

SYSTEMATICS AND PROPAGATION OF SOME ECONOMICALLY IMPORTANT SHRUBS OF HIMACHAL PRADESH

THESIS

By

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Submitted in partial fulfilment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

In

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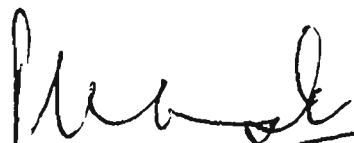
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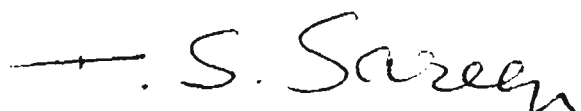
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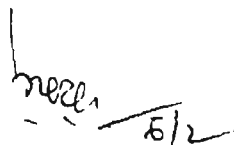
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(RAJESH UPPAL)

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Chapter-I

INTRODUCTION

Amongst the problems that require immediate attention in India are those of energy and environment. As far as the rural scenario of India is concerned, the two are immediately inter-linked, because of environmental degradation which is to a large extent the result of utilization of biomass for domestic energy consumption. In fact over 50 per cent of the fuel is consumed in India for cooking (Anonymous,1980). Wood is the principal source of fuel accounting for 68.5 per cent of the country's requirement. The firewood demand is presently about 125 m t per annum. It is expected to rise to about 350 to 375 m t by the end of the century (Patel,1987). The demand of wood for fuel and as the raw material in industry has been responsible for the large scale deforestation that the country has witnessed.

The LANDSAT - imagery interpretations undertaken by the National Remote Sensing Agency at Hyderabad have shown that the total area under good forest cover i.e., forest with a density of 10 per cent decreased from 55 m ha to 46 m ha between 1972 and 1982. Approximately 1.3 m ha of forest disappear every year. Today, the total areas under forest cover in India is less than 13 per cent against the desired cover of about 33 per cent. In order to stop the destruction of forest and yet meet the energy needs of the poor, it would be necessary to undertake production of biomass on a massive scale. It is estimated that plantation of fast

growing trees on about 1000 ha of land will provide enough wood to generate 3 MW of power and provide enough firewood for 125 to 150 families. The total area afforested between 1950-1980 was between 3.5-3.7 m ha but the survival rate is not known. The prime need of the day is to undertake extensive plantation on wastelands. The planning commission expects to bring nearly 70 m ha of land under additional forest cover by 2000 A.D. In view of our timber requirements another 15 m ha will have to be reforested.

The National Forest Policy lays down that in plains 33 per cent and in hilly areas 60 per cent of the total geographic area should be under forest. Whereas the area under forest is 22.8 per cent for the country and is only 38.2 per cent in Himachal Pradesh (Anonymous, 1988). Huge tracts of the Himalayan state have been encroached upon or turned into wastelands and the process is still continuing at a disastrous pace. The destruction of forest ecosystem is resulting in severe soil erosion, floods, landslides, receding of glaciers. The increased runoff lead to less infiltration, reduced ground water levels, resulting in drying up of water resources, ultimately upsetting not only the economy of hill state but also disturbing the agricultural production in plains due to floods and other climatic vagaries.

The various factors contributing towards large scale denudation of hills in Western Himalaya are, the over

exploitation of fuel (Singh,1982), fodder and packing material from forests. Average per capita consumption of fuelwood in Himachal Pradesh is 0.6 per cent per year, amounting to a total of 2.3 m t per annum (Singh,1982) as against a prescribed yield of 0.7 m m^3 from the forests covered by working plans. The area under green fodder is too scanty, contributing 0.6 per cent of the total area under agriculture in the state. Till date wood as a raw material was used in packing horticultural produce, particularly apple in Himachal Pradesh. Recently cardboard boxes and eucalyptus wood coming from plains of Punjab and Haryana has partially substituted the above source as Himachal government has put a complete moratorium on felling of trees. Apple production with compound growth rate of 16.9 per cent (Singh,1983) is a land mark in state's economy. It is estimated that in Himachal Pradesh, the wood worth of 20 m boxes equivalent to 0.2 m m^3 is axed every year for packing of apple, other fruits and vegetables (Stokes,1983). This raw material came from softwoods with a rotation of more than 100 years like silver fir, spruce and pines. The production statistics may aggravate the situation in future as it is envisaged that by the dawn the century the apple production is expected to a twice that of 1983. If we do not discard our dependence for packaging material without restocking them with fast growing species, the severe ecological disaster of the Himalayan region is imminent.

It has been observed that mostly sclerophyllus shrubs

and trees are pioneer species which colonise or hold ground on degraded lands is an indication of nature's resistance to prevent degradation, thereby providing us an information on how to cope up with the situation. The sclerophyllous nature of the shrubs helps them to withstand drought, frost, fire and survive in extremities, as most of these species are non-exacting and nutrient requirement of these shrubs is low, besides elevated root shoot ratio makes these species suitable for restoration of vegetal cover on denuded hills.

The shrubs due to their hardiness to frost and drought, resistant to pests and diseases, make them more adaptable to their habitat. There is a huge number of shrubs in sub-Himalayan tract which are not only helpful as soil binder but can provide a plentiful of fuelwood and fodder to the local people hence ameliorate the economic status. These shrubs are also valued for their medicinal properties, therefore, it is a pre-requisite to make these shrubs an integral part of the programme of eco-development and management of watersheds. However, the basic priority in planting shrubs should remain a step towards restoring green cover and subsequently to create favourable conditions for the growth of trees by improving the site. The useful shrubs also have an impact on agriculture, as these shrubs strengthen the field bunds, check the runoff rate, maintain soil fertility conserve soil, thereby augment economy.

The planting of trees is labour intensive, their life

span is very long in comparison to shrubs, therefore, the farmers are reluctant to use these species as a supplement to their domestic requirements (Purohit, 1987). Add to it, tree growth is difficult on the rocky, barren and severely eroded areas, in the initial stages. The growth of shrubby stratum will create favourable environmental conditions for tree growth by way of conserving moisture, increasing soil fertility, developing soil flora and fauna, protect tender natural regeneration from natural calamities. The primary objective of forest cover is to have maximum beneficial effects on watersheds. Therefore, the incorporation of soil binding grasses, climbers and shrubs is of utmost importance to expedite land stabilization (Chauhan, 1984).

No serious attempts have been made to exploit shrubby flora for ecological restoration, even their role in rural economy for providing fodder and fuel has not been highlighted. Similarly, there is no comprehensive literature available on the systematics of shrubby flora of Himachal Pradesh. There is also very scanty literature available on their propagation techniques. The study of shrubs did not receive the required attention of scientists and were considered weeds by foresters. But in highly degraded ecological conditions for providing fuelwood and fodder requirements, their role in ecological rehabilitation of wastelands particularly on inclined slopes has an edge over tree planting. Hence we should treat shrubs as provider

but not as weeds. The present investigations entitled, "Systematics and propagation of some important shrubs of Himachal Pradesh" were proposed to be undertaken with following objectives:

- 1) to survey and compile shrubby flora of Himachal Pradesh
- 2) to determine the germination percentage and seed viability in response to various treatments and
- 3) to determine the optimum time for propagation of different species by stem cuttings with or without hormonal use under field and mist chamber conditions.

Chapter-II

REVIEW OF LITERATURE

Himachal Pradesh presents a varied topography, soil geology, climate and has a rich and diversified flora. An authentic records of botanical collections have been made by Chaudhary and Wadhawa (1984). They stated that the earliest attempt to collect plants from Himachal Pradesh was made by William Moorcroft (1725-1825), who collected plants from Kangra, Kullu and Lahaul & Spiti way back in 1921.

The countess of Dalhousie was the first person to collect plants from Shimla in 1829. She collected about 600 species. Dr J P Royal (1800-1858) made extensive collections in Bashahr, Kinnaur and Shimla around 1830. Victor Jacquemont, a French botanist visited the region of Kinnaur and Shimla around 1830. In 1844, General Walker and his wife made collections from Shimla. Others who collected in and around Shimla and contributed to Sir William Hooker's herbarium were Colonel Munro (1818-1880), Lt Colonel Edward Madden (1805-1856), J P Winterbottom (1803-1854) & Richard Strachey (1817-1908).

Michael Pakenham, Edgeworth, the first ecologist of India, collected plants from Himachal Pradesh. Lord William Hay and Lance collected plants from different places of Himachal Pradesh. R.S. Simpson made collections from Shimla in 1847. William Hawtayne made collections from Mandi and Kullu during the same year. James William Grant made collection from Kinnaur in 1850. Sir Henry collected plants

from Shimla and its neighbouring areas in 1877. Brandis made collections from Bashahr and other areas in 1881. J.F. Duthie (1845-1922) made collection trips to different areas in Himachal Pradesh.

In 1982, Bhattacharya and Uniyal mentioned 325 species of flowering plants and ferns in Pangi and Triloknath in Chamba. A few papers are also available on economic plants of Lahaul & Spiti (Singh, 1956; Sarin, 1967 and Arora et al., 1980).

Chaudhary and Wadhawa (1984) have enumerated 3000 species of Himachal Pradesh. Similarly, Aswal and Mehrotra (1985) have given an account of approximately 1000 species of flowering plants of which 40 species have been reported new to Himachal Pradesh.

Maithani et al. (1986) have given the account of species like Woodfordia, Buddleia, Desmodium, Carissa, etc. They opines that these species which are colonising or holding the ground on degraded lands have the capacity to restore greenery of natural wasteland, besides, this they have also categorised the species according to their relative importance as fuel or fodder etc.

Sharma and Chauhan (1987) published an account of approximately 60 species of Himachal Pradesh giving their distribution, uses and mode of propagation.

In order to restore the greenery, it is of utmost importance to have an information about propagation techniques.

PROPAGATION STUDIES

Studies pertaining to propagation through seed and stem cuttings of shrubs are scanty. On account of this, different aspects related to propagation have been revived by citing examples from other arboreal species.

Propagation through seed

Seed is the most common means of propagation for self-pollinated plants and is also extensively used for many cross-pollinated plants and is often the only possible method of propagation. Most seem to present no special problem in germination and come out when sown at appropriate season.

Seeds of Carissa opaca germinate as early as March, but in this case seedlings die of drought in subsequent hot weather. Its seeds mostly germinate during rainy season. The seeds of this species have good power of penetrating grass and weed growth but succumb to excessive dampness (Troup, 1921). He also reported that natural and artificial reproduction of Cordia could be obtained by seed. The seeds germinate during the rainy season in which they fall and the seeds of Murraya koenigii germinate freely without any difficulty under partial shade soon after falling down from the plant after maturity.

Although many species do not pose any problem in germination, but the success of massive programme depends on the availability of the quality seed in desired quantity. The procurement of seeds in large quantity is entirely dependent on bearing behaviour of species. A new species bears fruit/seeds fairly regularly while others do so at an interval of one or several years. The seeds/fruits, which mature simultaneously are easy to harvest while which are of intermittent type and mature over a long interval makes the harvesting operation difficult and expensive (Maithani et al., 1989).

Seeds of many woody plant species from temperate zone do not germinate properly when placed under conditions which are normally regarded as suitable for germination, termed as dormant.

Seed dormancy in general aids the survival of wild plant population by preventing out season emergence and by spreading germination over weeks or even by years, thereby increasing the opportunities for successful seedling establishment. In contrast, the same phenomenon pose a problem to nursery operator, attempting to produce large uniform crop of seedlings.

The medium which retard germination vary rapidly, so dormancy is rather a relative term. It describes conditions which results both from inherited properties and conditions imposed by environment. It may vary in degree within a

species (Row,1982) depending on differences between individuals in Acer compestris location in Acer saccharum (Wang,1987).

Seed dormancy has been attributed to one or more reasons namely hard and impervious seed coat (Barton,1965 and Row,1982), immature embryo (Nikolaeva,1969 and Villiers, 1972), after ripening requirements (Barton,1965), inhibitor and germination stimulators (Evenari,1949), sensitivity to light (Flint and Mcalister,1937; Nagao et al.,1959).

These factors can be counter acted by soaking seeds in water for a specified period (Kemp,1975; Hartman and Kester,1976; Bowen and Eusibio,1981 and Sheikh,1980). According to their opinion seed soaking in water makes it permeable to water and gases and remove inhibitors. Many chemicals such as GA_3 , citric acid, etc. have been tried by various workers in Eucalyptus spp. by Bachelard (1967), in Pistacia integerrima by Dahab et al. (1978), in Nothophagus spp. by Gordon (1979) and Shafiq (1980), and in Tilia by Yang (1983).

Scarification which is a process of breaking of dormancy by mechanical alteration of seed coat, in order to make it permeable to water and gases. The scarification can either be done mechanically or by means of chemical (Hartmann and Kester,1976).

The purpose of mechanical scarification is to modify

the hard impervious seed coat by sand paper, cutting with file, cracking the seed with the help of hammer or by specifically designed scarifiers (Hartmann and Kester, 1976). Acid scarification (H_2SO_4) is another mean of breaking dormancy (Koo ~~bat~~ tion, 1954; Kemp, 1975; Hartmann and Kester, 1976).

Propagation by stem cuttings

Many woody plants are difficult to propagate sexually by conventional seeding methods due to difficulty in breaking dormancy, poor germination, slow seedling growth and lack of uniformity among progenies.

Asexual propagation by cuttings ensure perpetuation of desirable traits, true-to-type, allows production of larger plants, shorter production cycle. With the advent of synthetic auxins, intermittent mist, cuttings have become the easiest and most desirable method of propagating woody species.

The first scientific paper on rooting was, however, published by Dah mel du Monceau over two centuries ago in 1758, while the first root promoting substance was postulated by famous botanist, Sachs (1882). Zimmerman and Wilcoxon (1935) were first to use chemicals that induce rooting, since then a variety of growth regulators like indole acetic acid, indole butyric acid, naphthalene acetic acid and indole propionic acid have been widely used for

inducing rooting of stem cuttings of many plants species (Zimmerman and Wilcoxon,1935 and Sen and Bose,1966).

However, many workers (Dikshit,1956; Singh,1956 and Sircar,1971) have reported that IBA was found to be more effective in inducing rooting than other growth regulators due to non-toxicity over a wide range of concentration and its wide adaptability.

According to Nanda (1975) auxin initiates cell division and elongation of meristematic tissue, differentiation of cambial initials into root primordia and the mobilization of reserve food material by enhancing the activity of hydrolyzing enzymes.

Auxin is a root promoter but there are certain species which do not root even with the application of auxin (Pearse, 1939; Hatcher and Gasner,1947; Tyce,1957) and do not have any impact on species which can root easily (Bialobok and Jankiewicz,1957). A lot of species exist in forests which can be categorised (Nanda,1970) as easy to root, difficult to root and obstinate to root.

According to Maini (1968), Chandra and Khushdil (1977), Chandra (1978), Puri and Shamet (1988), Magnolia grandiflora, Populus spp., Leucaena leucocephala and Salix are a few species which are easy-to-root, while Grewia optiva, Celtis australis, Robinia pseudacacia, Abies pindrow, Cedrus deodara and Pinus gerardiana are difficult-to-root (Gupta and Chandra,

1979 and Puri and Shamet, 1988), but can be counteracted with the application of appropriate hormonal dose of IBA.

A large number of workers all the world over have successfully experimented over vegetative propagation by using various techniques like use of auxin, tissue culture, etc. in different species, viz., Albizzia leucida (Purkayastha and Kumar, 1973), Acacia sp. (Harsh and Muthana, 1985), Celtis (Jauhari and Rehman, 1959), Juniperus communis (Hinesley and Blazich, 1980), Pinus spp. (Libby and Conkle, 1966; Barry and Sachs, 1968; Lepisto, 1972; Kormainik and Brown, 1973; Bhatnagar, 1977; Hassig, 1983) and Populus spp. (Seth and DeSarkar, 1960; Seth, 1969; Mathur, 1972; Ragonese et al., 1973).

Success in propagation is influenced by optimum concentration of growth regulator, form and kind of regulators, kind of carriers, age of the plant and the species of the plants (Lek, 1925; Stoutemyer, 1937; Nanda, 1970). Several reviews on the effectiveness of different synthetic growth substances on the induction of rooting have been published (Hartman and Kester, 1983; Nanda and Kochar, 1985).

Season or time of the year when cuttings were taken and planted have a considerable influence on rooting. In deciduous species, hardwood cuttings root better during growing season. The seasonal changes in rooting response of stem cuttings have been ascribed to either change in food farming substances or due to physiological status of the plant or to changes in endogenous content of growth

substances (Nanda and Jain,1971; Nanda and Kochar,1985; Hartmann and Kester,1986).

An increased biosynthesis of auxins in active season and decreased level of inhibitory substances and morpho-physiological conditions of the plant are the major decisive factors for rooting (Fadl and Hartmann,1967; Nanda,1970). The differential response of rooting in stem cuttings, which is attributed to growth phase has been confirmed by various workers. According to Marygina (1968), if the stem cuttings of Picea are taken from mother plants in early spring before bud break or in mid summer after cessation of extension growth, there was an appreciable increase in rooting, while Vitez and Penait (1968) were of the opinion that active growth period is best suited for highest percentage of rooting. Roberts and Fuchigaini (1973) recommended February-March as the best season for Douglas fir.

John (1979) reported summer as the best season for rooting of Larix. Jobling (1981) was of the opinion that in broadleaved species, cuttings taken early in the season, planted in vermaculite and peat usually root better in comparison to other seasons. Chauhan and Sehgal (1982) observed that season plays a pivotal role in rooting of stem cuttings of Grewia optiva, Cordia spp. and Morus alba. Fraysee et al.(1984) found summer as best season for balsam poplar, spring for Pinus taeda (Cunnigham and Buijtenen,1983), rainy season for rooting of willows (Fraysee et al.,1984),

while Raina et al.(1987) observed better rooting percentage in stem cuttings processed during summer months of the year, while according to Kwon et al.(1987) two years old cuttings of Pinus, Abies and Quercus gives a success in rooting upto 92, 97 and 84 per cent respectively, in appropriate season. The time of planting influences the rooting behaviour. Smith (1984) observed July-August as the best and January the worst for Nerium indicum.

Propagation under intermittent mist

One of the chief problems encountered in plant propagation by cuttings is to keep them in wet conditions until the roots are formed. In past, this was accomplished by keeping relative humidity of surrounding air at a high level (Raines,1940 and Gardner,1941).

Langhans (1955) conducted that water spray under high pressure reduces rate of transpiration without altering the rate of photosynthesis by keeping the relative humidity high and leaf temperature low. This technique enables easy rooting of those plants which were previously considered difficult-to-root. In addition, intermittent mist will keep slow rooting cuttings alive for longer period, giving them chance to root before they die of desiccation (Stoutemyer,1942; Tinga et al.,1963; Streitberg,1967; Hartmann and Kester,1976).

Intermittent mist has an advantage over continuous

misting as relatively less water is used under intermittent mist and the temperature of the rooting media does not go beyond safe limits (Hess and Snyder, 1955).

There was a loss of nutrients from the older tissues under leaching action of mist. It was, therefore, suggested that little amount of nutrient water to be added to replenish these lost nutrients (Wott and Tukey, 1960), Tukey (1978) did extensive work on mist propagation and concluded that the effect of mist is similar to that of rains, dew and fog on plants growing in natural environment.

Parkerson (1983) observed that a wide range of broad-leaved and coniferous species rooted successfully under mist. Puri and Shamet (1988) have also stressed the importance of phytoenvironment, particularly that of high humidity for proper rooting of cuttings.

(Bahuguna et al. (1988) reported successful rooting in Woodfordia fruticosa under mist conditions. Kanwar reported 95, 70 and 70 per cent rooting in Adhatoda vasica, Robinia pseudacacia and Grewia optiva, respectively.)

(A significant increase in per cent success in rooting in Jasminum sambac was noticed by Pappiah and Muthuswamy (1979) under intermittent mist which were treated with 2000 ppm of IAA.) Shamet et al. (1989) found that cuttings of Celtis australis and Punica granatum rooted successfully by pre-planting treatment of IBA 2000 ppm.

Chapter-III

MATERIAL AND METHODS

1. A SYSTEMATIC ACCOUNT OF SHRUBBY FLORA OF HIMACHAL PRADESH

1.1 Area surveyed

1.1.1 Geography

The present studies were conducted in Himachal Pradesh. It is situated between latitude 30° - $30'$ and 33° - $10'N$ and longitude 75° - $30'$ and $79^{\circ}E$.

The physiography of Himachal Pradesh is characterised by hilly terrain. Areas adjoining Punjab border are comparatively plain which include some parts of Kangra and Una districts and some areas of Nalagarh Tehsil of Solan district. Elevation increases from southwest to north-east in Himachal Pradesh. The region reflects an intricate mosaic of mountain ranges, hills and valleys. The glaciated and snow capped peaks are prominent features. The Dhauladhar range looks in supreme majesty over Kangra valley, while Pir Panjal, the Greater Himalaya and Zaskar ranges, stand guard over Chamba, Lahaul & Spiti, Kullu and Kinnaur. The mountainous slopes are rich in forest and meadows.

1.1.2 Climate

Due to variation in elevation climatic conditions are also variable in the state varying from hot to sub-humid tropical in the southwest to temperate, alpine and glacial in northern and eastern high mountains. Frequency of rainfall

decreases as we move from west to east and south to north east. Maximum rainfall is recorded at Dharamshala in Kangra district and minimum in Lahaul & Spiti district. Temperature also decreases while moving from west to east. Maximum temperature is received in some parts of Una adjoining Punjab boundary. In winter, areas having higher elevation receive precipitation in kind of snow.

1.1.3 Soils

The soils of this region are the result of climatic factors and geomorphic processes aided by geolithology. On the whole, the soils are young and thin and any depth in them whatever occurs is in the valleys or on gentle slopes. The soil vary between high base status soils of humid region and shallow, black, brown and alluvial soils found mainly in northern parts of Chamba district, southern parts of Lahaul & Spiti, central part of Kinnaur district, central and eastern parts of Shimla district, southern and eastern parts of Sirmour district, eastern half of Bilaspur district, southern Mandi and Kullu districts and northern tip of Solan district and adjoining parts of Shimla districts. Sandy soil, red loamy, red sandy, alluvial and soils of arid region with some development are also present. Mostly these soils are found in north western and south eastern tip of Kinnaur district. It covers the south western Chamba district, most of Kangra, Solan and Hamirpur districts, north western Mandi, northern half of Bilaspur district and south western Shimla districts.

The soils are similar to Tarai soils of humid region which are mainly confined to north eastern tip of Chamba district and northern parts of Lahaul & Spiti district except for north eastern tip.

The glaciers and snow cap soils are found in very high altitudes in north western, north eastern and south western parts of Lahaul & Spiti district, northern tip of Shimla district and certain parts of Kullu district.

1.2 Zonal floristics of shrubs of Himalayan Himachal Pradesh

The area under present investigations ranges upto an altitude of 4800 m and constitutes a lofty chains of mountains, traversed by a series of ridges, brooks, forest communities, alpine pastures, valleys and terraced field. The shrubby flora of Himachal Pradesh can be classified under four zones as given below:

1.2.1 Sub-montane and low hills sub-tropical

The prevalent shrubs are: Dodonea viscosa Linn., Carrisa carandas Linn., Zizyphus spp., Vitex negundo Linn., Berberis lycium Royle., Woodfordia fruticosa Kurz., Indigofera dosua Buch-Ham., Leptodermis lanceolata, Debregeasia hypoleuca Wedd., Prinsepia utilis Royle., Clerodendron spp., Zanthoxylum armatum Roxb. etc.

1.2.2 Mid hills sub-humid

Important shrubs and climbers associated with this

region include: Vitex negundo Linn., Indigofera pulchella Roxb., Berberis aristata DC., Hypericum perforatum Linn., Prinsepia utilis Royle., Desmodium tiliariaefolium D.Don., Carissa spp., Zizyphus spp., Elaeagnus parvifolia Wall., Capparis spinosa Linn., Plectranthus rugosus Wall., Elsholtzia spp., Rubus spp., Spiraea canescens D Don., Lonicera quinquelocularis Hardw., L. angustifolia Wall. ex DC., Viburnum nervosum Don., V. cotinifolium Don., Daphne papyracea Wall.ex Steud., Sarcococca spp., Rosa moschata Mill., Jasminum officinale Linn., J. humile Linn.

1.2.3 High hills temperate moist

The shrubs frequently growing in this region include: Lonicera quinquelocularis Hardw., L. purpurascens, Viburnum nervosum, Berberis aristata DC., Rosa macrophylla Lindl., R. sericea Lindl., Hypericum oblongifolium Linn., Indigofera pulchella Roxb., Skimmia laureola, Zanthoxylum armatum Roxb., Woodfordia fruticosa Kurz., Flacourtia indica Roxb., Desmodium spp., Carissa carandas Linn., etc.

1.2.4 High hills temperate dry zone

The vegetation in this zone is chiefly composed of shrubs like: Desmodium tiliariaefolium Don., Berberis aristata DC., Hippophae salicifolia Don., H. tibetana Don., Rubus spp., Indigofera gerardiana Wall.ex Baker, Spiraea spp., Sorbaria tomentosa (Lindl.)Rehd., Lonicera spp., etc.

1.3 Specimen collection

Each plant was observed for taxonomic description during three phenophases namely: once during flowering, seeding and the emergence of new leaves, buds during active vegetative growth. Also the seasonal changes in plant as to evergreen or deciduous were studied by visiting the sites during three main seasons viz., winter, summer and rainy. Six field visits were made at each location in a year. The data (samples) were collected for two years starting from 1988 and through 1989.

The present work is in continuation of the earlier collection of Shri N S Chauhan submitted to the Herbarium, Department of Forest Biology and Tree Improvement, University of Horticulture and Forestry, Solan. Add to it, in the present collection of 82 species, not included earlier were taken into account with a view to have a complete record about the shrubby flora of the state, the related information as available in: The Wealth of India (CSIR, New Delhi, 1976); Flora of Himachal Pradesh (Chaudhary and Wadhwa Vol. I, II and III, 1984); Flora of Bashahr Himalayas (Nair, 1977), Flora of British India (Hooker, 1875); Flora Simlensis (Collett, 1902) were also incorporated in the text. However, the propagation studies were carried out only in 24 species:

1. Woodfordia fruticosa Kurz.
2. Murraya koenigii Spreng.
3. Prinsepia utilis Royle.

4. Zizyphus oxyphylla Edgew.
5. Carissa carandas Linn.
6. Adhatoda vasica Nees.
7. Rosa moschata Mill.
8. Jasminum officinale Linn.
9. Berberis lycium Royle
10. B. aristata DC.
11. Zanthoxylum armatum Roxb.
12. Indigofera pulchella Roxb.
13. Nerium indicum Mill.
14. Rubus niveus Wall.
15. Debregeasia hypoleuca Wedd.
16. Lonicera quinquelocularis Hardw.
17. Plectranthus rugosus Wall.
18. Coriaria nepalensis Wall.
19. Dodonaea viscosa Linn.
20. Spiraea canescens Don.
21. Elaeagnus parvifolia Wall.
22. Viburnum nervosum Don.
23. Desmodium tiliaefolium Don.
24. Vitex negundo Linn.

Voucher specimens were collected and preserved as per the standard procedure given by Santapau (1955). These have been deposited in the Herbarium of the Department of Forest Biology and Tree Improvement of the Dr Y S Parmar University of Horticulture and forestry, Solan, HP, India.

2. PROPAGATION STUDIES

2.1 Propagation by seed

2.1.1 Collection of seed

Seeds were collected from ripened fruits which were dried in sun for 10-15 days for early extraction of seed and to protect them from fungal infection.

2.1.2 Viability of seed

The tetrazolium chloride test (Agarwal, 1980) was used to assess the viability of seeds. A representative sample of 100 seeds was drawn from a lot of $\frac{1}{2}$ kg seed collected for each species by thoroughly mixing and by using spoon. The seed was conditioned by keeping the seed sample overnight on moist blotting paper. Bisecting of seed was done while the seed is still on paper by cutting the seed laterally with a sharp razor blade, then the excised embryo end was placed in tetrazolium chloride solution and placed on a slide with a camel hair brush.

1. Preparation of solutions

a) **Tetrazolium solution:** One per cent solution of tetrazolium chloride was made and the pH of the solution for making dilution was in the range of 6-8.

b) **Lactophenol solution:** It was used for clearing grasses such as blue grass and timothy grass after staining to judge the

behaviour of embryo. The solution was prepared by mixing lactic acid, phenol, glycerine and water in the ratio of 1:2:1, respectively.

2. **Staining:** The prepared seeds were placed in a suitable container at a temperature of $40 \pm 2^{\circ}\text{C}$ for 4 h, when the sample had attained sufficient staining, the tetrazolium solution was discarded.
3. **Evaluation of samples:** The seeds were examined under microscope and the following parameters were observed:
 - i) A germinable seed is one in which embryo was lightly stained with a well defined outline and
 - ii) In which embryo was missing or unstained was considered as dead or non-germinable seed.

2.1.3 Effect of pre-sowing treatments on seed germination

The experiment was conducted to determine the per cent germination of seed. The following set of treatments were performed for the evaluation of germination percentage both under mist and field conditions:

Treatments

T_1 = Simple water

T_2 = Cold water for 24 h

T_3 = Cold water for 48 h

T_4 = GA_3 (100 ppm) for 24 h

T_5 = Sulphuric acid (for seeds with hard seed coat)

1. **Cold water soaking:** The seeds were soaked in cold water at $5^{\circ}C$ for 24 h (T_2) and 48 h (T_3). The wet seeds were dried between the folds of filter paper and sown in polythene bags and in nursery.
2. **GA_3 treatment:** The seeds were soaked in GA_3 solution (100 ppm) by dipping them for 24 h, then washed in running tap water until the seed is free from hormone. GA_3 solution was prepared by dissolving the requisite quantity of chemical in small amount of 45 per cent ethyl alcohol and then made to desired volume by adding distilled water.
3. **Acid treatment:** The seeds were pre-treated with concentrated sulphuric acid for 20 min. The quantity of acid used for the treatment was about 10 times the volume of seed. Seeds were thoroughly washed in water for two hours to make them acid free and then the excess of moisture was removed by holding the seed between two papers of filter paper.

2.1.4 Selection of site and preparation of nursery beds

A good sunny site with sandy loam soil was selected for

sowing seed in the field. Fields were prepared by deep soil working 2-3 times, sieving the soil and adding good amount of compost and sand. Each bed was $1 \times 1 \text{ m}^2$ in size.

2.2 Propagation by stem cuttings

The experiment was performed both under field and mist conditions by following a treatment schedule with the below mentioned hormones and specified concentrations.

2.2.1 Treatments

a)	Control	distilled water
b)	IBA	500, 1000 and 2000 ppm
c)	IAA	500, 1000 and 2000 ppm
d)	NAA	500, 1000 and 2000 ppm
e)	Months of planting	March(spring); June(rainy) and October(winter)

1. **Preparation of stem cuttings:** Cuttings were taken from 10 randomly selected young shrubs of comparable vigour. Cuttings of 20-25 cm length and 0.75-1.0 cm in diameter with at least 2-3 nodes were procured from fully matured one year old healthy shoots of selected mother plants. The severed cuttings were immediately coated with synthetic wax on both the ends and all the leaves and branches were severed simultaneously and the wax on all the exposed surfaces was applied with budding knife to prevent moisture loss. Further these cuttings were packed by embedding them in

spagnum moss and later in a gunny bag and moistened the pack adequately. Within 36 h after collection, the cuttings were inserted in polythene bags either in the mist chamber or in the field. The cuttings were given an upper slanting cut and were subjected to various chemical treatments by treating at lower end in liquid medium as mentioned above.

The cuttings were divided into three groups according to their diameter. In every treatment there were three replications with 10 cuttings each. The cuttings were then tagged.

2. **Preparation of IAA, IBA and NAA solution:** The solutions were prepared by dissolving a weighed quantity of chemicals in small amount of alcohol. The required volume was made by adding a known quantity of distilled water to prepare stock solution. The stock solution was further diluted to desired concentrations. Fresh stock solution was used every time.

3. **Treatment of cuttings:** The cuttings were treated with different growth promoting substances by quick dip method for 5 seconds. The solution of different concentrations were poured in plastic containers and cuttings were dipped in solution upto 3-5 cm depth. After this they were taken

to the field immediately for planting.

2.2.2 Selection of site and preparation of nursery beds

A sunny site, with sandy loam soil was selected for field planting of cuttings. Beds were prepared by soil working, 2-3 times, 10 kg of compost was added per bed and homogenous nursery beds of 3x3 m were made.

2.2.3 Planting of stem cuttings

The treated cuttings were planted 5-7 cm deep with the help of planter and spaced at a distance of 10 cm in rows with 15 cm apart. There were 10 cuttings in each replication and 30 in each treatment. The cuttings were lightly watered regularly thrice a day.

The per cent success in rooting was recorded 90 days after planting.

2.2.4 Mist planting

The mist propagation experiments were conducted in 'Mist Chamber' designed and built at the Dr Y S Parmar University of Horticulture and Forestry, Solan. This mist chamber had all automatically regulated systems for environmental control.

Mist frequency was regulated by Phytotimer Model ETOZ. Moisture film was controlled by Model ME 002. Air and bed temperature controlling devices were AT 002 and ST 002 models,

respectively. A potentiometer was used in both the cases for coarse and fine adjustments.

Polythene bags of 6x12 cm filled with river bed sand which served as a rooting medium was used for planting of cuttings. The cuttings were inserted at a depth of 5-7 cm. There were 30 cuttings in each treatment like in field trials.

The cuttings were kept in a mist cycle of 5 seconds, after a lapse of 5 minutes. The bed temperature was maintained at $25^{\circ} \pm 2^{\circ}\text{C}$. The relative humidity was maintained between 70-80 per cent throughout the experimental trial.

STATISTICAL ANALYSIS

The data recorded for different parameters were subjected to appropriate statistical analysis as per the procedure given by Cochran and Cox (1970).

Chapter-IV

EXPERIMENTAL RESULTS

PROPAGATION STUDIES

These are dealt with as follows:

1. Propagation through seeds

1.1 Viability of seeds

The tetrazolium chloride test was used to determine the viability of seeds of various species.

It is evident from Table 1 that the viability of seed varied from 76.5 to 98.0 being lowest in Zanthoxylum armatum and highest in Murraya koenigii.

1.2 Effect of pre-sowing treatment

The results pertaining to per cent success in germination of seeds of species mentioned earlier under mist and field conditions are presented in Tables 2 and 3.

Specieswise performance is as follows:

Woodfordia fruticosa Kurz.

The data reveals that T_2 and T_3 treatments were statistically at par with each other. Only in case of T_4 the germination percentage was significantly more. The same phenomena was true also under field conditions.

The range of mean maximum and minimum values of per cent germination varied from 95.67 to 70.28 and 63.00 to

TABLE 1. Viability of Seeds accessed by tetrazolium chloride Test

Species	Total No of seeds	Seeds strained	Percent Viabilily
<u>Woodfordia fruticosa</u> Kurz.	200	194	97.0
<u>Murraya koenigeei</u> Royle	200	196	98.0
<u>Prinsepia utilis</u> Royle	200	191	95.5
<u>Zizyphus oxyphylla</u> Edgw.	200	189	94.5
<u>Carissa carandas</u> Linn.	200	184	92.0
<u>Adhatoda vasica</u> Nees.	200	186	93.0
<u>Rosa moschata</u> Mill.	200	182	91.0
<u>Jasminum officinale</u> Linn.	200	181	90.5
<u>Berberis lycium</u> Royle	200	172	86.0
<u>Berberis aristata</u> DC.	200	171	85.0
<u>Zanthoxylum armatum</u> Roxb.	200	153	76.5
<u>Indigofera pulchella</u> Roxb.	200	193	96.5
<u>Nerium indicum</u> Mill.	200	123	86.5
<u>Rubus niveus</u> Wall.	200	164	82.0
<u>Debregeasia hypoleuca</u> Wedd.	200	172	86.0
<u>Lonicera quinquelocularis</u> Hardw.	200	184	92.0
<u>Plectranthus rugosus</u> Wall.	200	156	78.0
<u>Coriaria nepalensis</u> Wall.	200	193	96.5
<u>Dodonaea viscosa</u> Linn.	200	185	92.5
<u>Spiraea canescens</u> Don.	200	173	86.5
<u>Elaeagnus parvifolia</u> Wall.	200	184	92.0
<u>Viburnum nervosum</u> Don.	200	178	89.0
<u>Desmodium tiliaefolium</u> Don.	200	176	88.0
<u>Vitex negundo</u> Linn.	200	158	79.0

Table 2 . Effect of presowing treatments on per cent germination of seeds (1 under mist conditions)

Species	1988						1989					
	T1	T2	T3	T4	T5	CD 0.05	T1	T2	T3	T4	T5	CD 0.05
<u>Woodfordia fruticosa</u> Kurz.	73.33	76.67	81.00	95.67		7.95	70.28	72.82	78.12	92.32		7.02
<u>Murraya koenigii</u> Royle	80.67	81.33	86.00	95.00		8.90	78.37	79.12	85.19	94.33		7.66
<u>Prinsepia utilis</u> Royle	80.00	85.00	83.10	94.00		5.99	80.00	89.72	85.00	96.38		5.18
<u>Zizyphus oxyphylla</u> Edgw.	78.00	86.67	85.33	93.00		9.76	79.22	82.22	81.31	94.22		8.18
<u>Carissa carandas</u> Linn.	74.00	76.00	76.00	90.00		4.57	73.21	75.92	75.00	87.11		4.22
<u>Adhatoda vasica</u> Nees.	73.00	73.00	77.33	83.67		5.67	70.22	72.11	78.32	88.12		5.69
<u>Rosa moschata</u> Mill.	50.33	60.67	62.22	78.00		8.54	50.92	60.60	62.38	79.28		6.31
<u>Jasminum officinale</u> Linn.	78.00	81.67	82.00	90.33		9.10	78.81	86.22	80.21	86.32		9.92
<u>Berberis lycium</u> Royle	67.00	70.67	72.33	74.00		8.12	62.19	71.16	74.22	78.37		8.13
<u>Berberis aristata</u> DC.	61.33	63.33	72.67	72.68		8.47	60.22	61.38	71.82	74.42		9.82
<u>Zanthoxylum armatum</u> Roxb.	40.00	41.33	42.00	45.00	68.15	2.44	40.10	41.38	42.22	48.92	68.15	2.96
<u>Indigofera pulchella</u> Roxb.	85.33	88.00	90.67	95.33		3.52	80.17	81.28	82.27	88.33		3.32
<u>Nerium indicum</u> Mill.	70.33	71.67	77.67	84.67		5.75	70.14	71.29	79.12	87.29		6.16
<u>Rubus niveus</u> Wall.	49.67	62.33	66.67	73.67		5.55	49.99	62.42	66.69	74.28		4.38
<u>Debregeasia hypoleuca</u> Wedd.	71.33	74.67	73.33	82.33		6.57	69.89	71.18	72.22	82.96		6.00
<u>Lonicera quinquelocularis</u> Hardw.	60.67	57.33	61.67	83.29		7.92	60.18	61.20	62.22	81.26		7.29
<u>Plectranthus rugosus</u> Wall.	51.67	53.33	57.67	71.33		6.46	50.29	52.18	56.22	74.39		5.22
<u>Coriaria nepalensis</u> Wall.	70.67	67.33	71.67	86.29		7.92	70.18	71.20	72.22	86.22		7.62
<u>Dodonaea viscosa</u> Linn.	63.67	80.00	83.00	85.33		7.87	60.00	80.09	83.28	82.90		8.29
<u>Spiraea canescens</u> Don.	64.00	65.00	64.33	80.67		4.28	64.29	64.00	64.36	81.38		3.68
<u>Elaeagnus parvifolia</u> Wall.	61.00	63.00	64.67	88.00		7.55	59.29	60.28	61.29	87.00		7.89
<u>Viburnum nervosum</u> Don.	67.33	73.68	74.67	76.00	85.38	7.95	62.38	70.98	72.52	79.38	81.29	6.22
<u>Desmodium tiliaefolium</u> Don.	46.67	58.00	73.33	79.00		7.75	45.38	57.38	71.19	78.16		6.95
<u>Vitex negundo</u> Linn.	42.29	50.33	53.29	54.33	74.33	5.93	41.28	49.38	42.22	43.33	74.28	5.13

(3)

Table 3. Effect of presowing treatments on per cent germination of seeds (1 under field conditions)

Species	1988						1989					
	T1	T2	T3	T4	T5	CD 0.05	T1	T2	T3	T4	T5	CD 0.05
<u>Woodfordia fruticosa</u> Kurz.	53.00	58.00	59.67	63.00		2.64	57.11	58.31	58.92	63.68		2.15
<u>Murraya koenigii</u> Royle	60.00	69.00	61.33	75.00		6.55	60.28	61.32	65.77	77.72		4.20
<u>Prinsepia utilis</u> Royle	60.00	61.33	61.39	74.33		2.50	60.00	61.26	62.31	76.61		3.15
<u>Zizyphus oxyphylla</u> Edgw.	60.67	66.67	64.39	77.00		5.01	61.80	64.96	65.96	76.00		3.99
<u>Carissa carandas</u> Linn.	57.00	58.00	58.00	73.00		2.56	59.92	63.26	66.32	74.00		4.87
<u>Adhatoda vasica</u> Nees.	54.67	57.00	59.00	66.00		6.40	52.32	55.18	59.29	68.28		6.33
<u>Rosa moschata</u> Mill.	43.33	43.67	46.67	59.33		4.20	41.36	41.67	43.82	56.38		4.46
<u>Jasminum officinale</u> Linn.	52.00	52.68	50.00	62.83		5.53	52.22	52.33	53.78	59.19		4.92
<u>Berberis lycium</u> Royle	37.00	40.67	42.33	44.00		5.29	32.19	41.16	44.22	48.00		5.17
<u>Berberis aristata</u> DC.	31.33	33.33	42.67	43.39		4.45	30.22	41.38	41.79	42.39		4.39
<u>Zanthoxylum armatum</u> Roxb.	29.10	30.31	31.29	35.29	50.31	2.23	23.33	28.22	31.72	35.92	53.28	2.86
<u>Indigofera pulchella</u> Roxb.	64.67	65.67	66.33	78.33		4.32	64.82	65.82	67.00	78.16		4.92
<u>Nerium indicum</u> Mill.	40.33	41.67	47.47	54.67		3.18	40.14	41.29	46.12	52.29		2.96
<u>Rubus niveus</u> Wall.	29.67	32.33	36.67	38.67		3.71	29.99	32.42	36.69	40.12		4.08
<u>Debregeasia hypoleuca</u> Wedd.	49.67	50.33	50.33	53.29		5.76	50.17	51.32	52.92	56.00		5.81
<u>Lonicera quinquelocularis</u> Hardw.	40.00	43.00	49.33	53.67		6.41	40.22	42.11	50.31	56.92		7.02
<u>Plectranthus rugosus</u> Wall.	30.38	30.67	32.26	48.00		3.89	29.92	30.60	32.92	49.96		3.79
<u>Coriaria nepalensis</u> Wall.	51.33	54.67	53.33	62.33		2.67	49.89	42.82	48.12	52.32		2.22
<u>Dodonaea viscosa</u> Linn.	43.33	46.67	51.00	55.67		5.60	40.28	42.82	48.12	52.32		5.37
<u>Spiraea canescens</u> Don.	36.00	37.00	38.00	44.67		5.58	34.29	34.00	34.36	41.38		5.56
<u>Elaeagnus parvifolia</u> Wall.	44.00	44.67	47.67	66.00		5.48	40.00	40.09	43.28	62.00		6.72
<u>Viburnum nervosum</u> Don.	41.67	43.33	47.67	51.33	61.29	5.60	40.29	42.18	46.22	52.29	62.28	8.29
<u>Desmodium tiliaefolium</u> Don.	36.67	48.00	53.33	69.22		6.84	35.38	47.38	51.79	68.16		6.38
<u>Vitex negundo</u> Linn.	22.33	31.33	33.67	34.83	59.22	3.25	21.92	28.28	27.22	31.29	56.22	3.14

53.00 under mist and field conditions irrespective of years.

