagation is used to produce a plant identical in genotype with the mother plant. Elm is hard to root so it is

not commonly propagated through vegetative means. Treating cuttings with auxins or other plant growth regulators (PGR) are believed to promote root initiation and also help in root cell multiplication and elongation. Therefore, in order to determine the effect of different plant growth regulators on root initiation of Elm cuttings, the cuttings were treated with following PGRs at given concentrations, in replicated manner (5 replications).

S. No.	Name of PGR	Concentrations used
1.	Indole-3-Acetic acid IAA	200,400,600,800,1000 ppm
2.	Indole-3-Butyric acid IBA	200,400,600,800,1000 ppm
3.	Napthalene acetic acid NAA	200,400,600,800,1000 ppm

The propagation through cuttings was carried out at forest nursery, Division of Forestry, SKUAST (K), Shalimar during the year 2004. Hardwood and softwood cuttings of uniform size 22 cm in length of pencil thickness were collected in months of February and July 2004, respectively and bulked together. The hardwood cuttings were buried in soil and taken out in 1st week of March 2004. Both hardwood and softwood cuttings were raised in spring and summer in nursery beds at spacing of 22 x 22 cm, respectively. Hardwood cuttings were treated with growth hormones for 24 hours while as softwood cuttings were treated by a quick dip of 30 seconds only after giving a basal cut to the cuttings. The observations were taken with regard to rooting/survival,

height and collar diameter. Cuttings were treated with simple distilled water for maintaining control.

CHAPTER-4

EXPERIMENTAL FINDINGS

A. Status, distribution and concentration/hectare of Elm (*U. wallichiana*) in Kashmir

A detailed survey of all the districts of Kashmir valley was conducted during the year 2004 and observation with regard to status, distribution and concentration per hectare of Elm trees were recorded and are presented in Table-1. It was found that the tree grows in all the districts of valley, although their concentration varied from place to place. The tree was naturally found growing along river banks, streams, nallas besides farmers grow these trees on the boundaries of their fields, on sloppy lands and on wastelands.

Socio-economic studies of the randomly selected farmers in each district were studied. For the purpose average land holding was surveyed and assessed for all districts as per Annexure-I. It was observed (Table-1) that average land holding was maximum in district Pulwama with 0.70 ha/family, followed by Budgam, Anantnag, Kupwara, Baramulla and Srinagar with 0.31, 0.30, 0.29, 0.29 and 0.02 hectares, respectively. Average annual income of the farmers from such land holding on per hectare basis was also assessed. The highest income of Rs. 31,980.00 was recorded in Anantnag followed by Pulwama, Baramulla, Kupwara, Budgam and Srinagar with average annual income of Rs. 31,810.00, Rs. 27,850.00, Rs. 11,870.00, Rs. 11,500.00 and Rs.10,680.00, respectively.

Table 1: Status and Distribution of Elm (*Ulmus wallichiana* Planchon) trees in Kashmir valley.

S. No.	Name of district	*Average land holding of surveyed family (ha.)	*Average estimated annual income per ha. of land holding	*Average no. of Elm trees (ha.)	Average annual income from Elm trees per family (Rs.)	Average percentage of income contributed by Elm per year/family
1.	Anantnag	0.30	31,980.00	78.00	2,140.00	6.69
2.	Pulwama	0.70	31,810.00	49.75	2,120.00	6.68
3.	Budgam	0.31	11,500.00	30.00	650.00	5.70
4.	Kupwara	0.29	11,870.00	3.25	150.00	1.26
5.	Baramulla	0.29	27,850.00	3.00	78.00	0.28
6.	Srinagar	0.02	10,680.00	2.33	26.00	0.24

* Average of 64 families

The observations recorded and presented in Table-1 also revealed that in district Anantnag on an average 78 number of Elm trees were found growing per hectare of land and constituting about 6.69 per cent to the farmers total average annual income. Whereas Pulwama and Budgam ranked 2nd and 3rd with 49.75 and 30.00 number of Elm trees per hectare of land constituting about 6.67 and 5.70 per cent of farmers total average annual income, respectively. The minimum number 2.33 of Elm trees per hectare was assessed for Srinagar district which contributed 0.24 per cent to farmers average annual income. However, Baramulla and Kupwara districts had slightly better position with 3.00 and 3.25 number of Elm trees per hectare of land contributing about 0.28 and 1.26 per cent to the farmers annual income, respectively.

Old existing Elm trees

The information with respect to old existing Elm trees in Kashmir valley was collected while conducting informal interview with respectable citizens of concerned areas, farmers and during transit walk of the villages surveyed. It was found that good number of old Elm trees existed at different places in different districts. The information with respect to their location, age, height, girth stands presented in Table-2 (Plate I-VIII). Out of all the six districts surveyed, the trees were located only in four districts viz., Anantnag, Baramulla, Kupwara and Srinagar, whereas, no old tree was located in Pulwama and Budgam. In district Anantnag, seven trees were identified having an approximate age between 250-400 years, with average height of 91.0-107.25 ft (28.0-33.0m) and average girth of 9.75-15.43 ft (3.0-4.75m),

Table 2: Old Elm (*Ulmus wallichiana* Planchon) trees found growing in Kashmir valley during 2004.

S. No.	District	Block surveyed	Location of the tree	No. of Elm trees	Approx. age of trees (years)	Average height of trees	Average girth of trees
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Anantnag	Kulgam	*Graveyard of Shouch village	5	250-300	91.0-97.5′ (28.0-30.0m)	9.75-13.0′ (3.0-4.0m)
2.	Anantnag	Muttan	Muttan Mandir	1	300	94.25′ (29.0m)	10.4′ (3.20m)
3.	Anantnag	Achabal	Ziyarat Sharief of Hardpora village	1	400	107.25′ (33.0m)	16.25′ (5.0m)
4.	Kupwara	Langate	Ziyarat Sharief of Mohd. Bakir Sb. Langate	4	250-300	65.0-91.0′ (20.0-28.0m)	11.37-13.0′ (3.5-4.0m)
5.	Kupwara	Trehgam	Ziyarat Sharief of Sonareshi Baba Shumnagh	1	250-300	94.25′ (29.0m)	13.0′ (4.0m)
6.	Kupwara	Trehgam	Graveyard of Batergam	4	250-300	65.0-97.5′ (20-30m)	10.4-13.0′ (3.2-4.2m)
7.	Kupwara	Trehgam	*Graveyard of Syed Allai Mir Sb. Hiri Rishipora	4	250-300	65.0-71.5′ (20-22m)	11.37-12.18′ (3.5-3.75m)
8.	Baramulla	Zanigheer	Private land of Haji Bashir Ahmad at Dooru village	5	200-250	97.5-110.5′ (30-34m)	13.0-13.48′ (4.0-4.15m)
9.	Baramulla	Ruhama	Ziyarat Sharief of Baba Qalandar Logriwalpora	1	250-300	110.0′ (33.84m)	13.48′ (4.14m)

Continued Table 2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
10.	Srinagar	Kangan	Ziyarat Sharief of Kachnambal	1	250-300	91.0′ (28.0m)	13.81′ (4.25m)
11.	Srinagar	Kangan	Ziyarat Sharief of Kangan (on National Highway)	4	250-300	91.0-97.5′ (20-30m)	12.18-15.9′ (3.75-4.89m)
12.	Srinagar	Srinagar	Sericulture Nursery New Thead Harwan	1	250-300	110′ (33.84m)	13.67′ (4.20m)
13.	Srinagar	Srinagar	Emporium garden opposite Sher-e-Kashmir Park	6	250-300	91.0-99.5′ (20.0-30.6m)	12.20-16.25′ (3.75-5.0m)
14.	Pulwama	Pulwama	Could not locate	N.A**	N.A	N.A	N.A
15.	Pulwama	Shopian	Could not locate	N.A	N.A	N.A	N.A
16.	Pulwama	Pampore	Could not locate	N.A	N.A	N.A	N.A
17.	Pulwama	Tral	Could not locate	N.A	N.A	N.A	N.A
18.	Budgam	Budgam	Could not locate	N.A	N.A	N.A	N.A
19.	Budgam	Chadoora	Could not locate	N.A	N.A	N.A	N.A
20.	Budgam	Narbal	Could not locate	N.A	N.A	N.A	N.A
21.	Budgam	Khan Sahib	Could not locate	N.A	N.A	N.A	N.A
		Total number of old Elm trees		38			

* The crown of these trees was broken and were in damaged conditions.

** Not applicable.

respectively. The trees were located at graveyard of Shouch village, Mattan Mandir and Ziyarat Sharief of Hardpora village. In district Kupwara 13 trees were identified and located. Four (4) of them were found at Ziyarat Sharief of Mohammad Bakir Saheb Langate, Four (4) at Batergam, Four (4) at Hiri Rishipora and one at Shumnag. The trees were approximately 250-300 years old with average height and girth of 65.0-95.5 ft (20.0-30.0m) and 10.4-13.0 ft (3.2-4.0m), respectively. Six numbers of trees were found in Baramulla district at Dooru Sopore and Logriwalpora. The five of them were found on private land of Haji Bashir Ahmad Beigh at Dooru, whereas sixth-one was found at Logriwalpora. The approximate age of trees varied between 200-300 years with 97.5-110.0 ft (30.0-33.84m) height and having girth of 13.0-13.48 ft (4.00-4.15m), respectively.

