PREFACE

Of the 18000 species of plant found in India, 1300 contain aroma. Out of this, 65 plants have large and consistent demand. The art of perfumery in India is as old us our civilization. It flourished and perfected under patronage of Moghul Emperors. The perfumers of Kannauj practised the art of distillation from sandalwood, agar wood and flowers such as rose, kewra, etc. Cheaper synthetic fragrance over took naturals due to its price advantage, but blenders have now realised that the complex chemical components of each essential oil created in nature can no way be matched.

Majority of the one billion population of India lives in the rural villages. They, by far, rely on traditional medicines, mostly plant drugs, for their primary health care needs. Demand for medicinal plant is increasing in both developing and developed countries due to growing recognition of natural products and due to other reasons, sometimes out of compulsion as the only source of health care available in the villages. In recent years, the growing demand for herbal product has led to a quantum jump in volume of plant materials traded within and across the countries. Though India has a rich biodiversity, the growing demand is putting a heavy strain on the existing resources. While the demand for medicinal plants is growing, some of them are increasingly being threatened in their natural habitat. For meeting the future needs cultivation of medicinal plant has become inevitable.

Considerable knowledge on the botany, chemistry and the medicinal and aromatic uses of plants are available. As most of the plants hitherto were sourced from wild, cultivation technologies are not readily available for most of the crops. This practical manual is the out come of the demand of farmers who visit the station and request for specific information on the cultivation of these crops. Research data generated in the fifty year's of research at this station, in various other institutions of the Kerala Agricultural University, feedback from practising farmers, data from published and unpublished literatures etc. were used to compile the adhoc recommendation. This book is indented only as a training manual for farmers. It should be understood that agronomic requirements vary with plant type, soil, climate and other genetic and environmental factors.

We greatly acknowledge the fraternity of scientists and farmers who have spend tremendous amount of time and resources in generating valuable knowledge on cultivation of these groups of crops. We thank Dr. S. P. Ghosh, Dy. Director General ICAR, New Delhi for providing the foreword and Dr. H. P. Sigh, Horticultural Commissioner, Ministry of Agriculture, Govt. of India for giving a message in this manual. We acknowledge the visionary leadership of Dr. K. N. Shyamasundaran Nair, Vice-Chancellor, KAU, who provided the introduction to the manual. Dr. K. Sivaraman, Director, Directorate of Arecanut and Spices Development, Calicut was the force behind the preparation of this handbook. Dr. A. I. Jose, Director of Extension, KAU has been a constant source of encouragement. We profusely thank Dr. K. V. Peter, Director of Research, KAU for his whole-hearted support and sincere guidance to us for the preparation of the manual.

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Authors

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AJOWAN

Trachyspermum ammi

Family - Apiaceae

Ajowan is a profusely branched winter annual herb, 60-90 cm tall, the seed oil of which is a major source of thymol, being present to the extent of 35-60%.

Uses: Ajowan oil is aromatic, stimulant and carminative. It possesses antimicrobial activity. Ajowan seeds are employed alone or in combination with other spices and condiments in pickles, confectionery and beverages. It is a good remedy for indigestion. A paste of the crushed fruit is applied externally for relieving colic pains. It is also used in lotions and ointments.

Soil and climate: It is mainly grown as a winter crop in subtropical and temperate climate. It grows on any soil type but performs best in humus rich loamy soil. It is grown as a rainfed crop in heavy soils whereas it requires irrigation in light textured soils.

Seeds and sowing: It is generally propagated by seeds. The field is ploughed repeatedly during September-October, incorporating organic manures. Seeds are sown broadcast or drilled in rows 45 cm apart in November. Seed rate is 3-4 kg/ha. The seeds germinate in 7-14 days. Broadcast crop may be thinned to a spacing of 30-45 cm.

Manuring: Farm yard manure at 10-15 tonnes/ha N, P_2O_5, K_2O and S are applied at 80,30,30,50 kg/ha, respectively for obtaining best yields..

Aftercultivation: Irrigation is given immediately after sowing and later at 7-10 days interval. Weeding is generally done twice.

Plant protection: Collar rot caused by *Sclerotium rolfsii* is observed in some pockets. The disease can be controlled by spraying 0.2% Mancozeb

Harvesting and processing: Flowering starts in 2 months time. Harvesting is done in February-March when the flower heads turn brown. The harvested crop is dried, threshed and winnowed to separate the clean seeds.

The dried seeds are crushed and distilled to obtain the essential oil. Hydro or steam distillation is resorted to. Seeds lose the essential oil when stored for long time. On an average, the dry seeds contain 2-4% oil.

Chemical constitutents: The pale yellowish-brown ajowan seed oil has a characteristic thyme odour with sharp burning taste .The characteristic odour of ajowan oil is due to the high content of thymol. On standing, the major portion of thymol gets crystallized. The other major constituents are -pinene, p-cymene, dipentene, -terpinene and carvacrol.

CAMPHOR

Cinnamomum camphora

Family - Lauraceae

Camphor plant is an evergreen tree valued for the presence of camphor in its wood and leaves. Camphor tree is a native of Japan, China and Taiwan

Uses: Camphor is chiefly a pharmaceutical product though it is used in the preparation of artificial essential oils like lavender and lavendin. It is used as an incense and in balms of various kinds. It is employed as a masking agent in perfumery and sometimes used to achieve lift in perfume blends. Redistilled brown oil is used directly in soap perfumes for a masking effect. The oil is a source of safrole which is a starting material for the production of various perfumery chemicals.

Soil and climate: Camphor tree grows best at an altitude of 1350-1500 m with temperature not going below 33 C. In the Nilgiris it does well upto 2100 m above MSL. It withstands an annual rainfall of 1000 mm where it can be successfully cultivated. Fertile well drained sandy loam soils are best suited for the cultivation of camphor tree. Deeply tilled clayey soils are also suitable, provided rendered porous by mixing leaf mould and sand supplemented with artificial fertilizers.

Seeds and sowing: It is chiefly propagated through seeds and rarely through layers, branches, cuttings, root cuttings and root suckers. Fresh ripe fruits are collected either direct from the tree or soon after they fall. Removal of the pulpy seed coat and presoaking of the seeds in water for 24 hours enhances seed germination. Seeds are sown in nursery at a spacing of 6-8 cm in rows 25-30 cm apart and irrigated regularly. Seeds start germinating after 3 months of sowing. The nursery is maintained weed free. 12-16 months old seedlings are transplanted in the mainfield in 60 cm cube pits, 2-3 m apart.

Aftercultivation: Application of organic manures and inorganic fertilizers has proved beneficial. Plants are trimmed to a height of 1.5-2 m and maintained as bushes to facilitate picking of leaves.

Plant protection: Leaf blight disease in camphor is caused by *Glomerella singulata* which can be controlled by spraying difolatan and benomyl.

Harvesting and processing: Leaves and twigs are harvested every year and distilled to produce camphor oil. Wood over 50 years of age are also used for distillation. Bushes are harvested 3-4 times a year. The crude camphor oil is separated in various fractions as white, brown and blue camphor oils. White camphor oil is generally not used as such in perfumes, but it serves as a starting material for the production of a number of perfumery chemicals such as cineole, terpineol, menthol, thymol, etc. There is little difference in total yield of camphor when two or four pickings are taken in a year. Tender leaves as well as plants grown in the open contain more camphor. The yield of camphor and camphor oil is 50-80 kg/ha which varies widely with the part used and the geographical location. The essential oil distilled from branches, wood and root is obtained as a semi solid mass. The yield is generally 1-1.2%.

Chemical constituents: Leaf oil is reported to have the following constituents: sabinene 1.47%, -phellandrene 0.17%, -terpinene 0.24%, terpinolene 0.30%, furfural 0.16%, piperitone 2.4%, geranyl acetate 0.22%, cuminaldehyde 0.15%, safrole 13.4%, eugenol 0.12%, cinnamyl alcohol 0.18% and traces of more than twenty compounds

CARDAMOM

Elettaria cardamomum

Family-Zingiberaceae

Cardamom is a tall herbaceous perennial with branched subterranean rhizomes . *Elettaria cardamomum* Maton var. *major* Thw(wild cardamom) *E. cardamomum* Maton var. *minor* Watt. (syn. var. *cardamomum* Thw.; var. *minuscula* Burkill).: This includes most of the cultivated types. Several races such as Malabar, Mysore and Vazhukka are recognized under this variety.

Uses:- The dried capsules, the essential oil, oleoresin and tinctures are extensively used in the formulation of compounded mixtures for liquors beverages baked goods, canned foods, meats, sauces and condiments. Cardamoms are stimulant, carminative and flavouring agent. Dried cardamom fruits are used as a masticatory and in medicine. They are used for flavouring curries, cakes, bread and other culinary purposes. The essential oil is employed in perfumery and flavourings. The oleoresin has similar applications to essential oil in flavouring of processed foods but it is less used. The oil and oleoresins also find use in the preparation of aromatic, stimulant, stomachic and diuretic tinctures.

Soil and climate:- Cardamom grows wild in the evergreen rain forests of the Western Ghats in India between 750 m and 1500 m and in Sri Lanka above 1000 m altitude. They occur in the preclimax stage of the forest. In cultivation, the crop requires an annual rainfall of 1500-4000 mm, a temperature of 10-35 C and an altitude of 600-1200 m with moderate shade and protection from wind. Cardamom is generally grown in forest loamy soils rich in available phosphorus and potassium, but well drained deep loamy soils abundant in humus is ideal.

Seeds and sowing:-The plant is propagated vegetatively by divisions of rhizomes or by seed; the former is often used for planting small areas. Clonal propagation by tissue culture permits large scale planting of high yielding selections but is not advisable where *Katte* and other virus diseases are prevalent .In such areas seedling progenies are advisable as virus disease is not transmitted through seeds. Seed germination is often poor and irregular. Plants propagated vegetatively come to bearing one year earlier than the seedling propagated plants. For seedling propagation, ripe capsules of desired cultivar are collected from high yielding plants during September-October. Seeds are extracted by gently pressing the capsules and washing 3-4 times with water to remove the mucilaginous coating on the seeds. Seeds are dried in shade for 2-3 days and sown in the nursery within a fortnight as the seeds are short-viable. Seeds can be preserved for one month in the capsule form in polythene lined gunny bags.

The seeds are sown in primary nursery from where the young seedlings are transplanted 25-30 cm apart in a secondary nursery or in polybags during June-July where they are maintained for one year and the 18 month old seedlings are finally transplanted to the main field at 1.5-3 m spacing depending on the cultivar and soil conditions. Sixty gram seeds are sown on well prepared beds of 6 m^2, mulched with potha grass or straw and watered regularly. Seedlings will take 4-6 weeks to appear above ground. Shade trees like dadap, albizzia, jack, eucalyptus, red cedar and wild nutmeg are planted.

Varieties:- *'ICRI-1', 'ICRI-2', and 'PV-1' are the improved varieties available for cultivation.*

Manuring:-Cardamom plantation is fertilized with N, P_2O_5 and K_2O at 75:75:150 kg/ha respectively. Fertilizers are applied in two split doses before and after the south west

monsoon in a circular band 20 cm wide at 30-40 cm away from the base of the clumps and incorporated into the soil.

Weeding:-Mulching is practised to conserve moisture, reduce weed growth and overcome dry situation. Sickle weeding is required frequently. Forking is necessary in hard soils.

After cultivation:-Trashing is carried out during June-July with the commencement of monsoon to prevent spread of diseases and expose panicles for pollination by honey bees. Maintaining four bee colonies/ha during the flowering season is recommended for increased fruit set and capsule production. Shade regulation is essential to provide optimum shade. Red cedar (*Toona ciliata* Roem.) is an ideal shade tree which sheds leaves during rainy season and thus provides natural shade regulation .

Plant protection:- Cardamom thrips (*Sciothrips cardamomi*) and leaf eating caterpillars are common pests of cardamom which can be controlled by spraying 0.03% quinalphos. *Katte* or mosaic virus disease is transmitted by the aphid *Pentalonia nigronervosa*. *Azhukal* or capsule rot caused by *Phytophthora* species, clump rot or rhizome rot caused by *Pythium aphanidermatum*, leaf blotch caused by *Phaeodactylum venkatesanum* and *Chenthal* disease are frequently observed in cardamom plantations. Multifaceted approach consisting of field sanitation, use of tolerant cultivars, repeated drenching and spraying with 1% Bordeaux mixture, is to be resorted to for effective disease control.

Harvesting an processing :- cardamom plants normally start bearing capsules from the third year of planting. Picking is carried out at an interval of 30 days during September-February and the peak period of harvest is October-November. Cardamom capsules with green colour fetch a premium price. Hence emphasis has to be given on the preservation of green colour during curing and subsequent storage. A cardamom plantation gives economical yield for 10-15 years after which replanting has to be done.

Processing of capsules is done in specially built curing houses. The harvested capsules are washed in water to remove dust and soil particles. Then they are uniformly spread and dried on wire net trays for 36-42 hours at 50-60 C. The dried capsules are rubbed on wire mesh to remove the stalk and other waste particles. This is called *polishing*. The polished capsules are then graded according to size by passing through a series of 7 mm, 6.5 mm and 6 mm sizes. The graded produce is stored in polythene lined gunny bags to retain the green colour and to avoid exposure to moisture. The outturn of dried capsules is 20-25% of the harvested fruits. The average yield of dried capsules is 200-300 kg/ha/year.