Muraya koenigii Spreng.

A perusal of data reveals that T_4 treatment had given maximum success, while minimum was observed in T_1 , rest of them were statistically at par with each other. The same treatment was most effective under field conditions too on account of maximum per cent success, all other treatments were statistically at par with one another.

The maximum and minimum values of per cent germination varied from 95.00 to 78.37 and 77.72 to 60.00 under mist and field conditions, respectively during the years 1988 and 1989.

Prinsepia utilis Royle.

The data reveal that the application of GA_3 (T_4) had a profound impact on per cent germination of seeds, since it was statistically superior to all others which were in turn statistically at par with one another. The trend was similar under field because maximum success was recorded in the same treatment.

The mean maximum and minimum values of per cent germination varied from 96.38 to 80.00 and 76.61 to 60.00 under mist and field conditions, respectively during the year 1988-89.

Zizyphus oxyphylla Edgew.

A perusal of data manifests that all the treatments excluding T_4 were statistically at par with one another under mist conditions. The same trend was performed under field conditions during both the years.

The range of mean maximum and minimum values varied from 93.00 to 78.00 and 77.00 to 60.67 under mist and field conditions during 1988, whereas their corresponding values were 94.22 to 79.22 and 76.00 to 60.00 in the following year.

Carissa carandas Linn.

The data reveals that T_4 treatment had given maximum per cent germination followed by T_3 , T_2 and T_1 , respectively. There were no appreciable difference between T_2 and T_1 since the results obtained were statistically at par with each other. Similar trend was observed under field conditions.

The range of mean maximum and minimum values varied from 90.00 to 73.21 and 74.00 to 57.00 under mist and field conditions, respectively irrespective of years of study.

Adhatoda vasica Nees.

It is evident from the data that GA_3 (T_4) had given maximum percentage of germination both under mist and field conditions respectively, while other treatments were statistically at par with each other on account of statistical similarities. The range of mean maximum and minimum values

varied from 83.67 to 73.00 and 66.00 to 54.67 in mist and field conditions respectively during 1988; whereas their corresponding values were 88.12 to 70.22 and 68.28 to 52.32 during 1989.

Rosa moschata Mill.

A perusal of data makes it convenient that GA_3 (T_4) had better impact on germination while T_2 and T_1 treatments were closely related to one another, yet they were superior to control (T_1) under mist. Similar results were obtained under field conditions.

The range of mean maximum and minimum values of per cent germination varied from 78.00 to 50.33 and 59.33 to 43.33 under mist and field conditions, respectively during 1988; whereas their corresponding values were 79.28 to 50.92 and 56.38 to 41.36 in the following year.

Jasminum officinale Linn.

The data relating to per cent success in germination opined that T_4 treatment had given maximum per cent success in comparison to others, which were closely related to one another, since non-significant results were obtained amongst themselves.

When the experiment was performed under field conditions, it was observed that there was no appreciable difference among various treatments excluding T_4 during both the years.

The mean maximum and minimum values ranged from 90.33 to 78.00 and 62.63 to 52.00 under mist and field conditions respectively irrespective of years.

Berberis lycium Royle.

All the treatments excluding T_1 which had given minimum per cent success were statistically at par with one another both under mist and field conditions. The mean maximum and minimum values varied from 74.00 to 67.00 and 44.00 to 37.00 under mist and field conditions, respectively during 1988; whereas their corresponding values were 78.37 to 62.19 and 48.00 to 32.19 in the next year.

Berberis aristata DC.

The experiment performed under mist conditions had revealed that T_3 and T_4 treatments were statistically at par with each other, yet superior to rest, but under field conditions there was a non-differential response of various treatments.

The mean maximum and minimum values irrespective of years varied from 74.42 to 60.22 and 43.39 to 30.22 under mist and field conditions, respectively, irrespective of year of study.

Zanthoxylum armatum Roxb.

The seeds treated with sulphuric acid had a profound influence, since maximum success was obtained in T_5 treatment,

it was followed by T_4 , rest of the treatments were closely related to one another under mist conditions. The same (T_5) was best under field conditions, but other treatments were non-differential with respect to one another.

The mean maximum and minimum values of per cent germination varied from 68.15 to 40.50 and 53.28 to 23.33 under mist and field conditions respectively irrespective of years.

Indigofera pulchella Roxb.

It is evident from the data that all treatments were statistically at par with one another but T_4 treatment was statistically superior to the rest, both under mist and field conditions.

The range of mean maximum and minimum values of per cent germination varied from 95.33 to 80.17 and 78.33 to 64.67 under mist and field conditions, respectively irrespective of years.

Nerium indicum Mill.

It is apparent from the data that percentage of germination varied significantly with the treatments applied. The application of GA_3 exhibited the highest per cent success in germination followed by T_3 , while there was no appreciable difference between T_2 and T_1 .

The same treatment (T_4) had given maximum success when the experiment was performed under field conditions.

The mean maximum and minimum values of per cent germination varied from 87.29 to 70.14 and 54.67 to 40.14 under mist and field conditions respectively irrespective of years.

Rubus niveus Wall.

The data on per cent germination (Tables 2 and 3) of Rubus niveus revealed that T_4 had retained its superiority over others, while T_3 and T_2 were closely related to each other with a minimum success was obtained in control (T_1).

Under field conditions all the treatments were statistically at par with one another. The mean maximum and minimum values varied from 74.28 to 49.67 and 40.12 to 29.67 under mist and field conditions, respectively, irrespective of years.

Debregeasia hypoleuca Wedd.

A perusal of data revealed that T_4 treatment was statistically superior to others while others were at par with one another. All the treatments were at par with one another when the experiment was performed under field conditions.

The mean maximum and minimum values of per cent germination varied from 82.33 to 71.33 and 53.29 to 49.67

under mist and field conditions in 1988, whereas the same were 82.96 to 69.89 and 56.00 to 50.17 in the second year.

Lonicera quinquelocularis Hardw.

From the data presented in Tables 2 and 3, it was found that T_4 treatment was having statistically higher values in comparison to all others, but when the experiment was performed under field conditions, there was no appreciable difference between T_4 and T_3 on account of statistical similarities, yet they were superior to others during both the years.

The mean maximum and minimum values of per cent germination varied from 83.29 to 60.18 under mist and 56.92 to 40.00 under field conditions irrespective of years.

Plectrathus rugosus Wall.

The application of GA_3 (T_4) had a profound impact on per cent success in germination, since it was having statistically higher values than rest of the treatments, which were statistically at par with one another. Similar trend was observed when the experiment was performed under field conditions.

The range of mean maximum and minimum values of per cent germination varied from 71.33 to 51.67 and 48.00 to 30.38 under mist and field conditions, respectively during 1988, whereas their corresponding values were 74.39 to 50.29 and 49.96 to 29.92 in the next year.

Coriaria nepalensis Wall.

The data reveal that GA_3 (T_4) had given maximum percentage germination under mist and field conditions while others were at par with one another during both the years.

The range of mean maximum and minimum values of per cent germination varied from 86.29 to 70.18 and 62.33 to 49.89 under mist and field conditions, respectively irrespective of years.

Dodonaea viscosa Linn.

The data reveals that all the treatments, excluding control were statistically at par with one another during both the years. Similar trend was observed when the experiment was performed under field conditions.

The range of mean maximum and minimum values of germination per cent varied from 85.33 to 60.00 and 55.67 to 40.28 under mist and field conditions, respectively, irrespective of years.

Spiraea canescens Don.

It is evident from the Tables 2 and 3 that maximum per cent success could be obtained with T_4 treatment, since it was having statistically higher values than others. Whereas T_1 was having significantly lower values. There was

non-differential response of various treatments under field conditions since all were statistically at par with each other.

The range of mean maximum and minimum values varied from 81.38 to 64.00 and 44.67 to 34.29 under mist and field conditions, respectively irrespective to years.

Elaeagnus parvifolia Wall.

It is apparent from the table that all treatments except for T_4 , which had given maximum per cent success, were statistically at par with one another.

The mean maximum and minimum values of per cent germination varied from 88.00 to 59.29 and 66.00 to 40.00 under mist and field conditions, respectively irrespective of years.

Viburnum nervosum Don.

From the perusal of data, it is revealed that seeds treated with sulphuric acid had given maximum percentage of germination. Excluding control, where minimum success was obtained all other treatments were statistically at par with one another both under mist and field conditions.

The range of mean maximum and minimum values of per cent germination varied from 85.38 to 62.28 and 61.29 to 40.29 under mist and field conditions, respectively irrespective of years.

Desmodium tiliaefolium Don.

The data pertaining to per cent success in germination makes it clear that there was an appreciable increase in per cent success in germination with the application of GA_3 . Although T_3 and T_4 were statistically at par with each other, yet superior to control, under mist conditions. The same treatment had given maximum per cent success, but all other treatments were at par with one another when the experiment was performed under field conditions.

The range of mean maximum and minimum values of per cent germination varied from 79.00 to 45.38 and 69.22 to 35.38 under mist and field conditions, respectively irrespective of years.

Vitex negundo Linn.

A perusal of data revealed that sulphuric acid was effective in influencing the per cent germination because T_5 treatment was statistically superior to all others both under mist and field conditions.

The mean maximum and minimum values varied from 74.33 to 41.28 and 59.22 to 21.92 under mist and field conditions, respectively irrespective of years.

2. Propagation by stem cuttings

2.1 Propagation under field conditions

Specieswise performance is as follows:

Woodfordia fruticosa Kurz.

From the perusal of data (Table 4), it is evident that the per cent success in rooting differed significantly among seasons, hormones and concentrations during both the years. Interaction among different factors were also significant.

The mean values reveal that the winter season had significantly lower success as compared to other seasons viz., rainy and spring during both the years. Among hormones IBA was found to have significantly higher values than others, during both the years. It is also clear from the data that 1000 ppm concentration had a better impact in comparison to other concentration. The mean maximum and minimum values irrespective of seasons, hormones and concentrations ranged from 39.04 to 1.91 in 1988 and their corresponding values were 37.66 to 1.91 during 1989, respectively.

Murraya koenigii Spreng.

The results of the periodical investigations, are presented in Table 5. It was noticed that the success percentage was different amongst different seasons also significantly different results were obtained during both years.

Table 4. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of Woodfordia fruticosa under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	25.35	24.09	2.71	17.38	23.82	24.79	1.91	16.94
IAA	500	27.03	24.34	5.74	19.03	24.86	25.80	5.42	20.08
(ppm)	1000	28.20	24.35	9.01	20.52	26.79	26.32	7.15	21.88
	2000	29.99	28.57	10.50	23.02	28.42	27.97	9.27	18.69
Mean		33.82	36.29	10.61	26.95	30.17	32.09	15.33	25.83
IBA	500	28.81	33.42	10.50	24.37	28.66	31.52	14.18	24.78
(ppm)	1000	39.03	39.04	11.74	29.93	35.06	37.66	18.10	30.27
	2000	33.63	36.43	9.60	26.55	26.80	27.04	13.72	22.52
Mean		33.82	36.29	10.61	26.95	30.17	32.09	15.33	25.83
NAA	500	30.85	24.06	8.75	21.21	25.57	27.50	15.91	21.12
(ppm)	1000	37.04	24.09	5.14	18.95	24.09	25.60	13.68	22.99
	2000	27.96	23.57	1.91	17.81	21.41	22.48	12.13	18.67
Mean		28.61	23.39	6.26	19.32	23.61	25.19	13.90	20.93
Mean		26.29	28.47	8.09		26.85	27.99	12.17	

Season x concentration

Concentration (ppm)									
500	28.01	27.42	8.29	21.24	26.51	27.81	11.67	21.99	
1000	33.29	30.55	10.32	24.72	29.68	31.04	25.11	25.05	
2000	29.54	28.11	5.84	21.16	14.55	26.11	10.42	19.96	

CD		1988	1989
(0.05)			
Seasons		1.45	2.28
Hormones		0.91	0.84
Concentrations		0.94	0.82
Season x Hormone		1.61	1.94
Seasons x Concentrations		1.87	2.00
Hormone x Concentrations		1.74	1.52
Season x Hormone x Concentration		3.32	3.35

Table 5. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of Murraya koenigii under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	0.00	0.00	0.00	0.00	1.81	2.71	1.92	2.18
IAA	500	5.42	10.50	0.00	5.30	5.42	8.57	0.00	4.66
(ppm)	1000	6.54	7.94	1.91	5.46	7.33	8.74	1.91	6.99
	2000	8.97	7.33	1.92	6.40	10.95	11.89	2.71	8.51
Mean		7.37	8.59	1.27	5.72	7.88	8.73	1.54	9.93
IBA	500	12.00	13.34	3.83	9.72	12.92	14.56	7.15	11.54
(ppm)	1000	14.57	14.96	4.62	11.38	14.42	15.71	8.13	12.92
	2000	10.50	11.53	3.83	8.61	9.88	12.00	7.33	9.73
Mean		12.35	13.27	4.09	9.90	12.40	14.09	7.53	11.39
NAA	500	6.54	6.53	1.91	4.99	9.62	9.61	2.71	7.30
(ppm)	1000	8.74	9.36	2.71	6.93	10.50	11.54	6.03	9.35
	2000	4.62	8.13	5.73	6.16	4.62	8.74	4.62	5.99
Mean		6.63	8.00	3.45	6.03	8.24	9.96	4.45	7.54
Mean		6.57	9.95	2.30		9.51	10.12	3.86	

Concentration(ppm)	Season x concentration							
500	7.78	6.97	1.91	5.53	9.31	10.91	3.28	7.83
1000	9.95	10.75	3.08	7.92	10.75	11.99	5.35	9.36
2000	8.33	5.66	3.82	5.93	8.48	10.87	4.88	8.07

CD

(0.05)

1988

1989

Seasons

2.39

3.56

Hormones

1.14

1.18

Concentrations

0.89

1.30

Season x Hormone

NS

NS

Seasons x Concentrations

1.97

2.90

Hormone x Concentrations

2.00

2.39

Season x Hormone x Concentration

NS

NS

The differences due to hormones were proved to be significant. Similarly, differences among concentrations was also found to be significant. Likewise, interactions were also found to be significant.

It is evident from the data that there was no appreciable difference during rainy and spring seasons but both were superior to winter. The IBA was having statistically higher value during both the years. There was a gradual increase in success with successive increase in concentration upto 1000 ppm, thereafter a decline was observed in the years of investigations.

In the first year the mean maximum and minimum value varied from 14.96 to 0.00 per cent; whereas, the corresponding values in the following year were 15.71 to 1.92, respectively.

Prinsepia utilis Royle

The data pertaining to per cent success in rooting are presented in Table 6. It is apparent from the data that the success percentage was significantly different between seasons, hormones and concentrations during the years 1988 and 1989. Irrespective of years, the rainy season had better impact in comparison to other seasons viz., spring and winter. The IBA was found to be superior to IAA and NAA. A concentration of 1000 ppm had obtained best results.

Table 6. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of *Prinsepia utilis* under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	27.04	27.96	18.58	24.52	24.59	24.84	14.95	21.46
IAA	500	30.65	31.50	23.59	28.58	29.53	30.62	23.63	27.72
(ppm)	1000	31.52	32.36	24.09	29.32	30.63	31.93	23.83	28.79
	2000	31.92	33.61	25.84	30.45	31.92	33.609	25.59	30.37
Mean		31.36	32.49	24.50	29.45	30.69	32.05	24.75	28.96
IBA	500	44.81	45.95	29.99	40.25	48.64	52.936	33.62	46.06
(ppm)	1000	48.07	51.94	32.78	44.26	44.43	44.43	28.38	39.07
	2000	31.73	45.19	29.07	39.37	9.88			
Mean		41.53	47.69	30.61	47.29	45.89	47.70	30.65	41.41
NAA	500	31.50	31.73	22.52	28.65	28.20	30.22	19.94	26.12
(ppm)	1000	26.76	33.82	23.87	29.63	128.88	31.08	21.40	27.12
	2000	27.97	27.63	20.84	25.08	26.80	27.97	19.04	24.60
Mean		28.74	31.06	22.31	27.79	27.96	29.75	20.12	25.95
Mean		33.49	34.80	24.00		32.28	33.59	22.47	
Concentra- tion(ppm)									
	500	35.65	36.39	25.36	32.46	34.11	35.52	24.27	31.30
	1000	35.45	39.37	26.81	33.87	36.05	38.64	26.28	33.65
	2000	30.54	35.47	25.25	30.42	34.38	35.33	24.41	31.47
CD(0.05)						1988		1989	
	Seasons					1.03		0.40	
	Hormones					0.67		0.90	
	Concentrations					0.90		0.59	
	Season x Hormone					1.12		1.31	
	Seasons x Concentrations					N.S.		N.S.	
	Hormone x Concentrations					1.37		1.18	
	Season x Hormone x Concentration					NS		2.16	

Regardless of season hormone and concentration the mean maximum and minimum values were 51.94 to 18.58 during 1988 and 52.93 to 14.95 during 1989, respectively.

Zizyphus oxyphylla Edgew.

From the data presented in Table 7, it can be seen that rainy season was statistically a better season over spring and winter, the spring season was of intermediate in behaviour while winter was least effective. The IBA registered a maximum per cent success while others viz., IAA and NAA were at par with one another. Cuttings treated with 500 ppm of concentration had proved its superiority and beyond this limit, inverse effect was observed. All the interactions also showed significant differences among themselves during both the years.

The mean maximum and minimum values ranged from 48.83 to 15.60 regardless of years.

Carissa carandas Linn.

The data related to successful rooting in different seasons, hormones and concentrations are presented in Table 8. From the perusal of table, it is clear that there was no appreciable difference between rainy and spring season. The IBA and IAA were found to be statistically at par with each other. It was observed that concentrations of 500 ppm have a beneficial effect while, the trend was reversible

Table 7. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of Zizyphus oxyphylla Edgwe under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	25.10	26.66	16.07	22.65	22.77	24.09	16.60	20.97
IAA	500	27.04	28.66	15.98	23.87	26.32	27.50	17.50	23.76
(ppm)	1000	29.11	30.87	20.55	26.84	28.65	30.86	19.96	26.49
	2000	25.59	27.27	17.12	23.32	25.09	24.099	16.75	22.86
Mean		27.24	28.93	17.88	24.68	26.69	27.48	18.07	24.32
IBA	500	45.19	46.34	28.42	39.98	47.68	48.83	28.42	41.64
(ppm)	1000	40.59	43.66	25.56	36.60	41.55	46.15	27.26	38.32
	2000	39.62	40.01	26.56	35.39	43.66	44.62	24.60	37.62
Mean		41.08	43.33	26.84	37.32	44.29	46.53	26.76	39.19
NAA	500	27.96	29.32	16.75	24.67	25.00	28.39	17.08	23.48
(ppm)	1000	30.00	30.87	19.96	26.94	128.88	30.21	18.44	25.84
	2000	27.93	27.27	16.75	23.94	25.57	28.19	15.60	23.12
Mean		28.63	29.15	17.82	25.18	26.48	28.93	17.04	24.14
Mean		30.69	32.05	19.74		30.05	31.98	19.48	
Season x concentration									
Concentra- tion(ppm)									
	500	33.39	34.77	20.38	29.51	32.99	35.51	21.00	29.83
	1000	33.23	35.06	22.02	30.10	33.03	35.74	21.88	30.21
	2000	31.04	31.51	20.14	27.55	31.44	32.30	18.98	27.86
CD(0.05)							1988		1989
	Seasons						0.57		0.85
	Hormones						0.59		0.58
	Concentrations						0.41		0.61
	Season x Hormone						0.92		1.00
	Seasons x Concentrations						0.79		1.18
	Hormone x Concentrations						0.80		1.10
	Season x Hormone x Concentration						1.73		2.10

Table 8. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of *Carissa carandas* Linn. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	27.00	27.39	19.65	24.35	27.25	27.72	18.10	24.35
IAA	500	61.57	64.16	34.04	53.25	61.34	63.20	34.86	53.13
(ppm)	1000	44.29	46.33	31.31	40.62	45.19	47.20	30.21	40.83
	2000	42.89	44.04	30.21	39.04	43.09	45.38	28.20	38.89
Mean		51.25	51.50	31.85	44.30	49.87	51.92	31.09	44.28
IBA	500	42.89	44.04	30.21	41.03	45.38	46.53	30.22	40.71
(ppm)	1000	56.59	57.64	34.45	49.55	57.00	58.50	34.04	49.84
	2000	45.95	45.96	32.16	40.92	46.53	45.38	29.77	40.56
Mean		48.47	49.21	32.27	43.83	49.63	50.13	31.34	43.30
NAA	500	36.86	37.65	21.91	32.14	27.25	36.86	20.55	31.08
(ppm)	1000	38.65	40.78	24.60	34.67	35.86	39.03	23.26	33.31
	2000	33.00	33.83	18.43	28.42	37.66	34.65	18.10	28.58
Mean		36.17	37.42	21.64	31.74	33.54	36.84	20.63	31.99
Mean		40.48	41.67	26.28		40.56	41.65	25.29	
Season x concentration									
Concentra- tion(ppm)									
	500	47.10	48.61	28.72	42.14	44.65	48.86	28.54	41.64
	1000	46.51	48.25	30.12	41.61	46.01	48.24	29.17	41.32
	2000	40.61	41.27	26.93	36.12	42.36	41.80	25.35	36.01
CD(0.05)						1988		1989	
	Seasons					1.64		1.46	
	Hormones					0.58		0.42	
	Concentrations					0.74		0.46	
	Season x Hormone					1.37		1.15	
	Seasons x Concentrations					1.71		1.21	
	Hormone x Concentrations					1.42		0.84	
	Season x Hormone x Concentration					2.87		1.97	

beyond this limit and all related interactions were significant during both the years.

Regardless of season, hormone and concentration the mean maximum and minimum values ranged from 57.64 to 18.43 during 1988 and 58.50 to 18.10 during second year, respectively.

Adhatoda vasica Nees.

The data presented in Table 9 reveal that mean maximum and minimum values varied from 44.81 to 12.42 during 1988 and 44.23 to 10.50 in 1989, respectively. Among seasons, hormones and concentration maximum success was observed during rainy season in IBA and at a concentration of 1000 ppm.

The per cent success in rooting was found to be influenced not only by season, hormone, concentration and also by their interactions during both the years but season x hormone and concentration was found to be non-significant.

Rosa moschata Mill.

Data related to rooting in R. moschata are presented in Table 10. From the perusal of data, it was observed that the maximum rooting was observed in rainy season and it was lowest in winter, while dealing with hormones, it was found that IBA was statistically superior to IAA and NAA. 1000 ppm was significantly better over 500 ppm, 2000 ppm which were significantly better over control (0 ppm) and all

Table 9. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of *Adhatoda vasica* Nees. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	32.58	35.23	14.18	27.32	31.95	32.79	11.01	25.25
IAA	500	41.74	40.59	14.92	32.42	37.47	38.64	15.66	30.58
(ppm)	1000	40.20	41.17	17.12	32.82	39.82	40.40	14.93	31.71
	2000	38.84	40.01	13.30	30.71	36.07	36.86	17.78	30.24
Mean		40.26	40.59	15.11	31.98	36.32	37.17	14.84	29.44
IBA	500	43.28	43.66	18.75	35.23	40.19	42.89	18.72	33.93
(ppm)	1000	43.85	44.81	20.85	36.50	43.09	44.23	21.14	36.15
	2000	41.16	42.51	19.56	34.71	39.82	40.78	18.42	33.00
Mean		42.76	43.66	19.72	35.48	41.03	42.62	19.43	34.29
NAA	500	40.01	40.78	15.65	36.50	40.01	40.38	16.02	32.14
(ppm)	1000	38.45	39.23	17.41	35.23	38.05	39.43	14.56	30.68
	2000	35.65	36.84	12.42	28.30	37.43	36.87	10.50	28.26
Mean		38.03	38.95	15.16	33.01	38.49	38.89	13.69	30.36
Mean		38.41	39.60	16.04		37.31	38.24	15.06	
Season x concentration									
Concentra-									
tion(ppm)									
	500	41.67	41.76	16.44	34.71	39.22	40.63	16.08	32.21
	1000	40.83	41.73	18.46	34.85	40.32	41.35	16.55	32.84
	2000	38.55	39.79	15.09	31.14	37.77	38.17	15.65	30.50
CD(0.05)		1988				1989			
Seasons		1.00				0.50			
Hormones		0.55				0.58			
Concentrations		0.70				0.52			
Season x Hormone		NS				0.91			
Seasons x Concentrations		1.37				0.98			
Hormone x Concentrations		1.27				0.99			
Season x Hormone x Concentration		NS				1.82			

Table 10 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of *Rosa moschata* Mill. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	52.14	53.53	30.87	45.51	51.95	52.96	28.28	44.59
IAA	500	59.35	60.89	32.58	50.84	58.27	59.34	32.16	49.92
(ppm)	1000	60.69	60.06	28.65	51.80	60.23	60.89	33.63	51.58
	2000	57.84	60.01	30.43	49.42	57.42	58.69	31.94	49.35
Mean		59.29	60.32	29.21	50.68	58.64	59.64	32.57	50.28
IBA	500	71.57	73.94	35.05	60.18	71.26	73.25	33.83	59.45
(ppm)	1000	73.96	75.82	35.86	61.88	72.88	75.05	36.06	61.33
	2000	69.46	70.84	33.00	57.80	66.89	69.18	32.56	56.24
Mean		71.66	73.56	34.63	59.96	70.37	72.49	34.15	59.00
NAA	500	60.01	61.34	28.88	50.07	58.27	58.71	30.66	49.21
(ppm)	1000	61.37	62.04	28.29	50.53	60.66	61.36	32.16	51.39
	2000	58.04	59.56	29.27	48.37	57.00	57.20	28.65	47.61
Mean		59.80	61.05	28.11	59.66	58.64	59.09	30.49	49.40
Mean		60.72	62.12	31.54		59.90	61.04	31.52	
Season x concentration									
Concentration(ppm)									
	500	63.64	65.34	32.17	53.73	62.60	63.70	32.21	52.86
	1000	65.33	65.97	32.90	54.74	64.59	65.76	33.95	54.77
	2000	61.78	63.58	30.23	51.86	60.47	61.69	31.05	51.07
CD(0.05)		1988				1989			
Seasons		0.13				0.54			
Hormones		0.41				0.36			
Concentrations		0.60				0.59			
Season x Hormone		0.59				0.62			
Seasons x Concentrations		0.87				1.08			
Hormone x Concentrations		0.91				1.05			
Season x Hormone x Concentration		1.60				1.91			

related interactions were significant during both the years.

The mean maximum and minimum value varied from 75.82 to 28.28 irrespective of years.

Jasminum officinale Linn.

From the perusal of data on per cent success in rooting (Table 11), it is evident that per cent rooting differed significantly among different seasons, hormones and concentrations and their interactions among different factors were also found to be significant during both the years.

The mean values reveals that rainy season had significantly higher value as compared to other seasons during both the years. Amongst hormones IBA was found to have significantly higher values than the rest during both the years. It is also clear from the data that there was an appreciable increase in success upto a concentration of 500 ppm, thereafter a decline was observed. The mean maximum and minimum values irrespective of season, hormone and concentration, ranged from 61.11 to 26.26 in 1988 and their corresponding values were 60.01 to 24.26 during 1989, respectively.

Berberis lycium Royle

The results on per cent success in rooting as obtained from periodical investigations, are presented in Table 12. It

Table 11 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of Jasminum officinale Linn. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	35.26	35.25	26.26	32.25	34.83	35.26	24.26	31.45
IAA	500	40.57	45.19	31.23	38.05	41.55	45.19	30.23	30.99
(ppm)	1000	42.32	43.85	29.11	38.42	40.07	43.85	31.23	38.38
	2000	43.66	46.91	32.16	40.91	43.08	46.91	30.20	40.08
Mean		42.18	46.37	30.83	39.46	41.56	45.32	30.55	36.48
IBA	500	61.11	60.80	36.47	52.79	56.58	60.01	35.44	50.67
(ppm)	1000	57.00	56.80	36.47	49.89	57.17	56.79	36.54	50.16
	2000	56.38	55.15	36.95	49.49	51.16	55.14	34.22	46.84
Mean		58.16	57.58	36.46	50.73	54.97	55.15	34.22	49.27
NAA	500	41.55	45.57	32.58	39.90	41.55	45.57	40.16	42.42
(ppm)	1000	42.70	47.48	33.00	41.12	42.59	47.68	42.39	44.22
	2000	40.59	43.09	31.30	38.32	40.38	43.08	41.28	41.58
Mean		41.61	45.44	32.29	39.78	41.51	45.44	41.28	42.74
Mean		44.30	45.89	40.54		43.21	45.83	32.88	

Season x concentration

Concentration(ppm)									
500	47.74	50.52	33.42	43.91	46.56	50.25	35.27	41.36	
1000	47.34	49.44	32.86	43.14	46.61	49.44	36.72	40.25	
2000	46.87	48.38	33.47	42.90	44.87	48.38	35.23	42.83	

CD(0.05)		1988	1989
Seasons		0.63	0.51
Hormones		0.49	0.50
Concentrations		0.73	0.77
Season x Hormone		0.81	0.78
Seasons x Concentrations		1.31	1.37
Hormone x Concentrations		1.30	1.37
Season x Hormone x Concentration		2.32	2.44

Table 12 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of Barberia lycium Royle. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	9.35	11.01	0.00	6.78	6.65	9.26	2.71	6.20
IAA	500	15.34	13.76	2.71	10.60	16.06	16.06	0.00	10.70
(ppm)	1000	14.92	11.02	0.00	8.64	13.76	14.83	0.00	9.53
	2000	13.76	10.49	0.00	8.08	11.53	12.88	0.00	8.13
Mean		14.67	11.75	0.90	9.10	13.78	14.46	0.00	9.45
IBA	500	17.78	18.73	0.00	12.17	14.18	15.66	0.00	9.94
(ppm)	1000	19.67	21.36	0.00	13.66	17.12	16.41	0.00	11.17
	2000	23.57	24.60	3.85	17.34	18.95	20.23	0.00	13.39
Mean		20.34	21.56	1.28	14.39	17.08	17.43	0.00	11.50
NAA	500	10.49	10.40	0.00	6.96	11.37	7.94	0.00	6.43
(ppm)	1000	12.41	15.34	0.00	9.25	13.30	12.81	3.33	9.81
	2000	13.76	17.45	0.00	10.40	14.62	14.83	0.00	9.85
Mean		12.22	14.39	0.00	8.87	13.09	11.89	1.11	8.69
Mean		14.14	14.68	0.54		12.65	13.29	0.95	

Season x concentration

Concentration(ppm)									
500	14.53	14.29	0.93	9.91	13.87	13.22	0.00	9.02	
1000	15.66	15.90	0.00	10.51	14.72	14.68	1.11	10.17	
2000	17.03	17.51	1.28	11.94	15.36	16.01	0.00	10.45	

CD(0.05)

	1988	1989
Seasons	0.92	1.56
Hormones	0.88	0.76
Concentrations	0.74	1.24
Season x Hormone	1.39	1.51
Seasons x Concentrations	1.41	2.35
Hormone x Concentrations	1.41	N.S.
Season x Hormone x Concentration	2.63	NS

was noticed that the success per cent during seasons shows significant differences during both the years.

The impact of hormone was found to be significant during both the years. Similarly, differences among concentrations were also found to be significant. Likewise, the interactions were also found to be significant.

It is evident from the table that rainy season was having significantly higher values than spring and winter. The IBA recorded statistically higher values in contrast to other hormones. A concentration of 2000 ppm had given maximum success when compared to others viz., 500 and 1000 ppm.

In the first year the mean maximum and minimum values varied from 24.60 to 0.00 per cent whereas the corresponding values in the following year were 20.23 and 0.00 respectively.

B. aristata DC.

Data pertaining to per cent success in rooting are presented in Table 13. It is apparent from the table that per cent success in rooting was significantly different amongst seasons, hormones and concentrations during the years 1988 and 1989. There was no appreciable difference between rainy and spring seasons since they were statistically at par with each other, yet superior to winter, similarly there was no appreciable difference between IBA and IAA and a concentration of 500 ppm had a profound impact when it

Table 13. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of *Berberis aristata* DC. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	9.97	11.01	0.00	6.82	2.71	8.57	0.00	3.76
IAA	500	15.31	17.00	7.15	13.15	13.16	14.56	0.00	9.24
(ppm)	1000	15.76	17.40	0.00	11.03	14.56	18.11	0.00	10.89
	2000	14.34	14.17	0.00	9.52	14.56	13.16	0.00	9.37
Mean		15.13	16.19	2.38	11.23	14.22	15.27	0.00	9.83
IBA	500	18.10	18.75	0.00	12.28	14.96	16.36	0.00	10.44
(ppm)	1000	19.05	19.33	0.00	12.79	16.70	16.36	0.00	11.02
	2000	15.31	15.31	0.00	10.26	15.70	15.32	0.00	10.34
Mean		17.49	17.79	0.00	11.75	15.78	15.32	0.00	10.66
NAA	500	14.28	15.68	0.00	9.98	16.06	15.70	0.00	10.58
(ppm)	1000	11.56	12.16	0.00	7.90	13.30	14.95	0.00	9.41
	2000	9.26	11.53	0.00	6.93	9.27	10.50	0.00	6.59
Mean		11.70	12.96	0.00	8.27	12.87	13.71	0.00	8.86
Mean		13.47	14.53	0.59		11.39	13.39	0.00	
Season x concentration									
Concentration (ppm)									
	500	15.89	17.14	2.38	11.80	14.72	15.54	0.00	10.98
	1000	15.43	16.29	0.00	10.57	14.85	16.47	0.00	10.44
	2000	12.98	13.67	0.00	8.88	13.31	12.99	0.00	8.76
D(0.05)						1988	1989		
Seasons						0.97	0.91		
Hormones						0.80	1.11		
Concentrations						0.59	0.44		
Season x Hormone						1.25	0.90		
Seasons x Concentrations						1.15	1.19		
Hormone x Concentrations						1.16	1.00		
Season x Hormone x Concentration						2.19	2.16		

was compared with 1000 and 2000 ppm. Likewise, the interactions were significant during both the years.

Mean maximum and minimum values were 19.33 to 0.00 in 1988 and 18.11 to 0.00 in 1989, respectively.

Zanthoxylum armatum Roxb.

From the data presented in Table 14, it can be seen that per cent success in rooting vary with the season, hormone and concentration. In case of seasons, rainy season was found to be statistically superior to all others whereas IBA with a concentration of 1000 ppm was found to be significantly higher than their counterparts. All the interactions excluding season x concentration x hormone were significant during both the years.

Irrespective of the factors, the maximum and minimum mean values varied from 31.94 to 5.24 in 1988 and from 32.16 to 1.92 during 1988, respectively.

Indigofera pulchella Roxb.

It can be seen from the data presented in Table 15 that per cent success in rooting varied significantly during different seasons. The mean maximum and minimum value varied from 49.03 to 13.03 during 1988 and 49.41 to 11.75 in 1989, respectively. Hormonal studies manifested that IBA was statistically superior to IAA and NAA, while the concentration studies had revealed that a concentration of 1000 ppm was at

Table 14. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting of *Zanthoxylum armatum* Roxb. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	14.57	16.77	5.24	12.14	15.34	16.43	1.92	11.22
IAA	500	17.11	19.05	9.26	15.14	14.45	19.37	14.15	16.99
(ppm)	1000	18.74	22.40	12.87	17.67	19.66	21.14	14.18	18.32
	2000	20.83	23.31	14.56	19.57	20.55	22.50	15.32	19.45
Mean		18.89	21.58	7.37	17.46	18.22	21.01	14.55	18.25
IBA	500	26.80	28.42	18.43	24.55	27.50	28.88	18.73	25.04
(ppm)	1000	27.97	31.94	21.94	27.29	29.76	32.16	22.50	28.14
	2000	28.33	27.50	19.66	15.16	26.56	27.27	17.50	23.73
Mean		27.70	29.28	20.01	28.66	27.77	29.43	19.57	28.63
NAA	500	14.51	15.48	13.29	14.43	16.43	17.11	12.77	15.44
(ppm)	1000	17.11	18.74	15.34	17.06	18.42	19.06	12.87	16.78
	2000	12.41	15.34	9.88	12.54	16.04	16.12	9.35	13.84
Mean		14.67	16.52	12.83	14.21	16.96	14.43	11.66	15.35
Mean		18.96	20.96	12.58		19.86	21.07	11.91	

Season x concentration

Concentration (ppm)									
500	19.47	20.98	13.66	17.97	19.46	21.78	15.21	18.15	
1000	21.27	24.36	16.71	20.67	22.61	24.12	16.51	21.08	
2000	20.52	22.05	14.70	19.09	21.05	21.96	14.05	19.00	

CD (0.05)

	1988	1989
Seasons	1.88	0.81
Hormones	0.60	0.44
Concentrations	0.87	0.71
Season x Hormone	1.53	0.83
Seasons x Concentrations	1.83	1.33
Hormone x Concentrations	1.56	1.26
Season x Hormone x Concentration	NS	NS

Table 15. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Indigofera pulchella Roxb. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		23.28	25.32	14.07	20.89	21.97	25.35	12.99	20.10
IAA (ppm)	500	32.57	39.64	12.80	26.67	32.99	34.65	21.09	29.57
	1000	34.45	35.44	19.96	29.95	34.86	35.44	22.78	31.02
	2000	36.06	37.25	21.13	29.98	35.86	37.64	20.26	31.25
Mean		34.31	35.77	17.96	29.93	34.57	35.91	21.37	30.61
IBA (ppm)	500	41.43	45.38	24.59	37.30	41.94	45.96	24.59	30.49
	1000	47.49	49.03	30.17	42.23	47.87	49.41	30.66	42.64
	2000	37.26	39.60	25.34	34.07	38.25	40.39	25.82	34.82
Mean		42.06	44.67	26.70	37.86	42.68	45.25	27.02	35.98
NAA (ppm)	500	31.41	34.24	12.80	26.15	33.82	35.26	18.73	29.27
	1000	37.07	37.46	13.28	29.27	37.66	37.46	20.19	31.71
	2000	29.32	30.64	13.01	24.32	27.76	31.08	11.75	25.46
Mean		32.60	34.04	13.03	26.58	33.08	34.60	18.56	28.94
Mean		33.28	35.22	18.59		33.22	35.27	19.98	
Season x Concentration									
Concen- tration (ppm)	500	35.13	38.08	16.73	32.11	36.35	38.62	21.47	30.07
	1000	39.67	40.64	21.13	35.34	40.13	40.70	24.54	35.45
	2000	34.21	35.83	19.82	29.64	33.95	36.37	20.94	29.99

CD (0.05)	1988	1989
Season	1.68	1.14
Hormones	0.76	0.49
Concentration	0.78	0.83
Season x Hormone	NS	1.03
Seasons x Concentrations	1.61	1.60
Hormone x Concentrations	1.65	1.47
Seasons x Hormones x Concentration	NS	NS

first in merit and the last number was allocated to control.