Good number of trees (12) were located in Srinagar district at Kangan, Harwan and Srinagar. Six of them were found at Emporium garden opposite Sher-e-Kashmir Park, Srinagar, whereas, four were located at Ziyarat Sharief of Kangan. One tree each was located at Kachnambal and Harwan. The approximate age of the trees varied between 250-300 years with average height of 91.0-110.0 ft (20.0-33.84m) and having 12.18-16.25 ft (3.75-5.0m) girth, respectively.

In total 38 trees were identified as old Elm trees and were located. Out of these, the tree located at Ziyarat Sharief of Hardpora Achabal (district Anantnag) was reported to be old having approximate age of 400 years with 107.25 ft (33.0m) and 16.25 ft (5.0m) height and girth, respectively (Plate I). It was found that all these trees were situated at

various Ziyarat Shariefs (Shrines) except two location i.e. Dooru, Sopore where surprisingly five old Elm trees were found in the private land of Haji Bashir Ahmad Beigh S/o Late M. Akbar Beigh, R/o Dooru, Sopore who have inherited these trees and are 200-250 years of age with average height 97.5-110.5 ft (30.0-34.0m) and girth 13.0-13.48 ft (4.0-4.15m) and second at Emporium Garden, Srinagar.

B. To study propagation of Elm (*Ulmus wallichiana*)

The studies were undertaken to determine (a) maturity indices (b) dormancy of seed (c) seed weight (d) longevity of seed (e) raising of seedling nursery and (f) vegetative propagation through cuttings.

a) ***Maturity indices***

The observation taken with respect to maturity indices revealed that Elm (*Ulmus wallichiana*) tree comes into flowering early in spring. Flowers of Elm (*U. wallichiana*) were found borne on leafless twigs in spring, with elongated axis 6-11mm long. The flowers are minute, reddish in colour. Fruit is 9-13mm in diameter. Most of seeds were unfilled.

The optimal time to harvest is when a large amount of viable, germinable seeds can be collected. In order to determine the optimal time, seeds were collected weekly from phenotypically superior trees with effect from middle of March 2004 (15.03.2004). Bold and filled seeds were placed in Petri plates and then subjected to germination test at $20\pm1^{O}C$ in incubator. The test period was run through for 21 days. The results obtained are presented in Table-3 and revealed that seeds

collected on first day of collection i.e. 15.03.2004 showed a germination percentage of 18 per cent with mean germination time (MGT) and germination value (GV) as 14.02 and 1.75, respectively. Seeds collected on 22.03.2004 showed highest germination percentage of 96 per cent and MGT and GV as 1.47 and 54.88, respectively. Subsequently, seeds collected on 3rd, 4th and 5th day of collection i.e. on 29.03.2004, 05.04.2004 and 12.04.2004 showed reduction in germination percentage. The germination percentage was observed to be 93, 86 and 70 per cent in case of 3rd, 4th and 5th day of collection with mean germination time MGT as 2.04, 2.63, 4.80 and germination value (GV) as 52.21, 54.33 and 32.57, respectively. On last day of collection i.e. on 19.04.2004, no seed was available on trees.

The studies conducted therefore, revealed that Elm (*Ulmus wallichiana*) seeds start maturing with effect from 3rd week of March depending upon favourable environmental factors.

Dormancy of seeds

Seeds collected at maturity were subjected to germination test in incubator at 20±1^{O}C. The test period was run through for 21 days. The seeds started germinating from 3rd day of sowing which suggested that seeds of Elm (*U. wallichiana*) are not having any kind of dormancy.

Seed weight

Seed weight of 1000 filled seeds collected on middle of March (15.03.2004) was found to be 7.10 g (Table 3), whereas the seed weight

Table 3: Effect of collection dates on various germination parameters of Elm (*Ulmus wallichiana* Planchon) seed.

S. No.	Collection dates	Average seed weight 1000 seed (gm)	Germination parameters		
			Germination percentage	Mean germination time (MGT) days	Germination value (GV)
1.	1st day of collection (15-30-2004)	7.10	18	14.02	1.75
2.	2nd day of collection (22-03-2004)	10.14	96	1.47	54.88
3.	3rd day of collection (29-03-2004)	10.09	93	2.04	52.21
4.	4th day of collection (05-04-2004)	10.07	86	2.63	54.33
5.	5th day of collection (12-04-2004)	10.04	70	4.80	32.57
6.	6th day of collection (19-04-2004)	No seed available on trees		N.A.*	N.A.

* Not applicable.

of 1000 seeds collected on its maturity i.e. on 3rd week of March (22.03.2004) as determined was found to be 10.14 g. This showed that seed weight increased from seed development stage upto its maturity and was maximum at its maturity stage.

Longevity of seed

Moisture content of seeds and storage temperatures are two main factors that determine the longevity of seed during storage. Accordingly moisture percentage of Elm (*U. wallichiana*) seed collected at maturity as determined by maturity indices studies was assessed and was found to be 49.91 per cent. Therefore, longevity of the seed was determined by placing two sets of seed i.e. (a) one with original moisture content i.e. 49.91 per cent (b) with nearly 50 per cent reduction in original moisture content in refrigerator at 4^{O}C. The stored seeds were then subjected to germination tests. The results obtained are presented in Table-4. The observations recorded revealed that the seeds which were stored at 4^{O}C with original moisture content (49.91 per cent) and acted as control lasted for four (4) weeks only. It was found that on first day (0 day of storage), the germination percentage of 83.0 per cent was recorded which drastically reduced to zero (0) per cent after 45 days of storage. Germination percentage after 15 and 30 days was observed to be 62.0 and 15.0 per cent, respectively. Studies showed that MGT increased from 3.930-13.460 after 30 days of storage, whereas GV decreased from 42.267-1.627 after same period of storage.

Table 4: Storage studies of Elm (*Ulmus wallichiana* Planchon) seed conducted under reduced moisture content.

S. No.	Storage days		Storage at approximately 50 per cent reduced moisture content			Storage at original moisture content (control)		
			Germination percentage	Mean ger. Time (days)	Germination value	Germination percentage	Mean ger. time (days)	Germination value
1.	0 days	(01-04-04)	93.0 *(76.453)	2.040	52.217	83.00 *(66.023)	3.930	42.267
2.	15	(15-04-04)	86.00 (68.686)	2.630	54.338	62.00 (52.042)	6.080	25.900
3.	30	(01-05-04)	76.00 (60.744)	4.570	35.180	15.00 (22.457)	13.460	1.627
4.	45	(16-05-04)	70.00 (56.822)	4.800	32.575	-	-	-
5.	60	(01-06-04)	66.00 (54.410)	7.450	25.245	-	-	-
6.	75	(15-06-04)	65.00 (53.845)	5.635	28.282	-	-	-
7.	90	(01-07-04)	67.00 (55.141)	5.298	32.947	-	-	-
8.	105	(17-07-04)	65.00 (53.750)	5.640	27.445	-	-	-
9.	120	(01-08-04)	55.00 (47.894)	7.780	19.000	-	-	-
10.	135	(17-08-04)	45.00 (42.100)	8.790	13.840	-	-	-
11.	150	(01-09-04)	35.00 (36.226)	10.515	8.038	-	-	-
12.	165	(15-09-04)	22.00 (27.856)	12.600	3.170	-	-	-
13.	180	(01-10-04)	03.00 (06.662)	15.520	0.130	-	-	-
14.	195	(16-10-04)	0	0	0	-	-	-
	CD at 5% level		7.17987	1.47948	7.54117	8.8052	2.1716	9.8737
	S.E± mean diff.		3.54965	0.73144	3.72827	3.89230	0.95995	4.36463

*Figures in parenthesis are arc sign transformed values.

On the other hand, seeds with 50 per cent reduced moisture content (approximately 24.5 per cent) and stored at same temperature ($4^{O}C$) survived for 180 days with reduced germination. The germination percentage determined on first day (0 days) decreased from 93.0-3.0 per cent after 180 days of storage. Germination percentage of 45 per cent was recorded after 135 days of storage. The MGT recorded increased with ageing of seeds from 2.040 at beginning to 13.840 after 13.840 after 135 days of storage and reached upto 15.520 at 180 days of storage. GV was also determined and was found decreased with ageing of seeds. It decreased from 52.21 at beginning to 13.840 after 135 days of storage and to 0.130 after 180 days of storage.