The fruits are crushed and steam distilled for 4 hours to recover the essential oil. The oil content is 3.5-7% which is dependent on the cultivar, stage of harvest and conditions and duration of storage. Upto 11% oil is available in seeds while it rarely exceeds 1% in husks. Cardamom oleoresin with 52-58% of oil content is produced on a relatively smaller scale.

Chemical constituents:- Cardamom oil is a greenish-yellow liquid with a warm spicy aromatic odour somewhat pungent and faintly bitter at high concentration. The aroma and therapeutic properties are due to a volatile oil constituting 3-8% in the seeds, whose main constituents are cineole, terpineol and limonene.

CELERY

Apium graveolens

Family – Apiaceae

Celery popularly known as *Karnauli or Ajmod* is an annual or biennial erect herb whose seed on distillation gives a pale-yellow essential oil.

Uses: The oil is used as an essence in flavour and pharmaceutical industry. Bulk of the demand comes from the canned soup industry. It is used in the flavouring of all kinds of prepared foods such as soups, meats, pickles, vegetable juices and in the preservation of meat sauces. In pharmacy, the oil is used in certain preparations having sedative effect. It is highly priced for fixative purposes and as an ingredient of novel perfumes. It has a powerful odour and imparts a pleasant warm note. The oil is used in compounding ayurvedic formulations. Fruits yield 17% of a fatty oil which is used as an antispasmodic and nerve stimulant. Seeds of celery are rich in vitamin B.

Soil and climate: Celery flourishes well on fertile, well drained, sandy and silt loam soils. Clayey soils are not suitable. It prefers a moist, cool climate. It grows as an annual in the plains but as a biennial at higher elevations with cooler climate.

Seeds and sowing: The plant is propagated through seeds. Seeds obtained from primary umbels are heavy and produce better seedlings in comparison to seeds obtained from quarternary umbels. On hills or higher elevations, seeds are sown during March-April, transplanted in May and harvested in November. In the plains, seeds are sown during September-October, transplanted in January and harvested in May. Healthy seedlings are obtained by incubating the seeds at 90% relative humidity and 15-20^{0}C for 8-10 days. For transplanting one hectare, 1.5 kg seeds are sown in a nursery area of about 1000 m^2. Transplanting is done in moist soil at 30-40 cm spacing

Varieties: *Apium graveolens L.* var. *dulce* and *A. graveolens L.* var. *rapaceum (turnip-rooted celery)* are the two varieties recognized.

Manuring: The main field is thoroughly prepared incorporating organic manures at 10-20 t/ha. Fertilizer application of 200 kg N and 40 kg P_20_5/ha is recommended.

Irrigation: The crop needs plenty of water and the field is irrigated every 5-7 days during non-rainy period. The crop may lodge when strong winds blow after irrigation which may be prevented by providing wind breaks.

Aftercultivation: The field is kept weed free by 2-3 hoeings, first 3 weeks after transplanting and subsequently at 2 weeks interval.

Plant protection: A leaf miner, *Liriomyza trifolii* and fungus *Septoria apicola* infests the crop. The pest can be controlled by spraying 0.05% quinalphos EC or 0.2% carbaryl WP.

Harvesting and processing: The crop is harvested when the white flowers start turning reddish. The harvested crop is thrashed with sticks the next day and the seeds are taken. Average seed yield is 1-1.5 tonnes/ha.

Celery seed oil is obtained by the steam distillation of the seed. Usually, distillation is carried out for 18 hours.The celery seed contains 2-3% of essential oil. From the chaff also an essential oil can be obtained, which of course, lacks the better aroma of the seed oil. Celery chaff oil and synthetic d-limonene are common adulterants of celery seed oil which are difficult to detect.

Chemical constituents: Limonene, -p-dimethyl styrene, n-pentyl benzene, caryophyllene, -selinene, n-butyl phthalide and sedanolide are the main constituents. Celery leaf oil is richer in mono and sesquiterpenes in comparison to celery seed oil.

CHAMOMILE

Matricaria chamomilla

Family - Asteraceae

German or Hungarian chamomile is a much branched erect spreading annual herb. It has been introduced to India about 300 years ago during the Mughal period. Three species of chamomile are generally known. (i) *Matricaria chamomilla* known as *German or Hungarian Chamomile* and is the most common (ii) *Anthemis nobilis*. known as *Roman Chamomile* (iii) *Ormenis multicaulis* termed as *Moroccan Chamomile*

Uses: From chamomile essential oil, infusions, tinctures and fluid extracts are prepared for diverse uses. The essential oil is used in alcoholic and non-alcoholic beverages, ice-creams, ice candy, baked goods and chewing gums as flavouring agent. It is used in high class perfumes in low concentrations. Medicinally, it acts as antispasmodic, expectorant, carminative, anthelmintic, sedative and diuretic. It also possesses antimicrobial activity. It is used in infant ailments such as teething troubles and stomach disorders.

Soil and climate: The plant is grown as a winter crop in plains and as a summer crop on hills. For good seed germination, the optimum temperature is 18-20^{0}C. Temperature and light conditions have a greater effect on essential oil production. It grows on any type of soil, but comes up well on moist, moderately heavy soils rich in humus. The optimum soil pH is 7, though saline and alkaline soils having pH as high as 9.0 also support good growth.

Seeds and sowing: The crop is raised through seeds. Seedlings are raised in nursery during September-October. Seed rate is about 1 kg/ha. The seedlings are transplanted when 6 weeks old at a spacing of 30-40 cm.

Manuring: Adequate manuring is needed for good growth and yield of the crop. Application of 15-20 tonnes/ha of well-rotten farm yard manure and 80:40:20 kg N, P_2O_5 and K_2O/ha are recommended.

Aftercultivation: On normal soils, 3-4 irrigations are sufficient during the entire growing season. Saline soils need frequent light irrigations. Generally, one or two weedings and hoeings are required for raising a good crop.

Plant protection: Black bean aphids (*Aphis fabae*) is a serious pest. Flowers are attacked by an insect, *Nysius minor*, which causes them to shed. Another insect, *Antographis chryson* also attacks the plant and causes defoliation. The pests can be controlled by spraying any contact insecticide.

Harvesting and processing: The plants start flowering from February to April. The flowers are harvested at full bloom stage. Generally, 4-5 harvests can be taken at an interval of 10-15 days. The yield is 4000-7000 kg fresh flowers which gives 1000-1500 kg/ha on drying. Drying is done under shade between 22-24 C as the flowers are delicate. Fully dried flowers can be packed and stored in moisture free environment. The dried flowers are steam distilled for 4 hours at a pressure of 7 atmosphere/cm^2 in the steam generator. The oil being very viscous, forms a deposit along the inner walls of the condenser. Control the flow of cooling water so as to increase the temperature in the condensor. The oil yield varies from 0.3 to 1.3% depending upon the location, strain and the conditions and fertility status of the soil. The oil content in the flowers is maximum when the temperature is 22-25^{0}C during the flowering period. The average oil yield is 50-75 kg/ha.

Chemicl constituents: The essential oil contains 1-15% of chamazulene, which is responsible for the blue colour of the oil; azulene, farnesene, -bisabolol oxide a & b and a dicycloether

CHAMPAK

Michelia champaca

Family - Magnoliaceae

Champak, Champa or Yellow Champa is a large evergreen tree valued for its beautiful flowers with long-lasting fragrance. The tree is a great favourite in Hindu gardens, the exquisitely scented flowers being used for *Pooja* particularly of the Lord Krishna. The genus *Michelia* comprises about 50 species of evergreen trees or shrubs. The most popular among them are *Michelia champaca* L. and *M. figo* L.

Uses: Champa attars are produced in India which are used in hair oils as a head coolant. The flowers also yield a dye which is used as a base for other colours and for dyeing silk and cotton fabrics. By virtue of the refreshing appearance of its foliage, champa looks elegant even when it is out of flowers.

Soil and climate: Champa requires a mild climate and an elevation of 100-1000 m with partial shade for good growth. It can be grown on a wide variety of soils and well drained rich sandy loam soils are the best.

Seeds and sowing: The trees are propagated both by seeds and vegetatively by grafting. The creamy yellow variety is propagated by grafting on stocks of ordinary golden orange flowered variety which produces seeds in bunches and takes 7-8 years to flower

Varieties: Flowers are white, sovereign red or creamy light yellow in colour. 'Simhachalam' golden orange kind is the most sweet scented and is the most favoured of champas. The white flowered champa, though very sweet scented, lacks in substance and hence the fragrance does not last quite long.

Aftercultivation: Though large scale commercial cultivation of champa is not common, group planting is generally undertaken, particularly in informal gardens and homesteads. Care is to be taken till the grafts or seedlings are initially established in the field and thereafter not much attention is needed.

Harvesting and processing: The trees flower during April-May and again during September-October once they start blooming. A well grown tree yields 50-100 flowers daily during the peak season and 375 to 425 flowers weigh one kilogram.

The champak flowers are exquisitely fragrant. Owing to the presence of an oxidizing agent in the flowers they become brown within few hours after picking and are subject to odour deterioration. To prevent impairment of its odour by oxidation, the essential oil must be extracted soon after picking. The concrete yield by solvent extraction is around 0.26% which in turn is capable of yielding 26% of steam volatile oil. Enfleuraged flowers in sesame oil yield an excellent attar.

Chemical constituents: It contains important perfumery constituents such as cineole, iso-eugenol, phenyl ethyl alcohol, benzaldehyde, methyl anthranilate, benzyl alcohol, p-cresol and its methyl ether

CINNAMON

Cinnamomum verum

Family - Lauraceae

Cinnamon, also known as *true cinnamon or Ceylon cinnamon*, is an evergreen tree whose bark and leaves are strongly aromatic.

Uses: The bark, exported as *quills*, is used as a spice or condiment, for flavouring cakes and sweets and in curry powders, incense, dentrifices and perfumes. Bark oil is used in flavouring confectionery, liquors and in pharmaceutical preparations, especially to mask the unpleasant taste. Leaf oil is used in the manufacture of cheaper types of perfumes used in soap, tooth pastes hair oil, etc. In the flavouring industry, it is used as a modifier

Soil and climate: Wild cinnamon trees are confined to tropical evergreen rain forests upto 1800 m from MSL. The best cultivated cinnamon is grown at low altitudes in Sri Lanka with an average temperature of 30^0C and 2000-2500 mm rainfall per annum. Sandy loam soils with admixture of humus or vegetative mould is the best for sweet and fragrant bark. Proximity to sea, humid conditions and saltish water are good for the crop.

Seeds and sowing: It is propagated mainly by seed and rarely by cuttings of young 3-leaved shoots, layering of shoots and by the division of old rootstocks. Seeds soon lose their viability and should be sown fresh after the removal of the pulp. Germination takes 2-3 weeks time. Seeds are sown thickly in nurseries in May-June. When 4 months old, seedlings are transplanted into poly bags or baskets. After a further 10-12 months they are planted in the main field at 2-3 m spacing.

Manuring: Cattle manure or compost at 20 kg/tree/year may be applied. Inorganic fertilizers may be applied at 20:20:25 g N, P_2O_5 and K_2O/seedling in the first year which is gradually increased to 200:180:200 g/tree/year for grown up plants of 10 years or more.

Aftercultivation: Regular weeding is done in the early stages of growth and the seedlings are irrigated till they are established, if there is long drought period. Plants are pruned when they are 2-3 years old at a height of 15 cm above ground level. Side shoots growing from the base are cut to encourage growth of more side shoots till the whole plant assumes the shape of a bush.

Plant protection: Leaf spot and die back diseases caused by *Colletotrichum gloeosporioides*, grey blight caused by *Pestalotiopsis palmarum* and sooty mould caused by *Phragmocapinus betle* are the common diseases of cinnamon. Spraying of 1% Bordeaux mixture will control the diseases.

Harvesting and processsing: For the preparation of *quills*, the plants are harvested 3 years after planting when the shoots have grown 2-2.5 cm in diameter and 1.5-2 m in length. Harvesting is done in May or November. The correct time for cutting the shoots for peeling is determined by noting the sap circulation between the wood and the corky layer. If the bark separates readily the cutting is taken immediately in the early morning with sharp knife to prevent breaking and splitting of cut ends. The first harvest may yield 30-50 kg quills/ha/year. Better harvests are expected after 10 years when 170-200 kg of dried quills/ha/year are obtained.

The chips, featherings or trimmings of bark left after the collection of quills are used for distillation and the oil yield is 0.5-1% generally. For the extraction of leaf oil, the leaves and tender twigs are harvested in May and November. Wilting of the harvested leaves in shade for 24 hours and steam distill for 4-6 hours. The leaf oil yield is 0.5 to 0.7%.

Chemical constituents: The cinnamon bark oil is light yellow in colour when freshly distilled. On storage it becomes reddish. Bark oil contains mainly cinnamic aldehyde (60-75%), eugenol (10%) etc. while leaf oil has a slight camphoraceous odour resembling that of clove oil due to the presence of 70-95% eugenol.

CITRONELLA

(Java citronella)

Cymbopogon winterianus

Family - Gramineae (Poaceae)

Two varieties are recognized in *Cymbopogon nardus* (L.) *C. nardus var. lenabatu* (Ceylon citronella) and *Cymbopogon nardus var. mahapengiri* (Java citronella). The later is sometimes recognized as a distinct species, *C. winterianus* Jowitt.