Likewise, all the interactions involving season hormone and concentration excluding season x hormone and concentration were found to be statistically significant.

Nerium indicum Mill.

The data related to per cent success in rooting are presented in Table 16. From the perusal of data, it is evident that per cent success was strikingly different amongst seasons, hormones and concentrations. The seasonal changes were similar during both the years. Rainy season was the best followed by spring and winter. There was no appreciable difference in IAA and NAA as they were statistically at par with each other, but they had no comparison to IBA. A concentration of 1000 ppm had given maximum success in comparison to other concentrations. All the interactions were statistically significant during both the years. The mean maximum and minimum value varied from 70.03 to 22.15 per cent, irrespective of years.

Rubus niveus Wall.

From the perusal of data in Table 17, it is clear that per cent success in rooting differed significantly amongst different seasons, hormones and concentrations. Excluding season x hormone in the first year, while the same and season x concentration and hormone were significant in the second year.

Table 16. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Nerium indicum Mill. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		40.81	41.17	23.44	38.89	37.68	41.17	22.15	33.86
IAA	500	47.11	49.61	30.62	42.44	46.92	49.41	30.65	42.32
(ppm)	1000	53.13	55.35	30.83	46.43	54.13	57.97	32.79	47.83
	2000	57.00	58.27	34.45	49.90	56.58	58.22	34.23	49.64
Mean		52.41	54.41	31.97	46.25	52.54	55.21	32.55	46.54
IBA	500	61.81	41.17	23.44	38.37	37.66	41.17	22.75	33.66
(ppm)	1000	57.25	70.03	38.87	58.05	87.53	70.33	36.23	58.03
	2000	59.79	60.19	29.22	50.13	43.08	60.23	29.11	44.14
Mean		62.95	65.47	33.44	54.11	57.17	68.68	33.46	52.10
NAA	500	44.05	45.20	27.83	39.02	45.57	47.87	30.81	41.41
(ppm)	1000	45.19	46.72	32.99	41.63	47.49	51.19	32.77	43.81
	2000	42.90	42.51	29.96	38.45	43.09	40.98	29.05	37.70
Mean		44.05	44.81	30.22	39.70	45.38	46.68	30.87	40.97
Mean		49.35	51.52	29.83		48.19	45.96	29.75	
Season x Concentration									
Concen-	500	50.99	53.66	30.96	45.20	51.13	54.59	31.15	45.96
tration	1000	55.19	57.36	33.49	48.70	56.38	59.83	33.93	49.82
(ppm)	2000	53.23	53.65	31.21	46.16	47.58	53.16	30.79	43.84

CD (0.05)	1988	1989
Season	1.46	1.09
Hormones	0.82	0.73
Concentration	0.78	0.87
Seasons x Hormones	1.52	1.36
Seasons x Concentrations	1.62	1.70
Hormone x Concentrations	1.45	1.57
Seasons x Hormones x Concentration	2.87	2.92

Table 17. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Rubus niveus Wall. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		18.42	21.30	10.40	16.71	18.74	17.87	11.28	15.96
IAA	500	27.97	29.72	15.27	24.31	28.41	30.87	14.57	24.61
(ppm)	1000	22.50	23.94	14.05	20.16	23.28	25.26	15.48	21.34
	2000	22.50	23.91	14.05	20.16	23.28	25.26	15.48	21.34
Mean		26.74	28.09	15.35	23.39	27.30	27.35	15.59	24.08
IBA	500	39.23	40.00	23.03	34.09	40.20	40.01	23.28	34.56
(ppm)	1000	42.13	46.53	28.51	37.82	41.93	46.33	24.06	37.47
	2000	37.46	38.25	20.51	32.08	37.85	37.46	18.42	31.24
Mean		39.60	41.59	24.01	34.66	39.99	41.26	21.97	41.09
NAA	500	21.67	21.92	18.10	20.57	22.22	19.56	17.76	21.43
(ppm)	1000	19.36	20.23	15.70	18.42	21.02	24.30	16.75	20.28
	2000	18.10	19.55	15.29	17.66	19.65	11.28	16.04	18.42
Mean		19.71	20.87	16.36	18.87	20.96	18.38	16.85	20.04
Mean		26.12	27.89	16.22		26.76	27.70	16.41	
Season x Concentration									
Concen-	500	29.62	30.55	18.80	26.32	30.27	30.14	28.61	26.86
tration	1000	30.42	32.45	20.31	27.21	27.72	34.18	19.18	27.03
(ppm)	2000	26.02	27.25	16.60	23.29	26.93	27.43	16.65	23.67

CD (0.05)	1988	1989
Season	1.87	2.60
Hormones	1.25	0.66
Concentration	0.71	0.83
Seasons x Hormones	2.05	0.90
Seasons x Concentrations	1.57	2.16
Hormone x Concentrations	1.48	1.49
Seasons x Hormones x Concentration	3.01	3.48

The mean values reveals that the rainy season had significantly higher per cent success as compared to other season viz., spring and winter season. Among the hormones IBA was found to have significantly higher values than others during both the years. The data further reveal that a concentration of 1000 ppm was the desired one, since the success percentage was reduced with a subsequent increase in the level of hormonal concentration. The mean maximum and minimum values, irrespective of season, hormone and concentration, ranged from 46.53 to 10.40 in 1988 and their corresponding values were 46.33 to 11.28 during 1989, respectively.

Debregeasia hypoleuca Wedd.

The results on per cent success in rooting obtained from periodical investigations, are presented in Table 18. It was noticed that per cent success in rooting during different seasons, showed significant differences during both the years.

The differences in the per cent success in rooting amongst different hormones proved significant during both the years. Similarly, differences among concentrations were also found to be significant. Likewise, the interactions were also found to be significant.

It is evident from the table that rainy season exhibited statistically higher values than spring and winter season.

Table 18. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Debregeasia hypoleuca Wedd. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		31.73	31.27	19.32	27.44	27.26	29.77	20.76	25.93
IAA	500	37.46	38.44	22.77	32.89	35.85	40.20	22.45	32.83
(ppm)	1000	38.25	40.39	25.09	34.57	38.64	41.55	24.84	35.01
	2000	41.36	42.32	27.50	37.06	41.55	42.90	28.64	37.70
Mean		39.02	40.38	25.12	34.84	38.68	41.55	25.31	35.18
IBA	500	46.39	49.03	29.74	42.35	45.58	49.91	59.33	41.82
(ppm)	1000	47.50	50.96	31.07	42.46	47.10	50.38	32.16	42.89
	2000	58.06	59.58	33.82	50.48	58.06	60.31	34.24	50.86
Mean		50.58	53.19	31.54	45.09	50.24	53.36	31.91	45.19
NAA	500	37.85	38.64	23.03	33.18	37.26	38.84	21.94	32.83
(ppm)	1000	38.03	40.20	26.25	34.82	39.61	39.63	22.45	41.82
	2000	36.07	37.64	24.04	32.78	36.67	32.15	18.74	29.19
Mean		37.31	38.82	24.44	33.59	37.84	35.87	21.04	33.94
Mean		39.66	40.42	25.15		38.51	40.15	24.75	
Season x Concentration									
Concen-	500	40.56	42.03	25.18	36.14	39.56	42.81	24.57	35.82
tration	1000	41.19	43.85	27.47	37.28	41.78	42.85	26.48	36.90
(ppm)	2000	45.16	46.51	28.45	40.10	45.43	45.12	27.20	39.25

CD (0.05)

1988

1989

Season	1.10	0.70
Hormones	0.65	0.63
Concentration	0.86	0.80
Seasons x Hormones	1.18	1.00
Seasons x Concentrations	1.63	1.46
Hormone x Concentrations	1.55	1.44
Seasons x Hormones x Concentration	2.87	2.61

The IBA was having statistically higher values than the rest. A concentration of 2000 ppm proved statistically superior to all others, while 1000 and 500 ppm were at par with each other.

In the first year, the mean maximum and minimum values varied from 59.58 to 19.32; whereas the corresponding values in the following year were 60.31 to 18.74, respectively.

Lonicera quinquelocularis Hardw.

Data pertaining to per cent success in rooting are presented in Table 19. It is apparent from the table that per cent success in rooting were significantly different amongst seasons, hormones and concentrations during both the years 1988 and 1989. Irrespective of years the success percentage increased from 28.43 to 57.14 in spring season.

The interactions during both the seasons were found to be significant. Regardless of season, hormone and concentration, the mean maximum and minimum values were 57.14 to 19.64 during 1988 and 55.35 to 19.20 during 1989, respectively.

Plectranthus rugosus Wall.

The data related to per cent success in rooting in different seasons, hormones and at different concentrations are presented in Table 20. From the perusal of data, it is clear that different seasons were strikingly different. The

Table 19. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Lonicera quinquelocularis Hardw. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		28.43	29.77	19.64	25.95	24.60	27.74	19.20	23.89
IAA	500	39.03	40.39	23.81	34.41	39.42	40.39	23.04	34.28
(ppm)	1000	40.59	43.28	26.56	36.81	40.97	41.75	25.82	36.18
	2000	33.41	35.06	23.50	30.65	29.62	34.04	20.84	29.83
Mean		37.67	39.58	24.62	33.96	36.67	38.72	23.32	33.43
IBA	500	49.99	53.35	31.93	45.09	50.96	51.55	29.99	44.17
(ppm)	1000	57.14	56.79	33.00	48.31	55.35	54.76	33.41	47.84
	2000	38.84	41.35	29.76	36.65	40.00	40.96	29.33	36.72
Mean		48.15	50.49	31.56	43.40	47.73	48.75	27.98	38.15
NAA	500	39.85	42.90	25.59	36.10	43.28	43.85	29.35	37.16
(ppm)	1000	38.83	40.97	25.83	24.54	40.39	43.08	21.97	25.15
	2000	38.25	38.64	22.70	33.20	37.06	33.83	18.42	29.77
Mean		38.97	40.83	24.04	34.61	40.24	40.25	21.57	34.03
Mean		38.26	40.17	29.97		37.99	38.95	23.73	
Season x Concentration									
Concen-	500	42.95	45.54	27.11	38.53	44.55	45.26	25.79	38.53
tration	1000	45.52	46.94	36.39	39.88	45.57	46.53	27.06	39.72
(ppm)	2000	36.83	38.35	25.32	33.50	37.23	36.28	22.86	32.10

CD (0.05)	1988	1989
Season	1.18	1.30
Hormones	0.66	0.60
Concentration	0.57	0.60
Seasons x Hormones	1.23	1.22
Seasons x Concentrations	1.23	1.33
Hormone x Concentrations	1.07	1.12
Seasons x Hormones x Concentration	2.17	2.28

Table 20. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Plectranthus rugosus* Wall. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		39.23	40.40	18.98	32.87	35.66	39.81	20.23	31.90
IAA	500	51.75	53.73	30.00	46.16	48.83	50.97	31.08	43.62
(ppm)	1000	51.77	52.33	34.23	45.78	51.35	53.63	34.43	46.37
	2000	50.77	52.44	58.21	44.16	42.51	44.81	31.52	39.61
Mean		51.43	52.83	31.81	45.37	47.56	49.80	32.34	43.20
IBA	500	62.53	63.68	39.03	55.08	61.12	63.67	36.86	53.88
(ppm)	1000	68.31	69.44	39.81	59.18	65.40	66.99	38.65	57.01
	2000	64.65	65.15	31.94	53.91	54.94	57.71	34.45	48.87
Mean		65.16	66.09	36.92	56.06	60.48	62.79	36.65	53.25
NAA	500	50.96	52.14	25.09	42.71	47.10	45.95	23.57	38.87
(ppm)	1000	49.61	50.38	25.09	41.69	45.95	47.87	25.59	39.80
	2000	47.10	49.60	24.27	40.32	44.81	49.02	27.74	39.14
Mean		49.22	50.70	24.81	41.57	45.75	47.61	25.63	39.27
Mean		51.18	52.55	28.16		47.41	49.94	28.71	
Season x Concentration									
Concen-	500	55.08	56.51	32.37	47.98	52.35	53.53	30.50	45.45
tration	1000	56.56	57.38	33.04	48.88	54.23	56.16	32.89	47.72
(ppm)	2000	54.17	55.89	28.27	46.11	47.80	49.96	29.85	42.54

CD (0.05)	1988	1989
Season	0.88	0.74
Hormones	0.59	0.41
Concentration	0.62	0.48
Seasons x Hormones	1.03	0.76
Seasons x Concentrations	1.21	0.95
Hormone x Concentrations	1.15	0.87
Seasons x Hormones x Concentration	2.17	1.67

course of seasonal fluctuations were alike during both the years. Hormones as well as concentrations showed significant effect on per cent success in rooting. Similarly, interactions were also found to be significant during both the years.

Regardless of season, hormone and concentration, the mean maximum and minimum value ranged from 69.44 to 18.98 during 1988 and 66.99 to 20.23 during 1989, respectively.

Coriaria nepalensis Wall.

The data presented in Table 21 reveal that per cent success in rooting. It is apparent from the table that per cent success in rooting amongst different seasons, hormones and concentration varied significantly during both the years. The interactions among factors revealed significant effect during the course of these investigations. The rainy season was found to have significantly higher values, followed by spring and winter seasons.

The hormones and concentrations also showed significant difference with regard to per cent success in rooting. The interactions among three factors viz., seasons, hormones and concentrations was also significant.

The range of mean maximum and minimum values regardless of seasons, hormones and concentrations ranged from 59.93 to 30.87.

Table 21. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Coriaria nepalensis* Wall. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		33.20	34.45	31.73	35.13	29.10	33.20	30.87	31.06
IAA	500	36.06	38.25	32.37	35.56	36.07	36.47	31.73	34.75
(ppm)	1000	38.64	40.59	34.03	37.75	40.97	40.97	34.64	38.86
	2000	41.55	48.01	36.07	41.87	43.05	44.23	32.27	39.85
Mean		39.08	42.28	34.15	38.39	40.03	40.56	32.88	37.15
IBA	500	57.00	59.91	52.14	56.35	58.05	59.93	47.87	55.28
(ppm)	1000	51.36	55.55	46.34	51.08	48.44	51.36	43.28	47.69
	2000	46.15	48.83	45.19	46.72	40.59	44.05	37.86	40.83
Mean		51.50	54.76	47.89	51.38	49.02	51.78	43.00	47.93
NAA	500	39.81	42.89	35.26	39.32	29.77	32.78	33.20	31.92
(ppm)	1000	43.09	43.85	39.23	42.05	32.16	37.65	37.27	35.69
	2000	35.67	38.05	30.43	34.72	30.92	33.62	22.16	32.13
Mean		39.52	41.59	34.97	38.69	30.89	34.68	30.88	33.24
Mean		40.74	43.19	37.19		37.52	40.04	35.04	
Season x Concentration									
Concen-	500	44.29	47.01	39.92	43.54	41.29	43.06	37.60	40.65
tration	1000	44.43	46.66	39.86	43.62	40.52	43.22	30.39	40.74
(ppm)	2000	41.12	44.96	37.23	41.10	38.08	40.63	30.76	37.60

CD (0.05)

1988

1989

Season	0.47	0.51
Hormones	0.32	0.43
Concentration	0.38	0.56
Seasons x Hormones	0.56	0.67
Seasons x Concentrations	0.72	1.01
Hormone x Concentrations	0.69	1.01
Seasons x Hormones x Concentration	1.28	1.89

Dodonaea viscosa Linn.

The data pertaining to per cent success in rooting of D. viscosa are presented in Table 22. It is clear that per cent success in rooting during both the years differed significantly amongst different seasons, hormones and concentrations. The pattern of seasonal fluctuations during both the years was quite distinct and similar. The IBA was found to possess significantly higher value as compared to rest. A concentration of 1000 ppm was found to be the best while the least success was observed in control (0 ppm).

Interactions irrespective factors like season, hormone and concentration were statistically significant during the entire course of the investigations.

The mean maximum and minimum value irrespective of years varied within the range of 45.38 to 14.57.

Spiraea canescens Don.

The data pertaining to per cent success in rooting are presented in Table 23. It is apparent from the table that per cent success among seasons, hormones and concentrations varied significantly during both the years. The interactions among factors revealed significant effects. Seasonal fluctuations were similar during both the years. Rainy season was found to be having significantly higher values followed by spring and winter seasons.

Table 22 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Dodonaea viscosa* Linn. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		28.87	32.15	17.08	26.03	25.57	29.55	14.57	23.23
IAA	500	35.26	38.06	18.10	30.47	35.46	36.83	17.75	30.01
(ppm)	1000	37.07	39.62	19.90	32.20	35.19	40.00	19.62	31.60
	2000	30.62	33.62	18.38	27.54	32.56	38.84	16.41	29.27
Mean		34.41	37.10	18.79	28.59	34.40	38.55	17.92	30.29
IBA	500	34.65	32.15	23.84	30.21	39.03	39.81	20.51	33.11
(ppm)	1000	39.04	41.17	26.07	35.42	40.20	41.369	23.05	34.87
	2000	43.08	45.38	27.73	38.73	45.96	49.80	25.06	40.27
Mean		38.92	39.50	25.88	34.75	41.73	43.65	22.87	36.08
NAA	500	32.37	32.90	18.10	26.97	34.86	36.47	18.09	29.80
(ppm)	1000	37.06	30.43	20.54	31.62	36.07	38.84	20.84	31.91
	2000	29.75	37.24	19.56	27.71	31.02	31.30	17.28	26.72
Mean		33.01	36.85	19.40	28.76	34.00	35.53	18.72	29.47
Mean		33.79	36.56	20.29		33.92	36.82	18.45	
Season x Concentration									
Concen-	500	34.09	37.70	20.01	30.70	36.45	37.70	18.78	30.79
tration	1000	37.74	37.07	22.17	32.77	37.15	40.06	21.17	32.79
(ppm)	2000	34.48	38.78	21.89	31.70	36.51	39.98	19.50	32.08

CD (0.05)	1988	1989
Season	0.50	0.48
Hormones	0.58	0.93
Concentration	0.61	0.65
Seasons x Hormones	0.89	1.35
Seasons x Concentrations	1.09	1.17
Hormone x Concentrations	1.11	1.28
Seasons x Hormones x Concentration	2.02	2.35

Table 23. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Spiraea canescens* Don. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		23.04	24.06	13.29	20.13	23.79	26.79	17.09	22.55
IAA	500	36.47	37.66	18.09	30.74	34.03	35.86	21.41	30.43
(ppm)	1000	38.25	40.20	20.83	33.09	36.87	39.23	24.08	33.39
	2000	32.15	32.58	16.68	27.14	32.57	34.45	18.73	28.58
Mean		35.62	36.81	18.53	27.77	34.49	36.51	21.40	30.80
IBA	500	42.32	44.62	25.82	37.59	43.47	45.95	29.99	39.80
(ppm)	1000	46.72	50.57	29.55	42.28	46.15	48.83	31.52	42.16
	2000	35.26	37.07	27.92	33.41	37.66	38.05	25.82	38.60
Mean		41.43	44.08	27.76	33.35	42.42	44.27	29.11	28.60
NAA	500	36.26	39.22	24.09	33.19	36.46	33.58	19.37	29.80
(ppm)	1000	40.20	42.13	26.07	36.13	37.26	39.42	21.97	32.88
	2000	33.28	35.06	19.95	29.46	28.65	27.97	19.36	25.33
Mean		36.63	38.80	23.37	32.92	34.12	33.68	20.23	29.33
Mean		34.18	35.94	20.74		33.70	35.31	21.96	
Season x Concentration									
Concen-	500	38.35	37.59	33.19	33.84	37.99	38.46	23.59	33.35
tration	1000	33.04	42.28	36.13	37.17	40.09	42.49	25.85	36.15
(ppm)	2000	27.14	33.41	29.46	30.00	32.96	33.49	21.30	29.25

CD (0.05)	1988	1989
Season	1.05	0.61
Hormones	0.64	0.48
Concentration	0.57	0.55
Seasons x Hormones	1.55	0.80
Seasons x Concentrations	1.19	1.03
Hormone x Concentrations	1.08	1.01
Seasons x Hormones x Concentration	2.12	1.85

The hormones and concentrations also showed significant differences during both the years. The range of mean maximum and minimum values regardless of seasons, hormones and concentrations ranged from 50.57 to 13.29 in the first year and in the following year the same were 48.83 to 17.09, respectively.

Elaeagnus parvifolia Wall.

Table 24 represents the data pertaining to per cent success in rooting in E. parvifolia. Among different seasons, hormones and concentrations the per cent success was statistically significant during 1988 and 1989. Interaction were found to be statistically significant between hormones, seasons and concentrations.

Winter season was found to be having significantly lower values during both the years. Among hormones IBA had a better impact on rooting in comparison NAA (intermediate) and IAA (least). A concentration of 1000 ppm exhibited statistically highest per cent of success in rooting in comparison to 500, 2000 and 0 ppm of hormones.

The mean values irrespective of seasons, hormone and concentrations respectively varied from 49.21 to 20.23 in the first year and from 48.44 to 19.37 in the second year.

Viburnum nervosum Don.

The data pertaining to per cent success in rooting of V. nervosum are presented in Table 25. The perusal of the

TABLE 24. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Elaeagnus parvifolia Wall. under field condition.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	50.21	32.15	20.23	27.53	28.64	31.07	20.27	26.66
IAA	500	29.71	32.37	19.95	27.35	29.77	31.94	26.69	22.80
(ppm)	1000	32.79	34.40	20.83	29.34	31.52	33.62	25.85	29.99
	2000	33.41	36.06	24.59	31.35	34.45	36.66	25.35	31.82
	Mean	51.97	54.27	41.79	49.34	31.91	34.07	25.95	30.67
IBA	500	43.66	45.76	27.04	38.82	41.16	45.38	30.31	38.92
(PPM)	1000	47.68	49.21	29.53	42.07	40.57	48.44	31.30	40.10
	2000	36.28	37.66	27.00	33.64	44.03	41.06	22.50	30.87
	Mean	42.54	55.21	47.85	33.18	41.92	42.28	28.04	37.18
NAA	500	31.29	33.00	24.35	29.54	36.66	39.81	22.11	32.86
(ppm)	1000	35.05	37.06	24.35	52.16	38.64	36.87	25.09	33.53
	2000	30.43	30.65	21.68	27.58	25.56	30.39	19.37	25.10
	Mean	52.26	33.57	43.46	36.44	33.62	35.69	22.19	30.49
	Mean	54.24	56.05	43.32		35.81	37.31	25.39	
Season x concentration									
concent-	500	34.88	37.04	23.78	31.90	35.86	39.04	26.37	33.19
ration	1000	38.50	40.22	24.90	41.19	38.57	39.64	27.41	35.09
(ppm)	2000	34.37	34.79	24.42	30.86	31.34	34.37	22.40	29.26

CD(0.05)

1988

1989

Seasons	0.65	0.79
Hormones	0.52	0.61
Concentration	0.58	0.55
Seasons x Hormones	0.85	1.01
Seasons x concentration	1.08	1.07
Hormone x concentration	1.06	1.03
Seasons x Hormones x Conc	1.95	1.96

Table 25 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Viburnum nervosum Don. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		30.21	32.57	18.42	27.02	28.88	32.55	19.33	26.92
IAA	500	30.64	38.05	20.25	29.65	29.30	38.25	19.96	29.17
(ppm)	1000	34.25	40.00	22.47	32.24	33.20	40.20	20.13	31.17
	2000	30.85	34.01	20.08	28.31	29.76	40.19	19.04	29.66
Mean		31.91	37.36	20.93	30.06	30.76	39.54	19.71	30.00
IBA	500	41.94	45.95	27.25	38.38	42.51	43.46	25.82	37.26
(ppm)	1000	40.20	42.88	25.08	36.05	40.97	41.46	23.31	32.75
	2000	34.85	40.39	24.09	33.11	35.46	39.38	20.83	31.89
Mean		38.99	43.07	26.47	35.84	39.64	42.50	23.32	34.19
NAA	500	30.87	35.85	20.13	28.93	31.66	32.37	22.94	28.99
(ppm)	1000	35.66	38.84	20.36	31.59	33.83	33.83	22.19	29.95
	2000	31.30	35.66	19.49	28.82	32.15	30.21	21.14	27.83
Mean		32.59	36.78	19.96	29.78	32.54	32.10	22.09	28.92
Mean		33.43	37.47	21.20		32.96	35.96	21.11	
Season x Concentration									
Concen-	500	34.46	39.95	22.54	33.32	34.49	38.02	22.90	31.80
tration	1000	36.70	40.57	22.60	33.29	36.00	38.49	21.87	31.29
(ppm)	2000	32.32	36.69	21.23	30.08	32.46	37.26	20.33	30.01

CD (0.05)

1988

1989

Season	0.73	1.48
Hormones	0.86	0.85
Concentration	0.78	0.81
Seasons x Hormones	N.S.	1.57
Seasons x Concentrations	1.45	1.68
Hormone x Concentrations	1.48	1.51
Seasons x Hormones x Concentration	N.S.	2.98

data reveals that season, hormone and concentration and their interactions have a significant impact on per cent rooting. Rainy season was found to have statistically higher values during both the years, whereas winter season was found to have lower values. The IBA was found to be statistically superior to others. A concentration of 500 ppm was the best for various hormones, it was followed by 1000 and 2000 ppm.

The maximum and minimum values varied from 45.95 to 18.42 in 1988 and it ranged from 43.46 to 19.33 in 1989, respectively.

Desmodium tiliaefolium Don.

The mean values and critical difference on the effect of season, hormone and concentration and their interactions for the two consecutive years 1988 and 1989 are presented in Table 26.

The data reveal that there exist significant differences amongst seasons, hormones and concentrations as well as among interactions during both the years.

In case of seasons, rainy season was found to be superior to others, whilst IBA at a concentration of 2000 ppm was found to be significantly superior to all other counterparts. Rest, the interactions followed a similar trend during both the years.

Irrespective of factors, the maximum and minimum mean

Table 26 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Desmodium tiliaefolium Don. under field conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		16.37	17.39	11.53	15.10	17.41	21.13	13.30	17.28
IAA	500	30.86	32.15	19.90	27.64	31.09	31.93	21.96	28.33
(ppm)	1000	33.20	34.03	22.47	30.00	33.61	34.65	23.57	30.61
	2000	31.08	30.85	20.27	27.40	31.50	31.51	21.96	28.33
Mean		31.71	32.34	20.98	28.34	32.07	32.70	22.50	29.09
IBA	500	38.45	39.62	25.10	34.39	38.44	40.49	27.27	35.43
(ppm)	1000	40.00	41.35	24.59	35.32	42.30	38.25	36.32	35.63
	2000	43.08	42.12	28.19	37.80	42.70	43.47	28.88	38.35
Mean		40.51	41.03	25.96	35.93	41.14	40.77	27.49	36.27
NAA	500	28.84	30.86	20.51	26.74	27.73	30.62	21.10	26.48
(ppm)	1000	31.07	31.73	23.83	28.88	31.04	33.83	23.05	29.31
	2000	30.87	29.60	20.79	27.11	28.64	30.21	20.84	26.87
Mean		30.27	30.73	21.71	27.57	29.14	37.55	21.66	27.45
Mean		29.71	30.38	20.05		29.94	31.54	21.24	
Season x Concentration									
Concen-	500	32.72	34.21	21.84	29.59	32.42	34.38	23.44	32.08
tration	1000	34.75	35.70	23.73	31.40	35.65	35.57	24.31	31.85
(ppm)	2000	35.01	34.21	23.08	30.77	34.28	35.06	23.89	31.08

CD (0.05)

1988

1989

Season

0.55

0.67

Hormones

0.59

0.43

Concentration

0.84

0.89

Seasons x Hormones

0.91

0.76

Seasons x Concentrations

1.55

1.11

Hormone x Concentrations

1.50

1.06

Seasons x Hormones x Concentration

2.67

1.96

values varied from 43.08 to 11.53 during 1988 and 43.47 to 13.30 during 1989, respectively.

Vitex negundo Linn.

The data presented in Table 27 show, that the mean maximum and minimum values varied from 82.73 to 35.96 during 1988 whereas their corresponding values were 87.50 to 36.58 during 1989. The per cent success in rooting showed significant variation between seasons hormones and concentrations. A specific pattern of seasonal variation could be visualized and the trend was observed to be similar during both the years. The hormone IBA at a concentration of 1000 ppm had given best results. These were statistically superior to all others during both the years. In sum, expecting only season x concentration which was non-significant in the first year, while rest of them were found to be significant.

2.2 Propagation under mist

Specieswise performance is as follows:

Woodfordia fruticosa Kurz.

The data presented in Table 28, show that the mean maximum and minimum values for per cent success in rooting varied from 80.11 to 51.75 irrespective of years. The per cent success showed significant variation across seasons, hormones and concentrations. Rainy season was found to

TABLE 27 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting *Vitex negundo* Linn. under field conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control	0	59.79	62.73	35.96	52.82	62.50	67.50	36.58	59.28
IAA	500	70.38	70.38	44.43	61.73	71.35	72.39	39.81	61.81
(ppm)	1000	74.35	75.35	46.14	65.28	74.54	76.39	41.85	64.26
	2000	67.10	70.00	45.19	60.76	72.76	70.38	40.59	61.24
	Mean	70.61	71.91	45.26	62.59	72.88	73.05	40.65	62.23
IBA	500	76.79	78.09	53.53	69.47	77.43	84.17	54.94	72.18
(PPM)	1000	79.79	82.73	55.96	72.82	82.50	87.50	56.58	75.52
	2000	75.15	80.67	53.53	69.78	71.74	78.70	52.99	67.74
	Mean	77.24	80.49	54.34	70.69	77.22	83.45	54.93	71.81
NAA	500	68.64	66.14	40.00	58.26	68.06	71.55	44.24	61.28
(ppm)	1000	70.38	72.93	42.32	61.87	70.75	73.13	49.50	64.46
	2000	69.03	67.29	39.03	58.45	66.53	69.03	45.62	60.39
	Mean	69.35	68.78	40.45	59.52	68.44	71.23	46.46	62.04
	Mean	72.40	73.72	46.68		72.84	75.91	47.31	
Season x concentration									
concent-	500	71.93	71.53	45.98	63.14	72.28	76.04	44.59	64.30
ration	1000	74.84	77.00	48.14	66.66	75.93	79.00	46.24	67.05
(ppm)	2000	70.43	72.65	45.92	63.00	70.34	72.70	44.12	62.38
CD(0.05)						1988	1989		
Seasons						0.86	0.44		
Hormones						0.55	0.39		
concentrations						0.90	0.40		
season x Hormone						0.98	0.65		
season x concentration						N.S.	0.76		
hormone x concentration						0.96	0.74		
Season x Hormone x concentration						1.86	1.38		

Table 28. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent in success in rooting in Woodfordia fruticosa under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		55.76	54.73	52.15	54.21	54.54	55.37	51.75	53.86
IAA	500	57.20	61.34	56.79	58.44	61.17	60.48	57.63	59.76
(ppm)	1000	58.26	61.41	57.42	59.63	61.80	63.20	57.94	60.94
	2000	60.01	61.80	58.91	60.24	65.42	64.90	58.48	62.93
Mean		58.49	61.51	57.77	59.23	62.79	62.86	57.98	61.21
IBA	500	65.20	64.16	59.81	63.05	65.66	69.17	60.66	65.16
(ppm)	1000	71.89	71.29	66.71	69.96	74.68	80.91	71.26	75.62
	2000	65.20	67.69	65.67	66.19	66.32	70.63	60.45	65.79
Mean		67.73	67.57	67.01	66.40	68.88	73.57	64.12	68.70
NAA	500	60.92	60.67	59.38	60.32	62.51	64.42	57.20	61.37
(ppm)	1000	58.06	61.12	57.42	58.86	60.07	62.48	56.25	59.60
	2000	57.21	61.63	67.00	58.61	58.91	59.13	51.66	55.56
Mean		58.73	61.14	57.93	59.26	60.50	62.01	55.03	58.84
Mean		60.10	61.23	57.96		61.67	63.45	57.73	
Season x Concentration									
Concen-	500	61.10	60.05	58.32	59.82	63.11	64.69	58.49	62.09
tration	1000	62.73	64.60	60.51	62.61	52.51	68.86	61.78	65.38
(ppm)	2000	60.80	63.70	60.52	61.67	63.55	64.88	56.86	61.76

CD (0.05)	1988	1989
Season	1.05	1.06
Hormones	0.89	0.88
Concentration	0.86	1.29
Seasons x Hormones	N.S.	N.S.
Seasons x Concentrations	1.65	1.62
Hormone x Concentrations	1.63	1.03
Seasons x Hormones x Concentration	N.S.	N.S.

be having significantly higher values followed by spring and winter seasons. Winter season could not reflect any appreciable impact to promote rooting since the lowest categorised results were obtained in winter season.

The hormones and concentrations also showed significant differences with regard to per cent success in rooting during both the years. The season x hormonal and season x hormone x concentration interactions were non-significant in both of the years, while rest of the interactions were significant during the entire course of investigations.

Murraya koenigii Spreng.

Table 29 represents the per cent success in rooting in M. koenigii. The per cent success amongst different seasons, hormones and concentrations was found to be significant during 1988 and 1989. Interactions among different factors were also significant during both the years.

The mean values of the rainy season revealed significantly higher rooting per cent in contrast to spring and winter. Among the hormones IBA was found to have significantly higher values than others during both the years. It is clear from the data that a concentration of 1000 ppm was the most promising followed by 500, 2000 and 0 ppm.

The mean maximum and minimum values irrespective of seasons, hormones and concentrations ranged from 48.84 to

Table 29. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Murraya koenigii under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		33.21	35.23	34.24	34.32	33.42	33.62	33.42	33.48
IAA	500	34.04	34.25	33.20	33.83	34.03	34.65	33.62	34.10
(ppm)	1000	34.04	34.65	35.01	34.58	34.24	34.65	34.63	34.60
	2000	35.07	37.23	35.45	35.91	34.29	37.83	35.26	35.79
Mean		34.38	35.37	34.56	34.71	34.19	35.71	34.50	34.80
IBA	500	41.75	42.33	39.43	41.16	47.13	42.90	40.20	41.34
(ppm)	1000	48.64	48.84	45.57	47.68	48.83	49.27	46.15	48.06
	2000	41.17	41.56	39.62	40.78	40.97	41.74	40.20	40.97
Mean		43.85	44.24	41.54	43.20	45.64	44.63	42.18	43.45
NAA	500	34.04	34.04	33.20	33.76	35.05	35.05	33.62	34.58
(ppm)	1000	35.65	34.85	33.41	34.30	35.27	35.66	34.45	35.12
	2000	33.83	37.22	27.21	32.79	33.83	34.65	30.18	32.88
Mean		34.50	35.38	31.29	33.61	34.71	35.12	32.75	34.19
Mean		36.40	37.55	25.41		36.67	37.27	35.71	
Season x Concentration									
Concen-	500	36.61	36.87	35.27	36.25	38.75	37.53	35.81	37.37
tration	1000	39.44	39.44	38.14	39.00	39.44	39.86	38.41	39.23
(ppm)	2000	36.69	38.85	34.11	36.55	36.36	38.07	35.21	36.54

CD (0.05)	1988	1989
Season	1.20	1.00
Hormones	0.55	0.39
Concentration	0.50	0.62
Seasons x Hormones	1.11	1.22
Seasons x Concentrations	1.16	1.31
Hormone x Concentrations	0.96	0.98
Seasons x Hormones x Concentration	2.92	2.12

27.21 in 1988 and their corresponding values were 49.27 to 30.18 during 1989, respectively.

Prinsepia utilis Royle

The data related to per cent success in rooting against different seasons, hormones and concentrations are presented in Table 30. During the entire course of investigations, it was found that there was non-differential response of seasons, on account of non-significant results. The IBA proved to be superior to IAA and NAA and a concentration of 1000 ppm had given best results. The interaction between hormones x concentration was found to be significant during both the years. While other interactions were non-significant either in one year or both of the years.

Regardless of seasons, hormones and concentrations the mean maximum and minimum values were 60.25 to 29.07 during 1988 and 60.90 to 31.09 during 1989, respectively.

Zizyphus oxyphylla Edgw.

A perusal of data in Table 31 reveals that there was non-differential response of seasons on account of non-significant results, IBA was found to have significantly higher values in comparison to others, during both the years. It is evident from the data that a concentration of 1000 ppm had significantly better performance.

Interactions among different factors were significant

Table 30. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Prinsepia utilis* Royle. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		29.73	29.98	29.07	29.66	31.52	31.73	31.09	31.44
IAA	500	41.93	42.14	42.51	42.19	41.74	40.78	42.32	41.61
(ppm)	1000	43.47	43.47	43.08	43.34	41.75	41.92	42.99	43.22
	2000	43.09	43.66	44.42	43.72	41.74	43.43	44.24	43.13
Mean		42.83	43.09	43.33	43.08	41.74	43.05	43.18	42.65
IBA	500	54.76	53.75	53.75	54.08	54.34	55.56	53.74	54.55
(ppm)	1000	60.25	58.05	60.72	59.67	60.90	59.12	57.20	59.68
	2000	55.56	54.53	51.55	53.88	56.17	54.15	52.36	54.23
Mean		56.79	55.38	55.33	55.88	57.14	56.27	54.44	56.15
NAA	500	41.74	43.66	42.33	42.57	40.59	42.32	40.20	41.03
(ppm)	1000	43.47	41.73	42.70	42.63	43.17	43.09	41.17	41.81
	2000	41.54	40.18	40.78	40.83	39.42	40.40	49.62	39.89
Mean		42.25	41.83	49.91	42.01	40.39	41.93	40.33	54.16
Mean		42.41	42.12	42.42		42.87	43.00	42.25	
Season x Concentration									
Concen-	500	46.14	46.51	46.18	46.27	45.57	46.22	45.42	45.74
tration	1000	49.06	47.75	48.83	48.55	47.94	48.04	47.12	47.70
(ppm)	2000	46.73	46.12	45.58	46.24	45.77	45.99	45.41	45.72

CD (0.05)

1988

1989

Season	N.S.	N.S.
Hormones	6.79	0.89
Concentration	0.80	0.48
Seasons x Hormones	N.S.	N.S.
Seasons x Concentrations	N.S.	N.S.
Hormone x Concentrations	1.48	1.02
Seasons x Hormones x Concentration	N.S.	N.S.

Table 31. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Zizyphus oxyphylla* Edgw. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		43.85	39.43	43.66	42.31	42.13	43.08	43.66	42.96
IAA	500	45.38	47.49	47.49	46.78	48.46	45.76	50.19	48.13
(ppm)	1000	52.93	54.54	52.14	53.20	52.54	54.53	51.74	52.94
	2000	48.07	45.57	49.99	47.88	49.60	47.10	49.79	48.83
Mean		48.75	49.20	49.97	47.29	50.20	49.13	50.57	49.96
IBA	500	63.69	65.15	65.80	64.74	66.99	68.60	65.40	66.99
(ppm)	1000	58.29	61.83	56.79	58.97	59.42	64.89	59.61	61.31
	2000	57.21	57.63	58.97	57.94	61.80	62.96	61.57	62.11
Mean		59.73	61.53	61.36	60.55	62.63	65.48	62.19	63.46
NAA	500	46.15	47.10	49.79	47.68	47.87	48.45	49.99	48.77
(ppm)	1000	53.73	52.50	51.74	52.68	43.08	53.93	56.79	51.26
	2000	46.15	47.50	49.79	47.81	48.06	44.42	48.83	47.10
Mean		48.67	49.06	50.49	49.39	46.23	48.93	51.87	49.04
Mean		50.26	49.80	51.09		50.39	51.66	52.07	
Season x Concentration									
Concen-	500	51.74	53.24	54.87	53.28	54.33	54.27	55.19	54.61
tration	1000	54.98	56.29	53.55	53.94	51.68	57.78	56.04	55.16
(ppm)	2000	50.47	50.25	52.92	51.21	53.15	51.50	53.40	52.68

CD (0.05)		1988	1989
Season		N.S.	0.54
Hormones		0.74	0.78
Concentration		0.62	0.64
Seasons x Hormones		N.S.	1.19
Seasons x Concentrations		1.24	1.16
Hormone x Concentrations		1.18	1.22
Seasons x Hormones x Concentration		2.28	2.22

in one or the other year. The mean maximum and minimum values irrespective of seasons, hormones and concentrations ranged from 65.15 to 43.66 in 1988 and their corresponding values were 68.60 to 43.08 during 1989, respectively.