Raising of seedling nursery

The seedling nursery was raised from bold and filled seeds of Elm (*U. wallichiana*) in open nursery beds and in root trainers. The performance of seedling nursery in both cases was assessed in terms of germination percentage, survival, height and collar diameter. The observations recorded are presented in Table-5 (Plate IX). The analysis of data revealed that seedlings raised in open nursery beds were significantly superior with regard to germination percentage, survival percentage, plant height and collar diameter as compared to seedlings raised in root trainers. The germination percentage of seed sown in nursery beds was observed to be 91.66 per cent with a survival percentage of seeds of 72.78, whereas the germination percentage of seeds sown in case of root trainers was 85.33 per cent with survival

percentage of 39.45 only. Average plant height in case of seedlings

Table 5: Nursery raising of Elm (*Ulmus wallichiana* Planchon) in open beds and root trainers.

S. No.	Type of nursery*	Germination percentage	Survival percentage	Average plant height in (cm)	Average collar diameter (cm)
1.	Open beds	91.66	72.78	50.80	0.37
2.	Root trainers	85.33	39.45	18.83	0.18
	L Sd	2.297	9.389	2.049	0.019
	± Se diff.	1.844	4.266	0.930	0.008

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raised in open nursery beds was 50.80 cm with collar diameter of 0.37 cm as compared to the plant height of 39.45 and collar diameter of 18.83 in case of seedlings raised in root trainers.

Vegetative propagation of Elm (*U. wallichiana*) through cuttings

Elm is hard to root so it is not commonly propagated through vegetative means. Studies were, therefore undertaken to propagate it vegetatively through cuttings treated with different plant growth regulators PGR at varying concentrations. Both hardwood and softwood cuttings were raised in spring and summer, respectively in open nursery beds after treating them with PGRs. The results of hardwood cuttings obtained are presented in Table-6 & 7 (Plate X). The analysis of data (Table-6) revealed that cuttings treated with IAA at concentrations of 200, 400, 600 ppm, IBA @ 200, 400, 600, 800 ppm and NAA @ 200 ppm gave significantly higher rooting percentage as compared to control.

The observation recorded with respect to average root number and average root length also revealed significant difference as compared to control. Highest percentage of rooting was observed in case of cuttings treated with IAA and IBA @ 200 ppm (Table-6). It was found to be 27.270 and 27.120 per cent, respectively, whereas only 3 per cent of rooting was observed in control. However, cuttings treated with IAA and IBA @ 400 ppm also gave better results, but were insignificant when compared with 200 ppm concentrations. The rooting percentage recorded in case of IAA and IBA @ 400 ppm was found to be 19.99 and 21.60, respectively. The cutting treated with higher concentrations (1000

Table 6: Effect of plant growth regulators on rooting behaviour of Elm (*Ulmus wallichiana* Planchon) hardwood cuttings.

S. No.	Treatment	Rooting percentage		Average root number	Average root length (cm)
1.	Control	3.00	*(7.48)	3.60	13.40
	IAA				
2.	200 ppm	27.27	(31.48)	7.00	43.60
3.	400 ppm	19.99	(23.51)	6.00	45.40
4.	600 ppm	14.50	(20.16)	5.00	44.00
5.	800 ppm	7.20	(13.96)	5.20	48.00
6.	1000 ppm	1.80	(3.49)	2.20	8.80
	IBA				
7.	**200 ppm**	**27.12**	**(30.64)**	**10.00**	**36.80**
8.	400 ppm	21.60	(26.88)	7.00	25.80
9.	600 ppm	14.40	(17.54)	11.60	31.80
10.	800 ppm	14.40	(22.04)	3.00	50.80
11.	1000 ppm	0.00	(0.00)	0.00	0.00
	NAA				
12.	200 ppm	14.40	(21.75)	3.20	23.20
13.	400 ppm	12.60	(20.51)	3.80	40.00
14.	600 ppm	12.60	(20.51)	3.00	35.20
15.	800 ppm	7.20	(12.00)	5.80	19.40
16.	1000 ppm	0.00	(0.00)	0.00	0.00
	CD at 5% level	10.63	(11.78)	2.70	9.65

* Figures in parenthesis are arc sign transformed values.

Table 7: Effect of plant growth regulators on different aerial characteristics of *U. wallichiana*.

S. No.	Treatment	Average plant height (cm)	Average collar diameter (cm)
1.	Control	31.00	0.21
	IAA		
2.	200 ppm	87.00	0.71
3.	400 ppm	91.36	0.68
4.	600 ppm	94.00	0.56
5.	800 ppm	82.00	0.55
6.	1000 ppm	16.50	0.14
	IBA		
7.	200 ppm	51.57	0.36
8.	400 ppm	82.44	0.55
9.	600 ppm	57.12	0.44
10.	800 ppm	84.66	0.44
11.	1000 ppm	0.00	0.00
	NAA		
12.	200 ppm	72.55	0.41
13.	400 ppm	66.60	0.45
14.	600 ppm	72.60	0.41
15.	800 ppm	57.00	0.37
16.	1000 ppm	0.00	0.00
	CD at 5% level	42.43	0.33

ppm) of all the three plant growth regulators (PGRs) did not root except in case of IAA which resulted in meager percentage of 1.8 per cent even lower as compared to control.

The observations recorded with regard to average root number and root length also revealed significant differences as compared to control. Highest number of root number (11.0) was recorded in the cuttings which were treated with IBA @ 600 ppm, whereas it was recorded as 10.0 in IBA (200 ppm) and 7.00 in IAA 200 ppm as against of 3.60 in case of control.

Highest root length of 50.00 cm was recorded in the cuttings treated with IBA @ 800 ppm, followed by IAA 800, 400 and 600 ppm with average root length of 48.0, 45.0 and 44.0, respectively as compared with control where it was found to be 13.40 only.

Considering various combinations and parameters studied, it was observed that best results have been observed in cuttings treated with IBA @ 200 ppm, where rooting percentage, root number, root length was observed as 27.12, 10.00 and 36.8 cm, respectively. Subsequently, PGR treated cuttings were assessed with respect to ariel plant parts viz., average plant height and average collar diameter and results obtained are presented in Table-7. The analysis of data (Table-7) revealed that cuttings treated with IAA (200, 400, 600 and 800 ppm) and IBA (400 and 800 ppm) were significantly superior with regard to average plant height as compared to control. The highest plant height of 94.0 cm was recorded in IAA @ 600 ppm followed by IAA 400 and 200 ppm with average plant height of 91.360 and 87.00 cm, respectively. Subsequently average plant height of 84.660 cm and 82.4 cm was recorded in the cuttings treated with IBA 800 and 400 ppm, respectively as compared to control in which average plant height was 31.0 cm only. The observation recorded with respect to

average collar diameter also revealed significant differences as compared to control. Highest collar diameter of 0.706 cm was recorded in cuttings treated with IAA 200 ppm followed by a collar diameter of 0.68, 0.556 and 0.548 cm obtained in case of cuttings treated with IAA 400, 600 and 800 ppm, respectively as compared to control where it was only 0.212 cm collar diameter of 0.548, 0.486 and 0.438 was also recorded in the cuttings treated with IBA 400, 800 and 600 ppm, respectively. The cuttings treated with higher concentrations of IBA and NAA simply sprouted and withered of whereas cutting treated with 1000 ppm of IAA did put some height and collar diameter of 16.50 and 0.140 cm, respectively which was even lower than recorded in control where it was recorded as 31.0cm (plant height) and 0.212 cm (collar diameter).

Softwood cuttings raised in open beds after being treated with PGR's viz., IAA, IBA and NAA at concentrations of 200, 400, 600, 800 and 1000 ppm each by giving a quick dip for 30 seconds did not form roots except in case of IBA @ 800 ppm where 10 per cent of rooting was observed and survived for 1½ months only. Other treated cuttings simply sprouted and withered of within few days.

CHAPTER-5

DISCUSSIONS

The forests of Jammu and Kashmir are spread over an area of 20, 230 km^2 and consists mainly of evergreen conifers and broad leaved tree species. The commonly grown conifer species are the famous Deodar (*Cedrus deodara*), Kail (*Pinus wallichiana*), Fir (*Abies pindrow*), Spruce (*Picea smithiana*) etc., whereas common broad leaved tree species are Poplar (*Populus* spp.), Willow (*Salix* spp.), Elm (*Ulmus* spp.), Horse chestnut (*Aesculus indica*), Wild apricot (*Prunus* spp.), Black locust (*Robinia pseudoacacia*), etc.

Among these Elm (*Ulmus wallichiana*) is an important multipurpose tree species of Kashmir valley. It is a deciduous tree growing upto 33 m tall and about 2.7 m in girth (Anonymous, 1976). It is grown worldwide. Elm is essentially a north temperate assemblage, though three species exist in tropics. It occurs in North America and throughout Europe as far as Scotland, Southern Finland and North Central Asia, Turkey, Lebanon, Israel, Afghanistan and Himalayas (Anonymous, 1983). It is also grown in the east and is spread over China, Korea and Japan. In the South East Asia, it extends to Malaya to Sumatera, Sulavesi and Flores.

In Indian subcontinent, it is commonly distributed in Western Himalayas, Indus to Nepal at an altitude of 900-3000 m (Anonymous, 1976). In India, the tree species is reported to occur in HP, UP, Utranchal and Jammu & Kashmir.