Uses: Citronella oil serves as a starting material for the extraction of geraniol and citronellal which can be converted into aroma chemicals such as citronellol, hydroxy citronellol, synthetic menthol and esters of geraniol. These find extensive use in soap, perfumery, cosmetic and flavouring industries.

Soil and climate: Optimum growth and yield is obtained in sandy loam soil with abundant organic matter. Heavy clay and sandy soils do not support good growth. It grows best on soils with a pH around 6.0 though a pH range of 5.8-8.0 is suitable.

Citronella grows well under tropical and subtropical conditions. It requires abundant sunshine and moisture for good growth. Even though it grows upto 1000 m above MSL its growth is restricted, resulting in low yields, when grown above an altitude of 400 m. Annual rainfall of 1500-2000mm and will cool night temperatures are ideal for better growth of the plant and quality of the oil.

Seeds and sowing: Citronella grass is vegetatively propagated through slips at 60-90 cm spacing. About 20,000-30,000 slips are required for one hectare.

Varieties: Jorlab C2, RRL JOR-3-1970, CIMAP/Bio-13 and CIMAP/73-1

Manuring: Farm yard manure is applied at 10 tonnes/ha before planting. A fertilizer dose of 200 kg N, 80 kg P_2O_5 and 40-80 kg K_20 is recommended per hectare per annum.. Apply N in 4 equal split doses at an interval of about 3 months. P and K in full as basal.

Irrigation: Irrigation is required within 24 hours of planting if there is no rain. Depending on weather and soil conditions irrigate once in 3-4 days.

After cultivation: The field is to be kept weed free till a complete cover of the crop is obtained. Earthing up is done after about 4 months of planting and again after every harvest as the citronella rootstock has a tendency to work out of soil by itself.

Plant protection: Termite attack on planted slips and on the live clumps can be controlled by soil drenching with 0.05% chlorpyriphos EC. Leaf blight disease caused by *Curvularia andropogonis* and leaf spot by *Colletotrichum graminicola* appear with the on set of monsoon. These diseases can be controlled by prophylactic spraying of Dithane M-45 or Dithane Z-78 at 2g/l at an interval of 10-15 days during the disease prone period.

Harvesting and processing: The crop is ready for the first harvest after about 9 months of planting and subsequently at an interval of 3 months. Cut the grass above the first node at 20-45 cm from the ground. Flowering should be discouraged as it causes aging and reduces the life span of the plantation. Harvesting can be done 4 times a year. Generally, the crop is replanted 4-5 years and one year rotation with any legume species like horse gram, cowpea or sunhemp is recommended.

The harvested grass is wilted in shade for a short time and steam distilled within 24 hours. The oil yield varies with the season, soil fertility and distillation efficiency. On an average, oil recovery is 0.8-1.2% and the oil yield is 100 kg/ha during the first year and 150 kg/ha during subsequent years. Yields of

200-250 kg/ha/yr can be obtained under favourable conditions with good management.

Chemical constituents: Java citronella oil contain mainly citronellal 32-45%, geraniol 12-18% and citronellol 11-15%.

CLARYSAGE

Salvia sclarea

Family – Lamiaceae

Sage oils are obtained from different species of *Salvia*. Inferior Spanish and Dalmatian materials are obtained from *Salvia officinalis*, whereas a superior and more expensive oil is obtained from *Salvia sclarea* which is commonly cultivated. It is 60-90 cm tall herb with a widely branched deep root system.

Uses: The plants are extensively used in the flavour industry for the formulation of liquors and soft beverages.. The essential oil is used in perfumery because of its coriander-like notes. It is used as a flavour in liquors and as a modifier in spice compounds. The oil is also used in preparations of ice-creams, candy and baked goods.

Soil and climate: The plant is generally grown on poor soils. Slightly acidic soils of pH 4.0-5.5 are better. Clarysage is tolerant to cold and drought and adaptable to a wide variety of situations. Higher altitude with ample sunshine and few good showers in spring results in good yield of oil having superior quality.

Seeds and sowing: It is propagated through seeds. The seeds can be directly sown in the field or transplanted either in November or March-April depending upon the weather conditions. Seed rate is 3-4 kg/ha for transplanting. Seedlings appear in 10-15 days and are transplanted when 30-35 days old, at 1 m row spacing .

Varieties: Few high yielding hybrid varieties have been developed in Bulgaria. *Zarya* is a medium early variety and *Lazur* is cold resistant one.

Manuring:10-12 tonnes of organic manure to be incorporated in the field before planting. 100-120 kg N and 30 kg each of P_2O_5 and K_2O are recommended per hectare . N may be applied in 4 equal splits.

After cultivation: One or two irrigations may be given in case of a drought situation. Pre-emergence application of fluometuron or diuron at 2 kg/ha and post-emergence application of preforan or introchlor at 3 kg/ha can effectively control weeds. 2-3 hoeings should be done before the flowering season. After harvest, a hoeing is given.

Plant protection: Aphid *Acyrtosiphon salviae* is found to infest clarysage which can be controlled by a contact insecticide. Root knot nematode *Meloidogyne incognita* infests the plant heavily. It can be controlled by application of carbofuran granules at the rate of 1 kg a.i. per heatare. The fungus *Rhizoctonia solani* causes rot disease. Drenching with copper oxychloride or Bordeaux mixture is recommended for rot disease.

Harvesting and processing: The flowering tops and leaves are harvested twice a year during July and September. Excessive stalk growth is removed as it contains no significant amount of oil. Plants remain productive for 5-6 years and new plantation is started in a different location.

The harvested herb is to be distilled immediately with a view to avoid evaporation loss of essential oil. Distillation is carried out for a period 2-3 hours. Oil recovery of 0.15% is obtained on poor soils whereas 0.2-0.3% is achieved with improved varieties and good management when the yield of oil will be 40-50 kg/ha.

Chemical constituents: The chemical constituents of the oil are reported to be linalool, ß-ocimene, p-cymene, terpinolene, cis-3-hexen-1-ol, terpinen-4-ol, caryophyllene, -terpineol, citronellol, nerol, geraniol, and their acetates etc.

CLOVE

Eugenia caryophyllata (Syzygium aromaticum)

Family - Myrtaceae

Clove is a small evergreen tree valued for spice and essential oils. In trade, cloves are the dried unopened flower buds.

Uses: It is used as a table spice, in the preparation of curry powders, to season sausages and puddings. Clove buds, stems and leaves on steam distillation yield essential oils which are used in the manufacture of perfumes, soaps, in flavouring and in medicine. In medicine, cloves are stimulative, antispasmodic and carminative. In dentistry, eugenol in combination with zinc oxide is used for temporary filling of cavities.

Soil and climate: Cloves grow best with insular, maritime climates in the tropics upto an elevation of 1000 m. Annual rainfall of 1500-3000 mm and a temperature of 25-32 C are ideal. Drier weather is desirable for harvesting and drying the produce. Well drained, deep, sandy, red or acid loams with high humus content are best suited. Waterlogging is fatal.

Seeds and sowing: Cloves are propagated by seeds, though vegetative propagation through layering, approach grafting and budding has been met with occasional success. Fully ripened, freshly fallen fruits are collected, soaked in water and heaped under wet sacks for fermentation for 3 days. The seeds are then hulled with fingers, washed and sown in nursery at 15-20 cm spacing and watered regularly. Fresh seeds give a germination over 90%, but the seed viability diminishes sharply in storage. 1-1.5 years old seedlings can be transplanted to the mainfield at 6-7 m spacing in pits of 60-75 cm^3

Manuring: Cattle manure or compost is applied at 15 kg/tree/year. A well grown tree, of 15 years or more, is applied with N, P_2O_5 and K_2O at 300:250:750 g/plant/year. Application of coconut meal, bone meal or fish meal at 2-5 kg/plant is beneficial.

Aftercultivation: Irrigation is to be provided during summer months. Young plants are usually ring weeded. Mulching, partial shading and protection from heavy rains and winds are required during early stages of growth. Cloves can be intercropped in coconut, arecanut, nutmeg, coffee and banana plantations.

Plant protection: Termites, the coccid- *Saissetia eugeniae* and shoot borer (*Sinoxylon* sp.) are the common pests of clove. Termites can be controlled by drenching the soil with 0.05% chlorpyriphos EC. Dimethoate or methyl demeton sprays at 0.05% is efffective against the other pests. Leaf spot, twig blight and flower bud shedding are caused by different fungal pathogens. Die back caused by *Cryptosporella eugeniae* and sudden death by *Valsa eugeniae* are other diseases of the plant and can be controlled by spraying with 1% Bordeaux mixture.

Harvesting and processing: The trees begin to flower in 6 years. Full bearing is achieved by about 20 years and the production continues for 80 years or more. Bearing between years shows much variation. Clove clusters are hand-picked when the buds reach full size and turn pink but before they open. They are spread thinly on mats and stirred frequently for uniform drying. Well dried cloves will snap cleanly with a sharp click across the thumb nail and weigh about one-third of the green weight. On an average, a clove tree yields 3.5-7.0 kg/year which depends upon the age, size and condition of the tree. Yields upto 80 kg/tree/year have also been recorded.

Various parts of the clove tree yield essential oil on distillation. The duration of distillation ranges from 8-24 hours depending upon the size of the still, nature and

volume of steam and condition of cloves. Leaves and small twigs yield clove leaf oil. Clove stem oil is obtained from stems attached to the buds and flowers, whereas clove bud oil which has the highest quality and price is obtained from buds. The essential oil yield is 17-19% from clove buds, 6% from clove stems and 2-3% from clove leaves.

Chemical constituents: Clove bud oil contains mainly eugenol 80-90% and caryophellene 4-8%.

CORIANDER

Coriandrum sativum

Family - Apiaceae

Coriander is an annual erect aromatic herb. The young green plant is a culinary herb and the mature fruit a spice. The seed oil and oleoresins are commercially extracted. *Coriandrum sativum* var. *microcarpum* which is small fruited is largely temperate while *C. sativum* var. *vulgare* which is large fruited is mainly cultivated in the tropics and subtropics

Uses: The essential oil is used in the flavouring of processed food and to some extent in pharmaceutical products and perfumery formulations. Its major fraction of the oil is linalool, which accounts for its characteristic aroma. The oleoresin has similar application as the essential oil in flavouring and perfumery. The leaves and seeds are also used for the treatment of ailments like indigestion, dyspepsia, flatulence and piles.

Soil and climate: Coriander requires a frost free cool climate. It can be cultivated either as a winter crop during October or May-June. The plant grows on a wide variety of soils ranging from heavy black cotton soils to silt loams, though well drained medium to heavy soils are the best. The crop can be successfully cultivated as a rainfed crop on medium to heavy soils with well distributed soil moisture and as an irrigated crop on rich silt loams.

Seeds and sowing: It is propagated by seeds. Seeds are rubbed to separate one seeded mericarps before sowing. Sowing is done either by broadcasting or by using seed drills in rows 30 cm apart. The seed rate is 10-12 kg/ha for pure cropping and 4-5 kg/ha for mixed or intercropping. Seeds start germinating in 8-10 days of sowing.

Varieties: Lucas, Amber, NP(D)92, NP(D)95, NP(D)172, NP(J)24, NP(K)45 and S-33

Manuring: FYM at 10 t/ha and fertilizers at 100:40:40 N, P_2O_5 and K_2O/ha are recommeded.

Irrigation: The crop is irrigated immediately after sowing to ensure even germination and later on at 7-10 days interval depending upon the soil and climatic conditions.

Aftercultivation: The field is to be kept weed free by regular weeding and hoeing. Postemergence application of 5-6 kg of propanil brings about optimum control of weeds.

Plant protection: Diseases such as wilt (*Fusarium oxysporum*), tumour (*Protomyces macrosporus*), powdery mildew (*Erysiphe polygoni*), stem rot (*Sclerotina sclerotiarum*) and root rot (*Rhizoctonia bataticola*.) are reported in coriander. The diseases are controlled by spraying or soil drenching with 1% bordeaux mixture.

Harvesting and processing: The crop matures in 90-110 days. To avoid shattering of the fruit, it is generally harvested when the fruits in the main umbel have turned brownish or half of the fruits have turned brown. Harvesting is done either by uprooting the whole plant or by cutting them with sickle manually. The plants are then tied into small bundles and stacked for drying, keeping the bundles upside down, and then threshed to separate the fruits. The yield is 400-600 kg/ha under rainfed farming and 1400-2000 kg/ha under irrigated condition.

The essential oil is obtained by the steam distillation of mature dry fruits. Generally, distillation is carried out for 9-10 hours. The larger fruit contains 0.1-0.35% oil whereas the small fruit contains 0.8-1.8% oil. Oil recoveries as high as 2.6% have also been reported. An oil yield of 30-40 kg/ha is obtained. Coriander oil is often adulterated with sweet orange oil cedar wood oil, aniseed oil, turpentine or anethole.

Chemical constituents: Seed oil contains mainly -pinene 0.96-7.97%, p-cymene and phellandrene 3.69-9.91%, linalool 59.55-72.61%, borneol and decyl aldehyde 5.31-7.43%, myrcene 5.44%,-terpinene 5.44%, camphor 2.46% etc.

CUMIN

Cuminum cyminum

Family - Apiaceae

Cumin is a small slender glabrous annual herb. It is one of the most important condiments consumed all over the world.