Carissa carandas Linn.

The results on per cent success in rooting of C. carandas as obtained from periodical investigations are presented in Table 32. It was noticed that there was non-differential response of seasons, while different hormones and concentrations had given significantly variable results.

In case of hormones, IBA was found to be statistically superior to others, whereas a concentration of 1000 ppm had proved its superiority over other concentrations during both the years. All the interactions were significant in the first year of study, while hormone x concentration and season x hormone x concentration were only the significant interactions in the following year.

Regardless of seasons, hormones and concentrations the mean maximum and minimum value ranged from 64.91 to 34.03 during 1988 and 69.03 to 35.84 during 1989, respectively.

Adhatoda vasica Nees.

The perusal of data (Table 33) had revealed that there was non-differential response of seasons under consideration. The IBA has recorded the maximum rooting

Table 32. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Carissa carandas* Linn. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		35.65	36.44	34.03	35.37	35.84	36.25	37.04	36.38
IAA	500	49.03	45.59	45.72	46.79	54.95	54.56	52.34	53.95
(ppm)	1000	42.32	43.28	42.32	42.64	48.83	47.10	47.68	47.87
	2000	42.89	40.59	40.20	41.20	54.95	45.38	46.39	33.78
Mean		44.74	43.15	42.76	43.54	52.91	49.01	48.79	45.26
IBA	500	45.00	61.12	62.26	56.94	58.59	46.53	48.06	51.06
(ppm)	1000	56.59	64.43	64.91	61.97	69.03	65.45	64.41	66.29
	2000	45.96	59.58	59.35	54.96	58.48	61.60	59.78	59.99
Mean		49.58	61.71	62.29	57.69	62.03	57.86	57.42	59.50
NAA	500	36.86	49.22	47.49	44.52	41.74	42.70	40.59	41.67
(ppm)	1000	38.64	46.53	49.22	44.71	49.21	48.64	48.26	48.70
	2000	34.08	41.74	39.23	37.99	42.89	40.54	50.77	41.41
Mean		35.16	45.83	45.31	52.93	44.60	43.96	43.96	43.92
Mean		41.43	46.78	46.07		47.99	46.72	46.61	
Season x Concentration									
Concen-	500	43.63	51.97	52.00	49.20	50.75	47.93	46.99	48.55
tration	1000	45.85	51.41	62.15	49.80	55.69	52.73	53.51	54.37
(ppm)	2000	40.64	47.30	46.26	44.73	48.77	49.17	49.31	48.08

CD (0.05)	1988	1989
Season	N.S.	N.S.
Hormones	0.57	0.98
Concentration	0.66	1.02
Seasons x Hormones	1.31	N.S.
Seasons x Concentrations	1.48	N.S.
Hormone x Concentrations	1.20	1.88
Seasons x Hormones x Concentration	2.51	3.61

Table 33. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Adhatoda vasica* Nees. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		57.17	56.79	54.33	55.76	54.39	50.07	52.93	52.46
IAA	500	64.17	66.81	61.12	64.04	63.25	62.29	60.23	61.93
(ppm)	1000	64.66	65.91	70.03	66.86	62.29	61.36	67.01	63.55
	2000	62.96	64.44	67.49	64.95	62.00	60.39	60.26	60.88
Mean		63.93	66.71	66.21	65.28	62.51	61.35	62.50	62.11
IBA	500	68.31	69.45	63.38	67.14	69.96	68.86	66.34	68.38
(ppm)	1000	69.78	71.26	65.40	68.81	72.29	69.99	66.44	69.57
	2000	63.91	67.76	67.01	66.89	65.96	64.66	66.08	65.57
Mean		68.00	69.41	65.36	67.61	69.40	67.83	66.28	68.17
NAA	500	65.13	68.40	69.17	67.56	61.39	64.14	64.47	65.00
(ppm)	1000	56.29	63.68	60.49	60.15	60.31	50.96	61.12	57.46
	2000	51.51	58.48	58.40	56.16	60.20	51.56	58.91	56.89
Mean		57.69	63.53	62.77	61.29	60.63	55.55	61.50	59.78
Mean		61.43	63.62	62.15		61.73	58.69	60.80	
Season x Concentration									
Concen-	500	65.87	68.20	64.65	66.24	64.87	65.09	63.67	64.47
tration	1000	63.57	66.95	65.30	65.24	64.96	60.77	64.85	63.52
(ppm)	2000	60.13	63.55	64.33	62.67	62.72	58.87	61.75	61.11

CD (0.05)	1988	1989
Season	N.S.	N.S.
Hormones	2.13	1.00
Concentration	1.70	1.12
Seasons x Hormones	N.S.	N.S.
Seasons x Concentrations	3.12	N.S.
Hormone x Concentrations	3.22	2.04
Seasons x Hormones x Concentration	N.S.	N.S.

success, which is closely followed by IAA on account of statistically similarities in 1988 while in the following year it was statistically superior to rest of the treatments and a concentration of 500 ppm had given maximum rooting success when it was compared to others viz., 1000 and 2000 ppm, during both the years. Only the interaction between hormone x concentration was the only significant interaction during both the years.

The mean maximum and minimum value irrespective of years ranged from 71.26 to 51.51 during 1988 and 72.29 to 50.07 during 1989, respectively.

Rosa moschata Mill.

The observations recorded in both the years (Table 34) reveal that for successful rooting rainy season is the best season, while spring and winter seasons were statistically at par with each other. The IBA registered statistically higher values of rooting per cent than NAA and IAA.

There was a steady increase in per cent success in rooting upto 1000 ppm, thereafter, a decline took place.

All the interactions, except for season x concentration were significant in one or both the years. The mean maximum and minimum values varied from 79.24 to 52.73, respectively, irrespective of years. .

Table 34. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Rosa moschata* Mill. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		55.14	54.33	54.51	54.67	55.35	54.75	52.73	54.27
IAA	500	63.70	65.16	62.72	63.86	62.50	64.96	69.73	65.72
(ppm)	1000	68.36	72.95	65.15	68.82	67.49	68.30	70.03	68.61
	2000	65.11	67.24	65.80	66.06	63.00	65.65	67.06	65.23
Mean		65.75	65.12	64.55	66.24	64.33	66.30	68.94	65.52
IBA	500	73.62	75.49	71.60	73.57	75.88	76.70	72.55	75.00
(ppm)	1000	73.55	79.24	76.32	76.43	79.12	78.10	76.83	78.32
	2000	70.64	79.20	71.27	73.29	71.61	72.66	70.72	71.66
Mean		68.29	70.84	68.42	69.18	70.72	70.52	68.21	69.82
NAA	500	69.46	68.87	65.42	68.08	64.95	65.06	68.02	66.30
(ppm)	1000	70.03	70.33	65.11	68.50	68.30	70.40	69.63	68.84
	2000	62.59	66.98	64.16	64.58	65.65	64.16	66.95	64.32
Mean		67.36	68.72	65.92	67.17	66.30	66.84	68.20	66.48
Mean		65.23	66.96	64.30		65.07	65.92	65.73	
Season x Concentration									
Concen-	500	68.93	69.84	66.74	68.50	67.75	69.20	70.12	69.02
tration	1000	70.71	71.17	68.87	71.25	71.70	72.23	71.83	71.92
(ppm)	2000	66.13	69.50	67.07	67.57	65.48	67.49	68.25	67.07

CD (0.05)

1988

1989

Season	0.94	N.S.
Hormones	1.10	0.63
Concentration	1.00	0.78
Seasons x Hormones	N.S.	1.15
Seasons x Concentrations	N.S.	N.S.
Hormone x Cncentrations	1.68	1.42
Seasons x Hormones x Concentration	N.S.	0.70

Jasminum officinale Linn.

Table 35 represents the data on per cent success in rooting in J. officinale. The per cent success among different hormones and concentrations were found to be significant during the years of observation. The season x concentration and hormone x concentration interactions were found to be significant.

Among hormones IBA had statistically higher values in comparison to IAA and NAA. A concentration of 500 ppm was proved to be the best studied concentration when a comparison was made with other concentrations.

The mean values, irrespective of season, hormone and concentration varied from 78.00 to 51.16 during 1988 and their corresponding values were 77.63 to 52.73 during 1989, respectively.

Berberis lycium Royle

From the perusal of data on per cent success in rooting in B. lycium (Table 36), it is clear that there is no seasonal variation, while per cent rooting success differed significantly between different hormones and concentrations during both the years. The interactions between different hormones x concentration and season x concentration only were found to be significant during both 1988 and 1989 years.

Amongst hormones, IBA was found to have significantly

Table 35. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Jasminum officinale* Linn. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		52.74	53.54	51.16	52.47	54.34	52.73	55.14	54.07
IAA	500	60.94	61.57	60.90	61.13	59.35	57.00	57.00	57.78
(ppm)	1000	60.27	61.34	57.85	59.82	57.63	60.45	58.13	58.73
	2000	61.80	58.71	61.80	60.77	60.02	58.11	62.26	60.39
Mean		58.92	58.79	57.92	58.54	57.83	57.27	58.38	57.83
IBA	500	78.00	77.54	76.12	77.22	77.63	77.20	77.59	77.47
(ppm)	1000	63.62	64.90	66.95	65.17	70.63	68.72	64.91	68.08
	2000	62.96	64.20	66.83	64.66	63.92	66.50	60.25	63.55
Mean		68.21	68.88	69.96	69.01	70.48	70.80	62.58	69.70
NAA	500	59.36	61.80	60.67	60.61	59.36	57.42	58.96	58.38
(ppm)	1000	60.69	58.27	62.27	60.41	60.46	59.79	60.04	60.09
	2000	58.27	59.13	58.49	58.63	58.05	58.07	57.42	57.85
Mean		59.44	59.73	60.48	59.38	59.29	58.44	58.80	58.34
Mean		60.34	60.67	60.44		60.84	60.19	60.24	
Season x Concentration									
Concen-	500	66.10	66.97	65.89	66.32	65.45	63.87	64.51	64.61
tration	1000	61.54	61.50	62.35	61.79	62.90	62.92	61.02	62.28
(ppm)	2000	61.01	60.68	62.37	61.35	60.66	61.16	59.98	60.60

CD (0.05)

1988

1989

Season
 Hormones
 Concentration
 Seasons x Hormones
 Seasons x Concentrations
 Hormone x Concentrations
 Seasons x Hormones x Concentration

N.S.
 1.29
 0.84
 N.S.
 1.56
 1.68
 N.S.

N.S.
 1.27
 0.86
 N.S.
 1.82
 1.51
 N.S.

Table 36. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Berberis lycium Royle. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		28.20	30.20	27.02	28.47	27.96	28.42	27.50	27.96
IAA	500	31.31	31.51	32.16	31.66	30.43	30.87	31.27	30.86
(ppm)	1000	31.08	31.94	32.16	32.37	31.73	31.74	31.93	31.80
	2000	28.18	30.65	30.64	29.83	29.34	29.99	27.96	29.09
Mean		30.19	31.36	31.72	30.09	30.80	30.86	30.38	30.58
IBA	500	40.01	41.16	40.97	40.71	44.24	43.86	41.16	43.08
(ppm)	1000	48.45	49.32	47.48	48.38	45.96	46.14	46.11	46.06
	2000	38.84	39.42	39.04	39.10	42.17	43.47	39.42	41.86
Mean		42.43	43.26	42.49	42.73	44.30	44.49	42.56	43.78
NAA	500	29.77	31.30	31.30	30.79	29.32	29.99	28.79	29.36
(ppm)	1000	31.51	32.58	32.57	32.22	31.06	31.08	29.05	30.40
	2000	28.58	28.88	28.14	28.63	27.50	27.96	27.46	27.64
Mean		29.95	30.92	30.67	30.54	29.29	29.69	27.76	28.67
Mean		32.72	33.94	32.98		33.01	33.36	32.05	
Season x Concentration									
Concen-	500	33.69	37.01	31.97	34.39	34.66	34.90	34.78	34.78
tration	1000	34.66	37.91	32.98	37.47	36.25	36.32	36.06	36.21
(ppm)	2000	34.81	37.47	32.60	32.52	33.18	33.90	31.61	32.86

CD (0.05)	1988	1989
Season	N.S.	0.54
Hormones	0.41	0.78
Concentration	0.46	0.45
Seasons x Hormones	N.S.	N.S.
Seasons x Concentrations	1.06	N.S.
Hormone x Concentrations	0.86	0.98
Seasons x Hormones x Concentration	N.S.	1.86

higher values than others during both the years. It is also clear from the data that a steady increase was observed upto a concentration of 1000 ppm but when it goes beyond this limit a negative influence was observed. The mean maximum and minimum values irrespective of season hormone and concentration ranged from 49.32 to 27.02 in 1988 and their corresponding values were 46.14 to 27.46, respectively.

B. aristata DC.

The results on per cent success in rooting as obtained from periodical examination, are presented in Table 37. It was noticed that all the seasons were statistically at par with each other and non-significant results were obtained but the per cent success in rooting among different hormones and concentration showed significant differences during both the years.

IBA hormone was having statistically higher values than others. There was no appreciable difference between 500 and 2000 ppm of concentration, while 1000 ppm of concentration was the significantly better concentration over others.

Only season x concentration interaction was non-significant but rest of the interactions were significant during the entire course of investigations.

In the first year, the mean maximum and minimum values were 45.57 to 26.80; whereas, the corresponding values

Table 37. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Berberis aristata* DC. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		28.66	29.11	26.80	28.19	27.03	28.20	27.03	27.42
IAA	500	29.29	22.35	30.85	30.83	30.21	30.85	29.53	30.20
(ppm)	1000	33.62	32.65	30.21	32.14	30.87	33.00	31.73	31.86
	2000	30.85	29.32	26.32	29.27	31.09	30.21	27.50	29.60
Mean		31.25	31.51	29.12	30.75	30.74	31.35	29.50	30.55
IBA	500	39.04	39.42	36.87	38.44	37.07	38.05	36.05	37.05
(ppm)	1000	45.38	45.57	38.24	43.07	43.47	43.85	39.42	42.25
	2000	37.46	37.66	36.07	37.06	36.06	35.66	31.94	34.62
Mean		40.62	40.88	37.06	39.52	38.93	39.19	35.80	37.97
NAA	500	29.32	29.33	28.17	28.94	30.21	31.09	27.96	29.75
(ppm)	1000	30.87	31.51	32.99	31.80	31.74	31.52	32.37	31.87
	2000	29.42	30.87	30.31	29.84	28.42	28.88	27.81	28.37
Mean		29.53	30.57	30.44	30.19	30.12	30.83	29.35	29.99
Mean		32.52	33.10	30.86		31.70	32.31	30.45	
Season x Concentration									
Concen-	500	32.55	33.70	31.96	32.74	32.49	33.34	31.18	32.31
tration	1000	36.62	36.55	33.82	35.67	35.36	36.12	34.51	35.35
(ppm)	2000	32.25	33.06	30.86	32.06	31.92	31.58	29.08	30.67

CD (0.05)	1988	1989
Season	0.82	0.82
Hormones	0.36	0.57
Concentration	0.44	0.77
Seasons x Hormones	0.76	0.59
Seasons x Concentrations	N.S.	N.S.
Hormone x Concentrations	0.78	1.00
Seasons x Hormones x Concentration	1.58	1.22

in the following year were 43.85 to 27.03, respectively.

Zanthoxylum armatum Roxb.

The data pertaining to per cent success in rooting are presented in Table 38. It is apparent from the table, per cent success in rooting was significantly different amongst seasons, hormones and concentrations during the years 1988 and 1989.

The rainy season was observed to be the best season in contrast to other seasons. The IBA exhibited highest rooting per cent success followed by IAA and NAA and a concentration of 1000 ppm had given the maximum success during the entire course of investigations. All the interactions excluding season x hormone x concentration were significant during both the years of study.

Regardless of season, hormone and concentration the mean maximum and minimum values were 48.25 to 27.50 during 1988 and 49.41 to 26.80 during 1989, respectively.

Indigofera pulchella Roxb.

The data pertaining to per cent success in rooting among different seasons, hormones and concentrations are presented in Table 39. From the perusal of data, it is clear that the success in rooting during spring and rainy season was distinguishable while winter remained the least effective season. The course of seasonal changes tend to be alike during both the years. Hormones as well as

TABLE 38 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent in success in rooting in zanthoxylum armatum under mist condition.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Raing	Winter	Mean
Control		30.87	32.16	27.50	30.17	29.08	29.33	26.80	28.40
IAA	500	32.37	33.67	34.86	33.63	32.58	27.74	28.42	30.58
(ppm)	1000	33.41	35.26	36.27	34.98	34.04	33.83	34.77	34.21
	2000	34.85	36.67	37.07	36.20	34.25	34.25	28.42	29.97
	Mean	33.54	32.20	36.06	34.94	33.62	31.94	30.53	31.58
IBA									
(PPM)	500	39.42	40.78	39.23	39.81	40.39	40.78	42.89	41.35
	1000	46.15	48.45	47.29	47.29	47.68	49.41	47.29	48.12
	2000	41.73	40.01	40.58	40.77	41.16	39.82	39.04	40.00
	Mean	42.43	43.08	42.36	42.62	43.07	43.33	43.07	43.16
NAA									
(ppm)	500	30.86	31.50	30.22	30.86	31.94	34.39	29.99	32.11
	1000	32.37	33.41	31.31	32.36	33.20	33.62	29.99	32.27
	2000	29.77	31.30	29.73	30.27	33.75	31.91	28.43	31.36
	Mean	31.00	31.73	30.42	31.16	32.96	31.31	29.47	31.91
	Mean	34.46	35.62	34.08		34.68	34.48	33.02	

Season x concentration

concent-									
ration	500	34.21	35.31	34.77	34.76	34.97	34.30	33.76	34.34
(ppm)	1000	37.31	39.04	38.29	38.21	38.30	38.95	37.35	38.20
	2000	35.45	35.99	35.79	35.74	36.38	35.32	31.96	34.55

CD(0.05)		1988	1989
Seasons		0.84	0.78
Hormones		0.52	0.67
Concentration		0.56	0.76
Seasons x Hormones		0.95	1.09
Seasons x concentration		1.10	1.40
Hormone x concentration		1.02	1.40
Seasons x Hormones x Conc		N.S.	2.54

Table 39. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Indigofera pulchella* Roxb. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		48.26	46.72	42.70	45.89	43.30	49.80	48.07	48.38
IAA	500	51.54	54.95	52.54	53.14	52.24	54.95	52.54	53.28
(ppm)	1000	53.74	54.76	53.14	53.87	54.15	55.59	53.73	54.16
	2000	50.19	52.35	51.74	51.43	52.14	52.14	51.94	52.07
Mean		46.39	50.01	52.47	52.81	52.87	54.28	52.55	53.17
IBA	500	59.36	59.14	58.50	58.99	59.78	60.24	58.50	59.90
(ppm)	1000	66.73	68.98	67.70	67.95	67.24	69.46	69.94	67.55
	2000	54.74	56.60	55.76	55.70	53.74	54.14	51.54	53.14
Mean		60.27	61.57	60.44	60.76	60.25	61.28	58.66	60.06
NAA	500	47.68	45.95	48.07	47.23	50.58	52.73	49.03	52.07
(ppm)	1000	54.54	55.96	52.94	54.48	55.14	54.95	51.95	53.14
	2000	49.22	48.44	48.26	48.64	50.97	51.74	49.22	50.64
Mean		50.48	50.12	48.58	50.15	52.23	53.14	50.06	51.95
Mean		52.74	53.11	51.34		53.08	54.61	52.38	
Season x Concentration									
Concen-	500	52.99	53.34	53.03	53.12	54.23	55.97	53.36	54.52
tration	1000	58.33	59.90	57.72	58.65	58.51	59.99	57.20	58.57
(ppm)	2000	51.38	52.47	51.92	51.92	52.28	52.67	50.91	51.97

CD (0.05)

1988

1989

Season

0.97

1.33

Hormones

0.85

0.68

Concentration

0.84

0.62

Seasons x Hormones

N.S.

N.S.

Seasons x Concentrations

1.56

N.S.

Hormone x Concentrations

1.54

1.16

Seasons x Hormones x Concentration

N.S.

N.S.

concentrations showed significant effect on per cent rooting success. Only the interactions between hormone x concentration was found to be significant during the years 1988 and 1989.

Regardless of season, hormone and concentration, the mean maximum and minimum value ranged from 68.98 to 42.70 during 1988 and 69.94 to 43.30 during 1989, respectively.

Nerium indicum Mill.

The mean values and critical difference for the effect of season, hormone, concentration and interactions of the factors on per cent success in rooting on N. indicum for the consecutive years 1987 and 1988 are presented in Table 40.

The data reveal that there exists significant difference amongst hormones and concentrations but there was non-differential response among seasons.

All the interactions, except that between season and hormone, were significant during both the years.

In case of hormones IBA was found to be statistically superior to other, while a substantial increase in per cent success was observed from 0-1000 ppm of concentration.

Irrespective of the factors, the maximum and minimum values varied from 82.67 to 46.41 in 1988 and from 80.28 to 46.72 during 1989, respectively.

Table 40. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Nerium indicum* Mill. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		51.55	52.73	51.74	52.01	55.15	52.73	51.36	53.08
IAA	500	52.96	55.56	53.15	53.88	55.14	53.95	54.34	54.47
(ppm)	1000	54.95	57.00	54.96	55.63	53.53	57.11	51.94	54.19
	2000	60.27	60.70	54.99	58.65	57.01	58.12	55.77	55.65
Mean		56.06	57.70	54.36	56.05	54.89	56.39	54.02	54.87
IBA	500	60.14	61.87	65.92	60.47	60.36	68.34	66.78	67.82
(ppm)	1000	77.35	82.67	78.46	79.49	80.28	79.90	74.70	78.02
	2000	60.67	61.89	59.84	60.80	54.66	59.52	59.12	57.78
Mean		68.81	68.81	68.07	68.58	67.76	68.98	66.86	67.87
NAA	500	55.76	49.61	57.42	54.28	51.35	53.74	52.74	52.62
(ppm)	1000	54.87	52.55	52.99	53.48	53.34	55.97	55.34	54.88
	2000	50.61	46.41	56.53	48.85	48.83	46.72	49.42	48.32
Mean		53.78	50.52	55.20	52.20	51.17	52.14	52.50	51.94
Mean		57.57	57.45	56.62		57.24	57.57	56.18	
Season x Concentration									
Concen-	500	59.11	55.68	58.84	57.88	58.28	58.68	57.97	58.30
tration	1000	62.42	64.07	62.13	62.87	62.38	64.06	60.67	62.37
(ppm)	2000	57.18	57.33	57.11	57.21	53.16	54.80	54.77	54.24

CD (0.05)	1988	1989
Season	N.S.	N.S.
Hormones	1.17	1.54
Concentration	1.12	1.12
Seasons x Hormones	N.S.	N.S.
Seasons x Concentrations	2.45	2.26
Hormone x Concentrations	2.10	2.18
Seasons x Hormones x Concentration	4.23	4.26

Rubus niveus Wall.

From the perusal of data on per cent success in rooting (Table 41), it is apparent that the success percentage differed significantly between different seasons, hormones and concentrations during both the years. Interaction among different factors were also significant though in the first year while season x hormone and season x hormone x concentration were non-significant in the second year.

The mean values revealed that winter season had significantly lower value as compared to others viz., spring and rainy seasons during both the years. Among hormones IBA was found to have significantly higher values than others during both the years. It is clear from the data that a concentration of 1000 ppm was statistically superior to others. The mean maximum and minimum value irrespective of season hormone and concentration ranged 60.62 to 31.29 in 1988 and their corresponding were 65.16 to 29.50 in 1989, respectively.

Debregeasia hypoleuca Wedd.

The results on per cent success in rooting in D. hypoleuca, as obtained from periodical investigations, are presented in Table 42. It elucidates that there was non-differential response of seasons viz., rainy, spring and winter, while there was a significant difference among different hormones and concentrations during both the years.

Table 41. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Rubus niveus* Wall. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		33.21	35.25	34.23	34.23	33.42	38.06	35.66	35.71
IAA	500	40.40	41.93	40.01	40.72	41.74	42.90	40.01	41.55
(ppm)	1000	41.94	42.70	39.04	41.22	42.32	43.83	41.17	42.49
	2000	36.06	36.66	36.87	36.53	40.58	38.21	37.65	38.51
Mean		39.46	40.43	38.69	39.50	51.54	41.05	39.61	40.93
IBA	500	56.80	52.64	53.93	56.12	57.84	57.62	54.14	56.53
(ppm)	1000	60.62	58.48	55.77	58.08	60.91	65.16	59.36	61.81
	2000	54.94	55.76	52.34	54.34	55.38	54.95	52.76	54.35
Mean		57.25	57.29	54.01	56.18	58.04	59.24	55.42	57.56
NAA	500	41.36	42.51	34.03	38.30	36.87	38.25	33.00	35.70
(ppm)	1000	38.31	40.40	36.52	37.24	35.05	36.47	32.15	34.56
	2000	39.03	40.00	31.29	36.77	34.04	36.06	29.50	33.20
Mean		39.90	40.99	39.95	37.77	35.32	36.92	31.55	34.48
Mean		42.50	43.48	38.79		41.99	43.97	40.56	

Season x Concentration

Concen-	500	46.18	47.26	42.66	45.40	45.48	46.26	42.38	44.70
tration	1000	47.29	47.11	43.77	46.08	46.09	48.48	44.22	46.26
(ppm)	2000	43.34	44.13	40.16	42.55	43.32	43.07	39.97	42.12

CD (0.05)	1988	1989
Season	0.51	1.07
Hormones	0.59	0.72
Concentration	0.66	0.64
Seasons x Hormones	0.89	N.S.
Seasons x Concentrations	1.18	1.30
Hormone x Concentrations	1.20	1.22
Seasons x Hormones x Concentration	2.17	N.S.

Table 42. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Debregeasia hypoleuca Wedd. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		43.66	43.27	41.36	42.76	40.40	41.93	39.81	40.71
IAA	500	49.03	49.99	47.87	48.96	47.49	45.45	45.77	46.40
(ppm)	1000	50.00	51.94	49.60	50.51	52.15	52.74	51.45	52.14
	2000	52.93	53.94	51.55	52.80	53.53	54.54	52.14	53.50
Mean		50.65	51.96	49.62	50.73	51.05	51.91	49.89	50.65
IBA	500	58.29	58.77	58.48	58.51	49.02	48.45	47.29	48.25
(ppm)	1000	59.38	61.70	66.98	62.68	59.15	60.35	60.03	60.02
	2000	73.59	76.49	70.63	73.57	73.59	80.26	68.12	73.99
Mean		63.75	65.65	65.36	64.92	60.58	63.20	68.48	60.75
NAA	500	49.41	50.19	48.06	49.22	48.34	50.88	49.61	49.60
(ppm)	1000	51.55	51.74	51.55	51.61	53.15	53.35	53.54	53.34
	2000	47.67	47.29	45.19	46.72	38.25	49.79	48.19	47.74
Mean		49.54	49.74	48.27	49.18	50.08	51.34	49.44	50.22
Mean		51.90	52.65	51.17		50.53	51.93	49.39	
Season x Concentration									
Concen-	500	52.29	52.98	54.47	52.23	48.45	48.26	47.55	48.08
tration	1000	53.64	55.13	56.04	54.94	54.81	55.66	55.04	55.17
(ppm)	2000	58.06	59.24	55.79	57.70	58.46	61.53	55.15	58.38

CD (0.05)	1988	1989
Season	N.S.	0.57
Hormones	0.48	0.72
Concentration	0.73	0.56
Seasons x Hormones	1.02	1.09
Seasons x Concentrations	1.46	1.05
Hormone x Concentrations	1.30	1.69
Seasons x Hormones x Concentration	2.50.	2.11

It is evident from the data that IBA obtained statistically higher percentage of rooting than other hormones. There was a gradual increase in per cent success with an increase in concentration. Likewise, the interactions were also found to be significant during the entire course of study.

In the first year the mean maximum and minimum values varied from 76.49 to 41.36 in 1988, whereas the corresponding values in the following year were 80.26 to 39.81, respectively.

Lonicera quinquelocularis Hardw.

While observing the per cent success in rooting (Table 43), it was found that rainy season was statistically superior to spring and winter seasons. Amongst hormones IBA had proved its superiority over IAA (intermediate) and NAA (least) and a concentration of 1000 ppm registered the highest percentage of rooting amongst all treated cuttings during both the years.

All interactions, excluding season x hormone during both the years were found significant. Regardless of season, hormones and concentrations, the mean maximum and minimum values were 80.70 to 51.55 during 1988 and 81.26 to 50.72 during 1989, respectively.

Plectranthus rugosus Wall.

The experimental evidences recorded in Table 44 make

Table 43. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Lonicera quinquelocularis Hardw. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		52.34	53.93	51.55	52.61	55.14	51.74	51.94	52.94
IAA	500	63.22	68.90	67.06	67.03	66.67	66.71	67.29	66.56
(ppm)	1000	63.68	62.97	59.24	61.96	57.00	57.63	58.06	57.56
	2000	65.15	68.90	67.06	67.03	66.67	66.71	67.29	66.56
Mean		64.02	65.60	63.73	64.45	62.45	64.89	61.89	62.95
IBA	500	67.85	75.70	73.23	72.66	71.95	72.90	67.49	70.78
(ppm)	1000	80.64	80.70	74.29	78.54	81.26	80.69	71.89	77.95
	2000	65.92	67.24	65.94	66.36	67.02	66.17	66.42	66.63
Mean		71.49	74.55	71.16	72.38	73.41	73.25	68.60	71.75
NAA	500	57.42	60.91	58.74	59.03	61.11	62.03	59.34	60.82
(ppm)	1000	56.39	58.71	58.71	57.93	58.05	61.13	57.90	59.05
	2000	57.76	56.17	51.94	54.62	54.54	51.35	50.72	52.22
Mean		57.18	58.59	56.46	57.19	57.70	58.17	55.98	57.36
Mean		61.08	63.17	60.73		62.14	62.01	59.60	
Season x Concentration									
Concen-	500	62.83	67.18	65.62	65.21	65.58	68.42	62.35	65.45
tration	1000	67.39	69.43	66.69	67.83	68.65	69.51	65.71	67.95
(ppm)	2000	61.78	62.13	59.04	60.98	59.52	58.38	58.41	58.71

CD (0.05)

1988

1989

Season

1.60

1.16

Hormones

0.81

0.92

Concentration

0.92

1.38

Seasons x Hormones

N.S.

N.S.

Seasons x Concentrations

1.89

1.82

Hormone x Concentrations

1.69

1.31

Seasons x Hormones x Concentration

3.29

2.82

Table 44. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Plectranthus rugosus Wall. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		50.77	51.94	51.16	51.29	47.29	51.36	46.14	48.26
IAA	500	64.68	67.23	63.20	65.04	66.95	71.25	68.40	67.87
(ppm)	1000	63.22	65.40	62.75	63.79	70.63	72.55	66.95	70.04
	2000	63.44	66.20	60.91	63.51	60.46	63.20	62.02	61.89
Mean		63.78	66.28	62.29	64.11	66.01	69.00	65.79	66.60
IBA	500	70.44	71.92	71.25	71.20	71.89	74.40	68.06	71.45
(ppm)	1000	78.98	81.26	73.57	77.93	74.29	76.83	70.63	73.92
	2000	73.22	73.92	67.83	71.66	68.03	72.28	64.90	68.40
Mean		74.21	75.70	70.88	73.59	71.40	74.50	63.86	71.25
NAA	500	61.57	62.97	58.71	61.88	65.42	68.30	58.06	63.92
(ppm)	1000	60.01	60.99	58.91	59.93	61.13	59.56	57.64	59.44
	2000	57.88	59.78	57.26	58.29	57.84	60.01	55.96	57.93
Mean		59.81	61.21	58.29	59.96	61.46	62.62	57.22	60.43
Mean		62.14	63.78	60.65		61.54	64.37	59.00	
Season x Concentration									
Concen-	500	65.56	67.37	64.39	65.37	68.08	71.31	64.84	68.07
tration	1000	71.80	69.18	65.07	68.68	68.68	69.65	65.07	67.80
(ppm)	2000	64.84	66.42	62.00	64.42	62.11	65.16	60.96	62.72

CD (0.05)	1988	1989
Season	0.58	0.34
Hormones	0.74	0.41
Concentration	0.59	0.56
Seasons x Hormones	N.S.	0.61
Seasons x Concentrations	1.08	0.99
Hormone x Concentrations	1.13	1.09
Seasons x Hormones x Concentration	2.07	1.79

it clear that rainy season was the best, spring was intermediate and winter was ^y, least effective. IBA was the best recorded hormone while IAA was next in order of preference and a concentration of 1000 ppm had given maximum success during both the years.

All the interactions were significant except for season x hormone - one which was non-significant in the first year. The mean maximum and minimum values were 81.26 to 46.14, irrespective of years.

Coriaria nepalensis Wall.

The data pertaining to per cent success in rooting are presented in Table 45. It is apparent from table that the per cent success among different seasons, hormones and concentrations varied significantly during both the years. The seasonal fluctuations were similar during both the years, winter was found to be the least, since minimum success was recorded in this season, spring was intermediate while rainy season was statistically superior to both.

The hormones and concentrations had also shown highly significant results. All the interactions except for hormone x concentration and hormone x concentration were non-significant during both the years.

The mean maximum and minimum values irrespective of seasons, hormones and concentrations, ranged from 80.73 to

Table 45. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Coriaria nepalensis* Wall. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		63.45	64.84	62.03	63.45	59.13	64.41	60.98	61.47
IAA	500	63.36	64.92	63.33	64.03	60.23	60.23	58.05	59.50
(ppm)	1000	62.73	65.15	64.41	64.09	65.71	65.70	68.58	65.27
	2000	66.44	67.52	69.65	66.54	69.73	70.63	68.58	69.27
Mean		64.34	65.86	65.79	64.88	65.22	65.52	65.07	64.68
IBA	500	76.83	74.69	67.65	73.05	76.96	74.41	69.44	72.60
(ppm)	1000	73.57	78.52	71.92	74.67	76.66	74.32	69.44	73.47
	2000	71.89	80.73	72.59	75.07	77.87	79.24	83.45	80.19
Mean		74.10	72.98	70.72	74.28	76.16	76.99	74.11	75.42
NAA	500	65.44	68.30	63.49	65.74	66.96	65.49	58.96	63.80
(ppm)	1000	68.64	68.58	64.42	67.21	69.46	70.63	64.73	68.27
	2000	66.42	64.67	62.08	64.34	64.90	63.91	60.71	63.17
Mean		65.99	66.61	63.00	65.20	65.11	66.11	61.32	64.18
Mean		66.94	68.76	64.82		66.90	68.14	64.99	
Season x Concentration									
Concen-	500	67.35	68.41	63.57	66.44	67.05	66.71	62.15	65.30
tration	1000	68.31	70.75	66.91	68.65	70.61	70.21	67.58	69.47
(ppm)	2000	68.25	70.79	66.77	68.66	70.83	71.26	70.91	71.00

CD (0.05)

1988

1989

Season	1.01	1.15
Hormones	0.81	1.13
Concentration	0.68	0.78
Seasons x Hormones	1.33	N.S.
Seasons x Concentrations	N.S.	1.54
Hormone x Concentrations	1.28	1.58
Seasons x Hormones x Concentration	N.S.	2.44

62.03 in 1988 and their corresponding values were 79.24 to 58.05 during 1989, respectively.

Dodonaea viscosa Linn.

The results on per cent success in rooting, as obtained from periodical investigations are presented in Table 46. It was noticed that per cent success in rooting during different seasons, hormones and concentrations, showed significant differences during both the years.

It is evident from the table that rainy season was having significantly higher values than spring and winter seasons, IBA was having statistically higher values than other hormones and a concentration of 1000 ppm had given best results since maximum success was obtained when this concentration was applied to various hormones.

The interactions were found to be significant during 1988 while in the following year the interactions between season x hormone and season x hormone x concentration were non-significant. Regardless of season, hormone and concentration, the mean maximum and minimum values were 65.15 to 49.80 during 1988 and 70.07 to 47.49 during 1989, respectively.

Spiraea canescens Don.

The results on per cent success in rooting as obtained from periodical investigations, are presented in Table 47. It

Table 46. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Dodonaea viscosa* Linn. under mist conditions.

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		48.83	49.80	49.99	49.54	48.07	47.49	48.64	48.06
IAA	500	52.74	55.55	50.57	52.79	52.93	54.96	50.38	52.75
(ppm)	1000	54.54	57.21	51.75	54.49	54.73	55.57	51.55	53.96
	2000	52.34	51.16	50.77	51.43	50.19	50.38	49.60	50.06
Mean		53.20	54.64	51.03	52.86	52.61	53.63	50.51	52.21
IBA	500	57.82	59.35	60.89	59.35	60.69	59.54	58.27	59.60
(ppm)	1000	59.13	59.35	60.89	59.35	60.96	59.59	58.37	59.60
	2000	61.12	63.91	65.15	63.69	64.68	70.07	61.13	65.29
Mean		59.36	61.16	62.26	61.14	61.90	65.27	59.87	62.34
NAA	500	49.80	50.77	50.58	50.38	52.34	53.53	50.57	52.14
(ppm)	1000	54.54	54.76	52.14	53.81	53.53	56.38	52.34	54.08
	2000	49.88	51.36	51.56	50.93	48.83	53.13	50.38	50.78
Mean		50.07	52.29	51.43	51.46	51.56	54.34	51.09	52.33
Mean		53.01	54.47	53.76		53.53	55.18	52.63	
Season x Concentration									
Concen-	500	53.46	55.22	54.01	54.23	55.41	56.02	53.07	54.83
tration	1000	56.07	57.40	55.23	56.23	56.30	59.37	54.70	56.79
(ppm)	2000	53.71	55.48	55.82	55.00	54.66	57.86	53.70	55.37

CD (0.05)

19881989

Season	0.59	0.78
Hormones	0.61	1.07
Concentration	0.92	0.84
Seasons x Hormones	0.94	N.S.
Seasons x Concentrations	0.82	1.52
Hormone x Concentrations	0.83	1.60
Seasons x Hormones x Concentration	1.56	N.S.

Table 47 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in *Spiraea canescens* Don. under mist conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		48.06	48.83	48.06	48.32	48.64	50.97	49.09	49.86
IAA	500	53.93	55.14	50.57	53.21	51.55	53.38	52.33	52.54
(ppm)	1000	55.76	57.84	52.34	55.32	54.33	56.79	54.73	55.28
	2000	49.80	50.19	49.80	49.92	50.19	51.94	50.96	51.03
Mean		53.16	54.39	50.90	52.81	52.02	54.04	52.80	52.96
IBA	500	60.22	62.97	62.74	61.97	61.57	64.65	67.23	64.48
(ppm)	1000	65.66	71.26	65.15	67.35	64.89	68.58	69.16	67.55
	2000	58.91	60.89	58.69	59.50	61.57	68.03	62.73	62.11
Mean		61.59	65.04	62.19	62.94	62.67	67.08	66.37	65.38
NAA	500	47.87	48.84	48.83	48.51	48.83	49.22	45.53	47.87
(ppm)	1000	51.75	53.73	50.38	51.95	48.83	50.96	46.53	50.77
	2000	49.03	46.72	45.95	47.23	46.72	47.10	45.57	46.46
Mean		49.18	49.53	48.30	49.00	48.26	49.36	46.91	48.24
Mean		53.09	54.50	52.39		52.87	54.79	53.79	

Season x Concentration

Concen-	500	54.06	55.65	54.05	54.57	53.98	55.73	55.18	54.96
tration	1000	57.72	60.94	55.96	58.21	56.02	58.78	56.81	59.20
(ppm)	2000	52.58	52.60	51.48	52.22	52.82	53.69	53.09	53.21

CD (0.05)

	1988	1989
Season	0.98	0.46
Hormones	0.44	0.50
Concentration	0.46	0.40
Seasons x Hormones	0.89	0.76
Seasons x Concentrations	1.00	N.S.
Hormone x Concentrations	0.84	0.78
Seasons x Hormones x Concentration	1.72	1.42

was noticed that rainy season was the superior most, when it was compared with spring and winter seasons, when the comparative analysis of IBA, IAA and NAA was taken into account, the same sequence was observed, since they were at number 1, 2 and 3 spot, respectively and a concentration of 1000 ppm had given maximum per cent success during both the years.

All the interactions, except between season x concentration were significant during both the years, the mean maximum and minimum values varied from 71.26 to 48.06 during first year, whereas the corresponding values were 69.16 to 45.53 in the second year, respectively.

Elaeagnus parvifolia Wall.

The data presented in Table 48 show that winter was least effective amongst various seasons and promising results were obtained in rainy season. Hormonal studies had again proved the superiority of IBA, since other hormones could not have any appreciable impact. The desired concentration was 1000 ppm which was followed by 500 and 2000 ppm while least significant results were obtained in control.

All the interactions were significant for both the years. The range of mean maximum and minimum values regardless of season, hormone and concentration varied from 73.22 to 45.00 in the first year and in the next year the same were 78.76 to 48.26, respectively.