Number of Elm species viz., *Ulmus wallichiana, U. villosa, U. compestris, U. parvifolia, U. lancifolia* etc., do occur worldwide but *Ulmus wallichiana* is most widely distributed in Western Himalayas.

In Kashmir Elm (*Ulmus wallichiana*) is commonly known as Bren and is grown for its multifarious uses and has become a preferred tree specie in agroforestry system. It has been found to be suitable under moisture stress conditions of Kashmir valley.

Elm timber is suitable for light construction, planking, packing cases, furniture, handles for agriculture tools (Gamble, 1922, Pearson and Brown 1932). Its leaves are valued as good fodder and bark for ropes (Anonymous, 1976). The bark is also rich in tannin 0.76 per cent (Tej Singh, 1958). The bark has also been reported to be used in a recipe for an ointment to heal broken bones and also for treatment of cuts in Mussoorie (Melville and Heybroek, 1971). Because of its multifarious uses it has become most exploited tree species and also has been given the status of an endangered species (IUCN, 1978).

In nature Elm is propagated through seeds, however seeds of *Ulmus wallichiana* are scarcely available for afforestation due to high incidence of empty seeds and low longevity, therefore has problems in its propagation. Accordingly a research project entitled “Status and propagation of Elm (*Ulmus wallichiana*): A multipurpose tree specie of Kashmir valley” was undertaken to study its status, distribution and to address the problems of propagation with following main objectives:

1. To study status and distribution of Elm (*U. wallichiana*) in Kashmir valley, and

2. To study propagation of Elm (*U. wallichiana*).

The study was carried out in the Division of Forestry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir during the years 2004 and 2005 as per the methodology and materials used as described in Chapter-3.

In order to achieve the first objective of the project i.e. Status and distribution of Elm (*U. wallichiana*) in Kashmir valley, a detailed survey of all the six (6) districts of Kashmir was undertaken. The observations recorded as per questionnaire method (Annexure-I), interview method, transit walk method stands recorded in Table-1 & 2. It was observed that tree grows throughout valley, although its concentration varied from place to place, the tree was naturally found growing along river banks, streams, nallas besides, farmers grow these trees on the boundaries of their fields, on sloppy lands and on wastelands. Since the climate and soil of the valley is very much suitable for the growth of Elm tree, accordingly the tree has been grown very extensively and has been exploited extensively, thereby resulting in its being endangered.

In order to find out concentration of Elm tree per ha and its contribution in the income obtained by the farmers a socio-economic studies of randomly selected group of farmers in each district was conducted. It was found (Table-1) that Pulwama had maximum average land holding of 0.70 hectares per family followed by Budgam (0.31 ha.), Anantnag (0.30 ha.), Kupwara (0.29 ha.) and Baramulla (0.29 ha.). Srinagar district had minimum average land holding of 0.02 hectares per family. Although Pulwama had the maximum average

land holding per family but the annual income/hectare was highest in Anantnag (Rs.31,980.00) followed by Pulwama (31,810.00), Baramulla (Rs.27, 850.00), Kupwara (Rs. 11,870.00), Budgam (Rs. 11,500.00) and the minimum was in Srinagar (Rs. 10,680.00). This indicated that average income per family is not directly correlated with average land holding of the family, which suggests that agriculture farming system plays an important role in generating income.

The average number of Elm trees per hectare were also assessed (Table-1) and it was found that Anantnag district had highest number of Elm trees (78.00/ha.) followed by Pulwama (49.75), Budgam (30.0), Kupwara (3.0), Baramulla (3.0) and Srinagar (2.33) trees/hectares of land. Thereby indicating that Elm trees are grown in each district, although their concentration was more in southern districts as compared to others. This is probably because of general awareness among the farmers and adoption of the tree in the agricultural farming system.

The study conducted also revealed that Elm trees contributed its share in average estimated annual income per hectare of land holdings. Although percentage varied from district to district, but it was found to be maximum for Anantnag district where it contributed 6.69 per cent followed by 6.68 per cent for Pulwama and was minimum in Srinagar with 0.24 per cent. It was once again Anantnag and Pulwama districts which ranked 1st and 2nd so far the percentage of income per family generated by Elm is concerned. This higher income is obviously because of higher number of Elm trees per hectare in these two districts.

The information with respect of old existing Elm trees in Kashmir valley was collected and the observations with regard to their location, age, height, girth stands presented in Table-2 (Plate I to VIII). Thirty-eight Elm trees were identified and located in different parts of the valley. These old existing Elm trees were found in all districts except in Pulwama and Budgam. The average age of these trees ranged between 200-400 years, with approximate average height and girth of 65.0-110.0 ft (20.0-33.84m) and 9.75-16.25 ft (3.0-5.0m), respectively. Most of these trees (27.0) were found to be growing on Ziyarat Shariefs (Shrines) of religious saints, however five of them were found to be growing on private land of Haji Bashir Ahmad Beigh S/o Late Mohammad Akbar Beigh at Dooru village of Sopre tehsil and six at Emporium Garden, Srinagar. In the districts of Pulwama and Budgam, no aged Elm tree was located in the areas surveyed.

The existing aged trees suggests that the Elm has been grown in the valley for ages but has survived only in selected religious places, because of the people being superstitious, otherwise would have been cut and used by the locals for their uses. Therefore, these trees have become heritage of the valley and need to be protected and preserved.

During the course of survey it was observed that farmers wanted to grow the trees on their farm lands particularly in Anantnag, Pulwama, Budgam, Baramulla and Kupwara districts subject to the availability of nursery plant material through some agency. People were of the opinion that all the seeds of Elm (*U. wallichiana*) do not germinate for reasons unknown to them as such did not take the risk of raising Elm nursery. Vegetative propagation through cutting is also

difficult. Farmers of Quimoh block of Anantnag district were raising nursery plants but have stopped the same after introduction of fast growing exotic species of Poplar (*Poplus deltoides*).

In view of above observations, it is evident that if proper awareness is undertaken and plant material is made available, farmers will definitely grow more Elm trees in their lands.

In order to achieve the second objective i.e. "Propagation of Elm (*Ulmus wallichiana*)", studies were undertaken to determine (a) maturity indices (b) dormancy of seed (c) seed weight (d) longevity of seed (e) raising of seedling nursery and (f) vegetative propagation through cuttings.

a) ***Maturity indices***

The studies conducted on maturity indices revealed that the tree (*Ulmus wallichiana*) comes into flowering early in spring. Flowers were borne on leafless twigs in spring. They were minute, reddish in colour. Fruit 9-13 mm in diameter with a seed in centre. Most of the seeds were unfilled. It was found that matured and ripe fruits produced seeds which have potential of producing more and quality seedlings. Studies conducted and presented in Table-3 to find out the optimal time when large number of viable and germinable seeds of Elm can be collected, revealed that 3rd to 4th week of March is most suitable for the collection of Elm (*U. wallichiana*) seeds in the valley. It was found that seeds collected on 3rd week of March (22.03.2004) and last week of March (29.03.2004) showed maximum seed germination of 96 and 93 per cent, respectively. Whereas only 18 per cent of germination was

recorded on first day of collection of seed (15.03.2004) and no seeds were available on trees during third week of April.

Studies conducted therefore, revealed that Elm seeds matures from 3rd week of March onwards and these seeds should be collected between third and fourth week of March depending upon environmental conditions particularly temperature.

Significance of seed collection at proper time of maturity has been envisaged and worked out by various workers (Harrington, 1970, Stein *et al.*, 1974, Bonner, 1972 etc.). Knowledge of exact stage and time of seed maturity is essential so that harvesting is done at a time when seeds are ripe. The approximate dates of seed collection are even mentioned in botanical flora and several other publications, but these dates may vary as they are affected by altitude, rainfall and aspect. It is well documented that ripe seeds retain viability longer than those collected immature (Harrington, 1970, Stein *et al.*, 1974). Seed and fruit maturation is often accompanied by recognizable change in colour, taste, odor and texture of fruit and seeds. In broad leaved species colour change is also a useful index of ripeness. A relationship between seed maturity and colour has been established in several species e.g. *Liquidambar styraciflua, Plantanus occidentalis* (Bonner, 1972). Singh (1989) also reported that in spruce, germination per cent increased from 0.70 in August to 48.6 in October at maturity, whereas it increased from 0.50-32.14 per cent in October at maturity in *Abies Pindrow*.

b) ***Dormancy of seeds***

The seeds of Elm (*Ulmus wallichiana*) collected at maturity were subjected to germination test. It was observed that the seeds started germinating from third day of sowing which suggested that seeds of Elm (*Ulmus wallichiana*) do not have any kind of dormancy. Similar results stand reported earlier with the recommendation that the seeds of Elm (*Ulmus wallichiana*) should be sown immediately as they germinate within few days (Anonymous, 1986).

c) ***Seed weight***

High seed weight is an index of maturity and is often desirable, since it is correlated with rapid germination and good seedling establishment (Sorensen and Cambell, 1933). The seed weight determined during present studies revealed that seeds collected at maturity showed higher weight of 10.14 g/thousand (1000) seeds as compared to seeds collected at immature stages which weighed 7.10 g/1000 seedling. This is probably due to continued development of embryo within the fruit body from maturation to ripening resulting in more pulpy seeds.

d) ***Longevity of seeds***

Moisture content of seeds collected at maturity and storage conditions determine the longevity of seeds. In present investigations, seeds collected at maturity as determined by maturity indices were found to have moisture content of 49.91 per cent. These seeds were stored as such at $4^{O}C$. It was observed (Table-4) that on first day of

storage, 83.0 per cent germination was recorded and it reduced drastically to 15.0 and 0.0 per cent after 30 and 45 days of storage, respectively. Whereas MGT increased from 3.93-13.460 after 30 days of storage and GV decreased from 42.267-1.627 after same period of storage.