Uses: The seed is used as a spice for flavouring foods of various kinds like breads, cheese and curry powders. Cumin oil is preferred to the whole fruit in many types of flavouring preparations. The oil is also used in soap, perfumery and beverages. The absolute is superior to the oil for flavouring. Cumaldehyde, the chief constituent of cumin oil, is used in perfumery. The thymol free, distillation residue water is given to children as carminative and is useful in flatulence and gripping.

Soil and climate: Cumin is usually cultivated as a winter crop. It prefers low atmospheric humidity during flowering and seed setting. It is grown on well drained, medium to heavy textured soils of medium to high fertility. The incidence of wilt disease is more in light textured soils.

Seeds and sowing: The plant is propagated by seeds. Seed rate is 20 kg/ha for broadcasting and 12-15 kg/ha for drilling or line sowing at 25-30 cm between rows. Seeds are sown in November on well prepared seed beds.

Varieties: S-404, MC-43, RS-1, UC-52, UC-91, NP(D)-1, NP(J) 126, NP(J) 149

Manuring: The beds are manured with 10-15 t/ha of organic manure and 30-40 kg each of N, P_2O_5 and K_2O/ha. A top dressing of 30 kg N/ha is given after second weeding

Irrigation: The field is irrigated immediately after sowing. Thereafter, 4-5 irrigations are needed at an interval of 12-20 days depending upon weather and soil conditions.

Aftercultivation: Weeding is carried out twice, 20 and 40 days after sowing..

Plant protection: Not many pests are reported in this crop. Aphids attacking cumin can be easily controlled by tobacco decoction or a mild insecticide like malathion. Fusarium wilt (*Fusarium oxysporum* and *F. cumini*), blight (*Alternaria burnsii*) and powdery mildew (*Erysiphe polygoni*) are also observed on the crop which can be controlled by the application of maneb, MBC and wettable sulphur respectively.

Harvesting and processing: The fruits appear in tufts and mature in 80-100 days after sowing. The fruits are harvested before they shatter, by pulling the whole plants in the morning when they are wet. The uprooted plants are stacked for 2-3 days for drying in sun. The seeds are separated from the plants by winnowing. On an average a seed yield is 800-1500 kg/ha.

The dried fruit or seed is crushed and distilled immediately to obtain the essential oil. Steam distillation is usually carried out. The oil recovery ranges from 2.5 to 4.5% . Older seeds yield less oil. On an average, an oil yield of 25-30 kg/ha is obtained.

Cumin oil is often adulterated with synthetic aldehydes, the presence of which in small quantities cannot be detected by routine analysis, higher percentages affect the optical rotation.

Chemical constitutents: Cumin oil contain -pinene (14.3-19.7%), p-cymene (2.7-6.0%), terpinene (11.5-16.3%), cuminaldehyde (20.0-22.4%), p-menth-1,3-dien-7-al (11.1-13.5%), p-menth-1,4dien-7-al (23.6-24.3%), cuminyl alcohol (3.7-72.2)%, sabinene (3.38%), benzyl cinnamate (4.47%), farnesol (2.98%)

DAVANA

Artemisia pallens

Family - Asteraceae

Davana is a delicate, erect, branched annual herb, the flowering top of which yields an essential oil which is extensively used in high grade fine perfumes. Davana is probably a native of South India. It is an erect branched annual herb 45-60 cm tall and covered with greyish white tomentum

Uses: The oil is used for flavouring cakes, pastries, tobacco, beverages, sausages and preserved products. The leaves form an important component of garlands and bouquets

Soil and climate: Davana is a delicate plant and hence cannot withstand heavy rains. It prefers light drizzles, bright sunshine, and a mild winter with no frost and heavy morning dew during the growing season. Cloudy weather and rains during flowering and seed ripening stages adversely affects the yield. The crop grown during November gives the maximum herb and oil yield. However, the crop can be grown round the year for use in garlands and bouquets. The plant grows on various types of soils ranging from sandy loam to medium black soils, but humus rich red loam soils are ideal.

Seeds and sowing: The plant is propagated by seeds. Seeds are short-viable and hence cannot be stored for long. Transplanting is generally practised in the crop. A nursery area of 500 m^2 sown with about 1.5 kg seeds is sufficient for planting one hectare. The seeds are mixed with fine sand, broadcast over the nursery bed, covered with a thin layer of sand and watered regularly. Seeds germinate in about 3-4 days. When the seedlings are 10-12 cm tall they are transplanted to the main field at 15 x 7.5 cm spacing.

Manuring: Before transplanting, 12-15 tonnes of well decomposed FYM and 40 kg/ha each of phosphate and potash are incorporated into the soil. N is applied at 120 kg/ha in 4 equal splits, 3 for the main crop and 1 for the ratoon crop at 15 days interval.

Aftercultivaation: The crop is irrigated weekly. Two weedings are carried out in the main crop and one in the ratoon crop.

Plant protection: The crop is often subject to damping off at the tender early stage, particularly in the nursery. This disease, caused by *Rhizoctonia* species is common during cloudy and rainy period. Hence adjusting of sowing time is important for avoiding the disease. In severe cases, the disease can be controlled by soil drenching and foliar spraying with 0.2% Mancozeb or 1% Bordeaux mixture.

Harvesting and processing: The crop is harvested during February-March when a large number of flower buds start opening. Flower to plant ratio at the time of harvest is reported to be important in davana. Harvesting is done by cutting the whole plant with sickle at a height of 10 cm from the ground. The herb yield is 8-10 tonnes/ha.

The harvested herb is dried in shade for 2-3 days. The dried herb is steam distilled for a period of 6-8 hours for extracting the essential oil. The flower heads contain 0.3-0.4% of oil and in general, an oil recovery of 0.2% is achieved from the whole plant. The oil yield is 12-15 kg/ha.

Chemical constitutents: Davana oil contains davanone, fenchyl alcohol, cinnamyl cinnamate, caryophyllene, cadinene, linalool, dehydro-linalool, davanafuran, isodavanone, dihydro-rosefuran, n-alkanes, hydroxydavanone, geraniol and nerol. Davanafurans are responsible for the characteristic odour of davana oil though they

constitute only 0.8% of the oil. Oil with more than 50-60% davanone is preferred in trade.

EUCALYPTUS

Eucalyptus spp.

Family - Myrtaceae

Eucalyptus is an essential oil yielding tree which has perfumery, industrial and medicinal uses. The genus *Eucalyptus* comprises more than 700 species. *Eucalyptus citriodora* commonly known as *citron (lemon) scented gum or spotted gum* and *E. globulus* are the most common species cultivated for essential oils.. *E. citriodora* is a tall, graceful tree, 25-40 m high, with a crown of leaves and branches at the top. *E. globulus* grows to a height of 55 m.

Uses: The essential oil of *E. citriodora* is used in soap and cosmetic industries. It is an effective substitute for Java citronella oil and a source of citronellal for the manufacture of citronellol, hydroxy citronellal and menthol. The *E. globulus* oil is used in germicides and disinfectants to improve the odour. It is used as an antiseptic especially in the treatment of infections of the upper respiratory tract and in certain types of skin diseases. It is used as a stimulating expectorant in chronic bronchitis and as a vermifuge against hookworm. It is internally administered or inhaled with steam for asthma and respiratory disorders.

Soil and climate: Eucalyptus plants prefer tropical and subtropical climate but grow satisfactorily in temperate regions as well. They are frost sensitive in early stages. *E. citriodora* grows in plains upto 600 m while *E. globulus* prefers an elevation of 1300-2700 m. The former grows well on poor gravelly soils in rainfed areas but can be grown on any soil whereas the latter is chiefly grown on moisture rich loamy soils

Seeds and sowing: The plant is propagated by seeds only. Seeds can be sown directly in the field or seedlings can be raised in the nursery during February-September. Germination takes upto a fortnight depending upon atmospheric humidity and temperature. Cold stored seeds germinate in 2-4 days. Seedlings are maintained in the nursery for 2-3 months until they attain a height of 20-30 cm when they are transplanted to the mainfield at 70-100 cm spacing.

Manuring: 10-12 tonnes/ha of organic manure and 120:60:60 kg/ha of N, P_2O_5 and K_2O are applied.

Aftercultivation: Weeding is required during the initial period until the plants are established well

Plant protection: Seedlings, leaves and stems of *E. citriodora* are severely damaged by blight caused by *Cylindrocladium scoparium* Morgan. Drying and defoliation are caused by *Physalospora latitans* Sace. *Fusarium orthoceros* attacks the seedlings at the hypocotyl level. These fungal diseases can be controlled by spraying and drenching with 1% Bordeaux mixture or copper oxychloride.

Harvesting and processing: Harvesting is done when the weather is clear and oil content in leaves is maximum. Accordingly, harvesting leaves during February, April, July and October has been recommended. In Kerala, harvesting twice a year, in May and November, is practised. Plants can be pollarded to promote vigorous sprouting of side shoots. Fresh shoots sprout in about four weeks after pollarding, which are ready for harvesting after 4-5 months. First pruning is done at 30-45 cm above ground and the subsequent ones at 75-90 cm above ground.

The harvested leaves are steam distilled for 2-3 hours soon after harvesting to avoid loss of oil through evaporation as well as deterioration of its quality during storage. Though oil recoveries as high as 5% has been reported, 1-2% yield is frequently achieved in *E. citriodora*. The highest oil yield is obtained from the top

leaves. This oil has better solubility in alcohol and higher cineole content than the oil obtained from the lower leaves. A 6-8 years old tree yields 30-60 kg of leaves/year which gives 0.5-1 kg of oil.

Chemical constituents: *E. citriodora* oil is colourless to light yellow with a grassy verbena odour. The main composition of the oil is limonene 0.4-7.1%, 1,8 cineole 1.1-17.9%, citronellal 26.7-82.6%, linalool 0.3-0.9%, iso-pulegol 4.7-29.8%, citronellol 5.1-13.4%, caryophyllene 0.3-3.9% etc. *E. globulus* oil is colourless to light yellow with camphoraceous odour. The major constituents of the oil are cineole (60-70%) caryophyllene, camphene, sabinene, myrcene, p-menthane, , ß and -terpinene, fenchone, and ß-thujone, citral, verbenone, iso-amyl alcohol, trans-pino carveol, borneol, myrtenol, eudesmol, thymol, bornyl acetate, caproic acid, piperitone and globulol

FENNEL

Foeniculum vulgare

Family - Apiaceae

Fennel is a stout glabrous biennial or perennial aromatic herb whose fruit has a fragrant odour and a pleasant taste. In the species *Foeniculum vulgare* two cultivated forms are observed.(i) Bitter fennel: *Foeniculum vulgare* subsp. *capillaceum* var. *vulgare*. which yields bitter fennel oil and (ii) Sweet fennel: *F. vulgare* subsp. *capillaceum* var. *dulce* which yields sweet fennel oil. Indian fennel is sometimes referred to as a distinct form, var. *panmorium*

Uses: The fruits are used for flavouring soups, meat dishes, sauces, bread rolls, pastries, pickles, confectionery and liquors. The seeds yield essential oil which is used in perfumery, food, soap, liquor and drug industries. Medicinally, it is useful in infantile colic and flatulence. It also checks gripping and is used as vermicide against hook worms.

Soil and climate: Fennel requires a fairly mild climate. It is mainly cultivated as a winter season crop upto an altitude of 1800 m throughout the subtropical and temperate regions. In many countries, it is grown as a garden crop in home yards. It grows on a variety of soils, but thrives best on rich loamy soils containing sufficient lime. Saline and waterlogged soils are not suitable.

Seeds and sowing: The plant is propagated by seeds. Seeds are broadcast or drilled in rows 30-45cm apart, during October-November in plains and during March-April in higher elevations. Seed rate is 8-10 kg/ha. The seedlings when 8-10cm high may be thinned out to 20-30cm in rows.

Manuring: The field should be supplied with 15-20 t/ha of organic manure before planting and fertilizer application can be dispensed with at higher levels of organic manure application. When organic sources are limited inorganic fertilizers can be applied at 100:30:30 kg N, P_2O_5 and K_2O/ha. N is applied in 2-3 splits while P and K are applied as basal at the time of sowing.

Irrigation: Watering is required immediately after sowing if there is no rain. Subsequently, irrigation is to be provided at 7-15 days interval depending upon the weather and soil conditions.

Aftercultivation: Weeding is carried out twice, one and two months after sowing which is followed by topdressing of N.

Plant protection: Thrips (*Heriothrips indicus*) may severely damage the crop which can be controlled by the application of a contact or systemic insecticide. Blight (*Cercospora foeniculi*) and powdery mildew (*Leveillula tauria*) are the common diseases of fennel, which are controlled by spraying maneb (2g/l) and wettable sulphur (3g/l), respectively.

Harvesting and processing: The crop will be ready for harvest in 5-6 months time. Individual umbels are cut before they are fully ripe and the harvested crop is spread out in loose bundles to dry in the sun for 4-5 days. The dried fruits are then separated by thrashing and cleaned by winnowing. The average seed yield is 1000-1500 kg/ha.

The crushed fennel seeds, on steam distillation yield the essential oil. The oil content in seed varies considerably with the variety, being the lowest (0.7-2%) in fruits of Indian origin and highest (4-6%) in fruits obtained from Eastern Europe.

Chemical constitutents: Indian fennel oil contains over 70% anethole and 5% fenchone. Fenchone is mostly absent in European oils. The high percentage of anethole (upto 90%) and the relative absence of fenchone are responsible for its

delicate odour and flavour. anethole, the major being

The oil from wild growing bitter plants contains little d-phellandrene.