Table 48 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Elaeagnus parvifolia Wall. under mist conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		48.06	48.84	45.00	47.30	46.91	48.26	48.26	47.81
IAA	500	54.34	55.55	51.94	53.94	53.53	55.76	51.76	53.41
(ppm)	1000	57.84	59.82	53.54	57.00	56.30	57.85	53.93	56.19
	2000	55.34	55.55	51.96	54.02	53.54	57.65	51.16	54.18
Mean		55.90	56.97	52.47	55.04	54.62	57.09	51.28	54.59
IBA	500	68.95	73.22	69.21	64.90	70.34	76.08	78.76	67.63
(ppm)	1000	65.67	67.83	63.22	65.57	66.19	69.45	67.71	75.22
	2000	65.40	67.60	65.06	66.02	65.70	66.26	65.41	65.95
Mean		66.00	69.58	65.83	67.16	67.59	70.39	71.49	69.63
NAA	500	50.57	53.34	51.56	51.82	55.39	55.96	52.95	55.10
(ppm)	1000	53.13	56.38	53.35	54.28	57.42	57.41	55.55	56.80
	2000	49.02	53.13	51.57	51.24	53.73	53.43	52.54	53.40
Mean		50.90	54.28	52.16	52.45	55.51	55.60	53.68	55.10
Mean		55.05	57.40	53.90		56.13	57.94	56.24	
Season x Concentration									
Concen-	500	57.28	60.70	57.57	58.57	59.92	62.60	61.49	61.37
tration	1000	58.88	61.34	56.70	58.95	60.13	61.57	59.08	60.26
(ppm)	2000	56.65	58.76	56.20	57.20	57.61	59.11	56.32	57.69

CD (0.05)

1988

1989

Season

1.50

0.43

Hormones

0.49

0.84

Concentration

0.86

N.S.

Seasons x Hormones

1.22

1.41

Seasons x Concentrations

1.79

1.62

Hormone x Concentrations

1.57

1.82

Seasons x Hormones x Concentration

3.00

3.15

Viburnum nervosum Don.

A perusal of data reveals that seasons, hormones and concentrations have significant impact on per cent success in rooting (Table 49). Rainy season was found to be have significantly higher values during both the years, than winter season. The IBA was statistically superior to IAA and NAA and a concentration of 1000 ppm was significantly better over 500 and 2000 ppm which were statistically at par with each other.

All the interactions, except that between season x concentration, were significant during both the years. The mean maximum and minimum values varied from 66.26 to 46.14 during 1988, whereas their corresponding values were 64.16 to 46.15 in 1989, respectively.

Desmodium tiliaefolium Don.

As far as per cent success in rooting is concerned (Table 50), there was no appreciable difference between rainy and spring seasons since, the results obtained were statistically at par with each other and winter was the least effective season. Among various hormones tried IBA was the best followed by IAA and NAA. A concentration of 1000 ppm was superior to 2000 and 500 ppm, which were statistically at par with each other, yet superior over control.

All interactions showed significant differences amongst

Table 49 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Viburnum nervosum Don. under mist conditions

Treatments		Seasons							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		48.06	49.80	46.14	48.00	46.72	48.48	46.15	47.23
IAA	500	49.62	49.94	51.75	50.45	47.67	49.60	47.17	48.14
(ppm)	1000	50.38	49.99	52.34	50.90	49.22	51.16	49.41	49.93
	2000	50.96	53.53	55.15	53.21	51.94	53.13	49.79	51.62
Mean		50.32	51.15	53.08	51.52	49.61	51.29	48.79	49.89
IBA	500	58.92	62.49	57.00	59.47	59.47	59.60	63.49	60.77
(ppm)	1000	64.24	66.26	59.34	63.28	60.70	64.16	61.35	62.07
	2000	60.01	61.57	58.36	59.97	57.63	60.22	58.70	58.85
Mean		61.06	63.49	58.25	60.49	59.37	62.29	60.09	60.46
NAA	500	49.03	46.72	49.02	48.26	48.25	47.49	47.10	47.62
(ppm)	1000	52.53	54.53	52.97	53.34	56.17	54.74	49.60	53.60
	2000	48.25	48.44	49.10	49.93	48.07	48.26	46.54	47.30
Mean		49.94	49.89	50.36	49.84	50.83	49.49	47.43	49.47
Mean		52.34	53.58	51.79		51.62	53.14	50.61	
Season x Concentration									
Concen-	500	52.52	53.01	52.59	52.70	51.84	53.19	51.50	52.18
tration	1000	57.72	55.71	54.88	55.83	55.36	56.69	53.45	55.17
(ppm)	2000	55.91	54.55	54.20	54.80	52.54	53.87	51.36	52.59

CD (0.05)

1988

1989

Season	0.78	0.93
Hormones	0.70	0.62
Concentration	0.72	0.48
Seasons x Hormones	1.11	1.07
Seasons x Concentrations	N.S.	1.02
Hormone x Concentrations	1.34	0.92
Seasons x Hormones x Concentration	2.46	1.87

Table 50 Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting in Desmodium tiliaefolium Don. under mist conditions

Treatments		Seasons							
		1988				1989			
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Rainy	Winter	Mean
Control		43.85	44.42	39.81	42.69	44.43	46.72	40.49	43.91
IAA	500	54.54	55.76	45.95	52.04	54.74	55.36	47.30	52.53
(ppm)	1000	56.79	57.63	47.87	54.10	57.23	58.27	48.64	57.71
	2000	54.74	55.34	46.34	52.15	53.73	55.15	47.29	52.06
Mean		55.36	56.24	46.72	52.78	55.23	56.28	47.79	53.20
IBA	500	57.63	57.00	49.21	54.61	58.91	58.27	53.29	56.82
(ppm)	1000	58.48	48.92	49.60	55.66	60.25	61.57	51.35	57.72
	2000	61.12	60.03	52.14	57.76	60.45	61.57	50.58	57.53
Mean		59.08	58.65	50.32	56.01	59.87	60.47	51.74	57.35
NAA	500	52.75	54.53	46.31	51.20	45.95	48.45	46.59	47.05
(ppm)	1000	54.75	55.35	48.64	52.91	48.84	51.36	48.06	49.41
	2000	54.33	51.55	46.53	50.82	46.72	50.43	46.53	47.89
Mean		53.95	53.81	47.16	49.42	47.17	50.68	47.06	48.11
Mean		63.07	53.81	46.00		50.81	53.61	47.06	

Season x Concentration

Concen-	500	54.97	55.76	47.04	52.59	53.20	54.03	48.96	52.06
tration	1000	56.65	57.30	49.70	54.21	55.44	57.07	49.35	53.97
(ppm)	2000	55.77	55.64	48.33	53.24	53.63	55.71	47.68	52.34

CD (0.05)

1988

1989

Season	0.56	0.35
Hormones	0.53	0.35
Concentration	0.52	0.62
Seasons x Hormones	0.83	0.54
Seasons x Concentrations	0.96	1.10
Hormone x Concentrations	0.94	1.10
Seasons x Hormones x Concentration	N.S.	1.95

themselves one or another year. The mean maximum and minimum values ranged from 61.57 to 39.81 regardless of years, respectively.

Vitex negundo Linn.

Table 51 revealed the phenomenon that rainy season was statistically superior to spring and winter seasons latter could not reflect any appreciable impact to promote rooting since, lowest categorised results were obtained in winter season. There was no appreciable differences between IAA and NAA because of proximity of each other, IBA had proved its superiority by providing better success. A concentration of 1000 ppm was an optimum one, and a declining trend was observed afterwards.

All the significant interactions had followed the similar trend during both the years.

Irrespective of factors, the maximum and minimum mean value for per cent success in rooting varied from 91.81 to 72.15 during 1988 and from 100.00 to 71.66 during 1989, respectively.

TABLE 51. Effect of different treatments of IAA, IBA and NAA in different seasons on per cent success in rooting Vitex negundo under & must condition.

Treatments		Season							
		1988				1989			
		Spring	Rainy	Winter	Mean	Spring	Raing	Winter	Mean
Control	0	75.76	74.43	72.15	74.21	74.54	75.37	71.75	73.86
IAA	500	77.20	81.34	76.79	78.44	81.17	80.48	77.63	79.76
(ppm)	1000	78.26	81.41	77.42	79.63	81.17	83.20	77.84	80.94
	2000	80.01	81.80	78.91	80.24	85.42	84.90	78.48	82.93
	Mean	78.49	81.51	77.77	79.23	82.79	82.86	77.98	81.21
IBA	500	85.20	84.16	79.81	83.05	85.66	89.17	80.66	85.16
	1000	91.80	91.28	86.71	89.96	94.68	100.00	91.26	95.62
	2000	85.20	87.79	85.67	86.19	86.32	90.63	80.45	85.79
	Mean	87.73	87.57	84.06	86.40	88.88	93.26	84.12	88.70
NAA	500	80.92	80.67	79.38	80.32	82.51	84.42	77.20	81.37
(ppm)	1000	78.06	81.12	77.42	78.86	80.07	82.48	76.25	79.60
	2000	77.21	81.63	77.00	78.01	78.91	79.13	71.66	75.56
	Mean	78.73	81.14	77.93	79.26	80.50	82.01	75.03	78.84
	Mean	80.10	81.23	77.96		81.67	86.04	77.73	

Season x concentration

concent-									
ration	500	81.10	80.05	78.32	79.82	83.11	84.69	78.49	82.09
	1000	82.73	84.60	80.51	82.61	85.51	88.56	81.78	85.38
	2000	80.80	83.70	80.52	81.67	83.55	84.88	76.86	81.76

CD(0.05)

	1988	198
Seasons	1.05	1.06
Hormones	0.89	0.88
concentrations	0.86	1.29
season x Hormone	0.92	0.86
season x concentration	1.65	1.62
hormone x concentration	1.63	1.03
Season x Hormone x Concentration	N.S.	N.S.

SYSTEMATIC ACCOUNT OF SHRUBBY FLORA OF HIMACHAL PRADESH

The Himalaya are endowed with rich diversity of genetic resources from sub-tropical to alpine vegetation comprising of mixed broadleaved forests to coniferous stands and alpine scrubs to seasonal herbaceous flora. The floristic of the region embodies wide repository of economic plants irrespective of their habit, whether herbs, shrubs and trees, the harvesting of timber had been a major source of revenue from forests but the shrubs played an important role in rural economy by providing fodder, fuel, fibre and small timber, medicinal and aromatic sources, etc. Unfortunately, irrespective of their multiple uses, which are available with ease from the forest floor to hill people, These have not drawn the attention of the foresters and scientists. This nature's and reservior, capable of self-regenerating by coppicing have never been studied as a systematic component of any ecosystem both from the ecological and economic stand point of view.

There are several accounts on the forest flora of the Himalaya, of course including shrubs yet these contributed less weightage of reference in contrast to tree species. Foresters had also been concentrating on the silvicultural characteristics of forest trees and there is very scanty literature on shrubs of any region excepting those which excelled others on account of their medicinal or ornamental value.

Recently, some work has been started on the different aspects of shrubs of Himachal Pradesh such as propagation of six shrubby species (Sharma, 1989), calorific value of some important shrubs of temperate zone (Thakur,) and other miscellaneous studies. In present context propagation studies were made of 24 important shrubs of Himachal Pradesh. In addition, an attempt has also been made to compile the shrubby flora of Himachal Pradesh. In all 128 species have been described giving their scientific name, local name, diagnostic features, ecology and distribution; propagation studies and uses of 128 species described, include 82 collection by the author. The remaining list was updated from voucher specimens available in the Herbarium of the Department of forest Biology and Tree Improvement, Dr Y s Parmar University of Horticulture and Forestry, Solan, HP. The description of important representatives have been supplemented by the line illustrations so as to provide ease for their identification atleast upto the generic level.

Abelia triflora Br.

Family Caprifoliaceae

Vernacular name mali, male

Diagnostic features

A large shrub. Leaves ovate, lanceolate pale beneath. Flowers white tinged with pink, crowded in head like clusters at the end of branches. Calyx hairy. Corolla funnel shaped. Stamens 4, at the mouth of corolla tube. Ovary 3-celled. Fruit narrowly oblong, 1 seeded.

Flowering and fruiting July-September

Distribution and ecology

Chiefly found on lime stone and ridges. It grows chiefly in association with Indigofera. In deodar forests it provides nurser to seedlings.

Locality Shimla(Naldera 2200 m)

Propagation

Propagation is usually by green wood cuttings in summer to monsoon. Seeds sown in spring give better results.

Uses

Fuel: Wood serves as good source of fuel.

Fodder: Twigs are browsed by goats and sheep.

Small timber: Wood used for walking sticks.

Adhatoda vasica Nees.

Family Acanthaceae

Vernacular name basuti



ABELIA TRIFLORA Brown



ADHATODA VASICA , Nees

Diagnostic features

A large gregarious shrub with strong smell. Leaves ovate lanceolate, entire. Flowers white with red spots and streaks, in axillary compact cymes. Stámens 2; capsule clavate pubescent, 4 seeded.

Flowering and fruiting

December-March

Distribution and ecology

One of the commonest plant found every where on waste places, on river banks, dry slopes and thrive where other vegetation fails because of its immunity for browsing goats and other animals.

Locality

Solan(1400 m)

Propagation

Propagation is by green wood cuttings in rainy season and the application of IBA (1000 ppm) ensures higher rooting. Seeds are sown in spring and for optimum germination percentage, the application of 100 ppm of GA_3 is recommended.

Uses

Fuel: Wood used for gunpowder, charcoal and fire wood - calorific value 4340 cal/g.

Fertilizer: Plant is put to use as a green manure.

Medicinal: Fresh dried leaves constitute a drug 'Vasaka' used in bronchial troubles, diarrhoea and glandular tumour. Leaves are rich source of Vitamin C (250 mg/g), carotene (4500 mg/100 g).

Aralia cachemirica Dcne.

Family Araliaceae

Vernacular name ashola

Diagnostic features

A large herbaceous shrub. Leaves large bipinnate, leaflets 5-9 serrate, ovate lanceolate. Flowers white umbel in large terminal panicles. Ovary 2-5 celled. Drupe black.

Flowering and fruiting August-September

Distribution and ecology

Common and conspicuous plant in the undergrowth of fir and oak forest in western Himalaya upto an altitude of 3000 m.

Locality Shimla(Narkanda 2600 m)

Propagation

Propagation is by seed sown in spring with slight bottom heat and also by root cuttings.

Uses

Fuel: Used as a fuel in scarcity areas.

Fodder: Leaves and twigs are browsed by goats and sheep

Ornamental: Cultivated in gardens for variated foliage.

Arundaria Michx.

Two species are met within the region.



ARALIA CASHEMERICA Dcne.

Family Bambusaceae

Key to species

Leaves not net veined; stem sheath tapering upwards

.....A. falcata

Leaves net veined; stems sheath oblong tip rounded

.....A. spathiflora

A. falcata Nees

Vernacular name nirgal, nigal

Diagnostic features

Erect more or less gregarious shrub. Culms slender with waxy covering. Leaves thin veins obscure. Spikelet on long slender pedicles. Ovary narrowly oblong, tapering upwards styles-2.

Flowering and fruiting No well defined season

Distribution and ecology

Common more or less gregarious form in association with evergreen oak forests upto an elevation of 2100 m.

Locality Shimla(Cheog 2100 m)

A. spathiflora Trinius

Vernacular name ringal, nagal

Diagnostic features

An erect gregarious shrub. Culms glabrous thin straw coloured. Leaves narrow, veins conspicuous. Spikelet in the axil of large membranous sheath. Stigma plumose, sessile.



ARUNDINARIA FALCATA Nees

Flowering and fruiting

Throughout the year

Distribution and Ecology

Occurring between an altitudinal range of 2100-3000 m as an undergrowth of fir and oak.

Locality Shimla(Kufri 2600 m)

Propagation

Propagation is best affected by division of clump before annual growth started.

Uses

Fuel: Good source of fuel.

Fodder: Fodder for cattle.

Fibre: Used for making mats and basket.

Small timber: Locally employed for fishing rods, pipes and baskets.

Berberis Linn.

Four species are found in the region.

Family Berberidaceae

Key to species

Flowers in simple racemes

Fruit blue leaves coriaceous

Leaves ovate, finely reticulate, not glaucous beneath

.....B. aristata

Leaves broadly obavate, strongly reticulate glaucous beneath

.....B. asiatica

Leaves narrow oblanceolate, pedicels slender

.....B. lycium

Flowers umbellate

.....B. umbellata

B. aristata DC.

Vernacular name sumbla, kasmal

Diagnostic features

A thorny shrub with light brown rough bark, branches pale yellowish grey. Leaves obovate, entire or distinctly sharp toothed, coriaceous pale green beneath, veins very fine. Flowers in compound racemes thickly covered with glaucous bloom.

Flowering and fruiting

April-August

Distribution and ecology

Mainly confined to badly drained and completely stripped off soils in higher reaches of moist temperate forests from 1800-3000 m.

Locality

Shimla (Narkanda 2600 m)

B. asiatica Roxb.

Vernacular name kingora

Disgnostic features

An erect thorny shrub with light brown rough bark. Leaves broad, obovate, hard coriaceous, strongly reticulate and grey beneath, with large spinous teeth. Racemes corymbose dense flowered. Berries blue or black.

Flowering and fruiting

April-June

Distribution and ecology

Common in grassy and rocky slopes between an altitudinal range of 1200-2500 m in western Himalaya.



BERBERIS ARISTATA DC

Locality Shimla(Naldera 2100 m)

B. lycium Royle

Vernacular name kasmal, daruhaldi

Diagnostic features

An erect rigid shrub; bark, grey. Leaves simple, narrow lanceolate, coriaceous, mucronate, entire bright green above, glaucous beneath. Flowers pale small on elongate racemes. Berries blue.

Flowering and fruiting April-July

Distribution and ecology

Occurring on dry slopes, clearances and along the road side often gregarious in sub-tropical to temperate localities.

Locality Solan(1400 m);Shimla(2100 m)

B. umballeta Wall.

Vernacular name kasmal

Diagnostic features

An erect spinous shrub, often forming gregarious patches leaves oblanceolate to obovate. Flowers yellow, umbellate on long peduncles, pedicels slender, stigma flat sessile. Berries oblong.

Flowering and fruiting April-June

Distribution and ecology

Confined to higher reaches of western Himalaya between



BERBERIS LYCIUM, Royle

an altitudinal range of 2700-3300 m in dry and arid regions.

Locality Kinnaur(Pooh 2800 m);
 Lahaul & Spiti(Tabo 3200 m)

Propagation

Propagation is chiefly through seeds collected in the month of July and sown immediately after depulping and drying in shade. There is an enhancement in seed germination with the application of GA_3 (100 ppm). The treatment of cuttings with the IBA (1000 ppm) induces better rooting.

Uses

Fuel:	Excellent source of smokeless fuel.
Fodder:	Leaves and twigs are browsed by goats and sheep .
Food:	Berries are edible which acts as a laxative.
Medicinal:	The dried extract (rasaut,rusot) are used in native medicine and highly prized in ophthalmia.

Bridelia retusa Spreng.

Family Euphorbiaceae

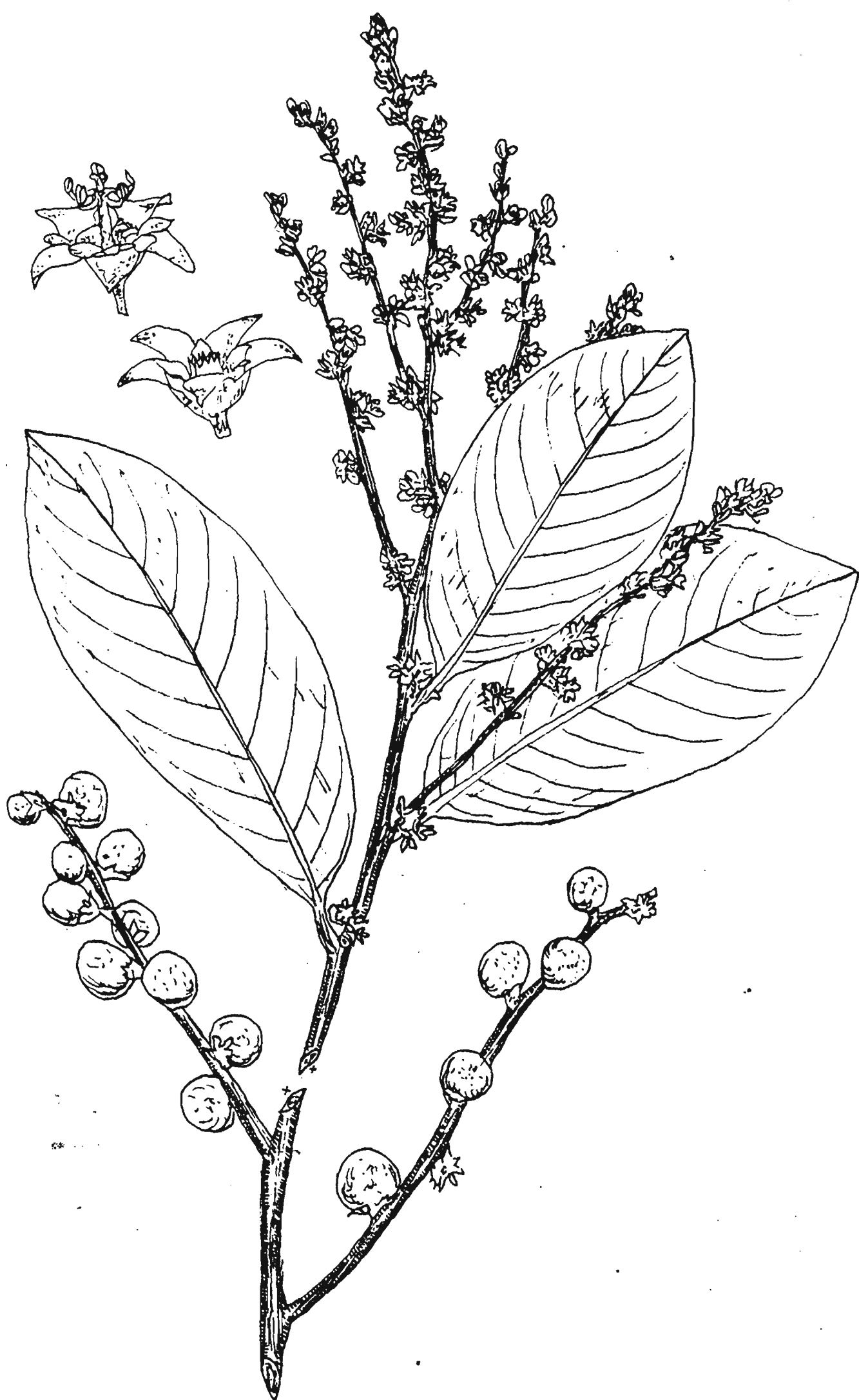
Vernacular name pathor, khaja

Diagnostic features

A large deciduous shrub. Leaves coriaceous, elongate elliptic. Flowers dioecious yellow, crowded in sessile clusters; male flowers very slender. Drupe fleshy, purple black.

Flowering and fruiting

May-September



BRIDELIA RETUSA, Spreng.

Distribution and ecology

Throughout India except the very dry regions common in deciduous forests.

Locality Solan(Oachghat 1300 m)
Propagation Propagated through seed.

Uses

Fodder: Leaves provide nutritive fodder.
Food: Fruit edible.
Medicinal: Bark contains tannin (16.40%), also exhibiting antiviral and hypoglycarmic properties.

Buddleia Linn. Two species occur in the region.

Family Loganiaceae

Key to species

Flowers hardly 0.65 cm long in slender spikes

.....B. asiatica

Flowers nearly 1.25 cm long in head or whorls

.....B. crispa

B. asiatica Lour.

Vernacular name dudhia

Diagnostic features

A large evergreen shrub. Leaves lanceolate acute or acuminate. Flowers white fragrant. Calyx lobes sub acute, corolla tube tomentose. Capsule glabrous, ellipsoid, seed with finely reticulate wings.

Flowering and fruiting April-October

Distribution and ecology

Chiefly found on road sides in grass savannahs. In lower Himalaya, it come up profusely on land slides.

Locality Solan(1300 m); Kinnaur(Nichar 1800 m)

B. crispa Benth.

Vernacular name chithiboi, prind

Diagnostic features

A shrub or a small tree; leaves extremely variable. those at the ends of flowering branches oblong lanceolate entire, those lower down deeply sinulate dentate. Flowers nearly sessile fragrant, in short dense spike. Calyx and corolla densely tomentose; capsule ellipsoid.

Flowering and fruiting March-May

Distribution and ecology

Found on dry slopes in rocks upto an elevation of 2600 m in the temperate region of western Himalaya.

Locality Shimla(Narkanda 2600 m)

Propagation

Propagation is done by seeds sown in spring with gentle bottom heat.

Uses

Fuel: Useful source of fuel.

Medicinal: , Roots dried and powdered which is used in the preparation of liquor.

Ornamental: Cultivated in gardens for attractive foliage

Callicarpa macrophylla Vahl.

Family Verbenaceae

Vernacular name sumali, birmole

Diagnostic features

A tall shrub. Leaves sharply toothed, upper surface wrinkled, lower surface tomentose. Flowers pink, crowded in axillary stalked cymes. Calyx bell shaped. Ovary 2-4 celled, style large, stigma capitate. Berry succulent contains 4. One seeded nutlets.

Flowering and fruiting July-September

Distribution and ecology

Chiefly on road sides and water places, also on cultivated lands and in ravines upto an altitude of 900 m in sub-tropical to temperate regions.

Locality Solan(1400 m)

Propagation

Propagation is readily affected by green wood cuttings in spring or summer, also by hard wood cuttings, layers and seed.

Uses

Fuel: Provides fuel.

Medicinal: Roots yield an aromatic oil used in stomach disorder.

Calotropis gigantea Br.

Family Asclepiadaceae

Vernacular name munda, rui

Diagnostic features

Large shrub. Leaves ovate or ovate oblong. Flowers purplish lilac white. Corolla pale purple. Follicles recurved. Seeds broadly ovate.

Flowering and fruiting November-July

Distribution and ecology

Very common on waste lands and road sides in the northern plains of India upto an altitude of 1200 m.

Locality Solan(Kandaghat 1200 m)

Propagation Propagated by seed..

Uses

Fuel: Stem is a source of charcoal powder.

Fibre: Bark is fibrous, yielding white silky and durable, material, used for fishing nets and bamboo strings. Floss of seed used for stuffing mattresses, pillow, etc.

Medicinal: Root bark is used for leprosy.

Capparis spinosa Lamk.

Family Capparidaceae

Vernacular name kawr, kakri

Diagnostic features

A trailing shrub. Leaves broad ovate or obovate. Flowers white, solitary, axillary on pedicels. Petals obovate. Filaments slender. purplish. Ovary as long as stamens.



CALOTROPIS GIGANTEA , Br.



CAPPARIS SPINOSA , Linn.

Fruit oblong crimson inside. Seeds numerous.

Flowering and fruiting April-November

Distribution and ecology

Grows on rocks affecting hot localities and inner dry valley of western Himalaya upto an altitude of 3600 m.

Locality Kinnaur(Pooh 2800 m);
Lahaul & Spiti (Tabo 3600 m)

Propagation

Propagation is by cuttings of old wood and also by seed.

Uses

Fodder: Leaves and fruits are favourite food of goats and sheeps.

Food: Fruit is prickled.

Medicinal: Seeds yield 34-36 per cent of pale yellow fatty oil. Bark is associated with diuretic and tonic properties.

Caragana Lam.

Two species are met within the region.

Family Papilionaceae

Key to species

Flowers peduncled C. brevispina

Flowers sub-sessile C. gerardiana

C. brevispina Royle

Vernacular name ari

Diagnostic features

An erect spinescent shrub. Leaves imparipinnate. Leaflets 5-7 pairs, elliptic, pubescent. Flowers yellow. Stamens

diadelphous; anthers uniform. Style glabrous. Pods linear turgid, woolly inside.

Flowering and fruiting

May-August

Distribution and ecology

Occurs in higher forests of western Himalaya as an under growth in fir and oak forests or in open lands on dry ridges.

Locality

Shimla(Narkanda 2600 m)

C. gerardiana Royle

Vernacular name

kathur, kanta

Diagnostic features

A diffuse spinescent shrub. Leaves imparipinnate; leaflets 3-5 pairs, elliptic mucronate. Flowers yellow solitary. Stamens diadelphous anthers uniform. Style glabrous; stigma minute. Pods linear, tomentose inside out.

Flowering and fruiting

May-August

Distribution and ecology

Confined to dry valleys of inner western Himalaya in Juniperus forests.

Locality

Kinnaur(Pooh 2800 m)

Propagation

Seed sowing in autumn or spring is recommended, soaking of seed in water for 2-3 days before sowing is advantageous Also propagated by root cuttings and layers.

Uses

Fuel: Useful fuel.
Fodder: Fodder for goats and sheep.

Carissa carandas Linn.

Family Apocynaceae

Vernacular name karaunda

Diagnostic features

An erect spinescent shrub. Leaves leathery, ovate, obtuse. Flowers white in small terminal cyme. Calyx segments acute. Ovary cells united; style short; stigma spindle shaped. Fruit an ovoid berry, green at first then red nearly black when ripe, 2-4 seeds naked.

Flowering and fruiting September-April

Distribution and ecology

Its natural habitat is confined to sub-tropical region of the state upto an altitude of 1500 m in chir pine forests.

Locality Solan(Shilli 1600 m)

Propagation

Propagated by seeds and cuttings (one year old shoot). The treatment of seed with GA₃ (100 ppm) improves germination behaviour. The application of IBA (1000 ppm) is recommended for rooting of stem cuttings.

Uses

Fuel: Good source of fuel.
Fodder: Leaves are fed to Mugha silk worm.



CARISSA CARANDAS , Linn.

Food: Ripe fruit sweet and edible, particularly suitable for tarts, pudding and jellies, unripe are prickled.

Medicinal: Root stomachic and antithelmintic.

Small timber: Wood used for making spoon and combs.

Fence: Planted as live fence due to thorny nature.

Clerodendron Linn.

Two species are found in the region.

Family Verbenaceae

Key to species

Leaves whorled; stem hollow.....C. indicum

Leaves opposite; stem solid.....C. infortunatum

C. indicum (Linn.) O.Kuntz ex

Vernacular name karu

Diagnostic features

A tall little branched shrub. Leaves in whorl of 3-5, oblong shortly acuminate. Flowers white usually 3 flowered cymes in the axil of upper leaves. Fruit dark bluish green when ripe.

Flowering and fruiting June-September

Distribution and ecology

Confined to sub-tropical region upto an altitude of 1400 m in open places and old cultivated land.

Locality Solan (1400 m)

C. infortunatum Gaertn.

Vernacular name parvik, karu



CLERODENDRON INFORTUNATUM, Gaertn.

Diagnostic features

A tall gregarious shrub. Leaves opposite, ovate shortly acuminate. Flowers white tinged with red. Calyx silky pubescent much enlarged coriaceous and red. Corolla densely pubescent outside elliptic or oblong. Fruit sub-globose, black when ripe.

Flowering and fruiting

May-October

Distribution and ecology

One of the commonest shrub in the plains and lower hills all over India in open places and old cultivated lands upto an elevation of 1400 m.

Locality

Solan(1400 m)

Propagation

Propagated by seed and one year old shoots in spring and rainy seasons respectively.

Uses

Medicinal: Leaves used as bitter tonic, vermifuge and laxative. Fruit juice introduced into the rectum for removal of ascarids.

Ornamental: Cultivated as hedge plant.

Colebrookia oppositifolia Sm.

Family

Labiatae

Vernacular name

moorti

Diagnostic features

An erect tomentose shrub. Leaves opposite shortly stalked, elliptic lanceolate. Flowers minute white, the male



COLEBROOKEA OPPOSITIFOLIA , Smith.

and female often on different plants, spike axillary or paniculate. Calyx divided nearly to the base into 5 linear teeth. Corolla white, minute. Stamens-4, equal. Nultels one only, hairy.

Flowering and fruiting

April-November

Distribution and ecology

Occurring in valleys and ravines in moist sub-tropical region of the state upto an altitude of 1400 m.

Locality

Solan(1400 m)

Propagation

Propagation is usually by seeds and stem cuttings in rainy season.

Uses

Fuel: The wood is used for gun powder charcoal.

Medicinal: Leaves applied to wound and sores.

Colutea nepalensis Sims.

Family

Papilionaceae

Vernacular name

braa

Diagnostic features

An erect nearly glabrous shrub. Leaves odd pinnate, leaflets 9-13, pale green, obovate. Flowers yellow often tinged with red, in axillary racemes; calyx bell shaped. Stamens diadelphous. Ovary stalked, pubescent; stigma strongly curved. Pods 'bladder like; seeds many kidney shaped.

Flowering and fruiting

June-September



COLUTEA NEPALENSIS Sims

Distribution and ecology

Common in moist and arid valleys of western Himalaya within an altitudinal range of 2400-3300 m.

Locality Shimla(Narkanda 2600 m)

Propagation

Propagation is by seed sown in spring, also by cuttings of mature wood in autumn in sandy soils.

Uses

Fuel: Fire wood - calorific value (4175 cal/g).
Fodder: Fodder for sheep and goats.
Medicinal: Leaves purgative, used as an adulterant in senna.

Coriaria nepalensis Wall.

Family Coriariaceae

Vernacular name masauri, makola

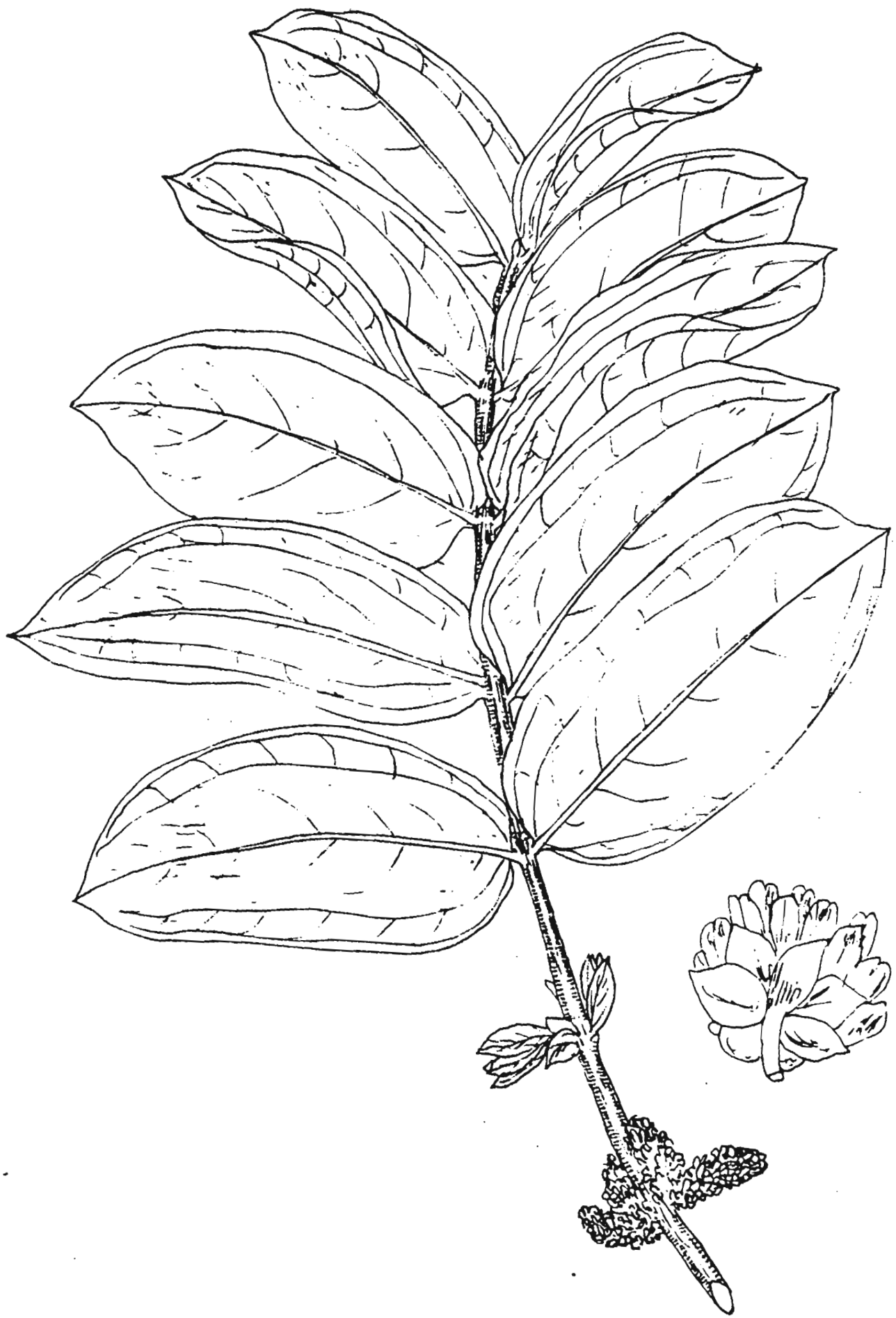
Diagnostic features

A glabrous shrub, bark red. Leaves opposite, nearly sessile, entire. Flowers small, regular in lateral clustered racemes. Sepals 5, imbricate. Petals 5 green smaller than sepals. Stamens 10, free, oblong, coral red. Fruiting carpels 5, 1-celled. Fruit small 1-celled.

Flowering and fruiting March-June

Distribution and ecology

It affects chiefly the outskirts of forest on rocky sites in sub-tropical regions of the state within an altitudinal range of 900-1300 m, preferring moist shady places.



CORIARIA NEPALNSIS, Wall.

Locality Solan(Oachghat 1300 m)

Propagation

. Propagation is by seed sown in August, treatment of seeds with GA₃ (100 ppm) enhances germination percentage. Also by stem cuttings in rainy season, the application of IBA (500 ppm) had a profound influence on rooting of stem cuttings in rainy season.

Uses

Fuel: Consumed locally as a firewood - calorific value 4610 cal/g.

Fodder: Food plant of silk moth.

Medicinal: Rich in tannin.

Small timber: Wood used for making boxes.

Cotinus coggygia Scop.

Family Anacardiaceae

Vernacular name tung, tunga

Diagnostic features

A deciduous shrub or a small tree. Leaves strongly aromatic, entire, obtuse, elliptic. Flowers on slender pedicels. Drupe compressed 1-seeded with prominent veins when ripe.

Flowering and fruiting March-August

Distribution and ecology

Gregarious shrub. Chiefly in the underwood of the forests of Pinus roxburghii and other broadleaved species.

Locality Solan(Oachghat 1300 m);
Shimla(Naldera 2100 m)



COTINUS COGGYRIA Scop

Propagation

Propagated by seeds, also by root cuttings and layers.

Uses

Fibre: Yellow wood from stem and branches constitute young fibre of commerce.

Medicinal: Powdered leaves and twigs are used in tanning of soft leather. Yields a yellow colouring matter used in textile and leather industries.

Small timber: Wood used for carving, picture frames, cabinet work and basketry.

Cotoneaster Linn

Three species are found in the region.

Family Rosaceae

Key to species

Erect shrubs. Leaves deciduous:

Flowers pink, in 3-10 flowered pedunculate cymes;
leaves glabrous

.....C. rosca

Flowers in 1-5 flowered more or less sessile cymes;
leaves pubescent

.....C. acuminata

A prostrate shrub. Leaves persistent

.....C. microphylla

C. acuminata Lindl.

Vernacular name raunsh, ruinshi

Diagnostic features

A deciduous shrub. Leaves entire with soft silky hairs. Flowers white, in compact cymes with 2-10 flowers at



COTONEASTER ACCUMINATA Lindl.

the end of short leaf bearing branchlets. Fruit sub-cylindrical, red when ripe.

Flowering and fruiting May-October

Distribution and ecology

Distributed commonly from 1500-3600 m in temperate region, particularly an undergrowth in oak forests.

Locality Solan(Shilli 1600 m)

C. microphylla Wall.

Vernacular name phedda

Diagnostic features

A dwarf much branched shrub. Leaves coriaceous, entire hairy. Flowers white, solitary. Calyx 5, petals 5. Ovary 2-5. Fruit globose, bright red.

Flowering and fruiting June-October

Distribution and ecology

Common in higher reaches of western Himalaya extending as high as alpine region upto 5000 m on rocks, exposed strips and blanks.

Locality Shimla(Mashobra 2100 m)

C. rosea Edgew.

Vernacular name raunshi

Diagnostic features

An erect deciduous shrub, twigs, light brown. Leaves elliptic, thin, membranous, bright green above, pale beneath. Flowers pink in corymbose cymes. Calyx 5, petals 5,

Ovary 2-5 celled. Fruit red, 1-seeded.

Flowering and fruiting

May-October

Distribution and ecology

Common in temperate region of the state between an altitudinal range of 1800-3000 m invading rocky slopes.

Locality

Shimla(Narkanda 2600 m);
Kinnaur(Kalpa 2800 m)

Propagation

Propagation is effective by seed in autumn, also by hard wood cuttings in August and by layers.

Uses

Medicinal: Stolon used as an astringent.

Small timber: Wood suitable for turnery, walking sticks and basketry.

Daphne Linn.

Two species are met with.