On the other hand seeds with nearly 50 per cent reduced moisture content (approximately 24.5 per cent) and stored at similar conditions were found to be viable upto 180 days of storage. In this case, germination of 93.0 per cent recorded on first day (0 day of storage) decreased to 3.0 and 0.0 per cent after 180 and 195 days of storage, respectively. The MGT recorded increased with ageing of seeds from 2.040 at the beginning to 15.520 at 180 days of storage. GV determined and was also found decreased with ageing of seeds. It decreased from 52.21 at beginning to 0.130 after 180 days of storage.

The decline in storage period of seeds having higher moisture content is a common phenomenon and possibly may due to sudden collapse of the embryo within the seeds due to high rate of moisture loss. Holmes and Buszewiez (1958) have recommended moisture content of seeds for storage between 5-12 per cent for most of tree species. Thapliyal *et al.* (1991) reported that seeds of *Bambusa tueda* with a moisture content of less than 10 per cent at ambient temperature maintained 50 per cent viability after 12 months, whereas all seeds stored at high moisture content lost viability completely in less than four months. Different moisture levels have been reported for storage of coniferous seeds in cold storage e.g. Pines 7-9 per cent, Betula 1-5 per cent (Baldwin, 1955). Harrington (1972) stated that for every $5^{O}C$

increase in seed storage temperature life of seed is halved. He also reported that for one per cent increase in seed moisture content, life of seed is also halved.

Studies conducted therefore, concluded that seed stored at reduced moisture content (about 50 per cent) increased the longevity of Elm seeds under storage at $4^{O}C$ to about 180 days with reduced germination of 3 per cent as against 30 days in case of seeds stored with original moisture content.

e) ***Raising of seedling nursery***

Studies conducted on nursery raising of *Ulmus wallichiana* revealed that nursery beds were the best medium for raising seedlings than those raised in root trainers of size 150cc (25 holes). The results obtained stands presented in Table-5 (Plate IX). The vigorous performance in terms of germination and survival recorded in case of seedlings raised in nursery beds was 91.66 and 85.33 per cent, respectively while it was only 72.78 and 39.45 per cent in case of seedlings raised in root trainers. The average plant height recorded in case of seedlings raised in open beds was about 2¼ times more than the seedlings raised in root trainers. The vigorous growth of seedlings raised in nursery beds may be probably due to abundance of space available to root system for drawing moisture and nutrients, transporting the same to the top, whereas root trainers provided very less space for root development. It may also be probably due to environmental conditions especially temperature and the medium used in root trainers (2:1:1, soil: dalweed: sand). Since root trainers of one size and one combination of medium was used in present studies,

therefore their performance can not be ignored and study needs to be carried out for finding out suitable medium and container size. Similar observations have been noticed by Misra and Jaiswal (1993) obtaining maximum survival, height, collar diameter in seedlings raised in biggest size of polybags. Sutherland and Day (1988) reported increase in seedling growth with increase in volume of container. Mughal (1996) reported that *Cupressus torulosa* and *Cedrus deodara* attain optimum shoot and root development when grown in open nursery beds, while as seedlings raised in poly packs did not exhibit better growth in terms of height and root development.

f) ***Vegetative propagation through cuttings***

The vegetative or asexual propagation is convenient, easiest and economical method of propagation, but unfortunately Elm is not commonly propagated through vegetative means as it is hard to root. Studies therefore were undertaken to propagate it vegetatively through cuttings, treated with plant growth regulators at varying concentrations. Both hard and softwood cuttings were used. Studies conducted (Table 6 & 7) revealed that lower concentrations of auxins effectively improved root initiation and development in hardwood cuttings when dipped for 24 hours. Rooting percentage was enhanced to 27.27, 27.12 and 14.40 per cent by use of IAA, IBA and NAA @ 200 ppm, respectively as against of 3.0 per cent in control.

Significantly superior results were also recorded for average root number, average root length (Table-6) average plant height and average collar diameter (Table-7) as compared to control.

IBA 200 ppm was significantly superior with average root number of 10.0 whereas average root length was also more in all cases of growth hormone treated cuttings compared with control. Subsequently the plant height and collar diameter (Table-7) in all growth hormone treated cuttings was found to be significantly superior than control except in higher concentrations of 1000 ppm, where it was lower than control. As against 31.0 cm of plant height in control, the cuttings treated with hormones gave average plant height ranging from 51.57 cm to the highest of 94.0 cm and also as against 0.212 cm of collar diameter in control the cutting treated with different concentrations of hormones gave average collar diameter ranging from 0.37 cm to the highest of 0.70 cm.

Considering various combinations and parameters studied it was concluded that best results have been observed in cuttings treated with IBA @ 200 ppm, where rooting percentage, average root number, average root length, average plant height and average collar diameter was observed as 27.12, 10.00, 36.8, 51.57 and 0.36 cm, respectively.

Softwood cuttings were also treated with auxins viz., IAA, IBA and NAA at similar concentrations by giving a quick dip of 30 seconds in the month of August did neither root nor survived. However, these studies can be explored further.

The purpose of treating cuttings with auxin type growth regulators (hormones) is to increase the percentage of cuttings that form roots to hasten root initiation, to increase the number and quality of roots produced/cutting (Hartmann *et al.*, 1993).

Elk (1973) reported that hardwood cuttings of *Ulmus* cultivar made in January-February and treating them with growth substances

and planted after the end of March gave promising results. Best results in terms of rooting, survival and establishment in the field after transplanting were obtained when hardwood cuttings of *Ulmus hollandica* were dipped in 1500 ppm of IBA for 15 minutes and inserted in compost heated bins (Whalley, 1975).Sharma *et al.* (1991) also found that lower concentrations were the most effective for cuttings of *Ulmus wallichiana* which were dipped for 24 hours.

Treating stem cuttings with auxins or other PGR's are believed to promote root initiation and also help in root cell multiplication and elongation producing numerous and long roots. It is probably due to this effect that hardwood cuttings of *Ulmus wallichiana* treated with various auxins at varying concentrations produced roots more in number and larger in length as compared to untreated ones.

CHAPTER-6

SUMMARY AND CONCLUSION

Elm (*Ulmus wallichiana*) locally know as Bren is one of the commonly found broad leaved tree species in Kashmir valley and is best know representative of family *Ulmaceae*. It is grown for its multifarious uses and had become a preferred tree species in our agroforestry system earlier. Unfortunately it has problems in its propagation which has resulted in its being endangered (IUCN, 1978). Therefore, present studies entitled **Status and propagation of Elm (*Ulmus wallichiana* Planchon): A multipurpose tree species of Kashmir valley** were undertaken and carried out at the Division of Forestry, SKUAST (K), Shalimar during the years 2004 and 2005 with following main objectives:

a) To study status and distribution of Elm (*Ulmus wallichiana*) in Kashmir valley, and

b) To study propagation of Elm (*Ulmus wallichiana*).

The results obtained are summarized below:

- The tree was found growing in all districts of Kashmir valley, although their concentration varied from place to place. The tree was naturally found growing along river banks, streams, nallas, besides farmers grow these trees on the boundaries of their fields, on sloppy land and wastelands etc.
- A socio-economic studies of randomly selected farmers in each district was conducted in order to find out concentration of Elm trees per ha. and its contribution in the income obtained by the

farmers. It was found that Pulwama had maximum average land holding of 0.70 ha. per family followed by Budgam, Anantnag, Kupwara, Baramulla and Srinagar with average land holding of 0.31, 0.30, 0.29, 0.29 and 0.02 hectares per family, respectively.

- In Anantnag district the average annual income assessed from average land holding per hectare surveyed was found maximum. It was to the tune of Rs. 31,980.00 as against lowest of Rs. 10,680.00 in case of Srinagar district.
- The average number of Elm trees on per ha. basis in various districts of valley viz. Anantnag, Pulwama, Budgam, Baramulla, Kupwara and Srinagar was determined to be 78.0, 49.75, 30.0, 3.0, 3.0 and 2.33, respectively. It indicated that Elm trees are grown in every district of valley, although their concentration was more in southern districts as compared to others. This is probably due to general awareness among the farmers and adoption of the tree in the agricultural farming system.
- The study conducted also revealed that Elm trees contributed its share in the average estimated annual income per hectare of land holdings. In Anantnag district, the contribution from Elm trees in the farmers annual income was determined to be 6.69 per cent as against lowest of 0.24 per cent in case of Srinagar district. The higher income in Anantnag and Pulwama is obviously because of higher number of Elm trees per hectare of land.