GERANIUM

Pelargonium graveolens

Family - Geraniaceae

Geranium also known as *Rose geranium*, is a bushy pubescent aromatic perennial shrub which produces an essential oil having strong rose-like odour with a minty top note. It is a suffrutescent bushy aromatic perennial shrub with cylindrical stem.

Uses: Geranium oil blends well with all kinds of scents, floral and oriental bouquets and is extensively used in perfumery and cosmetic industries. It is widely used for scenting soaps due to its stability in the slightly alkaline medium. The oil is also used for the production of rhodinol used in the manufacture of perfume compounds.

Soil and climate: A Mediterranean type of mild climate with a low humidity, warm winter, mild summer temperature and an annual rainfall of 1000-1500 mm is ideal for the crop. It grows successfully at an altitude of 1000- 2100 m. Well drained porous soils are suitable for its cultivation. Saline, alkaline and damp soils are unsuitable.

Seeds and sowing: There is no seed setting in geranium. The plant is propagated by stem and root cuttings. Terminal cuttings root earlier than middle and basal cuttings. IAA is better than IBA for inducing rooting. Rooted cuttings are raised in the nursery during November-January and transplanted after 2 months at 60 x 40 cm spacing in the main field after applying well decomposed FYM or Compost.

Manuring: Apply FYM at 10-12 t/ha. Inorganic fertilizers like phosphate and potash are applied at 40-60 kg/ha as basal while N is applied upto 200 kg/ha/year in six equal splits to cover the 3 harvests. Application of micronutrients such as Cu at 20 kg/ha/year and Mo at 3 kg/ha/year in 3-4 split doses is found to be beneficial.

Aftercultivation: Irrigation is provided daily for the first 3-4 days, on alternate days till two weeks and weekly thereafter. The crop requires weeding 20 and 40 days after planting and hoeing after harvest.

Plant protection: Attack of root-knot nematodes *Meloidogyne incognita* and *M. hapla* are common in this crop. These are controlled by applying carbofuran 3G granuls @ 1.0 kg a.i. *Fusarium oxysporum* and *Botryodiplodia theobromae* cause wilt disease for which the systemic fungicide benomyl is effective.

Harveting and processing: The crop is ready for harvest after 4 months from transplanting when the leaves begin to turn light green and exhibit a change from lemon like odour to that of rose. The green leafy shoots are harvested with a sharp sickle. Three harvests can be taken per annum and the crop remains in the field for 4-6 years. The yield of fresh herbage/ha/year from the 3 harvests is about 15 tonnes.

The harvested herb is immediately taken up for distillation. Steam distillation gives better quality oil as compared to hydrodistillation. Distillation takes 3-4 hours. The volatile oil is present mostly in the leaf blades and there is practically no oil in the woody stem. In large scale distillations, the oil recovery varies from 0.1 to 0.15% on fresh weight basis and the average oil yield is 18-20 kg/ha/year. A maximum oil yield of 60 kg/ha has been reported.

Chemical constituents: Geranium oil possesses strong, somewhat rose-like odour which is reported to improve with age when properly stored. The major chemical composition of the essential oil is reported to be iso-menthone 5.2-7.2%, linalool 3.96-12.90%, Guaia-6,9-diene 0.15-4.4%, citronellyl formate 1.92-7.55%, citronellol 19.28-40-23%, geraniol 6.45-18.4%

JASMINE

Jasminum grandiflorum

Family - Oleaceae

Jasmines are a group of shrubs which are commercially grown for their fragrant flowers and essential oil production. The term Jasmine is probably derived from the Persian word *Yasmin* meaning *fragrance* Though more than 2000 species are known, three species, viz, *J. grandiflorum* L., *J. sambac* Ait. and *J. auriculatum* Vahl. are commercially cultivated and only *J. grandiflorum* L. is grown for use in perfume.

Uses: The bulk of the flowers is used as such in garlands and decorative bunches for religious offerings and a small quantity for the production of oils and attars. Jasmine concrete and absolute are used in high grade perfumes, ranking next to the rose in the order of importance. Jasmine oil blends with every floral scent and extensively used as an important perfumery item throughout the world. Almost all high quality perfumes contain at least a small amount of jasmine oil. The absolute, though expensive, also blends with any floral scent imparting smoothness and elegance to the perfume composition.

Soil and climate: Jasmines are sun loving plants and prefer warm humid climate for successful growth. They perform well at elevations ranging from 600 to 1200 m. Areas having a warm summer and mild winter with sun almost throughout the year are considered the best. Jasmines can be grown on a wide range of soils, but well drained rich sandy loam to clay loam soils with a soil pH of 6.5-7.5 are best suited.

Seeds and sowing: Layers and cuttings can be used for propagation.. Cuttings for planting should be 20-25 cm long with 3-4 eyes and are dipped in seradix-B (or a solution of 4000 ppm of IBA) and planted under intermittent mist for rooting during January to March. Almost 90% rooting is achieved and the cuttings will be ready for transplanting in 4-5 months. Cuttings, are planted in pits dug upto 1 m in depth, and filled with top soil, cowdung and compost. Plants are spaced at 1 m in rows, 1.5 m apart.

Varieties: Improved varieties of *J. grandiflorum* ('Jaji mallige' and 'Ajjige') and *J. auriculatum* ('Vasantha mallige' 'Parimullai' and 'CO -1 mullai') are used for commercial cultivation

Manuring: Jasmine plant needs 15-30kg FYM, 60-120g N, 120-240g P_2O_5 and 120-240g K_2O/plant/year which are given in 3-4 split doses.

Aftercultivation: Pruning is needed to get high flower yield and to keep the bushes to manageable size. Plants pruned between 17th December and 7th June produce maximum number of branches and the highest yield of flowers. The shoots are cut at 30 cm height. Diseased leaves and dry shoots are also removed. After pruning, the soil around the plant should be stirred upto a depth of 15 cm and repeated every 2-3 months. The field should be kept clean by removing weeds as and when necessary. Irrigation is given if soil moisture is inadequate.

Plant protection: Red scale, mealy bug, jasmine bug, leaf eating caterpillar, white flies and mites are the common insect pests. Red mite can be controlled by spraying any acaricide like dicofol, tetradifon, chlorobenzilate or wettable sulphur and other pests with carbaryl 50 WP at 0.2% or methyl demeton at 0.05%. Black leaf spot and mildew are the diseases of this crop.

Harvesting and processing: The plant flowers from the second year of planting. The flowering period ranges between April and May and from August to November. Harvesting is done during early morning because the flowers contain maximum

perfume at this time. Flowers gathered at noon and in the afternoon yield lesser flower oil than those collected very early in the day. Warm weather and ample sunshine yield a crop of heavily scented flowers than in cool or rainy weather. The annual yields of flowers have been reported to be 750-1000 kg/ha. A jasmine plantation gives economic yield for 10-15 years after which the crop is removed and crop rotation is followed for some years before establishing a new jasmine plantation.

The essential oil in flowers is extracted through enfleurage which is widely used for production of jasmine attars in India. In this method, seeds of sesame or til (*Sesamum indicum* L.) are first soaked in water with a view to remove their covering and then dried in the sun. The fresh jasmine flowers and the dehusked sesame seeds are spread in thin layers, one above the other, for 10-12 hours daily. The exhausted blossom is replaced by fresh flowers and this process is repeated for 5-7 days till all the dehusked seeds are saturated with the perfume. One kg seed can extract the perfume from 3 kg flowers. The perfumed seeds are distilled and the vapours of jasmine are absorbed into sandal wood oil for production of attars. Solvent extraction, with petroleum ether or hexane, recovers practically all the odorous constituents. The solvent is recovered by vacuum distillation and the residue constitutes the concrete which is purified by extraction with 95% alcohol, whereby jasmine absolute is obtained. The usual yields are 0.30-0.35% concrete and 45-55% absolute. The annual yield of concrete is 4-5 kg/ha. Jasmine oil is also separated from jasmine concrete by liquid carbon dioxide extraction method.

Chemical constituents: The approximate composition of jasmine flower oil obtained by enfleurage is benzyl acetate 65.0%, d-linalool 15.5%, linalyl acetate 7.5%, benzyl alcohol 6.0%, jasmone 3.0%, indole 2.5% and methyl anthranilate 0.5%.

LEMONGRASS

Cymbopogon flexuosus

Family - Gramineae (Poaceae)

Lemongrass is a tropical perennial grass having typical strong lemon-like odour. *Cymbopogon flexuosus* (East Indian or true lemongrass). *Cymbopogon citratus* (West Indian) *Cymbopogon pendulus* (Jammu lemongrass) are commercially cultivated for extraction of oil.

Uses: It used for the isolation of citral and manufacture of ionones having the odour of violets. They are used in flavours, cosmetics and perfumes. The leaves and tender shoots are used for flavouring foods, drinks and tea and for scenting bathwater. The oil is used as a repellent against flies and mosquitoes.

Soil and climate: Lemongrass is generally grown on poor soils, though it flourishes on a wide variety of soils ranging from rich loam to poor laterite. The grass grows best on well drained sandy loam soil. It requires a warm humid climate with plenty of sunshine and rainfall ranging from 2500-3000 mm, uniformly distributed over the year. The grass prefers an average temperature of 23-30^{0}C. The plant is hardy and tolerant to drought. This crop is well suited for rainfed agriculture. It grows well at altitudes between 100 and 1200 m above MSL

Seeds and sowing: It is propagated through seeds and slips. Fresh seeds are to be used as viability of seeds are drastilay reduced after six months. Seed rate is 3-4 kg/ha for transplanting and 25-30 kg/ha for broadcast sowing. For transplanting, seeds are sown in a well prepared nursery. 45-60 days old seedlings are transplanted at a distance of 20-50 cm in rows, 20-75 cm apart depending on the soil fertility and tillering nature of the variety. **Varieties:** Sugandhi (OD-19),OD-23 RRL-16, LS-48, Pragati, Kaveri, Krishna

Manuring: Apply spent-lemongrass compost at 10 tonnes/ha and wood ash at 2 tonnes/ha, which are obtained as byproducts of grass distillation. 30 kg/ha each of N, P_2O_5 and K_20 as basal dose is to be applied at the time of planting. 60 kg N/ha/year may be applied as top dressing in 3-4 splits after every harvest.

Irrigation: 4-6 irrigations are essential for getting optimum yield in areas where rainfall is restricted or not well distributed.

After cultivation: Generally, 2-3 weedings are necessary during a year. Spraying Paraquat at 2-2.5 l/ha in 500 l of water immediately on the same day or the next day after cutting the grass for distillation is an excellent method of weed control. Burning of stubbles in summer is practised in some areas to ward off pests, diseases and weeds. Earth up after weeding and fertilizer application.

Plant protection: No serious pest and disease occur in the crop. Stem borer, *Chilotrea* species and leaf spot diseases caused by *Helminthosporium cymbopogi* and *H. sacchari* and long smut disease caused by *Tolyposporium christensenii* are reported.

Harvesting and processing: Take first cutting 3 months after planting, thereafter every 6-8 weeks depending on growth. Cut close to the base about 10 cm above ground level. Generally, 3 harvests are possible during the first year and 4-6 during subsequent years. The fresh grass yield ranges from 3 to 10 tonnes/cut/ha . The grass yield is highest in the third year of planting. Replant after 5-6 years. The essential oil is produced by steam distillation of the grass. The grass is distilled either fresh or after wilting. Wilting of grass for 2 days and chopping to 3 cm size yield more oil. On an average the oil recovery is 0.3-0.4% and the oil yield is 100-125 kg/ha/year.

Chemical constituents: *C. flexuosus* oil contains 75-85% of aldehydes consisting largely of citral.

LINALOE

Bursera delpechiana

Family - Burseraceae

Linaloe is a large dioecious tree whose wood as well as the berries and leaves yield essential oils which are used as the raw material for the extraction of linalool. Linaloe tree is a native of Mexico

Uses: Because of the stability to alkali, the oil is particularly useful in the manufacture of scents, cosmetics and soaps; transparent soaps. The berry oil resembles *Bois de Rose* and can be used as a fixative in perfuming lily, lavender, cananga and soaps.

Soil and climate: Linaloe plant requires a dry tropical climate with an annual rainfall of 500-1000 mm. It grows upto an altitude of 760 m. The tree is very hardy and it flourishes even on rocky soils. In deep sandy loam it attains good height with spreading branches. Well drained medium or light loamy soil with neutral pH is ideal for growing the crop. Waterlogging causes cracking of stems and finally wilting away to death.

Seeds and sowing: The plant is propagated by stem cuttings and seeds. Stem cuttings are usually used as seeds do not germinate easily and germination is very poor. Cuttings of about 1 m length and 1-3 cm diameter are first planted in nursery or poly bags. About 90% recovery is obtained. The rooted cuttings are transplanted to the main field after 4-6 months in pits of 80 cm cube at a spacing of 6-7 m. The plants establish in the field very quickly. They start shedding leaves during November and are completely bare of foliage till late March when new flushes appear.

Aftercultivation: They are very hardy and once established do not need much care. No serious pests and diseases are noticed.

Harvesting and processing: Linaloe plant raised from cuttings set fruits the first year itself while those from seeds take about 5 years for fruit set. New flush of leaves along with flower buds appear in April. Berries start setting by May and mature by July-August when they are harvested, dried and dehusked. One kg of dried husk is obtained from 5-6 kg of fully mature berries.