Family

Thymelaceae

Key to species

Flower heads without bracts; leaves 2-5 cm long

.....D. oleoides

Flower head with numerous bracts; leaves 6-10 cm long

.....D. papyracea

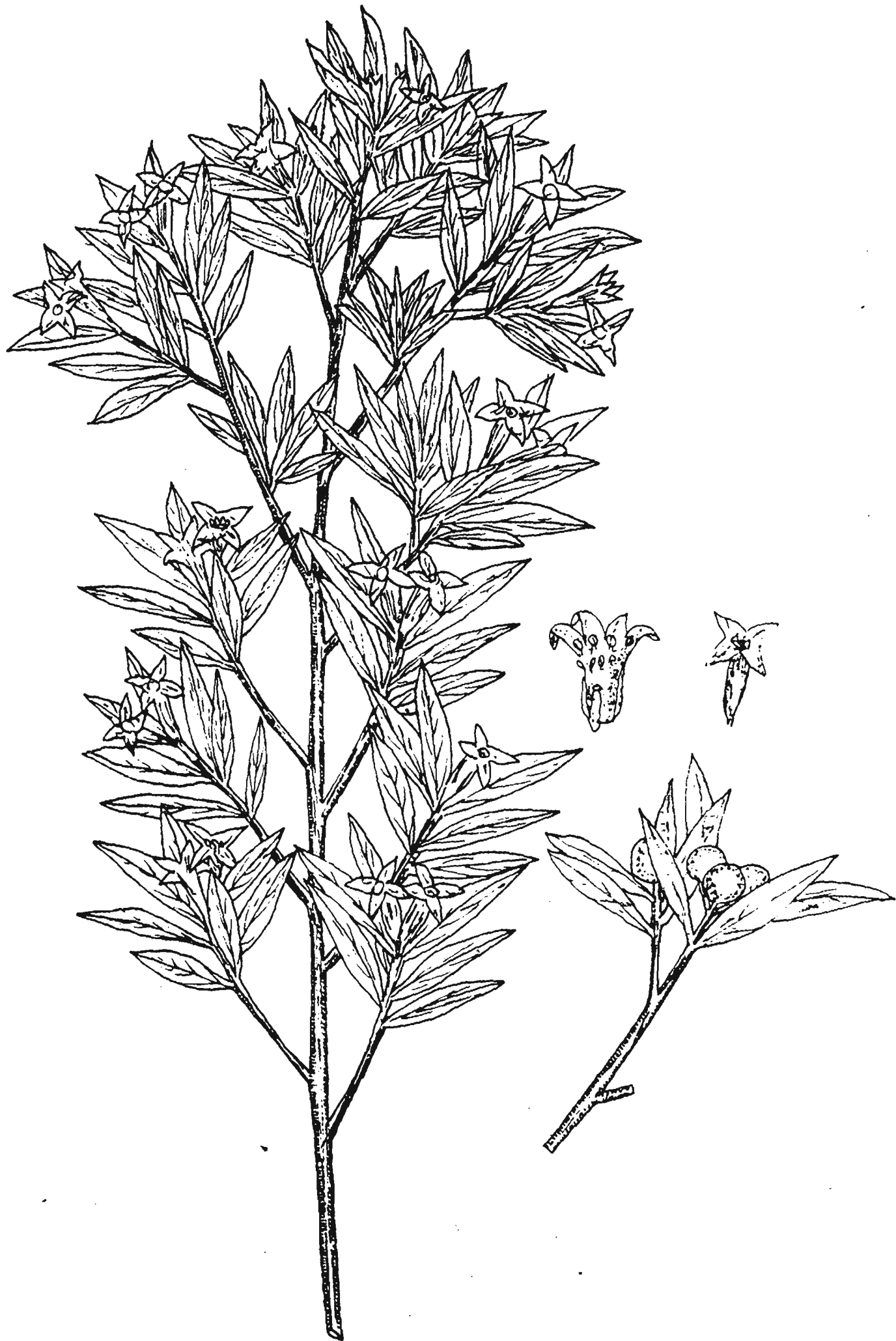
D. oleoides Schreib.

Vernacular name

kaghuti

Diagnostic features

A tall shrub, young shoots, pubescent. Leaves subsessile lanceolate, mid-rib prominent. Flowers white



with pink tinge, in terminal head; perianth segments 4, nearly equal. Anthers 8 on short filaments. Fruit orange or scarlet.

Flowering and fruiting

May-October

Distribution and ecology

Occurs between an altitudinal range of 900-2700 m in sub-tropical to temperate forests ascending upto an elevation of 3300, including the dry temperate zone. Sophora mollis and Cotoneaster spp., etc., are its chief associates.

Locality

Kinnaur(Skibba 2600 m);
Chamba(Dalhousie 2600 m)

D. papyracea Wall.

Vernacular name

kaghuti

Diagnostic features

A tall shrub. Leaves glabrous, lanceolate, narrowed into a marginate petiole. Flowers sweet scented, white in terminal head. Perianth rare, slender. Fruit ovoid succulent, red or orange.

Flowering and fruiting

May-September

Distribution and ecology

Confined to an altitudinal range of 1600-2100 m in deep moist temperate forests.

Locality

Shimla(2100 m)

Propagation

Propagated by seed, also by layers and cuttings of mature wood. The application of bottom heat is advantageous to the development of roots.

Uses

Fibre: The bark can easily be peeled off and employed for paper making.

Debregeasia hypoleuca Wedd.

Family Urticaceae

Vernacular name siaru, scharu

Diagnostic features

A large shrub or a small tree. Leaves alternate short stalked, broadly lanceolate. Flowers sessile; male and female on different plants. Male flowers: perianth tomentose, stamens 4. Female flowers: perianth tubular more or less adnate to enclosed ovary; stigma scrambling. Drupes small, aggregated in head.

Flowering and fruiting March-June

Distribution and ecology

Common in ravines and on the edge of rice terraces, chiefly along the water course.

Locality Solan(Oachghat 1300 m);
Kinnaur(Nichar 1800 m)

Propagation

Propagation is chiefly by stem cuttings in rainy season. The application of IBA (2000 ppm) increases the percentage of rooting. Also by seed in summer, the seed treatment with GA_3 (100 ppm) increases percentage of germination.

Uses

Fuel: Excellent source of fuel - calorific value 4587 cal/g.

Food: Fruit edible, also used for flavouring.
Fibre: Bark yields a fibre, suitable for ropes, cordage and fishing lines.

Desmodium Desv.

Two species are met with.

Family Papilionaceae

Key to species

Leaves 3 foliate; bracts subulate

.....D. tiliaefolium

Leaves 3 foliate; bracts orbicular, foliaceous

.....D. pulchellum

Leaves 1 foliate, ovate, softy tomentose

.....D. latifolium

D. latifolium DC.

Vernacular name kyopan

Diagnostic features

A large shrub, often with a short woody stem, branchlets, petioles and underside of leaves shortly tomentose. Leaves ovate, 1 foliate. Flowers bright purple in dense, axillary racemes. Pods clothed with hooked hairs, joints 3-6.

Flowering and fruiting July-September

Distribution and ecology

Pretty shrub grows to a large size in the Himalaya, chiefly on dry grassy slopes and in glades in the deodar forest where it is regularly associated with Indigofera upto an altitude of 2700 m.

Locality Solan(1400 m); Shimla(Mashobra 2100 m)



DESMODIUM TILIAEFOLIUM Don.

D. pulchellum Benth.

Vernacular name taung, tamin

Diagnostic features

A medium sized shrub. Leaves 3 foliate, terminal leaflets larger than the lateral ones. Flowers in long terminal racemes, yellow, several in the axil of a 2 foliate bracts. Pods small, minutely veined, joints 2.

Flowering and fruiting June-October

Distribution and ecology

Occurs throughout India in damp places and deciduous forests upto a altitude of 800 m.

Locality Sirmour(Dhaulakuan 800 m)

D. tiliaefolium G.Don

Vernacular name sambar, shamru, chamlia

Diagnostic features

A large shrub, with angular, densely pubescent branches. Leaves 3 foliate, leaflets form a rounded or cuneate base. Flowers red on slender pedicels, in ample panicles, branches slender, often drooping. Pods straight, joints 6-10.

Flowering and fruiting May-October

Distribution and ecology

Occurring between an altitudinal range of 1200-2700 m in western Himalaya, in association with deodar and blue pine.

Locality Solan(1400 m); Shimla(Kufri 2700 m)

Propagation

Propagated by seed and stem cuttings. There is an enhancement in seed germination with the application of GA_3 (100 ppm). The treatment of cuttings with the application of IBA (2000 ppm) induces better rooting.

Uses

Fuel:	The wood is a good fuel.
Fodder:	Branches are used for fodder.
Fibre:	The fibrous bark is used for rope and paper making.

Deutzia Thumb.

Two species are found in the region.

Family Saxifragaceae

Key to species

Smooth, with soft scattered stellate hairs, petals ovate

.....D. hookeriana

Rough with grey stellate pubescence hairs, petals oblong

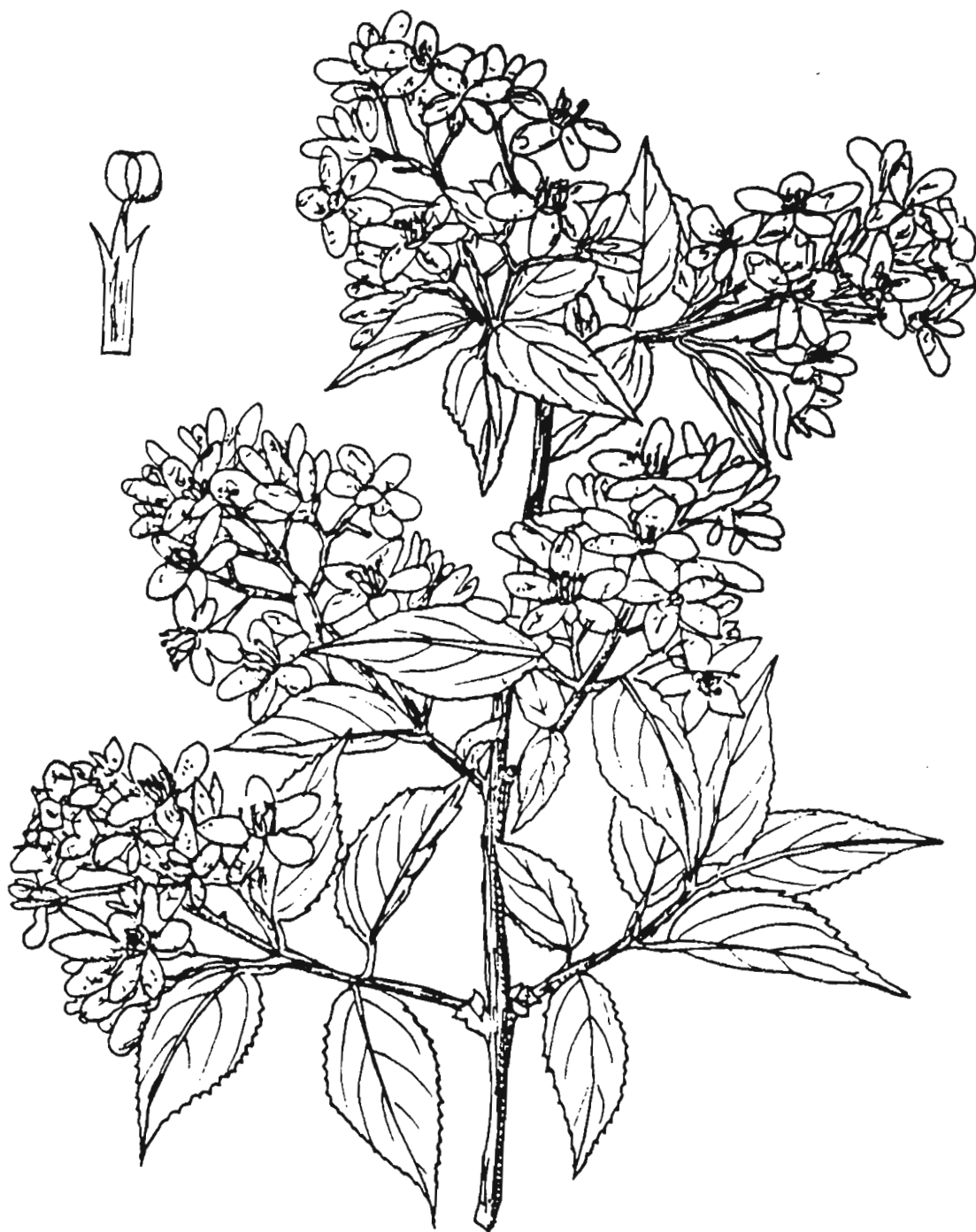
.....D. staminea

D. hookeriana (Schneid.) Shaw.

Vernacular name ghuglai, dahlochi

Diagnostic features

A tall shrub. Leaves serrate. Flowers white pentamerous; stamens 10; filaments winged. Ovary inferior, 3-5 celled; style 3-5. Capsule separating into 3-5 distinct cocci.



DEUTREA SIAMINEA Brown

Flowering and fruiting

May-August

Distribution and ecology

Usually in forest under growth upto an altitude of 2700 m in temperate region.

Locality

Shimla(Narkanda 2600 m)

D. staminea Brown.

Vernacular name

bujroi

Diagnostic features

A small shrub, bark peeling off in thin longitudinal strips. Leaves lanceolate or ovate lanceolate, minutely serrate. Flowers in terminal panicles. Petals oblong. Stamens 10, filaments broadly winged. Styles 4. Capsule 0.4 cm in diameter.

Flowering and fruiting

April-May

Distribution and ecology

Found usually in blanks or on dry hill sides on the borders of forests in western Himalaya within an altitudinal range of 900-2700 in sub-tropical to temperate regions.

Locality

Shimla(Mashobra 2200 m);
Kinnaur(Pooh 2100 m)

Propagation

Propagate readily by green wood and hardwood cuttings, also by seeds.

Uses

Fuel:

Source of fuel in scarcity areas.

Dodonaea viscosa Linn.

Family Sapindaceae

Vernacular name sonalla, walayti mehendi

Diagnostic features

A gregarious shrub or a small tree. Leaves coriaceous, lanceolate. Flowers regular polygamous, in short terminal panicles. Sepals 5. Stamens 8, as long as sepals. Ovary 3-4 celled. Fruit a membranous capsule, seeds opaque, dark brown or black.

Flowering and fruiting June-February

Distribution and ecology

Found in shady areas often covering extensive tracts in western Himalaya upto an elevation of 1500 m.

Locality Bilaspur(Barmana 900 m); Solan(1300 m)

Propagation

Propagation is chiefly through seeds in the month of March (sown immediately after depulping and drying). There is an enhancement in seed germination with the application of GA_3 (100 ppm). Also by cuttings in rainy season, treatment of cuttings with IBA (2000 ppm) induces better rooting.

Uses

Fuel: Good firewood - calorific value 4551 cal/g.

Food: Seed edible, containing semidrying oil.

Medicinal: Bark contains tannin, leaves used as wound dresser.



DODONAEA VISCOSA, Linn.

Small timber: Wood used for engraving, tool handles
and walking sticks

Ornamental: Planted as a hedge plant

Elaeagnus parvifolia Wall.

Family Elaeagnaceae

Vernacular name gunroi

Diagnostic features

A thorny deciduous shrub, densely covered with shining silvery scales. Leaves elliptic, lanceolate. Flowers white, scented, axillary on current year's branchlets. Fruit ovoid, glabrous.

Flowering and fruiting March-October

Distribution and ecology

Common throughout western Himalaya upto an altitudinal range of 1400-3000 m.

Locality Shimla(Mashobra 2100 m); Solan(1400 m)

Propagation

Propagation is by seed in spring season, the application of GA₃ increases germination percentage. Also by green wood cuttings in rainy season. The treatment of cuttings with IBA (1000 ppm) had a profound impact on rooting percentage.

Uses

Fuel: Wood is an important source of firewood-calorific value 4526 cal/g.

Food: Fruit prickled, eaten in curry.



ELAEAGNUS PARVIFOLIA Wall.

Medicinal: Flowers astringent and cardiac. Seed
yield and oil used in pulmonary
affections

Elsholtzia fruticosa (D.Don) Rehd.

Family Labiatae

Vernacular name pathoi, potha

Diagnostic features

A tall erect shrub. Leaves sessile, elliptic lanceolate serrate. Flowers shortly pedicelate in panicle spikes; bracts minute; corolla white pubescent. Stamens 4, didynamous anthers broadly elliptic. Ovary 4; style shortly 2-fid. Nutlets oblong.

Flowering and fruiting August-October

Distribution and ecology

Common as a forest undergrowth, more or less gregariously on hill side in company with Indigofera and Desmodium, offers protection to blue pine seedlings.

Locality Kinnaur(Kalpa 2600 m)

Propagation Propagation is by seed sown in spring and by green wood cuttings in summer.

Uses

Fuel: Useful source of fuel.

Flacourtia indica (Burm.f.)Merr.

Family Buxaceae

Vernacular name kemdai, kanderi

Diagnostic features

A large deciduous shrub. Leaves variable in shape from ovate to obovate. Flowers dioecious yellow in simple



FLACOURTIA INDICA (Barm.f.) Mers.

racemes. Male flowers: stamens numerous. Female flowers: ovary 2-6 celled; styles 5-11. Fruit a drupe, one seeded.

Flowering and fruiting May-June

Distribution and ecology

Very common shrub in deciduous forests, mostly in dry open places and rocks.

Locality Solan (1400 m)

Propagation

Propagated by seed sown in summer before the onset of monsoon.

Uses

Fodder: Branches and leaves lopped for fodder.

Food: Fruit edible.

Medicinal: Bark astringent and diuretic also used for tanning.

Small timber: Wood used for turnery, agricultural implements.

Hippophae Linn.

Two species occur in the region.

Family Elaeagnaceae

Key to species

Leaves clothed beneath with stellate hairs, the midrib more or less rusty scaly

....H. salicifolia

Leaves clothed beneath with silvery or rusty scale

....H. tibetana

H. salicifolia D. Don

Vernacular name dhurchuk

Diagnostic features

Shrub or a small tree with conspicuous silvery scales. Leaves alternate, membranous, linear lanceolate, white velvety. Flowers polygamous. Ovary 1-celled. Fruit enclosed within the lower part of perianth which is fleshy when seed ripens.

Flowering and fruiting

May-October

Distribution and ecology

Confined to inner dry tracts of western Himalaya in moist gravelly stream beds from 2700-3000 m.

Locality

Kinnaur(Kalpa 2600 m)

H. tibetana Schlecht.

Vernacular name

tarwa, chuma

Diagnostic features

A large thorny shrub, branchlets, underside of leaves densely clothed with silvery scales. Leaves alternate thinly coriaceous linear lanceolate. Flowers scarlet orange. Ovary 1-celled. Fruit enclosed within perianth. Seed dark brown.

Flowering and fruiting

June-September

Distribution and Ecology

Chiefly in moist gravelly stream beds of western Himalaya within an altitudinal range of 2700-3300 m.

Locality

Kinnaur(Pooh 2800 m)



Propagation

Propagation is by seed which do not germinate until second year. Also cuttings propagated by mature wood and occasionally by layers and root cuttings.

Uses

Fuel:	Firewood of good calorific value (4547 cal/g).
Fodder:	Important source of fodder in scarcity areas.
Food:	Fruit made into jellies.
Medicinal:	Fruit syrup rich in Vitamin C (135-605 mg/g). Twigs and leaves contain 4-5 per cent tannin.

Hypericum Linn.

Two species occur in the region.

Family Hypericaceae

Key to species

Petals rather longer than stamens; styles twice as long as ovary

.....H. oblongifolium

Petals twice as the stamens; styles not longer

.....H. patulum

H. oblongifolium Wall.

Vernacular name pingniara

Diagnostic features

A shrub much branched from the base. Leaves ovate or lanceolate. Flowers bright yellow, stamens 5; style 5 twice as long as ovary. Fruit capsule; seed numerous.

Flowering and fruiting March-October



HYPERICUM PATULUM, Thumb.

Distribution and ecology

Common in north western Himalaya at an altitudinal range of 1500-2100 m, chiefly on rocks.

Locality Solan(1400 m)

H. patulum Thumb.

Vernacular name piuli

Diagnostic features

A small sized shrub; leaves elliptic, lanceolate. Flowers yellow in few flowered cymes. Sepals elliptic obtuse. Petals twice as long as stamens. Style 5, as long as ovary. Capsule sub-globose. Seeds numerous minute.

Flowering and fruiting July-October

Distribution and ecology

Occurs between an altitudinal range of 900-2100 m in western Himalaya in open hill sides.

Locality Solan(1300 m); Kinnaur(Nichar 1800 m)

Propagation

Propagated by seeds which germinate readily, also by green wood cuttings in summer.

Uses

Medicinal: Seed aromatic stimulant, used externally and internally for dog bite and bee sting.

Ornamental: Hedge plant for attractive flowers.

Indigofera Linn.

Five species are met within the region.

Family

Papilionaceae

Key to species

Bracts long more or less enclosing the flower buds;
leaflets 9-11, ovate, thinly hairy. Pods glabrous

Bracts lanceolate gradually narrowed to a point

Flowers dark purple red I. atropurpurea

Flowers bright pink I. pulchella

Bracts boat shaped abruptly narrowed in a long tail
like point

.....I. hebeptala

Leaflets 19-35 oblong, densely hairy

.....I. dosua

Bracts minute

.....I. gerardiana

I. atropurpurea Ham.

Vernacular name kathi, kathoi

Diagnostic features

A large nearly glabrous shrub. Leaflets 5-6 pair, ovate oblong. Flowers dark purple in racemes. Stamens diadelphous; anthers uniform. Ovary sessile; style short, stigma capitate. Pods linear; seeds numerous.

Flowering and fruiting

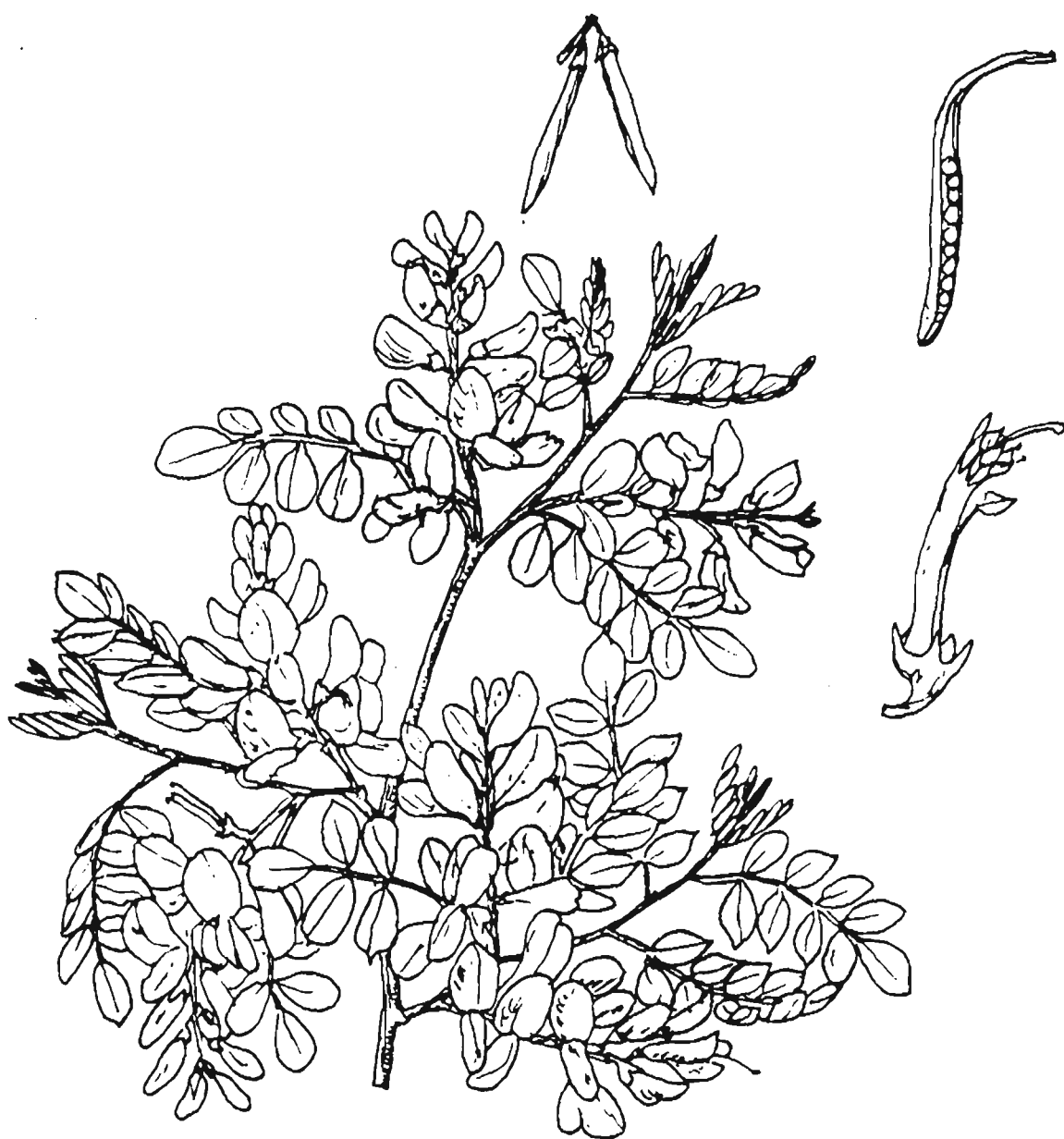
June-September

Distribution and ecology

Occurring between an altitudinal range of 700-3000 m in sub-tropical to temperate region. Chiefly in open places.

Locality

Kinnaur(Kalpa 2700 m)



INDIGOFERA GERARDIANA Wall.

I. dosua Wall.

Vernacular name kathi

Diagnostic features

A large densely pubescent shrub. Leaflets 10-12 pairs, elliptic or linear oblong mucronate. Flowers bright red; calyx densely silky. Stamens diadelphous. Ovary sessile; style short, stigma capitate. Pods linear; seeds numerous.

Flowering and fruiting June-July

Distribution and ecology

Confined to open slopes between an altitudinal range of 600-3000 m in sub-tropical to temperate forests.

Locality Shimla(Naldera 2200 m)

I. gerardiana Wall.

Vernacular name kathi, dande ka katha

Diagnostic features

A silvery pubescent shrub. Leaves opposite, both surfaces hairy. Flowers in axillary racemes. Stamens diadelphous. Ovary sessile; style short stigma capitate. Pods straight cylindrical.

Flowering and fruiting May-July

Distribution and ecology

Gregarious on dry grassy slopes useful in preparing ground for deodar planting as it keeps grss down.

Locality Chamba(Dalhousie 2600 m)

I. hebepetala Benth.

Vernacular name kathi

Diagnostic features

A tall glabrous shrub, branches erect; leaves opposite ovate. Flowers red, large, in axillary racemes. Stamens diadelphous. Ovary sessile; style short; stigma capitate. Pods with numerous seeds.

Flowering and fruiting April-September

Distribution and ecology

Prefers shady ravines in temperate to alpine regions of western Himalaya within an altitudinal range of 1800-4500 m.

Locality Shimla(Cheog 2100 m);
Kinnaur(Pooh 2800 m)

I. pulchella Roxb.

Vernacular name kathi

Diagnostic features

A large shrub. Leaves ovate, oblong. Flowers bright pink fading to blue. Stamens diadelphous. Ovary sessile, style short; stigma capitate. Pods linear seeds numerous.

Flowering and fruiting March-May

Distribution and ecology

Prickly shrub common in Pinus roxburghii and Shorea robusta forests.

Locality Solan(1400 m)

Propagation

Propagation is by seed and stem cuttings in summer and rainy season. Since the germination percentage is very high no special treatment is required to boost it while the application of IBA (1000 ppm) had a pronounced influence on inducing rooting.

Uses

Fuel:	Source of fuel - calorific value 4248 cal/g.
Fodder:	Excellent fodder for cattle.
Food:	Flowers of the plant are eaten.
Medicinal:	A decoction of root is given for cough and its powder is applied externally for chest pain.

Inula cappa DC.

Family Compositae

Vernacular name poshkar

Diagnostic features

An erect shrub. Leaves oblong lanceolate narrowed at both ends, thick green. Flowers yellow; bracts linear acuminate, silky. Achenes dusty white.

Flowering and fruiting September-November

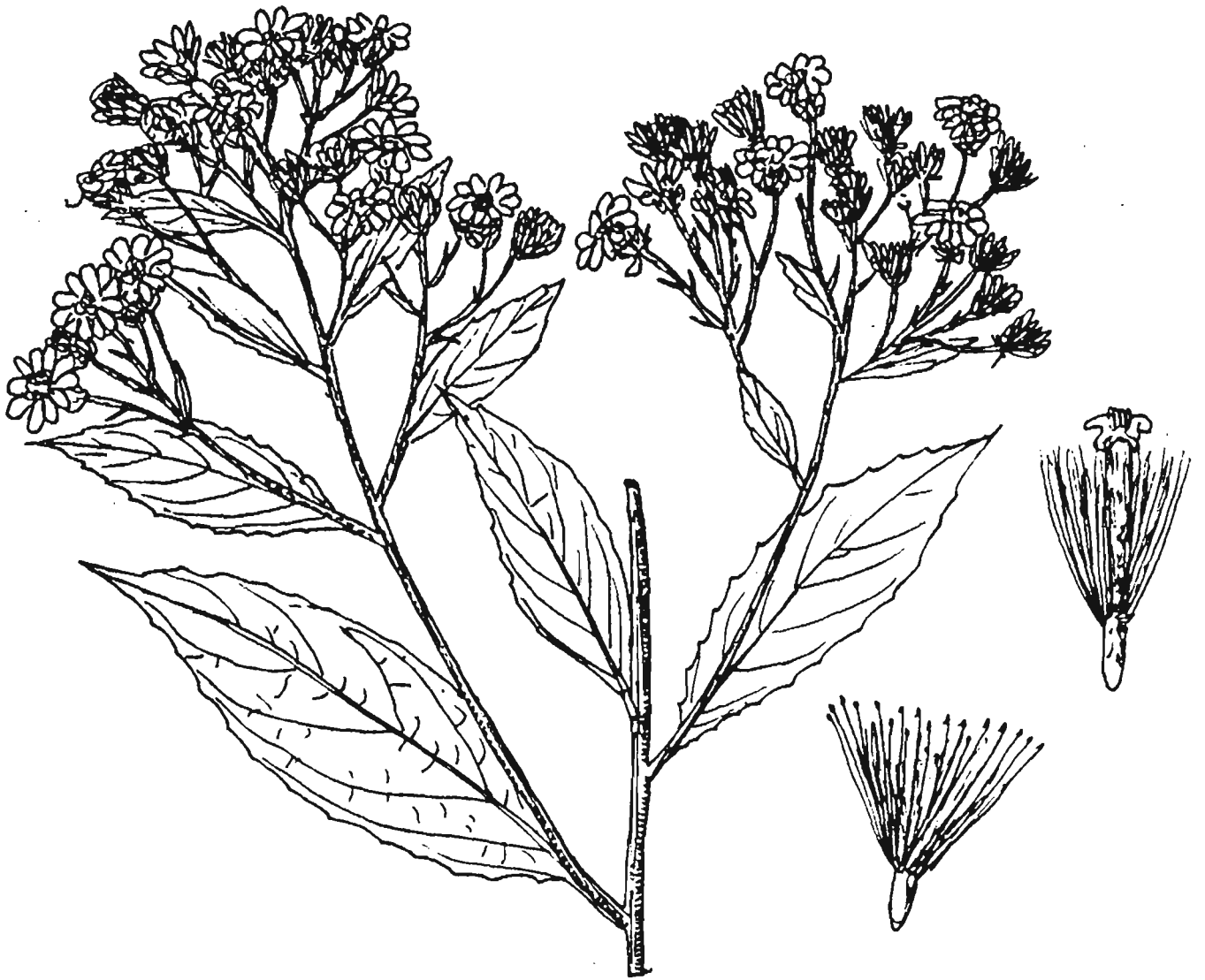
Distribution and ecology

Very common gregarious shrub in sub-tropical to temperate localities with an altitudinal range of 900-2100m.

Locality Solan (Nauni 1400 m)

Propagation

Propagation is by division or seed



INULA CAPPa DC

Uses

- Fuel: Woody stem is a good source of fuel.
- Ornamental: Grown in gardens for bright yellow and attractive flowers.

Jasminum Linn.

Three species occur in the region.

Family Oleaceae

Key to species

Leaves simple J. arborescens

Leaves imparipinnate

Terminal leaflets much longer than others

.....J. officinale

Terminal leaflets not longer than others

.....J. grandiflora

J. arborescens Roxb.

Vernacular name chemeli

Diagnostic features

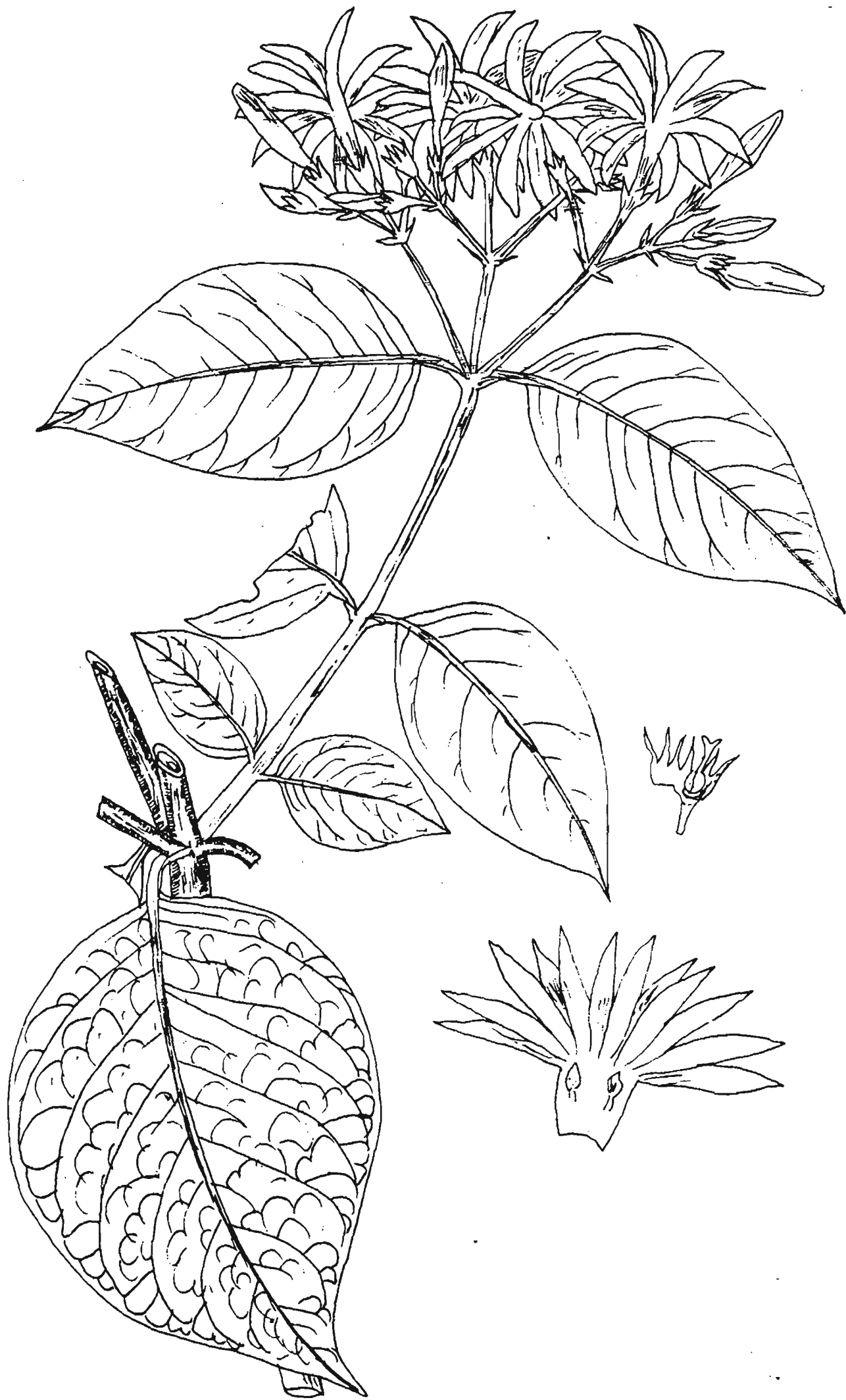
A large sub-erect shrub with straggling branches, leaves opposite, simple ovate or ovate oblong, acuminate. Flowers white, fragrant. Calyx hairy, teeth linear, as long as tube. Corolla lobes 9-12, linear lanceolate. Berries ovoid.

Flowering and fruiting April-August

Distribution and ecology

Common in most parts of India except for arid zones In outer Himalaya ascends to an altitude of 1300 m.

Locality Kangra(Nagrota 900 m);
Sirmour(Dhaulakuan 800 m)



JASMINUM ARBORENSCENS, Roxb.

J. grandiflorum Linn.

Vernacular name chambeli, joi

Diagnostic features

A large glabrous shrub. Leaves opposite, imparipinnate petiole and branches margined; leaflets 7-11, ovate or lanceolate, acute or acuminate. Flowers white often tinged with pink. Calyx glabrous. Corolla elliptic or obovate. Berries 1 seeded.

Flowering and fruiting May-September

Distribution and ecology

Ornamental shrub in sub-tropical to temperate areas of the state.

Locality Solan(Oachghat 1300 m); Shimla(2000 m)

J. officinale Linn.

Vernacular name halboti

Diagnostic features

A large twinning shrub. Leaves opposite, imparipinnate; petiole and rachis narrowly margined; leaflets 3-7. Flowers white fragrant, terminal cyme pedicels longer than calyx. Calyx teeth 5, 3-4 times longer than tube. Corolla ovate or elliptic. Berries 1 seeded.

Flowering and fruiting May-September

Distribution and ecology

Ecological requirements are similar to J. grandiflorum.



JASMINUM OFFICINALE, Linn.

Locality Shimla(Kufri 2700 m);
Kinnaur(Nichar 2000 m); Solan(1400 m);
Chamba (Banikhet 1800 m)

Propagation

Propagate readily by cuttings of nearly mature wood, layers and seed too. The treatment of seed with GA₃(100 ppm) increases germination percentage and the application of IBA (500 ppm) induces better rooting.

Uses

Fuel: Good quality fuel - calorific value 4182 cal/g.

Medicinal: Plants with anthelmintic and diuretic properties.

Ornamental: Bulk of flowers used in garlands and religious offerings.

Leptodermis lanceolata Wall.

Family Rubiaceae

Vernacular name padera

Diagnostic features

A small shrub; leaves opposite several pairs, stipules small persistent. Flowers white 5 merous, unisexual, nearly sessile. Corolla tube slender, hairy. Ovary 5 celled, style filiform. Capsule 5 valved; seed 5 fibrous.

Flowering and fruiting June-October

Distribution and ecology

Occurring in western Himalaya within an altitudinal range of 1400-3000 m on rocks.

Locality Solan(Kandaghat 1300 m);
Shimla(Mashobra 2200 m)

Propagation

Propagation is by green wood cuttings and seeds

Uses

Fuel: Excellent fuel - calorific value 4295 cal/g.

Foldder: Tender parts are consumed by goats and sheep .

Leycestris formosa Wall.

Family Caprifoliaceae

Vernacular name bhujnali, danda, bhekar

Diagnostic features

A small glabrous shrub. Leaves ovate lanceolate. Flowers pentamerous, zygomorphic in axillary spikes. Corolla funnel shaped. Stamens 5; ovary 5-8 celled; style slender; stigma capitate. Berry α seeded. Seeds minute.

Flowering and fruiting May-November

Distribution and ecology

A common shrub of mid and high hills ascending upto 2500 m in Abies forests.

Locality Chamba(Dalhousie 2600 m);
Sirmour(Habban 2400 m)

Propagation

Propagation is done by seed and hardwood cuttings..

Uses

Fuel: Good source of fuel.

Small timber: Hol'low stems made into whistles and fluters.

Lingustrum compactum Hk.f.& T.

Family Oleaceae

Vernacular name kakurchha

Diagnostic features

A large shrub or a small tree leaves entire. Flowers bisexual, tetramerous in terminal panicles. Corolla funnel shaped. Fruit berry, 2 celled and 2-4 seeded.

Flowering and fruiting May-January

Distribution and ecology

Found along streams in sub-tropical to sub-temperate regions with an altitudinal range of 1200-1800 m.

Locality Mandi(Jogindernagar 1600 m);
 Shimla(Shoghi 1600 m);
 Kinnaur(Nichar 1800 m)

Propagation

Propagated by seed sown in spring.

Uses

Fuel: Wood is a source of fuel.

Fodder: Plants are lopped for fodder, but of poor quality.

Litsaea salicifolia Hk.f.

Family Lauraceae

Vernacular name chandna, maida-lakri

Diagnostic features

An evergreen shrub. Leaves alternate, variable in shape elliptic, linear lanceolate. Flowers dark purple narrowly elliptic. Anthers 4 celled. Fruit purple black.