- Thirty-eight (38) numbers of trees were identified as old growing Elm trees and were located in different parts of the valley. They were found in all districts of valley except in Pulwama and Budgam where no aged tree was found in the surveyed area. The average age of these trees ranged between 200-400 years, with approximate average height and girth of 65.0-110 ft (20.0-33.84m) and 9.75-16.25 ft (3.0-5.0m), respectively. Among these trees the old Elm tree was located at Ziyarat Sharief of Hardpora of block Achabal, district Anantnag. The approximate age of the tree was 400 years with 107.25 ft (33.0m) and 16.25 ft (5.0 m) as height and girth, respectively. Most of the trees were found growing on Ziyarat Shareifs (Shrines) of religious saints but five of them were found on private land of Haji Bashir Ahmad Beigh S/o Mohammad Akbar Beigh at Dooru village of Sopore tehsil.
- Thus it may be concluded that the Elm trees have been grown in the valley for ages but has survived in selected religious places only, obviously because of people being superstitious. So the trees identified have become the heritage of the valley and need to be protected and preserved.
- The Elm (*Ulmus wallichiana*) has been declared as an endangered tree species. This is mostly because it has problems in its propagation. Natural regeneration is very poor and the tree species is not vegetatively propagated. Therefore, studies were undertaken to determine its propagation through seed and vegetative means.

- The studies conducted on maturity indices revealed that the tree (*Ulmus wallichiana*) comes into flowering early in spring. Flowers were borne on leafless twigs in spring. They were minute, reddish in colour, fruit winged, rounded and peppery, 9-13 mm in diameter with a seed in centre. Most of the seeds were unfilled. Studies conducted to find out the optimal time when a large number of viable and germinable seeds can be collected, revealed that 3rd to 4th week of March is most suitable time for collection of *Ulmus wallichiana* seeds in the valley depending upon environmental conditions particularly temperature. Therefore, seeds should be collected at proper time.

- The seeds of Elm (*Ulmus wallichiana*) collected at maturity were subjected to germination test. It was observed that the seeds start germinating from third day of sowing, thereby indicating that the seeds of *Ulmus wallichiana* do not have any kind of dormancy so do not require any kind of treatment.

- High seed weight is an index of maturity and is often desirable. The seed weight determined during present studies revealed that seeds collected at maturity showed higher weight of 10.14 g per thousand seeds as compared to seeds collected at immature stage which weighed 7.10 g per thousand seed.

- Moisture content of seeds collected at maturity and storage conditions determined the longevity of seeds. In the present study, the seeds collected at maturity were found to have moisture content of 49.91 per cent. The seeds were stored as

such at $4^{O}C$ and were found to survive for only four weeks. Germination percentage of these seeds reduced drastically from 83.0 per cent on first day of storage to 15.0 and 0.0 per cent on 30 and 45 days of storage.

- On the other hand seeds with nearly 50 per cent reduced moisture content (24.5%) and stored at same temperature ($4^{O}C$) were found to be viable upto 180 days of storage. In this case germination percentage of 93.0 per cent recorded on first day decreased to 3.0 and 0.0 per cent after 180 and 195 days of storage, respectively. The MGT recorded increased from 2.04 at the beginning to 15.520 at 180 days of storage. GV determined was also found decreased with ageing of seeds. It decreased from 52.21 at beginning to 0.130 after 180 days of storage.
- It is therefore concluded that seeds with approximately 50 per cent reduced moisture content and stored at $4^{O}C$ remained viable upto 180 days with reduced germination percentage of 3.0 per cent as against 30 days in case of seeds stored at same temperature with original moisture content under similar conditions.
- Studies conducted on raising of seedling nursery of Elm (*Ulmus wallichiana*) revealed that nursery beds were the best medium for raising seedlings as compared to seedlings raised in root trainers. The vigorous performance in terms of germination and survival was observed in case of seedlings raised in open nursery beds where it was found to be 91.66 and 85.33 per cent, respectively. On the other hand, it was found only 72.78 and

39.45 per cent in case of seedlings raised in root trainers. The plant height of seedlings raised in open nursery beds was found to be 2¼ times more than those of raised in trainers. The average collar diameter was also recorded to be maximum (0.37 cm) as against of 0.18 cm in case of seedlings raised in root trainers.

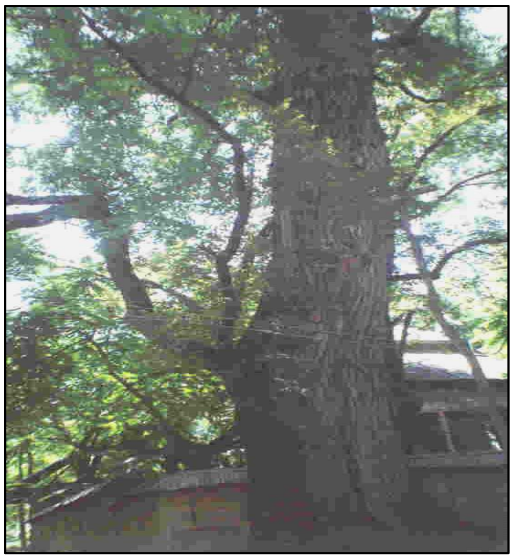
- Although best results were obtained in case of open beds but performance of root trainers can not be ignored as only one kind of medium (2:1:1) soil: dalweed: sand was used.
- As Elm is hard to root species, therefore studies undertaken to propagate it vegetatively by cuttings treated with various plant growth regulators (PGR's). Studies conducted revealed that lower concentrations of PGR's viz., IAA, IBA and NAA used @ 200 ppm significantly improved root initiation and development in hardwood cuttings dipped for 24 hours. IAA and IBA at concentrations of 200 ppm enhanced rooting percentage to 27.27 and 27.12, respectively over control in which rooting of 3.0 per cent was observed. However, cuttings treated with higher concentrations of 1000 ppm did not root except in case of IAA which resulted in meager percentage of 1.8 even lower than control.
- Average root number was higher in almost all growth hormone treated cuttings over control except in higher concentrations of 1000 ppm. IBA @ 200 ppm was significantly superior with average root of 10. Root length was also higher in growth hormone treated cuttings as compared to control.

- The plant height and collar diameter was found to be significantly superior than control. The average plant height of 94.0 was recorded in IAA @ 600 ppm as against of 31.0 cm in control. Average collar diameter of 0.706 cm was recorded in cuttings treated with IAA 200ppm as against of 0.212 cm in control.
- On the basis of studies conducted and considering various combinations and parameters, it was concluded that IBA @ 200 ppm is best growth regulator to be used for vegetative propagation of Elm (*Ulmus wallichiana*) through cuttings.
- Softwood cuttings which were also treated with auxins viz., IAA, IBA and NAA at similar concentrations by giving a quick dip of 30 seconds in the month of August did neither root nor survived. However, studies need to be explored further.

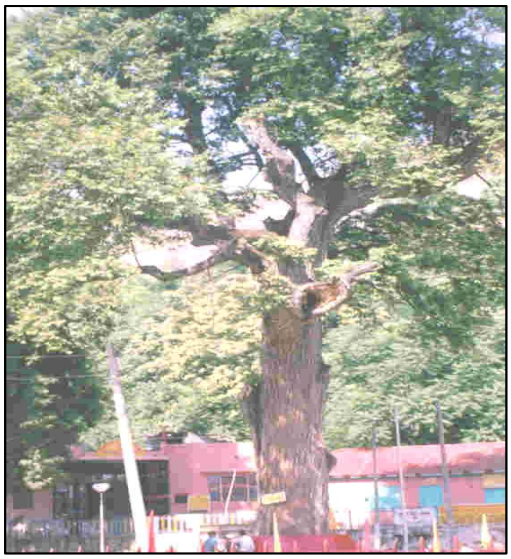
Thus it may be concluded that the Elm (*Ulmus wallichiana*) a multipurpose tree specie has been found growing in all the districts of Kashmir thereby indicating that the agroclimatic conditions of the valley are very much suitable for growing Elms. However, its concentration varied from place to place and was maximum (78.0 trees/ha.) in southern district (Anantnag) as compared to others and lowest (2.33 trees/ha.) in Srinagar district. Farmers were more aware about the benefits of the tree in south Kashmir and evidently it contributed maximum to the tune of 6.69 per cent in their estimated average annual income on one ha. of land holding. The identification and location of 38 old (200-400 years) Elm trees growing at different places around the Kashmir has indicated that the tree had been

growing for ages in the valley, but has survived only at religious places only because of the fact that people are superstitious in nature, otherwise would have been cut. The identified trees should be declared as heritage of Kashmir.