Almost all parts of the linaloe tree contain aroma. Mexicans distill the wood while Indians use the outer husks of berries. The husk oil yield is much less, 1.8% as compared to 2.5-3.0% obtained from the wood in Mexico. The berries can be steam distilled either fresh or dry. Fresh berries take about 5 hours while dry ones 20-25 hours for distillation. The still should not be filled up to the brim as the husks swell during distillation. Fresh fruits yield 1.5-2.5% oil while dried husks yield 8-12% oil. The wood oil is distilled from the wood of 40-60 years old trees which yield 7-12% oil while younger trees yield 2.5-3% oil. The seed oil produced in India is known as *Mysore Linaloe oil or Indian Lavender oil*. Leaf oil yield is 0.15-0.25%.

Chemical constituents: The approximate composition of the husk oil is methyl heptanol 1.5%, linalool 47.7%, linalyl acetate 40.8%, sesquiterpene and other viscous substances 8%. Mexican oil contains 60-75% linalool. the leaf oil has a sweet wafting odour and it contains 65-70% linalyl acetate.

MARIGOLDS

Tagetes spp.

Famiy - Asteraceae

Five species have been recognized in *Tagetes*. *Tagetes erecta* (African or Aztec Marigold), *Tagetes patula* (French Marigold), *Tagetes lucida* (Sweet Scented Marigold), *Tagetes minuta* (*T. glandulifera*.), Stinking Roger *Tagetes tenuifolia* (*T. signata* Bartl.) Stripped Marigold

Uses: African marigold flower oil is a fly repellent and has been suggested as a modifier in hair lotions of the bay-sum type. French type finds use in perfumery particularly in certain types of herbaceous fragrances like fougere and lavender and also in florals, such as jasmine, gardenia and violet. This oil is also employed in aldehyde oriented tabac bases. Oil of stinking roger finds applications in germicidal and microbicidal preparations due to the presence of tagetone which is toxic. Planting of marigold is highly effective in controlling nematode population in the soil.

Soil and climate: African and French marigolds are more widely cultivated as compared to other species. Marigolds, in general, require a mild climate between elevations of 700-1500 m. They come up well on well drained rich loam or sandy loam soils.

Seeds and sowing: They are propagated by seeds and cuttings; the former is preferred for establishing tall, vigorous and heavy yielding plantations. Seeds are sown during May-June on nursery beds. One month old seedlings are transplanted at 30-45 cm spacing

Varieties: *Tagetes erecta* (African or Aztec Marigold): 'Guinea Gold', 'Apricot', 'Primrose', 'Sun Giant', 'Fiesta', 'Golden yellow', 'Glitters', 'Happiness', 'Hawai', 'Crown of Gold', 'Honeycomb' and 'Cerpid'.

(ii) *Tagetes patula* (French Marigold): 'Rusty Red', 'Flame', 'Spry', 'Naughty', 'Marietta', 'Star of India' and 'Harmony'.

Interspecific hybrids between African and French marigolds are also popular. They are 50-60 cm tall with double flowers of 5-7 cm. Eg: 'Nugget', 'Show Boat', 'Red Seven Star', 'Red' and 'Gold Hybrid'.

Manuring: The land is cultivated well incorporating 20-30 tonnes/ha of well decomposed FYM or compost. A fertilizer dose of 400 kg N, 200 kg P_2O_5 and 200 kg K_2O/ha is suggested for higher yield.

Aftercultivation: Regular irrigation, weeding and hoeing are required to obtain more of large flowers. Initial flower buds are disbudded to obtain bushy and compact growth. **Harvesting and processing:** Flower heads are harvested when they have attained full size. Regular plucking of flowers increases the flower production. The flower yield is 8-12 t/ha for French marigold and 11-18 t/ha for African marigold.

All parts of the plant contain essential oil in varying concentrations. The oil is commercially obtained by steam distillation for 3-4 hours, absorbing the distillate in petroleum ether or benzene. Prolonged distillation spoils the fragrance. Marigold yields 0.02-0.08% oil giving 8-15 kg oil/ha/year.

Chemical constituents: African marigold flower oil is reddish yellow in colour, contains approximately ocimene 8.5%, limonene 14.03%, linalool 21.14%, linalyl acetate 13.75% and tagetone 40.38%. In French marigold oil Tagetone 40.4%, linalool 22.1%, limonene 14.0%, linalyl acetate 13.8% and ocimene 8.5% are the major constituents Oil of *T. lucida* contains estragol.

MINTS

(Japanese mint)

Family - Labiatae (Lamiaceae) (Lamiaceae)

Mints are aromatic perennial herbs with essential oil present in glands located in the subcuticular region. It is a downy perennial herb with rootstock creeping along or just under the ground surface. Four major mints recognized in this genus are *Mentha arvensis* L.(Japanese mint), *M. piperita* L.(Pepper mint), *M. spicata* L.(Spear mint) and *M. citrata* (Bergamot mint or Lemon mint).

Uses: It is the primary source of menthol, which is widely used for as flavouring and fragrance in confectioneries, toileteries, cosmetics and beverages. It is also employed in a number of medicinal preparations like ointments, balms, syrups, lozenges and tablets

Soil and climate: Medium deep soil, rich in humus is best suited. The soil should have a pH range of 6-7.5 with good water holding capacity but waterlogging is detrimental. Japanese mint grows well under subtropical conditions while others prefer temperate climate. Adequate and regular rainfall during the growing period and good sunshine during harvesting are ideal for its cultivation.

Seeds and sowing: Japanese mint is propagated through stolons. Seed rate is 400 kg/ha. A hectare of well established mint provides enough planting materials for 10 hectares. Stolons are planted either on flat land or ridges. In plains, they are planted in shallow furrows of 7-10 cm deep at a spacing of 45-60 cm .

Varieies: Red, purple and green varieties are known. MAS-1 and Hybrid-77.

Manuring: Farm yard manure at the rate of 10-12 tonnes/ha can be incorporated during land preparation. Inorganic fertilizers upto 160 kg N and 50 kg each of P_2O_5 and K_2O/ha are applied; nitrogen being applied in 2-3 split doses.

Irrigation: Irrigation enhances growth and improves the yield.

Aftercultivation: The field should be kept weed free, particularly during the initial stages of growth till proper establishment and coverage of the ground area.

Plant protection Termite attack observed during the dry months can be controlled by the soil application of application of chlorpyriphos 20 EC at 0.05%. Hairy caterpillars cause rapid defoliation. Cut worms, semi-loopers and red pumpkin beetle also attack the crop. These insect pests can be controlled by 5% DDVP, 2% methyl parathion dust or any other contact insecticide. Nematode attack has also been reported for which application of Fenamiphos at 10-12 kg/ha is effective. Mentha rust is caused by *Puccinia menthae* which results in severe leaf shedding. Powdery mildew caused by *Erysiphe cichoracearum* can be controlled by wettable sulphur application. *Macrophomina phaseoli* and *Thielavia basicola* cause stolon rot which is effectively controlled by the application of maneb or 1% Bordeaux mixture.

Harvesting and processing: Japanese mint is first harvested after about 4 months of planting when the lower leaves start turning yellow. Subsequently two more harvests can be taken generally at an interval of 80 days. The fresh herb yield ranges from 25 to 50 tonnes/ha obtained in 3 cuttings annually

The harvested herb and wilt in shade for a few hours. Both fresh and dry herb are employed for distillation. Steam distillation for 1.5-2 hours Fresh herb contains 0.4 to 0.6% oil. On an average, 100-150 kg oil/ha is obtained annually.

Chemical constituents: The chemical constituents in Japanese mint oil are reported to be l-menthone, d & l -iso-menthone, methyl acetate, camphene, esters of formic, iso-valeric and caproic acids, ethyl carbinol, hexanol l-limonene, ß-pinene, cineole,

3-octanol, linalool, menthofuran, neo-menthol, pulegone, piperitone and piperitone oxide

NUTMEG

Myristica fragrans

Family - Myristicaceae

Nutmeg plant is a spreading dioecious evergreen tree which yields two spices, the dried seed called *nutmeg* and the dried aril called *mace*..

Uses: Nutmeg is grated in small quantities for flavouring and confectionery. Mace is used with savoury dishes in pickles and ketchups. The seeds yield a solid fixed oil, *nutmeg butter*, which is used in ointments and perfumery.

Soil and climate: Nutmeg requires warm humid conditions with an annual rainfall of 1500 to 2500mm and temperature of 25-33^{0}C. It grows well from sea level to an elevation of 1300m. Extreme dry climate as well as waterlogging are injurious to the crop. For the cultivation of nutmeg, river banks and hill valleys with sandy loam and red laterite soils are ideal. Partial shade appears to be beneficial in early growth stages.

Seeds and sowing: Nutmeg is normally propagated by seeds. The seeds soon lose their viability and should be sown immediately. Large seeds of uniform size, round shape, light brown colour with thick mace and low terpene content are selected for sowing. Germination takes 4-6 weeks. The sprouted seeds are transplanted into polythene bags which can be planted in the mainfield after 6-12 months. Seedling progeny will give about 50% of each sex, which is very difficult to distinguish until the trees flower 4-6 years after planting. Cut off the surplus males at this stage, leaving one male to 10 females. Budding and grafting is followed to ensure female progeny. Nutmeg seedlings are planted in the mainfield in pits of 90 cm cube dug at 8 m spacing.

Manuring: Apply cattle manure at 10 kg/pit and gradually increased to 50 kg/tree for 15 years old tree. Likewise, fertilizers at 20:18:50g N, P_2O_5 and K_2O/tree in the first year is increased to 500:250:1000g in the fifteenth year.

Aftercultivation: Regular weeding and irrigation are required for good growth, early bearing and higher yield.

Plant protection: The hard scale (*Saissetia nigra*) infesting the shoots can be controlled by spot spraying with quinalphos at 0.05%. Shot hole caused by *Colletotrichum gloeosporioides*, leaf blight and fruit rot by *Botryodiplodia theobromae*, leaf spot by *Alternaria citri*, sooty mould caused by *Phragmocapinus betle* and horse hair blight are the common diseases of nutmeg, which can be controlled by spraying 1% Bordeaux mixture repeatedly.

Harvesting and processing: Trees come to full bearing between 15 and 20 years and continue for more than 40 years or more. Fruits ripen about 6 months after flowering. Fruits are available throughout the year but the peak period of harvest is from December to May. Fruit split open when fully ripe which are collected and dehusked. The aril is removed, flattened out and dried slowly in sun for 10-15 days. The nuts are dried for 4-8 weeks till the kernel rattles within the shell. A tree produces 1500-2000 or more fruits/year. Yields per hectare may vary from 1000-1500 kg of nutmegs and 200-250 kg of mace per annum. Mace to nutmeg ratio is about 7:200 on weight basis.

Essential oil is extracted from the seed, mace, leaves and also the bark, by steam distillation.For oil distillation, the economically viable and accepted materials are the rejections from spice trade. The oil yield ranges from 6 to 16% in nutmeg, 4 to 15% in mace, 0.14% in bark and 0.4 to 0.6% in leaves.

Chemical constituents: The seed essential oil contains 80% pinene and camphene, 4% myristicin which is poisonous, dipentene, p-cymene, d-linalool, terpineol,

geraniol, safrole, eugenol and isoeugenol. Mace essential oil is similar to nutmeg oil but it is fresher than the seed oil.

OCIMUMS

Sweet Basil (*Ocimum basilicum*)

Family - Labiatae (Lamiaceae)

Ocimums are an important group of aromatic and medicinal plants which yield many essential oils and aroma chemicals. In view of the great diversity, the various species have been classified into two broad groups, viz, *basilicum* and *sanctum* groups. **Basilicum** group includes *O. canum* (Hoary basil) , *O. basilicum* (Sweet/French basil), *O. americanum* and *O. kilimandscharicum* (Camphor basil). **Sanctum** group includes *O. sanctum, O. gratissimum, O. viride, O. suave, O. carnosumck* and *O. micranthum*. Clove scented ocimum *Clocimum* is a hybrid strain of *Ocimum gratissimum var. clocimum* obtained by crossing *O. gratissimum* race 1 and *O. gratissimum* race 2, developed at the Regional Research Laboratory, Jammu, India.

Uses: Ocimum oil finds diverse uses in the perfumery and cosmetic industries as well as in indigenous systems of medicine.. Among the various *Ocimum* species *Ocimum basilicum* is commercially cultivated for essential oil production. Its oil is employed for flavouring of food stuffs, confectionery, condiments and in toiletry. In the perfumery industry, the oil is used for compounding certain popular perfumes notably jasmine blends. *Ocimum sanctum* (*Krishna thulsi*) recognized as a sacred plant and has innumerable medicinal properties.

Soli and climate: Basil can be cultivated on a wide variety of soils, though moderately fertile well drained loamy or sandy loam soils are considered ideal for its cultivation. The crop comes up well under tropical climate upto an altitude of 1800 m. The growth is poor in areas which receive heavy and continuous rainfall. Frost is harmful to the plant.

Seeds and sowing: The plant is propagated through seeds. Seedlings are first raised in the nursery and then transplanted in the field. The seed rate is about 125 g/ha. 6-10 cm tall the seedlings are transplanted in the field at 40-60 cm spacing in rows.