Flowering and fruiting March-June

Distribution and ecology

Occurring upto an altitude of 1800 m in deep forests



LITSEA SPPLICIFOLIA Roxb.

on damp soils.

Locality Solan(Chail 1800 m)

Propagation

Propagated through seed in spring season.

Uses

Fuel: Useful fuel wood.

Fodder: Leaves fed to Magha silkworm.

Lonicera Linn.

Five species are found in the region.

Family Caprifoliaceae

Key to species

Corolla regular or nearly so

Flowers white or pink; berries red

.....L. angustifolia

Flowers purple; berries black

.....L. purpurascens

Corolla 2 lobed

Twigs with pith, peduncels more or less conspicuous

Leaves sub-sessile L hypoleuca

Leaves petiolate L. orientalis

Twigs hollow L. quinquelocularis

L. angustifolia Wall.

Vernacular name guang, chalu, pirlu

Diagnostic features

A large erect shrub. Leaves entire, lanceolate.
Flowers pentamerous, sessile in pairs on axillary peduncles.



LONICERA QUINQUELOCULARIS Hardw.

Corolla tubular, funnel shaped. Stamens 5. Ovary 2-3 celled; style filiform; stigma capitate. Berries red, few seeded.

Flowering and fruiting April-July

Distribution and ecology

A very common shrub in the under wood of oak, fir and deodar forests within an altitudinal range of 1800-3000 m.

Locality Kinnaur(Pooh 2800 m);
Lahaul & Spiti(Tabo 3200 m)

L. hypoleuca Dcne.

Vernacular name: guang, chalu, pirlu

Diagnostic features

A small erect shrub; leaves entire, nearly sessile, broad ovate. Flowers orange red, sessile, on axillary peduncles. Corolla tubular or funnel shaped. Ovary 2-3 celled, style filiform; stigma capitate. Berry fleshy few seeded.

Flowering and fruiting June-October

Distribution and ecology

A shrub of damp places in hill forests, in ravines and on shady places.

Locality Shimla(Narkanda 2400 m)

L. orientalis Lamk.

Vernacular name taknoi

Diagnostic features

A large shrub, nearly glabrous; bark peeling off in thin shreds. Leaves entire, elliptic. Flowers orange red in

in pairs on peduncles. Corolla tubular or funnel shaped. Ovary 2-3 celled; style filiform; stigma capitate. Berry fleshy, few seeded.

Flowering and fruiting May-October

Distribution and ecology

Ecological requirements are similar to L. hypoleuca.

Locality Shimla(Narkanda 2500 m)

L. purpurascens Hk.f.& T

Vernacular name chalu, pirlu

Diagnostic features

An erect shrub. Leaves shortly stalked hairy oblong. Obtuse or acute. Flowers pentamerous, sessile in pairs on axillary, peduncles. Corolla tubular, funnel shaped. Stamens 5. Ovary 2-3 celled, style filiform, stigma capitate. Berries fleshy, few seeded black.

Flowering and fruiting May-September

Distribution and ecology

Met with underneath the kharshu oak, yew, white birch and lilac rhododendrons at about 3000-3600 m in western Himalaya.

Locality Shimla(Narkanda 2600 m);
Kinnaur(Pooh 2800 m)

L. quinquelocularis Hardw.

Vernacular name taknoi, pirlu

Diagnostic features

A large deciduous shrub or a small tree; bark peeling

off in long fibrous strips. Leaves entire ovate. Flowers white, yellow afterwards in axillary nearly sessile clusters. Corolla funnel shaped. Ovary 2-3 celled; style filiform; stigma capitate. Berry fleshy, few seeded.

Flowering and fruiting

April-September

Distribution and ecology

A common and conspicuous plant in sub-tropical and temperate forests of western Himalaya preferring rather dry aspects and open hill sides.

Locality

Solan(1400 m);
Shimla(Narkanda 2400 m)

Propagation

Propagation is by seed and cuttings. The application of GA₃ (100 ppm) increases germinability of seed. The treatment of 1000 ppm of IBA promotes rooting of stem cuttings.

Uses

Fuel: An important source of fuel - calorific value - 4312 cal/g.

Fodder: Leaf fodder for goats.

Fibre: Bark yields a fibre suitable for stuffing mattresses.

Small timber: Wood suitable for turnery, carving, plough and tool handles.

Mahonia nepalensis DC.

Family

Berberidaceae

Vernacular name

chochar

Diagnostic features

An evergreen shrub. Branchlets coriaceous, oblong or broadly ovate. Leaves coriaceous, shining imparipinnate, leaflets 2-12 pairs. Flowers on long erect racemes several together near the end of branches. Berry oblong, dark purple.

Flowering and fruiting

April-June

Distribution and ecology

Mostly in shady forests of silver fir and oaks upto an elevation of 3000 m in moist temperate forests.

Locality

Chamba(1800 m)

Propagation

Propagated through seed.

Uses

Fuel: Provides fuel.

Fodder: Leaves and twigs browsed by sheep and goats.

Food: Fruit eaten.

Maoutia puya Wedd.

Family

Urticaceae

Vernacular name

dhul, khagshi, chawna

Diagnostic features

Shrub or small tree. Leaves alternate, elliptic or acuminate. Flowers sessile in compact head. Male flowers: stamens exerted. Female flowers: stigma sessile. Fruit succulent enclosing the lower portion of achenes.

Flowering and fruiting

March-September

Distribution and ecology

Confined to sub-tropical region upto an altitude of 1400 m, chiefly in ravines and old cultivated land.

Locality Chamba(1400 m)

Propagation

Propagated through seed.

Uses

Fuel: Wood used as fuel.

Fibre: Bark yields a strong fibre.

Maytenus senegalensis (Lamk.) Exdt.

Family Celastraceae

Vernacular name malkangni

Diagnostic features

A large shrub. Leaves grey coriaceous, obovate oblanceolate. Flowers small, pale greenish white, cymes axillary on short branchlets. Capsule 2 valved. Seeds 1-2, dark brown.

Flowering and fruiting

May-October

Distribution and ecology

Occurring upto an altitude of 1200 m in drier parts of western Himalaya.

Locality Kullu(1200 m)

Propagation

Propagated through seed in spring and by stem cuttings in rainy season.

Uses

- Fodder: Leaves are fed to cattle.
- Medicinal: Root and bark are used in medicine. The bark is ground to a paste and applied with mustard oil to kill lice.
- Small timber: Wood suitable for axe handles and carpentry.

Meriandra strobilifera Benth.

Family Labiatae

Vernacular name keyurkapat

Diagnostic features

A small aromatic shrub; branchlets and underside of leaf white, woolly. Leaves thick crenulate. Flowers small white, in tomentose dense cylindrical spikes. Corolla hypogynous gamopetalous. Stamens 4, didynamous. Ovary free, 4 lobed. Fruit. one seeded nutlet.

Flowering and fruiting April-October

Distribution and ecology

The shrub is chiefly found on dry rocks especially on lime stone upto an altitude of 2200 m.

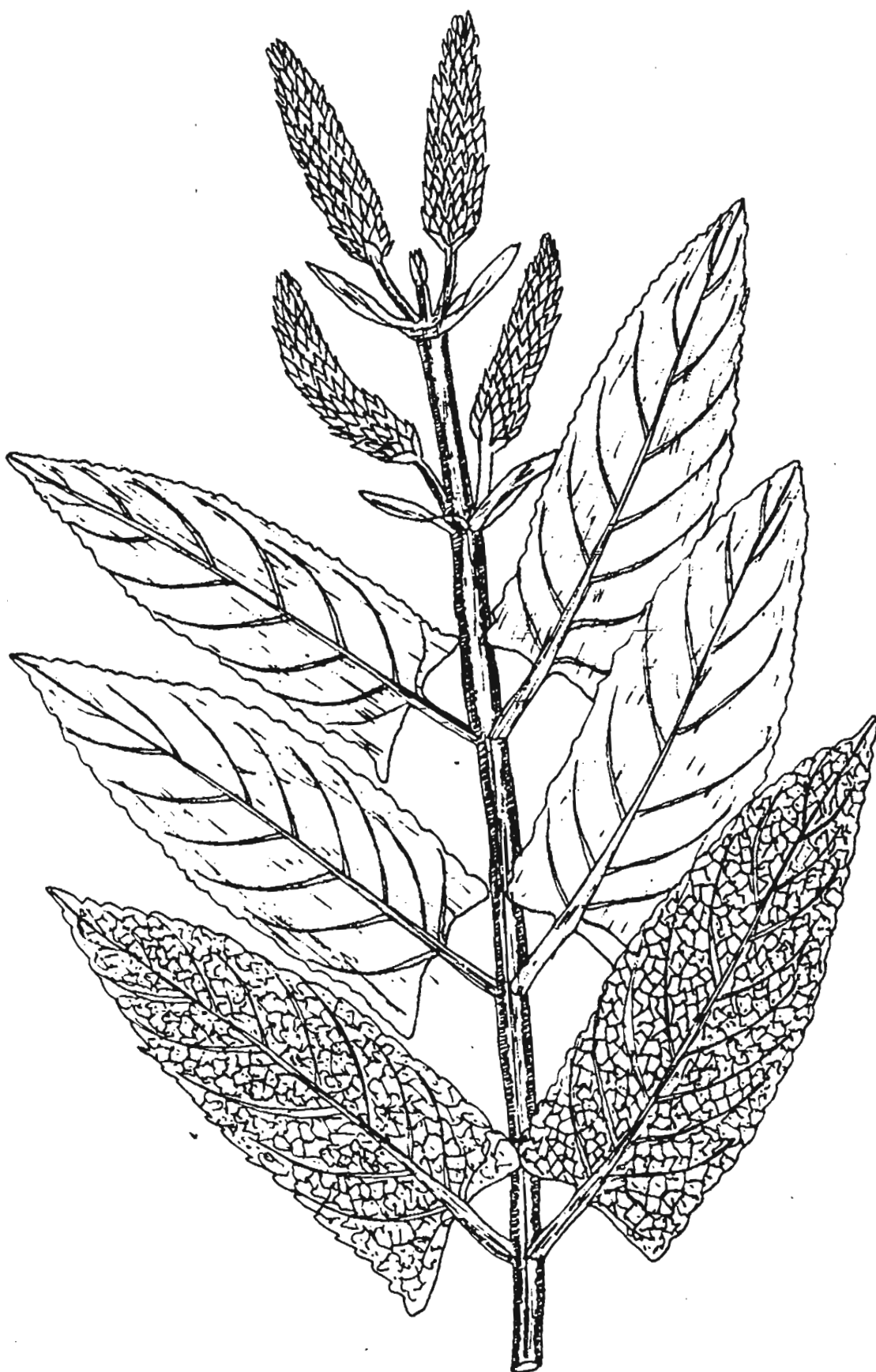
Locality v Shimla (2100 m)

Propagation

Propagated through seed sown in spring.

Uses

- Fuel: Used as a source of fuel - calorific value 4512 cal/g.
- Medicinal: Strong decoction of leaves used for skin diseases. Yield essential oil.



MERIANDRA STROBILIFERA, Benth.

Mimosa rubicaulis Lam.

Family Mimoseae

Vernacular name alay, al

Diagnostic features

A straggling prickly shrub. Pinnate 3-12 pair, leaflet 6-16 pair. Flowers tetramerous, pink in dense globose head. Petals 4-5. Stamens twice the number of petals and twice of their length. Pods stipulate glabrous curved seed 6-10.

Flowering and fruiting August-September

Distribution and ecology

A very common thorny shrub of Indian forests chiefly found in grass savannah land and abandoned areas, ascending upto sub-tropical regions.

Locality Kangra(1200 m); Solan(Oachghat 1300 m)

Propagation

Propagation is by seed sown in spring

Uses

Fuel: Wood a source of fuel - calorific value 4449 cal/g.

Medicinal: Roots, fruit and leaves are of minor medicinal importance.

Ornamental: Useful hedge plant.

Murraya Linn.

Two species are met with.

Family Rutaceae

Key to species

Nearly glabrous; leaflets 5-7

.....M. exotica



MIMOSA RUBICAULIS , Linn.

Pubescent, leaflets 10-25 M. koenigii

M. exotica Linn.

Vernacular name marchula, bilgar

Diagnostic features

A large shrub or small tree. Leaves imparipinnate, leaflets alternate. Flowers bisexual, pentamerous; petals imbricate; stamens 10. Ovary linear, 2 celled; style filiform; stigma capitate. Berries red, 2 seeded.

Flowering and fruiting March-September

Distribution and ecology

Ascending upto an altitude of 1600 m in sub-temperate forests, chiefly in ravines.

Locality Solan(1400 m)

M. koenigii Spreng.

Vernacular name gandhela

Diagnostic features

A large shrub or a small tree. Leaves imparipinnate, leaflets alternate. Flowers white, in terminal corymbose panicles. Ovary 2-celled; style short, cylindrical. Fruit black rugose.

Flowering and fruiting March-September

Distribution and ecology

Ascending upto an altitude of 1500 m in evergreen and deciduous forests.



MURRAYA KOENIGII, Spreng.

Locality Solan(1400 m)

Propagation

Propagated by seed and stem cutting. The application of IBA (1000 ppm) improves germination percentage and the treatment of seed with GA₃ (100 ppm) causes an appreciable increase in germination percentage.

Uses

Food: The leaves (M. koenigii) are used to flavour curries

Small timber: The wood is durable, and is used for agricultural implements

Myricaria Desv.

Two species occurs.

Family Tamariaceae

Key to species

Flowers pink; leaves 0.65 cm or less in length

.....M. elegans

Flowers white; leaves about 1.25 cm or more in length

.....M. germanica

M. elegans Royle

Vernacular name humber, umber

Diagnostic features .

A gregarious shrub. Leaves oblanceolate narrowed at both ends. Flowers white in long racemes. Stamens united in tube. Seeds with stalked comma.

Flowering and fruiting May-August

Distribution and ecology .

This shrub is very common along rivers in the inner Himalaya, often afford woody vegetation.

Locality Shimla(Mashobra 2200 m); Kinnaur(Skibba 2600 m)



M. germanica Desv.

Vernacular name bib, shalakat

Diagnostic features

A gregarious shrub. Leaves sessile, linear lanceolate. Flowers pink on short pedicels, in dense cylindrical racemes. Stamens united, shorter than petals. Petals obovate, twice the length of sepals; white above, red below. Seeds with stalked comma.

Flowering and fruiting May-August

Distribution and ecology

The ecology and altitudinal zonations are similar to M. elegans.

Locality Shimla(Mashobra 2400 m);
 Kinnaur(Spillo 2600 m)

Propagation

Propagated by seeds sown in spring.

Uses

Fuel: Wood provide fuel.

Fodder: Twigs are browsed by goats and sheep.

Myrsine Linn.

Two species occurs in the region.

Family Myrsinaceae

Key to species

Leaves small sub-sessile M. africana

Leaves usually large, pedicellate

.....M. semiserrata

M. africana Linn.

Vernacular name banwan, rikhdalmi

Diagnostic features

A small shrub, branches hairy. Leaves coriaceous minutely serrate. Flowers in axillary clusters of 4-6; calyx small persistent, corolla white; ovary free globose; stigma large capitate. Berries solitary red.

Flowering and fruiting March-October

Distribution and ecology

The shrub prefer shady places in drier forest like ban oak and rhododendron.

Locality Solan(Oachghat 1400 m);
Shimla(Kufri 2600 m)

M. semiserrata Wall.

Vernacular name bains, gaunta

Diagnostic features

A small evergreen shrub. Leaves coriaceous, elliptic lanceolate. Flowers white with slight pink tinge. Calyx small persistent. Corolla white. Ovary free, globose; stigmas 2-5. Fruit red; seed-1.

Flowering and fruiting March-October

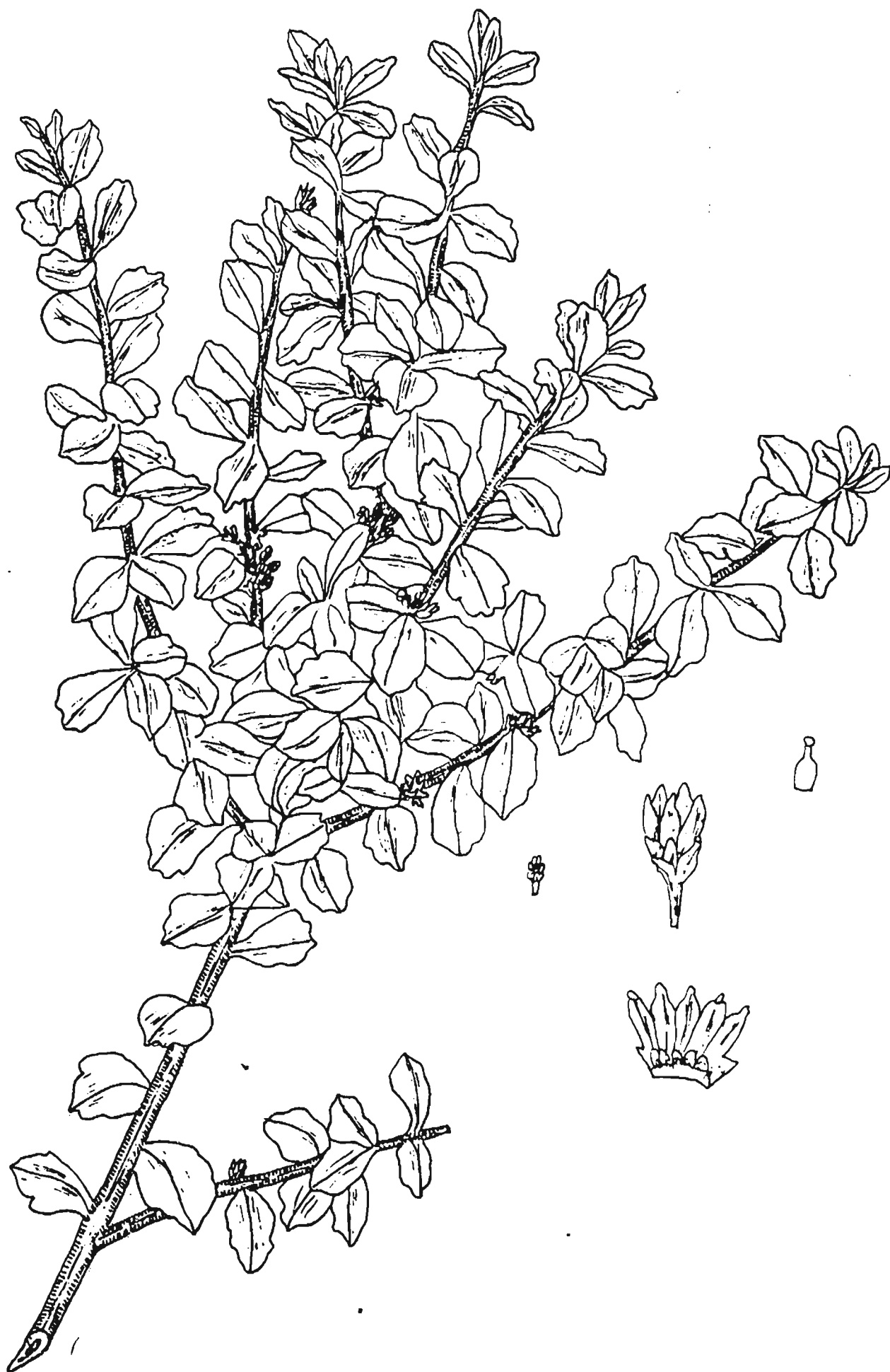
Distribution and ecology

The ecological requirements are similar to M. africana.

Locality Solan(Oachghat 1600 m);
Shimla(Fagu 2400 m)

Propagation

Propagation is chiefly by seed, also by green wood cuttings.



MYRSINE AFRICANA Linn.

Uses

Fuel: Good quality fuel.
Fodder: Twigs are browsed by sheep and goats.

Nerium indicum Mill.

Family Apocynaceae

Vernacular name kaner

Diagnostic features

An erect glabrous shrub; juice milky. Leaves shortly stalked, narrowly lanceolate. Flowers red or pink, fragrant in terminal cymes. Calyx lobes lanceolate. Anthers adhering in a cone found in the stigma. Ovary cells nearly distinct. Style long stigma conical. Follicles narrow.

Flowering and fruiting April-November

Distribution and ecology

Common shrub in streams and ravines dried in winter in sub-tropical western Himalaya upto an altitude of 1800 m.

Locality Solan(Oachghat 1400 m)

Propagation

Propagated by seed sown in spring, the pre-sowing treatment with GA_3 (100 ppm) increases sgermination percentage. Also by stem cuttings in rainy season, the application of IBA (1000 ppm) induces better rooting.

Uses

Medicinal: The bark and roots are poisonous.



NERIUM INDICUM, Mill.

Ornamental: An ornamental shrub with pink attractive flower;

Picrasma quassioides Benn.

Family Simarubaceae

Vernacular name karui, tithkai

Diagnostic features

A tall scrambling shrub. Leaves imparipinnate; leaflets opposite nearly sessile, 4-6 pair serrate. Flowers small greenish, pentamerous. Stamens 4-5. Drupe fleshy coriaceous.

Flowering and fruiting April-July

Distribution and ecology

Abundant in forests of high hills in western Himalaya chiefly in ravines under forests of deodar, oak and fir.

Locality Chamba(Banikhet 2100 m);
Kinnaur(Nichar 1800 m)

Propagation

Propagated by seed in spring, also by stem cuttings.

Uses

Fodder: Leaves and twigs are browsed by goats and sheep.

Food: Fruit eaten.

Medicinal: A decoction of bark is used to kill flea in cattle, seed yield a fully oil.

Small timber: Wood bright yellow, used in mosaic work.

Piptanthus nepalensis D. Don

Family Papilionaceae

Vernacular name chamba, chamboi

Diagnostic features

A large shrub, with alternate digitately trifoliate leaves; leaflets lanceolate, entire, sessile. Flowers large, bright, yellow, in short hairy racemes with broad, tomentose bracts. Pods linear lanceolate, 3-4 seeded.

Flowering and fruiting May-December

Distribution and ecology

Confined to temperate forests of Western Himalaya upto an altitude of 2700 m under shady wood of Pyrus pashia, Quercus semicarpifolia, Rhododendron arboreum, etc.

Locality Kullu(Bhunter 1600 m);
 Kinnaur(Nichar 1800 m)

Propagation

Propagation is by seed sown in spring, also by softwood cuttings in spring or early summer.

Uses

Fodder: Fodder for goats and sheep.

Ornamental: Planted for large yellow attractive flowers.

Plectranthus rugosus Wall.

Family Labiatae

Vernacular name chhichhri, pimur

Diagnostic features

A small shrub; leaves ovate, rugose above, white tomentose beneath. Flowers bluish or purplish white, in axillary cymes. Corolla boat shaped, narrowed at base. Stamens 5.



PLECTRANTHUS RUGOSUS Wall.

Flowering and fruiting

March-October

Distribution and ecology

Common in dry hill sides and rocks and in the inner valleys of western Himalaya upto an altitude of 1800 m.

Locality Solan(Oachghat 1300 m);
 Kinnaur(Nichar 1800 m)

Propagation

Propagated through seed sown in spring and also by cuttings in rainy season. Treatment of seeds with GA₃ (100 ppm) and of cuttings with IBA (1000 ppm) further improves their germination and rooting behaviour, respectively.

Uses

Fuel: Useful source of fuel.

Fodder: Fodder for sheep and goats.

Prinsepia utilis Royle

Family Rosaceae

Vernacular name bhekoi, bhek, bhekal

Diagnostic features

A deciduous thorny shrub. Leaves lanceolate, serrate. Flowers white in short racemes generally at the base of spines. Stamens numerous inserted below petals. Fruit oblique, fleshy purple, drupe, endocarp coriaceous, seed only one.

Flowering and fruiting

April-June

Distribution and ecology

A well known shrub on dry hill sides near small spring



PRINSEPIA UTILIS, Royle.

or water course in sub-tropical to sub-temperate region of the state upto an altitude of 2200 m.

Locality Solan(Oachghat 1400 m);
Shimla(Theog 2200 m);
Kinnaur(Nichar 1800 m)

Propagation

Propagated by seed sown in June before the onset of monsoon. The treatment of seed with GA₃ (100 ppm) increases germination percentage. Also by cuttings in rainy season, the application of IBA (1000 ppm) induces better rooting.

Uses

Fuel: Common fuel.

Fodder: Leaves lopped for fodder.

Medicinal: Seed yield a semidrying fatty oil used for cooking purpose, also suitable for for hydrogenation and soap making.

Small timber: Wood used for walking sticks.

Pyracantha crenulata Roem.

Family Rosaceae

Vernacular name gingoru

Diagnostic features

A large spinescent shrub, leaves entire, lobed. Flowers white, carpels 5 free. Stamens α . Ovary either enclosed or adnate to calyx tube. Fruit orange, 1-5 celled stone, 1- or rarely 2 seeded.

Flowering and fruiting April-September

Distribution and ecology

A pretty shrub which usually affects banks of stream

in higher hills in temperate region of the state within an altitudinal range of 1500-2000 m.

Locality Solan(1400 m)

Propagation

The fruit can be broadcast in bed without separation of seed. For higher germination scarification of fruit in water along with maceration of pulp is practised prior to sowing.

Uses

Medicinal: Fruit contain tannin.

Small timber: Wood used for axe handles, walking sticks.

Rhamnus Linn.

Three species occurs in the region.

Family Rhamnaceae

Key to species

Spinous, leaves nearly or quite opposite

.....R. virgatus

Unarmed, erect; leaves alternate

Flowers in clusters R. triqueter

A prostrate shrub not armed leaves coriaceous

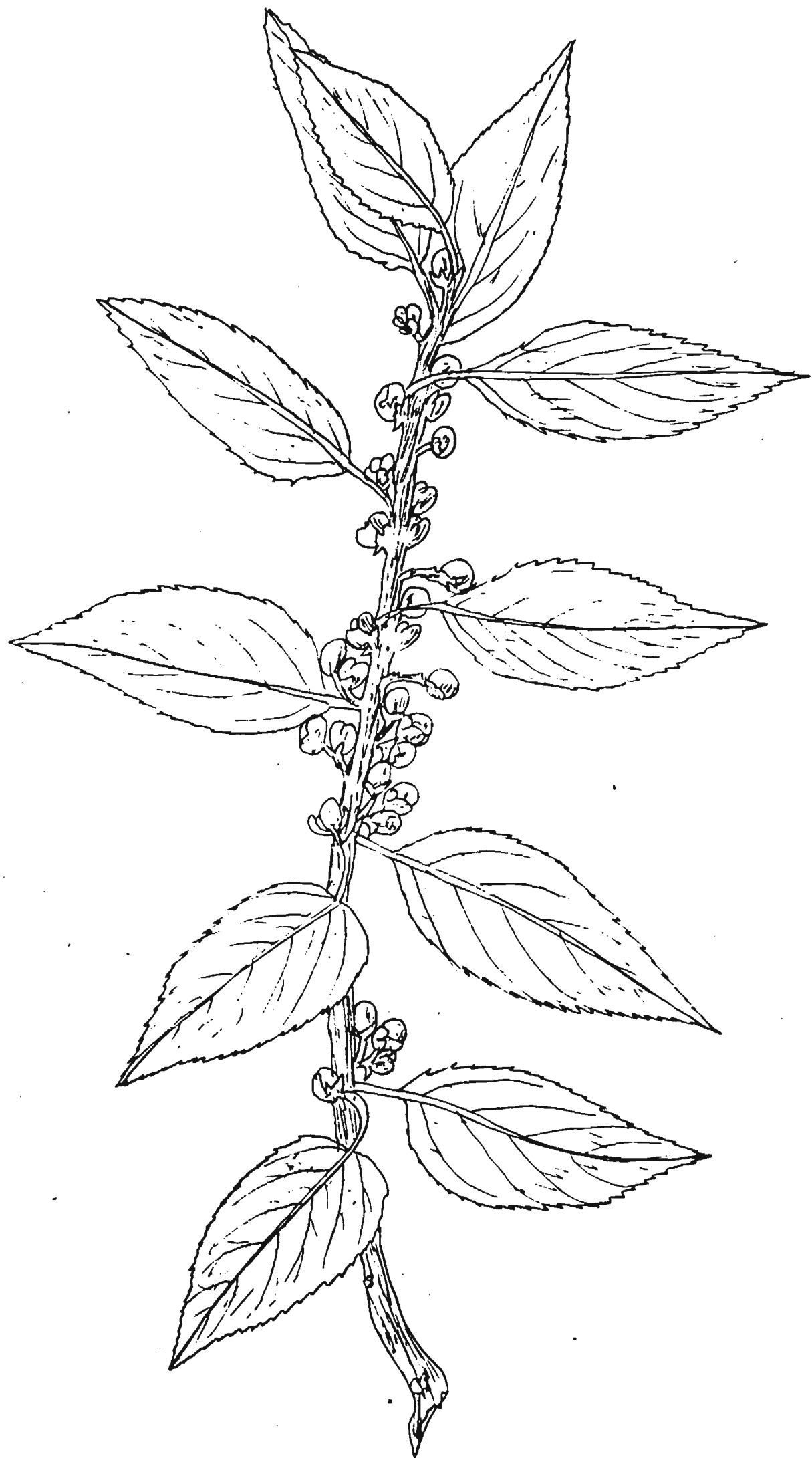
.....R. procumbens

R. procumbens Edgew.

Vernacular name luhist, lhish

Diagnostic features

A small prostrate shrub. Leaves serrate, alternate. Flowers solitary on long slender pedicles; petals wanting;



disk thin, clothing the calyx tube. Ovary free 3-4 celled, stigma papillose obtuse. Drupe 1 seeded.

Flowering and fruiting May-August

Distribution and ecology

Climbing on rocks (Lime stone) in temperate region of the state within an altitudinal range of 2100-2700 m.

Locality Shimla(Kufri 2700 m)

R. triqueter Laws.

Vernacular name katheru, gaunt

Diagnostic features

A shrub or a small tree; leaves serrate, alternate. Flowers clustered in axillary racemes, petals wanting; disk thin, clothing the calyx tube. Ovary free 3-4 celled; stigma papillose obtuse. Drupe 1-seeded. Seed with a broad open groove.

Flowering and fruiting July-September

Distribution and ecology

A common shrub in sub-tropical region of the state upto an altitude of 1800 m.

Locality Shimla(Shoghi 1600 m);
Kinnaur(Nichar 1800 m)

R. virgatus Roxb.

Vernacular name thanthar, chaurdha

Diagnostic features

A small shrub; leaves serrate, alternate, opposite

glabrous. Flowers greenish, on slender pedicels, in axillary clusters; petals minute. Ovary free 3-4 celled; stigma papillose. Drupe 1 seeded.

Flowering and fruiting

April-August

Distribution and ecology

Its natural habitat varies from sub-tropical to temperate region within an altitudinal range of 1500-2400 m.

Locality

Chamba(Banikhet 2100 m);
Kinnaur(Nichar 1800 m);
Shimla(Mashobra 2200 m)

Propagation

Propagated by seed sown in autumn and by layering, also by old wood cuttings.

Uses

Fuel: An excellent fuelwood - calorific value 4633 cal/g.

Fodder: Leaves and twigs are lopped for fodder.

Medicinal: Bark used as a tonic.

Small timber: Wood used for turnery, carving and also for agricultural implements.

Ribes Linn.

Two species occur in the region.

Family

Saxifragaceae

Key to species

Pubescent and viscid with stipulate glands, leaves with obtuse lobes

.....R. orientale

Nearly glabrous, leaves with large acute lobes

.....R. glaciale



RIBES ORIENTALE , Poir.

R. glaciale Wall.

Vernacular name kukuliya, mangle, durbai

Diagnostic features

A small shrub, leaves alternate, palmately lobed frequently clustered on arrested branchlets. Flowers green pubescent. Calyx superior, petals 4-5, stamens as many. Ovary inferior 1 celled. Berries nearly globose.

Flowering and fruiting May-October

Distribution and ecology

It is found in high temperate forests along with Quercus semecarpifolia, Rhododendron campanulatum.

Locality Chamba(Dalhousie 2600 m);
Kullu(Manali 2700 m)

R. orientale Poir.

Vernacular name amlarich, kansi, teila

Diagnostic features

A small unarmed shrub; leaves alternate, palmately lobed frequently clustered on arrested branchlets. Calyx superior, petals 4-5; stamens as many. Ovary inferior, 1 celled. Berries glandular pubescent, reddish yellow.

Flowering and fruiting May-September

Distribution and ecology

A shrub of arid tracts of western Himalaya upto an altitude 3600 m.

Locality Chamba (Pangi 3000 m);
Kinnaur (Pooh 2800 m)

Propagation

Propagated by seed which germinate readily. Also propagated by hardwood cuttings, mound layering in summer is also practised.

Uses

Food: Fruit highly acidic used for tarts, jam and jellies.
Fodder: Seed cake used for livestock.
Medicine: Seed yields a dry oil.

Rosa Linn.

Three species are met within the region.

Family Rosaceae

Key to species

Flowers 5-merous

Leaves 5-20 cm; leaflets 7-11

.....R. macrophylla

Leaves 1-5 cm; leaflets 5-9

.....R. webbiana

Flowers 4-merous

Climbing shrub, flowers white R. moschata

R. macrophylla Lindl.

Vernacular name bhaunra, keyoi

Diagnostic features

A large erect thorny shrub. Leaves imparipinnate, glabrous or slightly pubescent; leaflets 3-6 pair. Flowers red in large corymbs. Bracts large entire. Calyx lobes often longer than the petals. Ovaries and fruit red, elongate, ovoid enclosing numerous dry 1-seed hairy carpels.

Flowering and fruiting May-December

Distribution and ecology

A petty undershrub in the forests of fir, oak in temperate regions of Western Himalaya within an altitudinal range of 2100-2600 m.

Locality Chamba(Banikhet 1800 m);
Shimla(Mashobra 2200 m)

R. moschata Mill.

Vernacular name Keyoi, kunjo

Diagnostic features.

A thorny shrub, climbing to the top of lofty trees. Leaves imparipinnate; leaflets 3 pair, evenly serrate. Flowers white in large compound terminal corymbs. Calyx lobes twice or three times the length of tube. Ovary α ; styles united into a hairy column. Fruit dark brown globose.

Flowering and fruiting April-June

Distribution and ecology

It is a characteristic shrub of exposed hills among bushes and occasional covers in forests of sub-temperate region.

Locality Solan(1400 m); Shimla (Shoghi 1600 m)

R. sericea Lindl.

Vernacular name chapala, dur kunja

Diagnostic features

A large shrub; leaves imparipinnate; leaflets 3-4 pairs. Flowers white or pink; tetramerous, solitary, without bracts. Calyx lobes silky. Ovary α . Fruit flesh scarlet.

Flowering and fruiting May-September

Distribution and ecology

Confined to alpine region of the state within an altitudinal range of 2700-4200 m on peaks and ridges with Rhododendron companulatum and kharshu oak.

Locality Shimla(Fagu 2700 m); Kinnaur(Kalpa 2800 m)

R webbiana Wall.

Vernacular name Sikanda, manvar

Diagnostic features

A large erect shrub. Leaves imparipinnate; leaflets



ROSA SERICEA Lindl.

2-4 pair , obovate or rotundate, entire. Flowers pink, solitary. Ovaries $\propto$. Berries enclosing numerous dry 1-seeded hairy carpels.

Flowering and fruiting

June-September

Distribution and ecology

Extends to inner dry region of Western Himalaya upto an altitude of 4000 m.

Locality

Chamba(Pangi 3200 m);
Shimla(Narkanda 2800 m)

Propagation

Propagated by seed, also by hard wood cuttings in autumn, in spring layering is also practised. The treatment of seed with GA_3 (100 ppm) increases germination percentage and application of IBA (1000 ppm) induces better rooting.

Uses

Fuel: Stem and branches are used as fuel.

Food: Fruit eaten.

Medicinal: Fruit pulp rich in Vitamin C.

Ornamental: Planted as ornamental climber/shrub for stabilizing the land slides or disturbed habitats, around parks, gardens and roadside.

Rubus Linn.

Three species occur in the region.

Family

Rosaceae

Key to species

Flowers white

Lower surface of leaflets grey or white tomentose, stem and branches glabrous covered with white bloom

.....R. biflorus

Stem and branches shaggy with long tawny bristles

.....R. ellipticus

Flowers pink, leaflet 3-5, calyx tube long pointed

.....R. niveus

R. biflorus Ham.

Vernacular name achhoi

Diagnostic features

A large trailing shrub; leaves alternate, compound; leaflets 2 pair., softly white tomentose beneath. Flowers white on slender pedicels, solitary. Calyx free broadly cap shaped, petals 5. Stamens α . Ripe carpels numerous fleshy, 1-seeded. Fruit yellow, globose.

Flowering and fruiting April-September

Distribution and ecology

Common gregarious shrub in fir and oak forest within an altitudinal range of 1800-3000 m in temperate forests.

Locality Shimla(Fagu 2400 m);
Kinnaur(Kalpa 2600 m)

R. ellipticus Sm.

Vernacular name anchhu, lalachhu

Diagnostic features

A large shrub with long angular branches. Leaves

imparipinnate; leaflet one pair. Flowers white in axillary corymbs panicles. Calyx free broadly cup shaped, petals 5. Fruit yellow.

Flowering and fruiting March-September

Distribution and ecology

A common shrub in sub-tropical to temperate areas of the state within an altitudinal range of 700-1200 m in hollows and depressions providing moist shady habitat.

Locality Kangra(Nurpur 800 m);
 Kinnaur(Nichar 1600 m);Solan(1400 m)

R. niveus Wall.

Vernacular name bhera, bheare

Diagnostic features

A large straggling gregarious shrub; branches dull brown or greyish. Leaves imparipinnate; leaflets one pair. Flowers pink, in axillary corymbs. Calyx free broadly cup shaped, petals 5, stamens ∞ . Ripe carpels numerous, fleshy 1-seeded.

Flowering and fruiting April-August

Distribution and ecology

Ecological requirement are similar to R. biflorus

Locality Shimla(Fagu 2400 m); Kinnaur(Kalpa 2600 m)

Propagation

Propagated by seeds sown immediately after ripening in

the month of September, also by stem cuttings in autumn and rainy seasons. The application of GA₃ (100 ppm) and IBA (1000 ppm) to seed and cuttings increases germination percentage and induces better rooting, respectively.

Uses

Fodder: Serves as the excellent source of honey flora.

Food: Edible wild fruit used for jam and jellies.

Sarcococca saligna Muell.

Family Euphorbiaceae

Vernacular name tiliari

Diagnostic features

A glabrous evergreen shrub. Leaves coriaceous, alternate lanceolate or elliptic. Flowers yellowish white, monoecious, in short compact axillary spikes. Stamens 4, free opposite to sepals. Ovary 2-3 celled. Berries purple, ovoid.

Flowering and fruiting June-September

Distribution and ecology

Very common undergrowth in dry hill forests, especially those of oak and rhododendron.

Locality Shimla(Kufri 2600 m)

Propagation

Propagated by seed and cuttings which root easily.

Uses

Medicinal: Leaves used in rheumatism.

Small timber: Wood used for walking sticks.

Sophora mollis Grah.

Family Papilionaceae

Vernacular name sakina

Diagnostic features

A shrub or a small tree. Leaves imparipinnate, leaflets 20-30, often alternate. Flowers bright yellow, in axillary racemes, generally appearing before leaves. Pods glabrous, 5-6 seeded.

Flowering and fruiting March-July

Distribution and ecology

Profusely distributed gregarious shrub, covering large exposures on hill sides upto an altitude of 1800 m.

Locality Shimla(Shoghi 1600 m)

Propagation

Propagated by seed, green wood cuttings and layers

Uses

Fuel: Useful fire wood.

Fodder: Goat browse on plant while it is said to be poisonous to other animals.

Medicinal: Seed used for destroying vermin, contain an alkaloid cystisine. Roots promote hair growth and impart dark colour to it.

Sorbaria tomentosa (Lindl.) Rehd.

Family Rosaceae

Vernacular name latkar, lotkar

Diagnostic features

Shrub or perennial herb, leaves pinnate; leaflets 6-10 pair, lanceolate sharply toothed. Flowers α white, in large terminal panicles. Calyx free, persistent in fruit, segments as well as petals 4-5. Stamens 20-60. Carpels 5, free; ovules 2 or more. Seed minute.

Flowering and fruiting May-September

Distribution and ecology

All along the higher ranges of western Himalaya between 1800-3300 m including dry temperate zone, occupying hill sides on cooler aspects and ravines in company with Desmodium tiliaefolium, Prinsepia utilis, etc.

Locality Shimla(Kufri 2700 m);
Kinnaur(Chango 3000 m)

Propagation

Propagated by seed sown in spring and also by cuttings in rainy season.

Uses

Fuel: Chief source of fuel wood in temperate zone - calorific value 4358 cal/g.

Medicinal: The bark contains tannin. The extract of aerial parts cures cardio vascular and nervous ailments.

Small timber: Small boxes are made from wood.

Spiraea Linn.