There are problems in its propagation. High incidence of empty seeds, low viability and longevity besides, hard to root from vegetative cuttings has aggravated the situation and the farmers have stopped its plantation. Present studies conducted revealed that seeds collected at proper maturity stage as was determined to be 3rd-4th week of March depending upon suitable environmental conditions resulted in the maximum seed germination (96 percent) Seeds at maturity weighed 10.14 g/1000 seed as against of 7.10 g at immature stage. These seeds were not having any kind of dormancy, therefore, need no seed treatment. However, their longevity could be increased from 30 days (with original moisture content) to 180 days with reduced moisture content (approximately 50 per cent of the original moisture content) with reduced germination percentage of 3.0 per cent. This also enhanced the germination of seeds. It was also found that seeds sown in well prepared open nursery beds resulted in much superior seedlings in terms of height and collar diameter as compared to seedlings obtained in root trainers. Success has also been achieved in vegetative propagation through dormant hardwood cuttings treated with various plant growth regulators viz., IAA, IBA and NAA with varying concentrations of 200, 400, 600 and 800 ppm in average root formation, root length, root number, plant height and collar diameter. However, the best treatment combination was determined as IBA treated dormant hardwood cuttings @ 200 ppm.

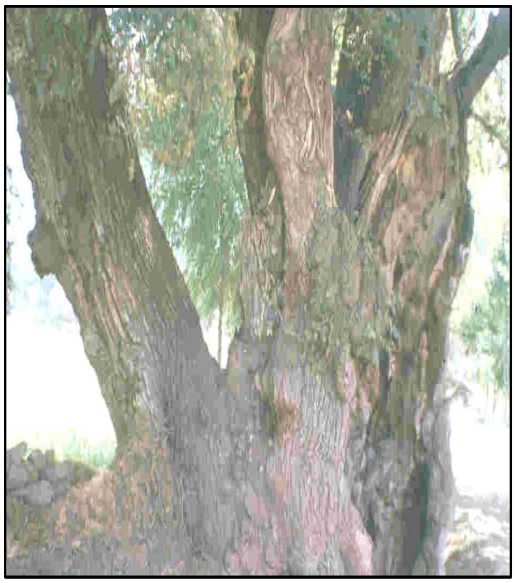


Age approximately 400yrs
Plate I Hardpora, Achabal, Anantnag



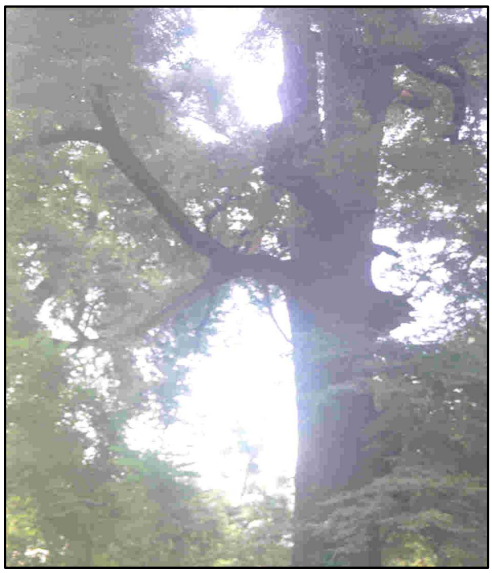
Age approximately 300yrs
Plate II Mattan Mandir, Mattan, Anantnag

Age approximately 250-300yrs
Plate III New Thead, Harwan, Srinagar

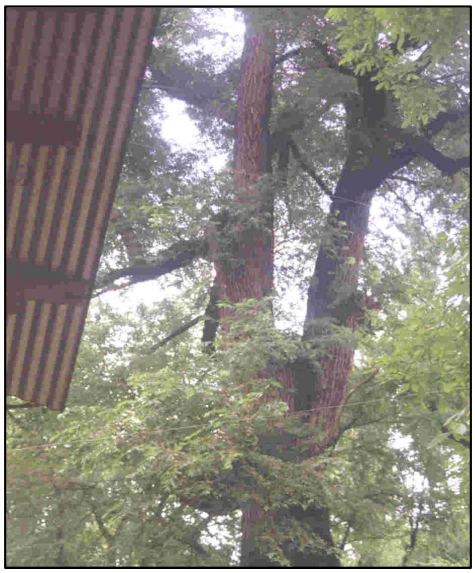


Age approximately 250-300yrs
Plate IV Kach Nambal, Kangan, Srinagar

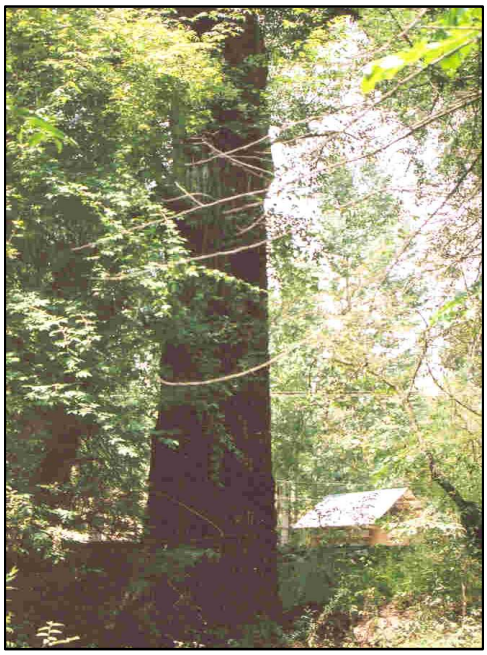
Plate I-VIII: Old Elm (*U. wallichiana* Planchon) trees located growing in Kashmir valley



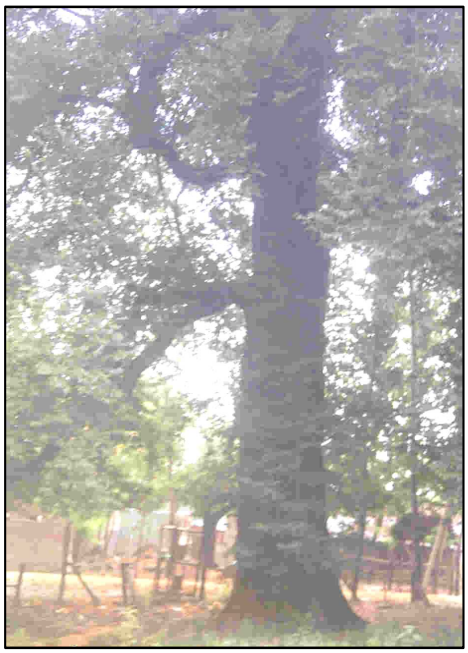
Age approximately 300yrs
Plate V Dooru, Zainageer, Baramulla



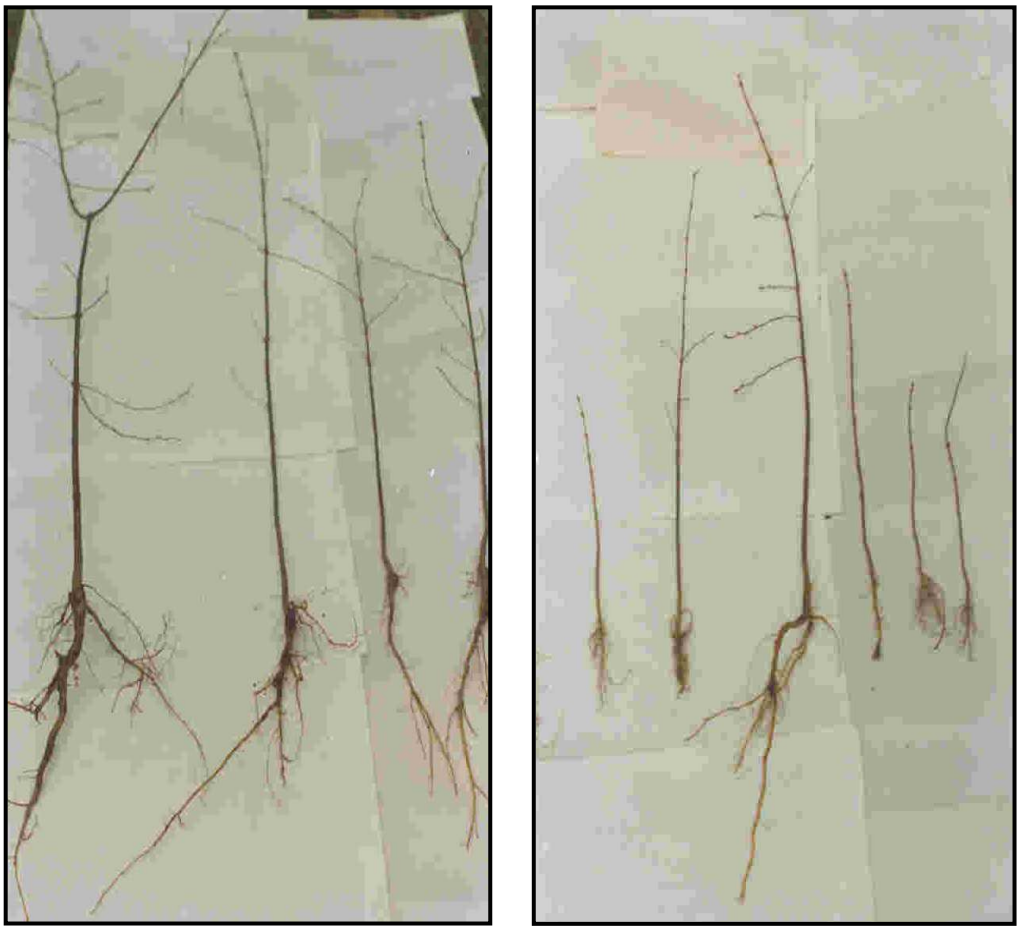
Age approximately 250-300yrs
Plate VI Logri Walpora, Rohama Baramulla