Manuring: At the time of planting, apply 10-15t farm yard manure. A medium fertilizer dose of 40:40:40 kg/ha of N, P_2O_5 and K_2O is recommended for economic yield though good response has been received upto 120:100:100 kg/ha.

Irrigation: Irrigation is required once a week when it is raised as a summer crop.

After cultivation: The field should be kept weed free for the first 20-25 days. Weeding is usually carried out once or twice.

Plant protection: Leaf spot caused by *Corynespora cassicola*, scab by *Elsinoe arxii* blight caused by *Alternaria species* and *Colletotrichum capsici* are the main disease which occur in the crop. It can be controlled by spraying 0.2% zineb or maneb. Wilt caused by *Fusarium oxysporum* is more pronounced in rainy season. This is controlled by drenching with mancozeb at 0.1%.

Harvesting and processing: Basil is harvested when the plant is in full bloom (9-12 weeks after planting) and lower leaves start turning yellowish. For high quality oil, only the flowering tops are harvested. In some areas it is possible to get four floral harvests. The first harvest is done when the plants are in full bloom and the subsequent ones after every 15-20 days. Floral harvests yield 3-4 tonnes of flowers and the final harvest of the whole plant yields 10-15 tonnes of herb per hectare. Thus two grades of oil are obtained, ie, *flower oil and herb oil*. The flower oil has a superior note and is more expensive. Distillation is carried out for 1-1.5 hours. The young inflorescence contains 0.3-0.5% oil and the whole herb 0.10-0.25%. Generally, an yield of 15-20 kg of flower oil and 10-15 kg whole plant oil is obtained per hectare.

Chemical constituents: Ocimum oil is rich in camphor, citral, geraniol, linalool, linalyl acetate, methyl chavicol, eugenol and thymol

PALMAROSA

Cymbopogon martinii

Family - Gramineae (Poaceae)

Palmarosa is a tall perennial grass, the flowering tops and foliage of which contain a sweet-smelling oil of rose-like odour. In this species, the following two varieties are recognized .*Cymbopogon martinii var. motia* (Palmarosa, Rosha or Russa grass) and *C. martinii var. sofia* (Gingergrass).

Uses: Palmarosa yields superior oil which is used in perfumery, for flavouring tobacco and blending soaps due to the lasting rose note it imparts to the blend.

Soil and climate: Although it grows best on soils having neutral pH, it can survive and give economic yields on alkaline soils of pH upto 9. Motia grass prefers well drained soils. Palmarosa grass is a tropical plant and it grows in warm humid areas. It is susceptible to frost. It doesnot tolerate stagnant water.

Seeds and sowing: It is propagated best through seeds and also through slips. Seeds are sown on nursery beds. Seed rate is 5 kg/ha. Mix seeds with fine sand in the ratio of 1:10 to ensure even distribution and ease of sowing. The beds are watered lightly and regularly. In about 4-6 weeks, seedlings are ready for transplanting. Healthy and established seedlings, about 15 cm tall are carefully removed from the nursery and transplanted in rows, 20-60 cm apart with the plants spaced at 20-60 cm. Spacing can be increased on fertile soils.

Varieties: ODP-2, IW 31245, IW 3629, IW 3244, Trishna

Manuring: Apply farm yard manure at 10 t/ha before planting. Fertilizers at 20 kg N, 50 kg P_2O_5 and 40 kg K_20/ha are given at planting as a basal dose. 40 kg N/ha is applied in two splits during the growing season. The NPK application should be repeated each year at the time of appearance of fresh leaves.

Irrigation: Irrigated at 10-14 days interval during non-rainy periods.

After cultivation: Diuron at 1.5 kg ai/ha and oxyfluorfen at 0.5 kg ai/ha can effectively control weeds.

Plant protection: No serious pests and diseases have been reported in this crop. Leaf blight caused by *Curvularia trifolii* and rot by *Dreschlera cymmartinii* are reported.

Harvesting and processing: Harvest at the initial seed setting stage which is10-15 days after flowering. The grass is cut at a height of about 10 cm from the ground level and the whole plant is used for distillation. During the first year one to three cuttings can be obtained depending upon the climatic conditions. After the first harvest, subsequent harvests can be taken at 70-80 days interval and 3-4 cuttings can be taken a year. The plantation remains productive for 4-6 years. The grass yield is 6-10 tonnes/cut/ha.

Wilt the grass in shade for 24-48 hours before distillation. All parts of the plant contain essential oil, the maximum being present in flowers and the least in the stalks The average oil yield is 125-150 kg/ha/annum though an yield of 250 kg/ha is not uncommon.

Chemical constituents: Motia oil contains upto 95% of geraniol.

PATCHOULI

Pogostemon patchouli

Family - Labiatae (Lamiaceae)

Patchouli is an erect, branched, pubescent aromatic herb.

Uses: The essential oil of Patchouli is one of the best fixatives which is highly valued in perfumes, soaps, cosmetics and flavour industries. Tenacity of odour is one of the great virtues of patchouli oil and is one of the reasons for its versatile use. The oil possesses antibacterial and insect repellent activity.

Soil and climate: A well drained deep loamy soil rich in humus and nutrients, with a loose friable structure and with no impervious hard layer at the bottom is ideal. A pH range of 5.5-6.2 is suitable. Patchouli prefers warm humid climate with a fairly heavy and evenly distributed rainfall of 2500-3000 mm per annum, a temperature of 24-28^{0}C and an average atmospheric humidity of 75%. It grows successfully upto an altitude of 1000 m above MSL. The crop grows well under irrigation in less rainfall areas. Patchouli is a shade loving plant and can be grown as an intercrop in orchards, coconut or arecanut plantations.

Seeds and sowing: The plant is propagated vegetatively by stem cuttings having 4-5 nodes and 15-20 cm length.. Cuttings are prepared from the apical region of healthy stocks. The basal 2-3 pairs of leaves are carefully removed and the cut ends are treated with IBA, IAA or NAA at 500, 1000 or 1500 ppm respectively for better rooting. Cuttings are planted 3-5 cm apart in nursery beds, seed pans or polythene bags. It is important to provide aeration, partial shade and regular watering in order to get early and good rooting. Rooting occurs in 4-5 weeks and they are ready for transplanting in 8-10 weeks. Before transplanting, the field is prepared well and laid into beds of convenient size. Rooted cuttings are transplanted at 40-60 cm spacing and irrigated if there is no rain.

Varieties: Improved varieties commonly cultivated are 'Johore', 'Singapore' and 'Indonesia'

Manuring: Before transplanting the beds are incorporated with organic manure at 12-15 t/ha and N, P_2O5 and K_2O at 25:50:50 kg/ha and leveled. After 2 months, 25 kg N is applied. Subsequently, 100kg N/ha is topdressed in two split doses; the first dose just after the harvest and the other about two months later.

After cultivation: Constant watering, regular weeding and light cultivation after every harvest are essential for proper growth and yield of the crop

Plant protection: The crop is highly susceptible to root-knot nematode, *Meloidogyne incognita*. An integrated approach consisting of crop rotation, application of neem oil cake, carbofuran and systemic nematicide proved effective. Leaf blight caused by *Cercospora* sp. is controlled by spraying 0.5% solution of zineb. Yellow mosaic disease is transmitted by white fly, *Bemisia tabacci* (Gen.). Caterpillar and leaf webber attacks can be controlled by spraying methyl parathion (Sarwar, 1969; Sarwar and Khan, 1972)

Harvesting and processing The crop is harvested when the foliage becomes pale green to light brown and the stand emits a characteristic patchouli odour. The first harvest of the leaves is taken after about 5 months of planting. Subsequent harvests can be taken after every 3-4 months depending on the local conditions and management practices. Harvesting is done in the cool hours of the morning to avoid loss of essential oil. Young shoots of 25-50 cm length which contain at least 3 pairs of mature leaves are cut. In practice, a few shoots are always left unplucked to ensure better growth for next harvest. The crop stands for 3-4 years.

The harvested herb is dried in shade allowing free air circulation for about 3 days. Proper drying is very important for the quality of oil. During drying, the material should be frequently turned over for promoting uniform drying and for preventing fermentation. Completely dried material can be pressed into bales and stored in a cool dry place for sometime. The dried herbage is steam distilled for its oil. Interchange of high and low pressures (1.4 to 3.5 kg/cm^2) produces better yield as more cell walls rupture in this process. Duration of distillation is 6-8 hours. Prolonged distillation gives higher yield and better quality of oil. But if it is distilled for too long, the oil will have a disagreeable odour. The oil yield varies from 2.5 to 3.5% on shade dry basis. On an average, from one hectare we get 8000 kg fresh leaves annually which on shade drying yield 1600 kg and on distillation give 25-40 kg of oil. Patchouli resinoid is also prepared occasionally by extracting the leaves with volatile solvents such as benzene. Such extraction gives 4.5-5.8% of resinoid which contains 70-80% of alcohol soluble absolute.

Chemical constituents

Caryophyllene, -guaiene , -bulnesene, patchouli alcohol and pogostol are some of the important constituents.

ROSE

Rosa damascena

Family - Rosaceae

Rose is a perennial erect shrub with beautiful sweet scented flowers. Out of about 120 species of roses, three species are commercially used for the production of rose oil, namely, *Rosa damascena*., *R. gallica* and *R. centifolia*. *R. damascena* is the most important species with a delicate fragrance from which most of the high grade rose oil is produced.

Uses: Rose oil is one of the oldest and most valuable perfumery raw materials The extracted absolute adds lasting notes. Bulgarian rose oil is used for flavouring certain types of tobacco. Limited quantities of otto are employed in flavouring soft drinks and alcoholic liquors. Rose water and rose jam is used for making syrups and medicinal preparations.

Soil and climate: Roses come up in almost all climates. The plant needs plenty of sunshine and protection from strong winds for proper growth. Humidity above 60% and a temperature of 15-20^{0}C is congenial for plentiful harvest. A temperature of 0-5^{0}C for a fortnight prior to blooming enhances the quality and quantity of flowers. At the time of flowering the temperature should be 25-30^{0}C and the relative humidity 60%. The plant grows on a wide range of soils, but light and well drained soils are considered ideal. Acidic soils inhibit growth and reduce flower yield. Alkaline soils with pH range of 7-9 are quite suitable.

Seeds and sowing: Rose is propagated vegetatively by cutting and budding. Cuttings taken from mature plants in January are planted at a spacing of 10 x 30 cm in a nursery or in poly bags. Treatment of cut ends with 200 ppm IBA induces profuse rooting. The rooted cuttings are ready for transplanting when they are about 9-12 months old. The rooted cuttings are planted in trenches, about 1 m deep and 0.5 m wide, spaced 1 m apart. The trenches are filled with well rotten FYM at 8-10 tonnes/ha. About 10,000 plants are required for planting one hectare of land.

Manuring: Rose is a soil exhausting crop. In addition to the cattle manure a good crop requires 200 kg N as calcium ammonium nitrate, 50 kg P_2O_5 as superphosphate and 30 kg K_2O as muriate of potash per hectare in 2-3 split doses annually.

Irrigation: Rose plants need frequent irrigation during the period of vegetative growth, flowering and just after pruning.

Aftercultivation: Plants are regularly pruned, once or twice a year, for getting higher yield of flowers. October-February is the best time for pruning. Plants should be pruned upto a height of 50 cm from the ground level. It takes 75-90 days for flowering after pruning. Weeding and hoeing should be done after pruning. Generally, 3 weedings and hoeings are required annually. Annual weeds can be controlled by herbicides like simazine or atrazine applied at 3 kg/ha in light soils and 5 kg/ha in medium or heavy soils.

Plant protection: Insect pests of roses are *Macrosiphum rosae* (Aphididae), *Eulecanium caryli* (Coccidae) *Agrilus chrysoderes* (Buprestidae), *Podophylla fulho* (Scarabaedae) and *Rhynchites hungaricus* (Curculionidae). The external feeders can be controlled by the application of mercaptothion 50 EC at 0.1%. The root feeders and borers are controlled by soil application of carbofuran 3G at 1.0 kg a.i. per hectare. Leaf spot is the main fungal disease which can be controlled by regular application of 1% Bordeaux mixture or 0.2% mancozeb.

Harvesting and processing: Rose plants flower during March-April in the plains and May-June on hills. The peak flowering period is about 45 days. Sporadic flowering

may continue throughout the year. Flowers are harvested from 5 a. m. to 9 a. m. in the early morning, when they begin to open. The average yield of flowers is 2000-3000 kg/ha/year.

Rose oil is extracted from the flowers by distillation for 2-3 hours or by extraction with volatile solvents. The flowers can be stored in clean cold water for a period of 3 days without any loss in oil recovery or change in oil quality. The average oil yield is 0.03%. Water distillation is a popular method for obtaining rose water. *Rose attar* is obtained by water distillation of rose flowers and collecting the distillate over sandal wood oil. *Otto of rose* is prepared by the water distillation of rose flowers and redistilling the distillate 2-3 times till it gets saturated with the oil dissolved in it. Then it is chilled and the oil drops floating on the surface of water are removed. The yield of the oil comes to about 0.0045%

Chemical constituents: Rose oil is a colourless liquid, but on aging develops an amber colour. The essential oil contains various alcohols, aldehydes, ketones, esters, phenols, terpenes and acids. The major components are citronellol 38%, paraffins 16%, geraniol 14%, nerol 7%, ß-phenyl ethanol 3%, eugenol methyl ester 3%, linalool 2%, ethanol 2% and farnesol 1%.