Family Rosaceae

Key to species

Flowers pinkish	 <u>S. bella</u>
Flowers white	
Leaves narrowly sessile	 <u>S. canescens</u>
Leaves stalked	 <u>S. vaccinifolia</u>

S. bella Sims.

Vernacular name chakroi

Diagnostic features

Shrub or perennial herb. Leaves simple. Flowers pink, unisexual. Calyx free, persistent in fruit, segments as well as petals 4-5. Stamens 20-60, on a fleshy disk. Ripe carpels glabrous. Seeds thin, minute.

Flowering and fruiting May-August

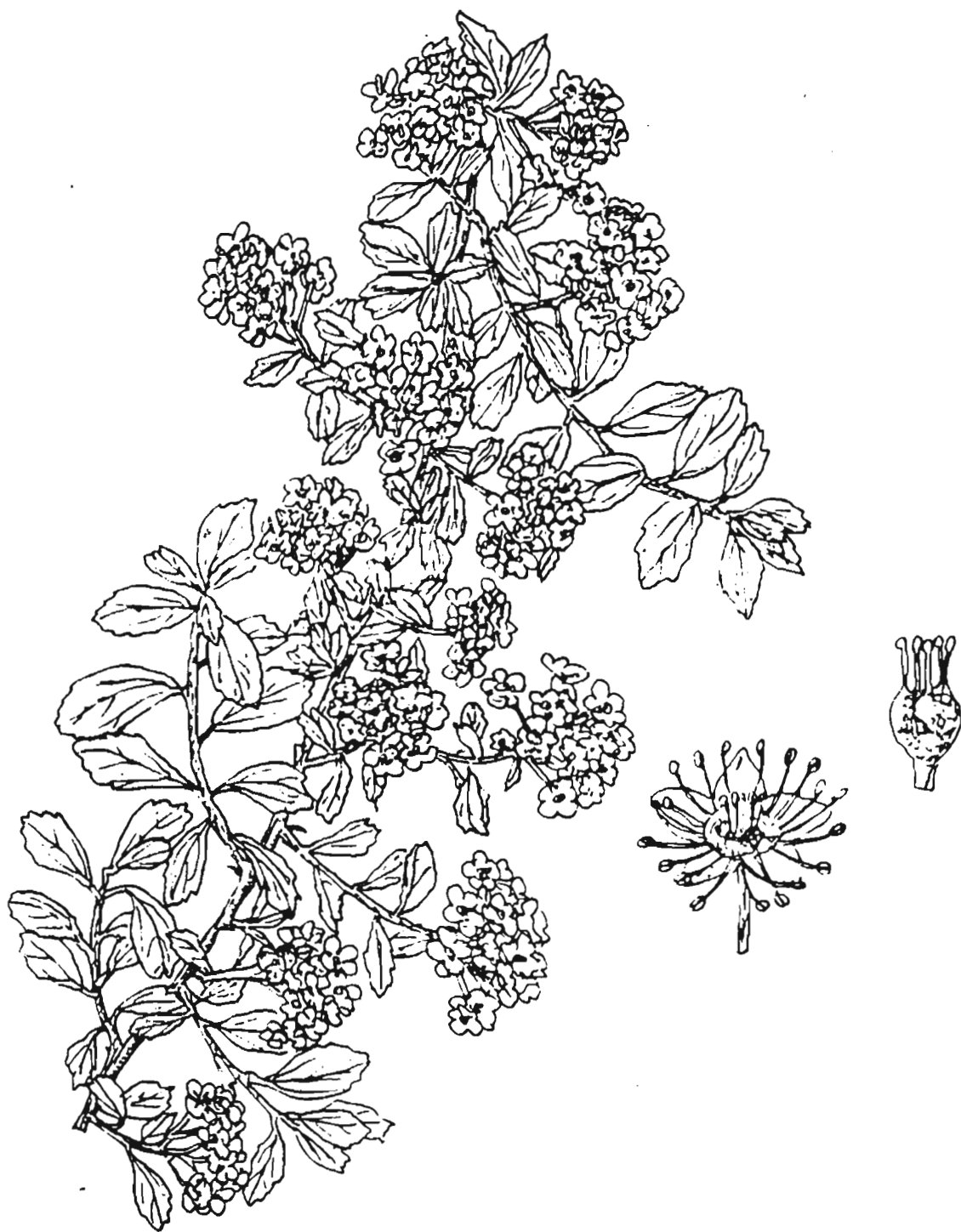
Distribution and ecology

Occurs both in high temperate coniferous and mixed broadleaved forests, extending even in dry temperate and cold desert zone on barren sites.

Locality Sirmour(Habban 2600 m);
Shimla(Naldera 2200 m);
Lahaul & Spiti(Kaza 4000 m);
Kinnaur(Pooh 2800 m)

S. canescens D.Don

Vernacular name takoi, chokroi



SPIREA CHNESCENS Don

Diagnostic features

Shrub or perennial herb. Leaves nearly sessile, entire or 3-5 toothed at tip. Flowers white, bisexual. Calyx free, persistent in fruit, segments as well as petals 4-5. Stamens 20-60. Ripe carpel glabrous. Ovules 2 or more. Seeds thin minute.

Flowering and fruiting

May-October

Distribution and ecology

Common shrub confined to slopes as a stiff bush both in conifers and broadleaved forests.

Locality

Kullu(Manali 2700 m);
Shimla(Narkanda 2800 m)

S. vaccinifolia D.Don

Vernacular name takoi, chakroi

Diagnostic features

A small gregarious shrub. Leaves simple, glabrous, glaucous beneath. Flowers white, bisexual. Calyx free, persistent in fruit, segments as well as petals 4-5. Stamens 20-60. Carpels 5, free; ovules 2 or more. Seeds thin, minute.

Flowering and fruiting

May-July

Distribution and ecology

Sporadic in distribution from sub-tropical to temperate zone with an altitudinal range of 1200-2400 m.

Locality

Shimla(Cheog 2100 m)

Propagation

Propagated by seed in spring and stem cuttings in rainy seasons. In S. canescens the application of IBA (1000 ppm) and GA₃ (100 ppm) to stem cuttings and seed increases the percentage of rooting and germination, respectively.

Uses

Fuel: Important source of fuel in scarcity areas.

Medicinal: Bark contains tannin.

Small timber: Wood locally consumed for making small boxes.

Staphylea emodi Wall.

Family Staphylaceae

Vernacular name chitra, marchhob

Diagnostic features

A shrub or a small tree; bark marked with white longitudinal strips. Leaves trifoliate; leaflets serrate, pale beneath. Flowers bisexual, regular, pentamerous in terminal short compact erect panicles. Petals as well as calyx segments white; stamens 5. Fruit membranous. Capsule 3 celled. Seeds few, bright brownish grey.

Flowering and fruiting April-August

Distribution and ecology

Found evenly distributed in ravines and moist forests of fir and oak and mixed trees in western Himalaya above 2000 m.

Locality Shimla(Narkanda 2700 m)

Propagation

Propagation is by seed, layers and suckers. Green wood cuttings root easily.

Uses

Small timber: The long straight shoots are made into walking sticks.

Syringa emodi Wall.

Family Oleaceae

Vernacular name shaphroi, shapa

Diagnostic features

A large shrub; young shoots and inflorescence pubescent. Leaves entire, pale beneath. Flowers white or purplish, strongly scented, crowded in short compact cymes. Calyx companulate more or less persistent. Fruit a coriaceous more or less cylindric capsule. Seeds pendulous in pairs.

Flowering and fruiting

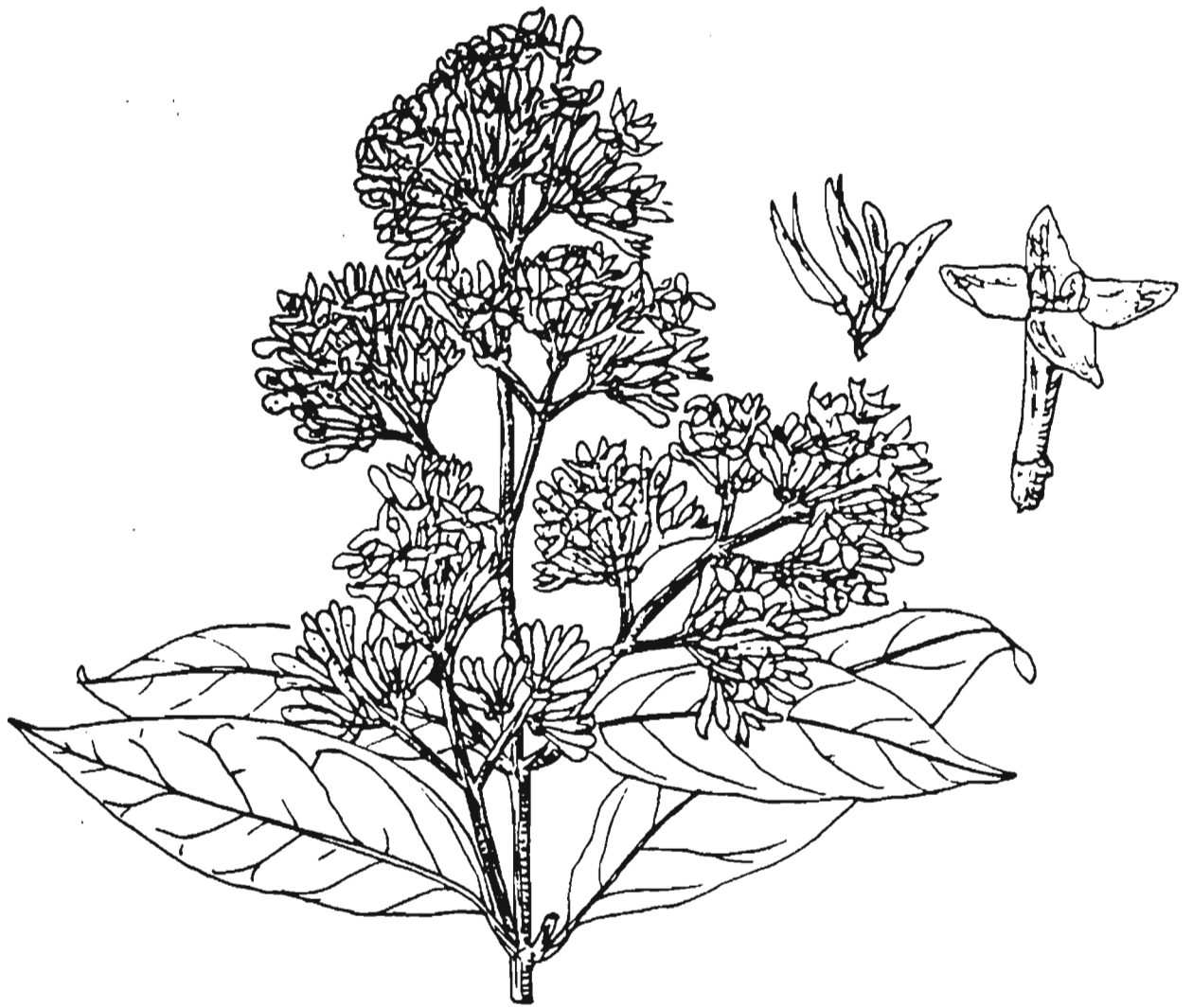
Distribution and ecology

Sporadic in distribution in shade and depressions extending from sub-tropical to temperate region upto 3600 m.

Locality Shimla(Narkanda 2800 m);
Lahaul & Spiti(Kaza 3600 m)

Propagation

Propagated by seed in spring season.



SYRINGA EMODI Wall.ex Don

Uses

Fodder: Leaves used as fodder for goats

Thevetia peruviana (Pers.)K.Schum.

Family Apocynaceae

Vernacular name pile kaner, zardkunel

Diagnostic features

A large glabrous evergreen shrub or a small tree. Leaves alternate, linear with strong mid-rib. Flowers yellow; corolla funnel shaped. Fruit angular, broad, black when ripe. Seeds orbicular 2-4.

Flowering and fruiting July-September

Distribution and ecology

Abundantly found in sub-tropical and temperate habitat from 600-1800 m.

Locality Solan(Kandaghat 1400 m);
Shimla(Shoghi 1600 m)

Propagation Propagated by seed.

Uses

Medicinal: Leaves purgative and emetic. Roots made into a plaster are applied to tumour. Seeds used as abortifacient and purgative in rheumatism and dropsy. All parts of the plant including latex are poisonous and contain glycoside.

Viburnum Linn.

Family Caprifoliaceae

Key to species

Leaves sharply toothed

.....V. nervosum

Leaves entire

Leaves oblong, glabrous, calyx limb obsolete

.....V. coriaceum

Leaves ovate or orbicular, tomentose beneath

.....V. cotinifolium

V. cotinifolium D. Don

Vernacular name bhutnoi, marghwala

Diagnostic features

A large deciduous shrub. Leaves rugose, ovate, elliptic or orbicular, crenulate or nearly entire. Flowers white or pink in a compound umbel. Stamens 5, ovary 1-3 celled. Corolla white, tinged with pink. Drupe fleshy, 1-seeded.

Flowering and fruiting April-September

Distribution and ecology

A common shrub in higher hill forests of oak and deodar affecting open places on rather drier exposures upto an altitude of 2800 m.

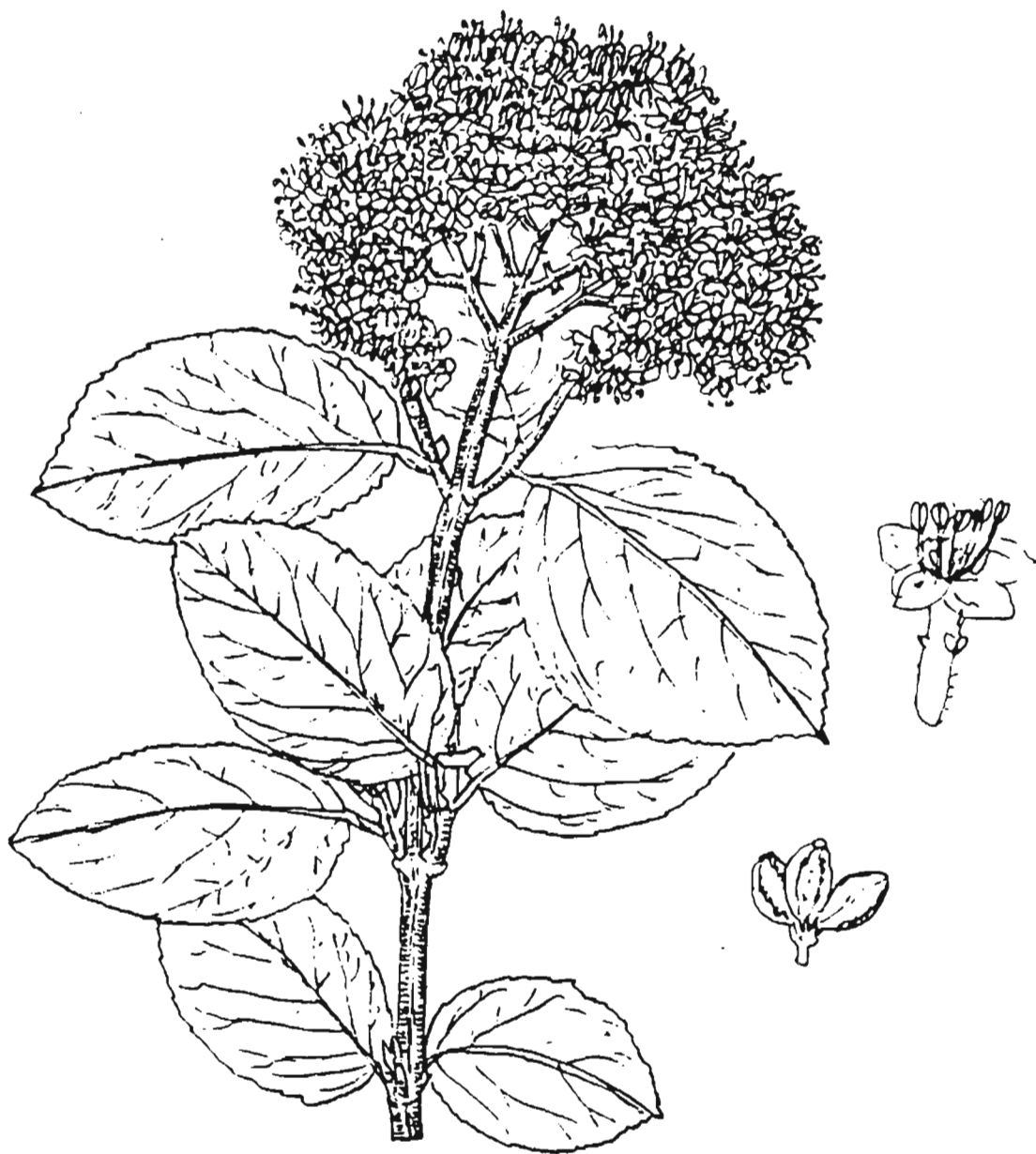
Locality Kinnaur (Kalpa 2600 m);
 Shimla (Kufri 2600 m)

V. coriaceum Bl.

Vernacular name kalatitmaliya, rashnia

Diagnostic features

A shrub or a small tree. Wood white hard close grained. Leaves coriaceous, glabrous. Inflorescence pedunculate, calyx



VIBURNUM COTINIFOLIUM Don.

glabrous; corolla white, tubular, pubescent. Drupe ovoid black, succulent.

Flowering and fruiting July-October

Distribution and ecology

Frequent in western Himalaya in rather dry forests. Chiefly seen with ban oak and rhododendron upto an altitude of 2400 m.

Locality Solan(Oachghat 1400 m);
Shimla(Sanjauli 2000 m)

V. nervosum D.Don

Vernacular name ternoi

Diagnostic features

A large shrub or a small tree; young shoots and inflorescence softly tomentose. Leaves membranous, elliptic, serrate. Flowers white or rose coloured, fragrant in terminal short dense sessile corymbs. Corolla funnel shaped. Stamens in 2 series near the mouth of corolla tube. Drupe ellipsoid, red.

Flowering and fruiting July-November

Distribution and ecology

It grows chiefly among kharshu oak and with rhododendron in moist temperate forests.

Locality Shimla(Mashobra 2200 m)

Propagation

Propagated by seed after complete removal of moisture



VIBURNUM NERVOSUM Don.

from seed and by green wood cuttings, the application of IBA (500 ppm) had a profound influence on rooting of stem cuttings in rainy season and the treatment of seed with GA₃ (100 ppm) enhances germination percentage.

Uses

Food: The fruit is sweet and edible.

Yield an oil which is used both for cooking and burning.

Medicinal: Leaves source of tonic and astringent.

Vitex negundo Linn.

Family Verbenaceae

Vernacular name shimalu, banna

Diagnostic features

A large shrub or a small tree; strongly scented leaves opposite, digitately 3-5 foliate, lanceolate, entire toothed. Flowers small, bluish purple in cymes. Calyx campanulate, truncate. Corolla small tubular. Stamens 2-4, didynamous. Ovary 2-4 celled. Drupe supported by more or less enlarged calyx, endocarp bony 1-4 celled.

Flowering and fruiting June-August

Distribution and ecology

One of the common shrubs found throughout sub-tropical to sub-temperate ranges of western Himalaya upto an altitude of 1600 m at denuded sites, banks of streams and road sides. Rare in forests.

Locality Solan(Oachghat 1400 m)

Propagation

Propagated through seed and stem cuttings. Scarification of seeds with sulphuric acid enhances germination percentage. The application of IBA (1000 ppm) induces higher rooting of cuttings.

Uses

Fuel: Wood of high quality fuel - calorific value 4321 cal/g

Food: Seeds edible after boiling

Medicinal: Extract of leaves showed anticancer activity against tumour cells. Roots tonic febrifuge, diuretic and used in rheumatism

Small timber: Young shoots used for basket making

Woodfordia fruticosa Kurz

Family Lythraceae

Vernacular name dhaula, dhau, dhatti

Diagnostic features

A large ornamental shrub more or less pubescent. Leaves opposite sometimes in whorls or 3, sessile, underside white with black dots. Flowers numerous, bright brick red. Calyx tubular curved, segments 6; petals 6, linear lanceolate. Stamens 12; ovary 2 celled. Fruit capsule. Seeds many minute.

Flowering and fruiting March-June

Distribution and ecology

A common shrub of mixed deciduous forests occupying dry



WOODFORDIA FRUTICOSA Kurz.

hill sides and in rocky slopes upto an altitude of 1800 m.

Propagation

Propagated by seed sown in June-July and also hardwood cuttings in rainy season. The treatment of seed with GA₃ (100 ppm) increases germination percentage. The application of IBA, IAA and NAA promotes higher rooting percentage in comparison to control.

Uses

- Fuel: Excellent source of fuel - calorific value 4763 cal/g
- Medicinal: Leaves and bark contain 12-20 and 20-27 per cent tannin respectively

Wikstroemia canescens Meissn.

Family Thymelaeaceae

Vernacular name chambai, chamleta

Diagnostic features

A small shrub. Leaves opposite, membranous, oblong lanceolate. Flowers yellow, in axillary and terminal panicles. Perianth long silky. Fruit black silky, pericarp thin, black when ripe.

Flowering and fruiting June-October

Distribution and ecology

Often confined to higher ranges from 1800-2800 m, invading northern aspects and sheltered sites. Also descends down upto 1200 m in shallow shady depressions of mixed coniferous forests.

Locality Solan(Oachghat 1400 m);
 Shimla(Mashobra 2200 m)

Propagation

Propagated by seed. Drying of seed is a pre-requisite for better germination.

Uses

- Fuel: Wood used for fuel
- Food: The oil obtained from seed is both edible and also used for burning
- Fibre: Ropes and paper are made of inner bark

Zanthoxylum armatum Roxb.

Family Rutaceae

Vernacular name timru, timbur

Diagnostic features

A shrub or a small tree. Leaves alternate, imparipinnate, sessile, lanceolate. Flower yellow, dioecious, in branched axillary powder. Ripe carpels rugose, red, solitary rarely 2-3. Seeds shining, blue or black.

Flowering and fruiting July-October

Distribution and ecology

Occurs upto altitude of 1900 m in sub-tropical to temperate region of western Himalaya.

Localaity Solan(1400 m)

Propagation

Propagated by seed, sucker, root and stem cuttings. The treatment of seed with sulphuric acid enhances germination

percentage of seed and the treatment of cuttings with IBA (1000 ppm) had a profound impact on rooting of cuttings.

Uses

Medicinal: The fruit is a remedy for toothache and also used to purify water

Small timber: Wood is used for walking sticks, branches for making tooth brushes

Zizyphus Juss.

Three species occur in the region.

Family Rhamnaceae

Key to species

Leaves pubescent or tomentose

Leaves velvety, tomentose beneath

.....Z. nummularia

Leaves not velvety beneath

.....Z. oenoplia

Z. nummularia W. & A.

Vernacular name jhahrberi, jhandiaber

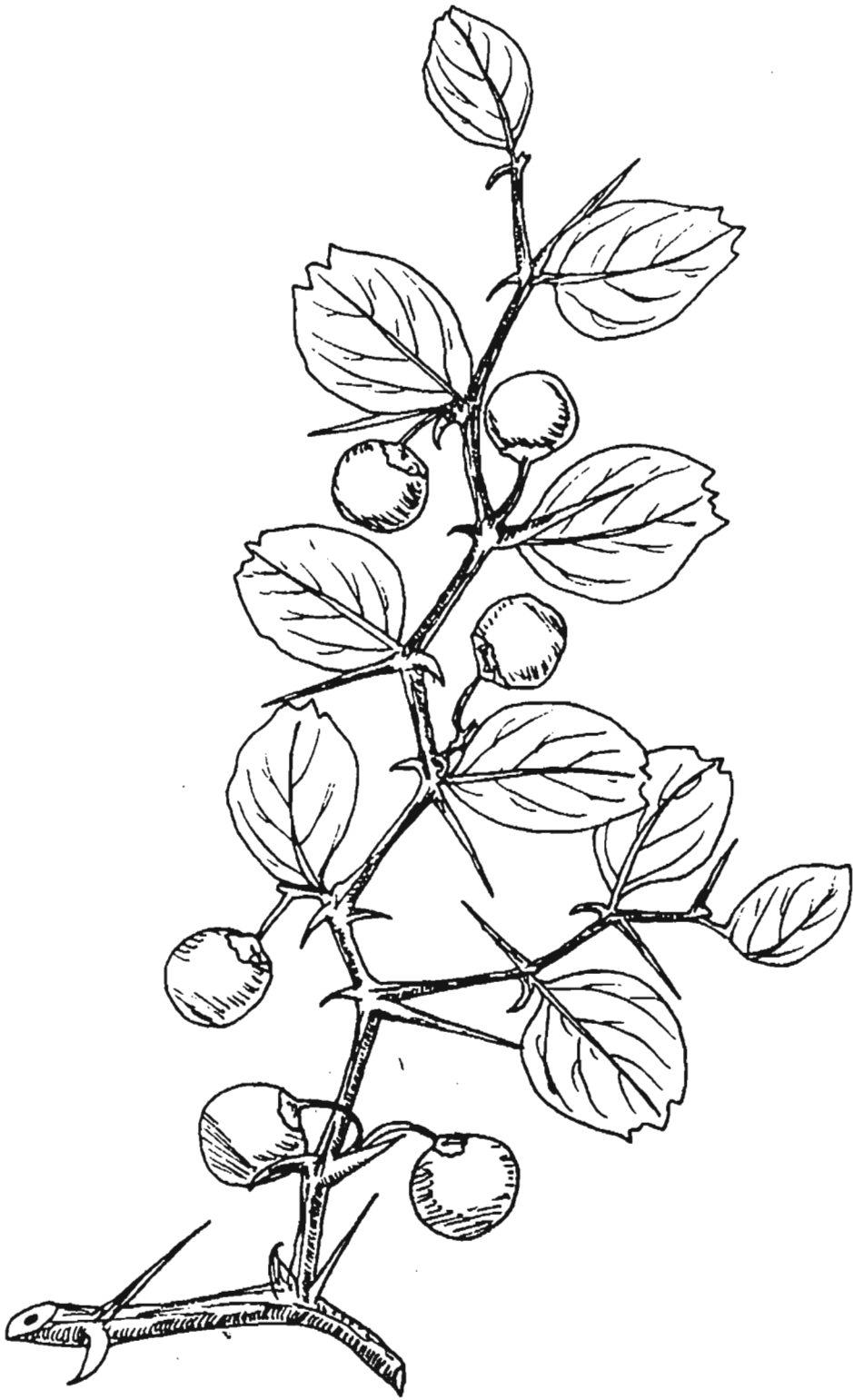
Diagnostic features

A thorny shrub. Branches, young shoots underside of leaves and inflorescence grey pubescent; spines slender. Leaves elliptic. Flowers small, pentamerous, in axillary cymes. Calyx cup shaped. Ovary 2-celled. Drupe globose stone rugose, shell hard bony.

Flowering and fruiting March-September

Distribution and ecology

A gregarious shrub characteristic of arid and dry region



ZIZYPHUS NUMMULARIA W. & A.

where it covers extensive areas in sub-tropical areas of Himachal Pradesh upto an altitude of 900 m.

Locality Kangra(Nagrota 800 m);
 Solan(Nalagarh 700 m)

Z. oneoplia Mill.

Vernacular name makoh

Diagnostic features

A straggling or climbing shrub; prickles short, sharp often solitary. Branchlets underside of leaves and inflorescence clothed with tomentum. Leaves oblique, ovate or obovate, lanceolate minutely denticulate. Flowers in short axillary cymes. Drupe black, stone tuberculate.

Flowering and fruiting June-September

Distribution and ecology

It prefers open bushy places to regular forests in drier and occasional in moist sites upto an altitude of 2200 m.

Locality Solan(1400 m); Kinnaur(Nichar 1600 m)

Z oxyphylla Edgew.

Vernacular name beri

Diagnostic features

A large shrub or a small tree; youngest shoot and inflorescence pubescent. Leaves glabrous obtuse, minutely serrate. Flowers greenish yellow, anther. Drupe 2-celled, red or black when ripe.

Flowering and fruiting June-September



ZIZYPHUS OXYPHYLLA Edgew.

distribution and ecology

Ecological requirements are similar to that of Z. nummularia.

Locality Solan(1400 m)

propagation

Propagated by seed, by green wood cuttings and by root cuttings. Scarification of seed with sulphuric acid increases germination percentage. The application of IB λ (500 ppm) is recommended for vegetative propagation of species by stem cuttings.

Uses

- Food: Fruit edible
- Medicinal: Bark yields tannin. Stem and root bark contains alkaloid
- Fencing: Recommended as a biological fence
- Small timber: Combs made of wood

Chapter-V

DISCUSSION

Shrubs are unique component of a forest ecosystem embodying wide ecological adaptability and multiple uses. Their coppicing property along with easy regeneration make them an important renewable resource sustaining the rural household. However, till date no concerted effort has been attempted in any region to document the shrubby floristics, encompassing their morphological, diagnostic and economic characteristics. In the earlier floras of the region namely 'Flora Simelensis' (Collett, 1902), 'Bashahr Himalaya' (Nair, 1977) and 'Flora of Himachal Pradesh' (Chaudhry and Wadhwa, 1984). These are enumerated along with other vegetation. The current description on 128 species highlights not only their diagnostic characters but also incorporates their propagation techniques and economic uses.

The voucher specimens of 90 field collections made by the author have been deposited in the Herbarium, Dr YS Parmar University of Horticulture and Forestry, Solan 173 230. Information on remaining species are either taken from the floras mentioned above or by the use of voucher specimens submitted to the above Herbarium by earlier collectors.

Important shrubs of the low reaches including the

Viburnum nervosum, Zizyphus spp., etc. are a few species which are an important source of food in certain pockets of the state.

In addition to their economic importance these species also render advantage in maintaining ecological balance. Berberis spp., Capparis spinosa, Calotropis gigantea, Clerodendron indicum, Deutzia staminea, Flacourtia indica, Indigofera atropurpurea, Mahonia nepalensis, Mimosa rubicaulis, etc. are prevalent on the exposed sites and are important from conservation point of view. These are certain species like Abelia triflora, Budelia retosa, Caragana brevispina, Cotoneaster spp., Desmodium spp., Deutzia staminea, Lonicera quinquelocularis etc., occupying the forest floor, protect the tender regeneration of commercial species. The shrubs are not only confined to wastelands and forest floor but also occur in moist and damp places e.g., Lonicera hypoleuca, L. orientalis, Myrsine spp., Nerium indicum, Piptanthus nepalensis, Pyracantha ceranulata, Sorbaria Tomentosa, etc. Their wide ecological adaptations open new potentials of hill conservation, displaying an array of niches from exposed and barren sites to forest florae and from damp places to dry temperate zone, etc. The present compendium on shrubs will go a long way in managing in our ecosystem and in the sustenance of rural economy.

Shrubs, reported for their profuse seed formation, are generally regenerated by sexual means. It is now a common observation that their perpetuation at native sites is badly affected due to large scale disturbances in forest ecology including the forest floor. Many endemic species are giving way to xerophytic types, illustrating successional changes in vegetation. Species which fail to acquire ecophysiological adaptations for seed viability, seedling establishment and survival at the parental habitats are eliminated. Maithani et al.(1986) reported an excellent example with a shift in the period of seed sowing in Carissa opaca from autumn to rainy season.

Till date no systematic effort has been made to study the biology of their sexual regeneration as these did not figure in our plantation schedule. But their multiple uses (including fuel and fodder), easy establishment and coppicing, along with excellent soil binding property render these as valuable plant types for social forestry and agroforestry models. Considering the scanty information on the seed germination process and vegetative propagation by stem cuttings, the present studies were conducted on 24 important shrubs of the Himachal Pradesh. In most species the seed viability was more than 90 per cent. However, Zanthoxylum aramatum with 76.5 per cent success was the lone exception. A success of 82 per cent in Berberis aristata and 84-94 per

cent in Rosa spp. observed by Bahuguna ~~et al~~ (1988) and Swejda and Poapst (1984) respectively is in close promimity to the present findings.

The germination percentage of seeds in response to various pre-sowing treatments viz., simple water, cold water; 24 hours and 48 hours revealed that overall germination percentage under mist conditions vary with the treatment applied. The application of GA_3 had a pronounced impact on seed germination, excepting when the seed coat was hard. Likewise, there was an appreciable increase in per cent germination from 71.33 to 96.67 with the application of GA_3 (100 ppm). Majority of the species (Adhatoda vasica, Carissa carandas, Coriaria nepalensis, Debregeasia hypoleuca, Desmodium tiliaefolium, Dodonaea viscosa, Elaeagnus parvifolia, Jasminum officinale, Lonicera quinquelocularis, Murraya koenigii, Nerium indicum, Prinsepia utilis, Plectranthus rugosus, Spiraea consescens and Woodfordia fruticosa) had recorded more than 80 per cent success, while it was in the range of 60-80 in species like Rosa moschata, Berberis aristata and B. lycium. However, (in species like Viburnum nervosum, Vitex negundo and Zanthoxylum armatum which were having hard seed coat recorded a germination percentage of 76.00, 54.73 and 45.00, respectively with GA_3 (100 ppm).) Nevertheless, these species obtained significant increase in per cent germination i.e., 85.33, 74.33 and 68.15, respectively when treated with sulphuric

acid. The recorded increase in per cent germination in the latter case may be attributed to the removal of hard seed coat by sulphuric acid. These findings are in conformity with the observations of (Koobation (1954), Heit (1967), Shafiq and Kattanch (1971-72), Crane and Forde (1974), Nalwadi et al.(1975), Sheikh (1979) and Roy and Pathak (1983)).

The increase in per cent germination with the application of GA_3 may be attributed to the fact that it acts as a supplement to physiological requirements, Hess (1964), also propounded similarly. These results are in agreement with the findings of Dahab et al.(1975) in Pistacia integerrima; Carpenter and Smith (1981) in Paulownia tomentosa; Yang (1983) in Tilia mongolica and Sharma (1989) in Coriaria nepalensis, Berberis lycium and Debregeasia hypoleuca. According to them, chemicals like GA_3 , citric acid, enhanced germination by making the seeds permeable to water and gases and removal of inhibitors. In contrast to findings in Woodfordia fruticosa, Sharma (1989) reported that there was higher germination success in soaking seeds for 48 hrs as compared to GA_3 application.

Similar trend, excepting their numerical value exhibited in germination behaviour when the experiment was performed under field conditions. The success in germination percentage was relatively lower under field conditions in comparison to mist. This may be attributed to the fact that under mist conditions an optimum temperature and relative humidity was maintained throughout the growing period. As a result of

which there was better activation of embryo axis and mobilization of reserve food material under mist conditions, but in the absence of congenial conditions i.e., temperature and relative humidity, the activity of α amylase, other hydrolytic enzymes and their de novo synthesis get hampered (Pleg, 1965) and reflected under field conditions.

(The studies on propagation of these 24 shrubby species collected in three seasons viz., winter, spring and rainy were also conducted under nursery and mist conditions. The main aim of this study was to find out the best season, hormone and concentration on rooting of cuttings. Three doses of IAA, IBA and NAA (500, 1000, 2000 ppm) each constituted the treatments.

The results indicate that propagation of shrubs is possible by stem cuttings. Under mist conditions all the species registered maximum rooting during monsoon, followed by spring and winter.) The rooting percentage was lower under field conditions during the two years under study (Tables 4-28) revealing that atmospheric humidity along with minimal soil moisture irrespective of spring or monsoon may induce higher root emergence and later their survival than the higher moisture percentage in the soil profile leading to eventual decay of wood. .

(The rooting of stem cuttings is thus moisture specific. The ascending order of rooting success is arranged as rainy > spring > winter.) (The decline is abrupt from rainy to winter

season in field conditions. The possible cause for this type of seasonal behaviour of shrubs to rooting may be attributed to the fact that most of species in my study are evergreen.) Like any other arboreal species the thumb rule of asexual propagation of deciduous species in winter and evergreens in rains hold equally good for shrubs also. Besides the environmental conditions the application of hormones also influence the rooting percentage. As such it may be premature to suggest with accuracy the level of concentration of hormones used, unless more information is available on the affect of different doses of various auxins on rooting.

The experiments were also planned under mist conditions with controlled temperature, relative humidity, moisture and homogeneous soil conditions. Surprisingly, significant differences in rooting success were observed between various seasons. Unlike field conditions these seasonal differences especially with regard to winter were not sharp. In other words, under uniform environmental effect the cuttings of different species revealed seasonal behaviour with rainy season again inducing the highest rooting followed by spring and lowest being in winter. This clearly manifests that the rooting behaviour though a physiological manifest can be broken down marginally by favourable conditions. Since seasons are periodical the phenophases of shrubs during monsoon correspond to the active vegetative phase with food material in stems at its peak, whereas in winter all the

species under study have exhausted their food reserve after sexual phase. The end of October in woody species corresponds to very slow growth of vegetative phase. Similarly, during spring, very little food reserve is available in the cuttings collected before the commencement of active growth phase. Since the sample collection in this study coincided with the phenophases, the physiological conditions of stem cuttings seem to have played a vital role in expressing the seasonal periodicity in rooting of stem cuttings. Although no attempt has been made to monitor the levels of food materials in cuttings amongst different phenophases. Yet it can be pronounced safely that higher rooting in rains is attributable to the evergreen nature of this material. This type of seasonal periodicity in rooting of stem cuttings has also been correlated to growth phase by many workers (Deuber and Farrar, 1940; Roberts, 1969; Zsuffa, 1974; Kennedy and Selby, 1984; Mahalovich et al., 1987). [Sharma (1989) also corroborated my findings that Woodfordia fruticosa, Coriaria nepalensis and Debregeasia hypoleuca should be propagated either in spring or in rains.] [However, Deolle and Mitchell (1964) and Roberts and Fuchigami (1973) reported that spring is an ideal season for most forest species.]

The type of auxin and the extent of its concentration have a profound influence on the rooting behaviour of different species. Of all the auxins under study the IBA had registered significantly higher rooting success than others, while the IAA and NAA were significantly superior

than control. [All the 24 species treated with different hormones, exhibited significantly greater rooting response to the IBA than others. The effect of auxins in enhancing root initiation of stem cuttings confirms the findings of research workers (Thimann and Went, 1934; Cooper, 1936; Hartmann, 1946; Nanda et al., 1968; Wise et al., 1985; Puri and Shamet, 1988). Numerous reports indicate the higher efficacy of IBA in enhancing root initiation (Nanda et al., 1968; Barry and Sachs, 1965; Pain and Roy, 1981; Negi and Tewari, 1984; Chandra and Yadava, 1986 and Shamet and Kumar, 1989).]

The natural and artificial regeneration of shrubs are not perfectly understood. There is very scanty information on their silvic requirements. The fast changing ecology of the forest floor warrants that whereas on one hand we accumulated more information on reproductive biology of their seed and on the other use asexual means for their propagation. The vegetative propagation of shrubs akin to coppicing can also help to have more biomass than regeneration by seed. Furthermore, vegetative propagation is a low cost technique for raising massive stock of true to type at a short notice. The use of mist propagation can be handy in this direction.

Chapter-VI

SUMMARY

The most common method of propagation of shrubs, since time immemorial, has been seed. It is quite often the only possible means. The ecophysiological adaptations of many of these shrubaceous species are likely to be limited in their natural habitat sooner or later. Therefore, a study has been conducted to gain multidimensional insight into the behaviour of seed germination process as well as an alternative method of propagating shrubs by vegetative means. In this context, 24 species have been investigated in order to contemplate and determine the impact of various pre-sowing treatments (cold water: 24 hours and 48 hours, GA₃; 100 ppm and sulphuric acid; concentrated) on seed germination as well as to evaluate the effect of various auxins viz., IAA, IBA and NAA with different concentrations on rooting of stem cuttings under field and mist conditions.

The propagation potential of seeds has revealed that the viability of all species was above 80 per cent except Zanthoxylum armatum with 76.5 per cent success. In seed germination studies under mist conditions it was found that the application of GA₃ had a pronounced impact on seed germination but in species like Viburnum nervosum, Vitex negundo, Zanthoxylum armatum, the treatment of seeds with sulphuric acid was having an edge over GA₃. However, the pattern of germination recorded under field conditions was almost similar except for numerical values. Although,

The studies on seasonal variation pattern of vegetative propagation by stem cuttings had revealed that all the species have recorded maximum rooting during rainy season, both under field and mist conditions. Besides there was a sharp decline in percentage of rooting in winter under field conditions, which was quite contrary to mist conditions.

The effect of different hormones namely, IAA, IBA and NAA had revealed that the type of auxins and their concentrations have an appreciable impact on rooting percentage. Of all the auxins, IBA had obtained significantly higher rooting than others while IAA and NAA were significantly superior to control.

In sum, it can be concluded that the propagation of shrubs is possible by seed and stem cuttings. In contrast to propagation by seeds, the vegetative propagation is having an edge. Since, the propagation by vegetative means can be accomplished throughout the year, which is not possible in case of propagation by seeds. Besides, the vegetative propagation also helps in obtaining more biomass than regeneration by seeds, on account of their coppicing behaviour. Furthermore, it is a low cost propagation technique to obtain a desired stock in a specified period of time. Moreover, propagation under mist conditions is supplementary in this direction.

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