Age approximately 300yrs
Plate VII. Hiri, Rishipora,



Age approximately 300yrs
Plate VIII Langate, Kupwara



Open beds **Root trainers**

Plate IX : Uprooted seedling of Elm (*Ulmus wallichiana* Planchon) raised in open bed and root trainers


PROPAGATION OF ELM (Ulmus wallichiana)
THROUGH CUTTINGS
[Growth Harmone Treated]
Spring Planting

Plate X : **Elm (*Ulmus wallichiana* Planchon) raised through PGR treated cuttings**

Appendix-I

Status and Distribution of Elm (*Ulmus wallichiana*) in Kashmir valley

S. No.	Block	Ave. land holding of surveyed families (ha.)	Ave. estimated income from land holding of surveyed families per year (lakhs)	Average number of Elm trees per ha. of land	Average income from Elm trees (lakhs/year)	Percentage of income contributed by elm per year
			District Anantnag			
1.	Quimoh	22.85	35.25	127	1.90	5.39
2.	Kulgam	20.85	24.00	60	1.20	5.00
3.	Shangas	23.75	12.10	80	1.70	14.00
4.	Achabal	12.00	10.55	45	0.70	3.63
	Mean	**19.71**	**20.47**	**78**	**1.37**	**6.69**
			District Pulwama			
1.	Pulwama	46.00	18.00	50	1.80	10.00
2.	Pampore	87.00	21.00	48	2.25	10.71
3.	Shopian	17.35	26.10	12	0.06	0.24
4.	Tral	29.25	16.35	89	1.34	8.19

	Mean	**44.91**	**20.36**	**49.75**	**1.36**	**6.68**
						Contd…
S. No.	**Block**	**Ave. land holding of surveyed families (ha.)**	**Ave. estimated income from land holding of surveyed families per year (lakhs)**	**Total number of Elm trees per ha. of land**	**Total income from Elm trees (lakhs/year)**	**Percentage of income contributed by elm per year**
			District Budgam			
1.	Budgam	17.40	8.00	34	0.47	5.87
2.	Chadoora	13.80	8.89	42	0.60	4.34
3.	Narbal	30.00	7.00	30	0.31	4.42
4.	Khan Saheb	19.90	5.55	16	0.30	5.40
	Mean	**20.35**	**7.36**	**30**	**0.42**	**5.70**
			District Srinagar			
1.	Kangan	4.75	3.40	7	0.0009	0.026
2.	Ganderbal	0.81	0.42	6.33	0.0035	0.83
3.	Lar	0.50	0.12	0	0	0
4.	Srinagar	0.50	0.40	1	0.062	1.08

	Mean	**1.64**	**1.08**	**2.332**	**0.0026**	**0.240**

Contd…

S. No.	Block	Ave. land holding of surveyed families (ha.)	Ave. estimated income from land holding of surveyed families per year (lakhs)	Total number of Elm trees per ha. of land	Total income from Elm trees (lakhs/year)	Percentage of income contributed by elm per year
			District Baramulla			
1.	Pattan	13.35	14.70	7	0.014	0.09
2.	Ruhama	25.05	11.65	1	0.005	0.042
3.	Zanigheer	22.95	35.53	2	0.15	0.42
4.	Bandipora	14.85	9.45	2	0.05	0.52
	Mean	**18.80**	**17.83**	**3**	**0.03**	**0.200**
			District Kupwara			
1.	Langate	16.20	17.90	3	0.10	0.5
2.	Trehgam	13.10	2.40	5	0.21	0.875

3.	Vovoora Sogam	29.05	5.55	1	0.025	0.45
4.	Rajwar	17.10	4.58	4	0.05	2.4
	Mean	**18.86**	**7.60**	**3.25**	**0.096**	**1.26**

Appendix-II

Analysis of variance (Balanced Designs)

Analysis of variance for germination (reduced) – Table 4.

Source	**DF**	**SS**	**MS**	**F**	**P**
Treatment	12	30980.9	2581.7	58.27	0.000
Error	39	1728.0	44.3	-	-
Total	51	32708.9	-	-	-

MGT Mean Germination time (reduced moisture)

Source	**DF**	**SS**	**MS**	**F**	**P**
Treatment	12	723.919	60.327	56.39	0.000
Error	39	41.723	1.070	-	-
Total	51	765.642	-	-	-

Germination value

Source	**DF**	**SS**	**MS**	**F**	**P**
Treatment	12	13526.3	1127.2	40.54	0.000
Error	39	1084.3	27.8	-	-
Total	51	14610.7	-	-	-

Germination percentage

Source	**DF**	**SS**	**MS**	**F**	**P**
Treatment	2	9698.7	4849.3	79.07	0.000

Error	9	552.0	61.3	-	-
Total	11	10250.7	-	-	-
MGT Mean Germination time					
Source	**DF**	**SS**	**MS**	**F**	**P**
Treatment	2	199.877	99.939	54.22	0.000
Error	9	16.588	1.843	-	-
Total	11	216.65	-	-	-
Germination value 'Gv'					
Source	**DF**	**SS**	**MS**	**F**	**P**
Treatment	2	3444.9	1672.4	43.86	0.000
Error	9	343.2	38.1	-	-
Total	11	3688.1	-	-	-

Appendix-II

Analysis of variance (Balanced Designs)

Analysis of variance for germination (reduced) – Table 5.

Source	**DF**	**SS**	**MS**	**F**	**P**
Medium used	1	120.33	120.33	36.84	0.000
Error	10	32.67	3.27	-	-
Total	11	153.00	-	-	-
Survival					

Source	**DF**	**SS**	**MS**	**F**	**P**
Medium used	1	3332.7	3332.7	61.09	0.000
Error	10	545.5	54.6	-	-
Total	11	3878.2	-	-	-
Average plant height					
Source	**DF**	**SS**	**MS**	**F**	**P**
Medium used	1	3065.6	3065.6	1192.22	0.000
Error	10	25.7	2.6	-	-
Total	11	3091.3	-	-	-
Average collar diameter					
Source	**DF**	**SS**	**MS**	**F**	**P**
Medium used	1	0.11603	0.11603	497.29	0.000
Error	10	0.00233	0.0023	-	-
Total	11	0.11837	-	-	-

Appendix-II

Analysis of variance (Balanced Designs)

Analysis of variance for rooting percentage – Table 6.

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	4	366.06	91.51	1.30	0.282
Treatment	15	5387.87	359.19	5.09	0.000
Error	60	4236.98	70.62	-	-
Total	79	9990.91	-	-	-

Average number

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	4	2.075	0.519	0.11	0.977
Treatment	15	749.550	49.970	10.93	0.000
Error	60	274.325	4.572	-	-
Total	79	1025.950	-	-	-

Average root length

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	4	394.0	98.5	1.69	0.164

Treatment	15	21203.1	1413.5	24.23	0.000
Error	60	3500.4	58.3	-	-
Total	79	25097.5	-	-	-

Appendix-II

Analysis of variance (Balanced Designs)

Analysis of variance for Average plant height – Table 7.

Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	4	9450	2362	2.10	0.092
Treatment	15	74170	4945	4.40	0.000

Error	60	67499	1125	-	-
Total	79	15119	-	-	-
Average collar diameter					
Source	**DF**	**SS**	**MS**	**F**	**P**
Replication	4	0.46509	0.11627	1.75	0.151
Treatment	15	3.39068	0.22605	3.40	0.000
Error	60	3.99003	0.6650	-	-
Total	79	7.84580	-	-	-

						Annexure-I	
1.	Name		Block		Village		Site
2.	Name of household with parentage:				_____		
3.	Total land holding of household:				_____		
4.	Income of household from land holdings?				_____		
5.	Do you grow elm? (Yes/No):				_____		
6.	No. of elm trees owned:				_____		
7.	Type of plantation: (Block/ Boundary / Canal etc.)				_____		
8.	Purpose of growing elm trees: (Commercial / Household / other):				_____		
9.	Approximate income generated from elm:				_____		
10.	Any problem in growing elm tree?				_____		
11.	Do you want to grow more of these trees?				_____		
12.	Any information pertaining to Elm during the course of survey				_____		

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***Original not seen**