ROSEMARY

Rosmarinus officinalis

Family - Labiatae (Lamiaceae)

It is an evergreen dense highly branched herb or undershrub growing upto 1 m in height with lavender-like leaves, and a characteristic aroma.

Uses: Its essential oil is used almost wholly in the perfumery industry in the production of soaps, detergents, household sprays and other such products. It is an excellent fixative material. The oil contributes a strong, fresh odour, which blends well with various other oil odours . It is used as a culinary herb

Soil and climate: It requires light dry soil, preferably lying over chalk. Neutral to alkaline pH is suitable. The plant rosemary comes up well in Mediterranean climate. It is susceptible to frost injury. In cooler areas it can be cultivated in summer season.

Seeds and sowing: The plant is propagated through seeds and vegetatively by cuttings, the latter being generally adopted. The cuttings should be 15 cm long and leaves removed from the basal half portion. The cuttings are put in nursery beds of sandy soil at a depth of about 10 cm. The rooted cuttings are transplanted in rows, 120 cm apart with a plant to plant spacing of 30-40 cm.

Manuring: The main field is prepared well incorporating 10-15t/ha of organic manures. Fertilizers are applied at 100:40:40 N, P_2O_5 and K_2O/ha, N being applied in 4-5 split doses during each year.

After cultivation: Irrigation is needed when the soil is depleted of water during non-rainy period.The field of rosemary is to be kept weed free by regular weeding and hoeing. Intercultivation keeps the soil loose and clean from weeds and promotes proper plant growth and development.

Plant protection: *Phytocoris rosmarini* and *Ortholylus ribesi* are reported to infest rosemary crop.

Harvesting and processing: The shoots are cut for distillation when they have reached their maximum size but before they become woody. The hard wood imparts an undesirable turpentine odour to the essential oil. Harvesting is usually done during May-June. Frequent cutting of the bushes after 2-3 years keeps them free from becoming leggy and promotes the formation of numerous young shoots.

Freshly harvested twigs and leaves are steam distilled to obtain the essential oil of rosemary. Steam distillation at 2-3 times atmospheric pressure gives an oil yield of 1.0-1.5% of freshly harvested plants and 1.5-2.5 % of dried leaves.

Chemical constituents: The essential oil contains chemical components as -pinene 7-24%, camphene 3-9%, 1,8-cineole 15-20%, p-cymene 2-3.7%, linalool 14-17% as major components.

SANDALWOOD

Santalum album

Family - Santalaceae

The term sandalwood, in the world market, is frequently used for a variety of woods that yield oils similar in smell to that of the *East Indian Sandalwood* which is the *true sandalwood*. The East Indian Sandalwood is a small evergreen tree with slender drooping branches. Sandal tree is a plant parasite and its roots thrive on many types of host plants such as *Cassia siamea, Pongamia pinnata, Lantana acuminata, Cajanus cajan,* etc.

Uses: Sandalwood oil is used primarily in perfumery because of its outstanding fixative properties. It is used in preparing all types of perfume compositions especially Indian attars like Hina, Gulab, Kewda and Jasmine in which the natural essential oils from distillate of floral distillation is absorbed in sandalwood oil. With neem oil, it is used as contraceptive. It is used for healing wounds and blisters caused by the smallpox vaccination. Sandalwood is also one of the finest woods for carving. The wood is smooth with uniform fibres. Saw dust from heartwood is mostly used in incense for scenting cloths and cupboards.

Soil and climate: Warm tropical climate is best suited to sandalwood tree. It grows best between altitudes of 600 m and 1350 m above MSL though it may grow between 360 m and 1850 m altitude. Annual rainfall of 600-1600 mm is ideal for its growth. More than 1800 mm of rain is not very conducive to its growth. It grows well on laterite soils on the slopes of hills exposed to the sun.

Seeds and sowing: The plant is propagated through seeds. Barring a few tissue culture attempts, vegetative propagation has not been very successful. Seeds are obtained from plants over 20 years old. Fresh seeds obtained from October fruiting are depulped, dried and sown on seed beds. Gibberellic acid is used to bring down the dormancy period and to induce quick and uniform germination. After germination, seeds are put in polybags of size 15 cm x 25 cm. A host plant is sown in the polybag when the seedling reaches 15 cm in height. The optimum stage for planting is when the seedlings are 25-50 cm high and the basal portion becomes darker. Pits of 30-50 cm cube are dug and the sandal seedlings along with the host seedlings are planted from May to October at 2.5-4.0 m spacing.

Aftercultivation: Weeds are removed as and when necessary. In case the sandalwood seedlings are overtopped by the host plant the host is lopped to provide sufficient light to the seedlings. The heartwood formation is at its peak when the trees are 30-60 years and the trees attain a girth of 40-60 cm.

Plant protection: Sandal spike disease transmitted by the aphid *Jassus indicus* (Aphididae) is reported to be caused by mycoplasma-like organisms which causes severe reduction in leaf size and shortens internodes. As a prophylactic measure, any contact insecticide may be sprayed to control the vector.

Harvesting and processing: As the roots are richest in oil, sandalwood tree is harvested by uprooting and not by cutting to avoid the loss of root system.

Sandalwood oil is obtained chiefly by steam distillation of the powdered wood soaked in water for about 48 hours. Distillation is carried out at a steam pressure of 1.4-2.8 kg/cm^2 for 48-72 hours. The oil content is about 10% in the roots and 1.5-2% in the chips which constitute a mixture of heartwood and sapwood. The yield from the heartwood varies with maturity and locality.

Chemical constituents: The major constituents of sandalwood oil are reported to be -santalol 60%, ß-santalol 30%, ß-santalene, ß-curcumene, ß-farnesene, santene,

santenol, santenone, teresantalol, teresantalic acid, santalic acid, nor-tricyclockasantalol, borneol and isovaleraldehyde

THYME

Thymus vulgaris

Family - Labiatae (Lamiaceae)

Commercial supplies are derived from *Thymus zygis* (*white thyme*) and *T. vulgaris* (*garden thyme*). The demand for garden thyme is more and hence commonly cultivated. *Thymus serpyllum* and *T. satureioides* are wild species

Uses: The essential oil of the plant has a powerful fresh odour masking other unpleasant smells. This plant is extensively used as a pot herb in cooking, perfumery and in liquor distillery. Thyme oil finds its major use in the perfumery industry in soap and detergent work. Thymol has a powerful medicinal odour and finds more applications in flavours than in perfumes. Owing to the presence of thymol the oil shows germicidal properties and is effective against a variety of pathogenic bacteria. It is employed in dental preparations, oral hygiene products, vermifuges and antigastro-intestinal products. In aromatherapy, garden thyme is regarded as one of the most important elements because of its antiseptic properties. The essence is effective in treating whooping cough as well as parasitic infestations. The dried leaves and floral tops constitutes the thyme of commerce known as *Thymi Herba* in pharmacy. Dried flowers and leaves are used to preserve linen from insects and to impart characteristic smell.

Soil and climate: Light loamy fertile and calcareous soils are suitable. On heavy wet soils, the leaves become less aromatic. The plant grows best in a warm humid climate at an elevation of 1500-4000 m from MSL.

Seeds and sowing: Thyme is propagated by divisions of the old plant cuttings, layering or by seeds. Cuttings and layers are prepared during summer months. Seeds are sown on well prepared nursery beds. Seedlings are very small and remain inconspicuous for several weeks after germination. Planting of rooted cuttings, layers or transplanting of seedlings is done during late summer at a spacing of 30-45 cm between plants and 60 cm between rows.

After cultivation: In autumn, a light dressing of farm yard manure is given. Fertilizers are applied at 100:40:40 kg N, P_2O_5 and K_2O/ha. Top dressing of N in the spring promotes the formation of numerous leafy shoots. Irrigation is given when warranted. The field is to be kept weed free.

Plant protection: Not much pests and diseases are reported in this crop.

Harvesting and processing About 15 cm long shoots, in the early flowering stage, are harvested during May-June. The lower portions of the stem, together with any yellow or brown leaves are rejected.

The harvested herb is transported to the drier immediately. Alternatively, on a smaller scale, the herb can be tied in small bunches and hung on to dry in the sun or in a well ventilated shed or room. The dried flowering tops are steam distilled to get the thyme oil. On an average, the oil recovery is 2%.

Chemical constituents The chemical composition of the oil is reported as p-cymene 15-50%, linalool 3-13%, borneol 2-8%, carvacrol 0-20%, thymol 5-60%, ß-pinene 4.6-4.7%, limonene + 1,8-cineole 35.7-44.4%, camphor 11.6-16.3% etc.

TUBEROSE

Poliyanthes tuberosa

Family - Amaryllidaceae

Tuberose occupies a very special position because of its prettiness, elegance and sweet pleasant fragrance.

Uses: This bulbous plant is the source of tuberose oil of commerce which is very expensive and used in high grade perfumery. It is also cultivated for cut flowers and for preparing bouquets and garlands.

Soil and climate: Although tuberose can be grown under a wide range of climatic conditions, a mild climate with an average temperature ranging from 20^0C-30^0C is considered ideal. Loam and sandy loam soils having a pH range of 6.5 to 7.5 with good aeration and drainage are best suited for its cultivation

Seeds and sowing: The plant is propagated by bulbs. Spindle shaped disease free bulbs having a diameter of 1.5-3.0cm are used for planting. Mother bulbs are the best for planting as they flower early. Finger or side bulbs take 2-3 years to come to flowering. Best time of planting is from May to July. Land is ploughed 2-3 times and soil is brought to fine tilth. Well-rotten FYM is applied and mixed well. Furrows are opened 25-30 cm apart and bulbs are planted at 25 cm spacing in furrows. About 1.25 lakhs (800-900 kg) of bulbs are required for planting a hectare of land.

Varieties: (i) Single petal: most widely cultivated. Flower is pure white and has got a single row of corolla segments. Eg. 'Calcutta single', 'Mexican single', 'Rejat Rekha' and 'Suvarna Rekha'. (ii) Double petal: Petals are in several whorls. Eg. 'Pearl' and 'Calcutta double' (iii)Semi-double: Similar to double but with only 2-3 rows of corolla segments.(iv) Variegated: This has got variegated leaves with yellow margins.

Of the 4 types, the single type has the maximum fragrance and is popular among the growers for the production of essential oil.

Manuring: FYM at 20-30 t/ha is incorporated into soil before planting. A fertilizer dose of 100:200:200 kg N, P_2O_5, K_2O/ha is generally recommended. Half the dose is applied basally and the other half as topdressing when the flower spikes start appearing.

Aftercultivation: Weekly irrigation and regular weeding are required for best yield. Thrips are reported to attack the crop.

Plant Protection : The lily caterpillar, *Polytela gloriosa* (Noctuidae) and the leaf web worm, *Nausinoe geometralis* (Pyralidae) are the two serious pests which can be controlled by the spray application of any contact insecticide of low mammalian toxicity.

Harvesting and processing: The flowering season is between June and October. Flowers will be ready for harvest in 3-3.5 months time. They are harvested by cutting the fully opened spikes from the base during the cool hours of the day either in the morning or evening. From single planting 2-3 ratoons can be taken for which the flower stalks of the main crop are headed back and the plot is manured and irrigated. The average yield comes to 5-10 tonnes/ha for planted crop, 9-12 tonnes/ha for first ratoon and 4-6 tonnes/ha each for subsequent ratoons.

Tuberose is one of those plants, the flowers of which continue to develop their natural fragrance for some time after they have been harvested. The flower oil is extracted by enfleurage and solvent extraction with petroleum ether. Freshly picked flowers, before they open are enfleuraged. About 150 kg of flowers yield 1 kg of absolute of enfleurage which contains 11-15% of steam volatile oil. Extraction of

tuberose flowers with petroleum ether yields 0.08-0.14% of concrete. The concrete contains 3-6% of a steam volatile oil.

Chemical constituents: The chemical constituents of tuberose flower oil include geraniol, nerol, farnesol, benzyl alcohol, methyl benzoate, benzyl benzoate, methyl salicylate, methyl anthranilate, eugenol and butyric acid.

VANILLA

Vanilla fragrance

Family - Orchidaceae

Vanilla is an orchid, belonging to the family Orchidaceae. The genus *Vanilla* comprises over 100 species of stout, scandant, terrestrial or epiphytic herbs. But only three are important source of vanillin. They are *Vanilla frangrance* (Salisb.) Ames syn. *V. planifolia* Andrews, *Vanilla pompona* Schiede .(West Indian vanilla), *V. tahitensis* J.W.Moore (Tahitian Vanilla). *Vanilla fragrance* is the most popular and commercially cultivated species. It is a climber grown as wild in the forests, aerial roots are seen in nodes by means of which the plant clings and climbs.

Uses:- Its fruits, commercially known as beans, become aromatic on curing due to the development of an aromatic principle called vanillin. Vanilla is an important spice. Vanilla beans and derivatives are important in food flavouring, especially, confectionery, ice-creams, liquors and baked goods. Vanilla flavoured ice-creams, custards, milk shakes, cakes, puddings, chocolates, beverages and different confectioneries are very popular in the market. Vanilla is also used in perfumery and to a smaller extent in medicine. Nowadays, synthetic vanillin, which is cheaper and more convenient, is often used instead of vanilla. The aroma of genuine vanilla, however, cannot be matched because it is the result of the natural balance of vanillin and small quantities of other aromatic components contained in the pods.

Soil and climate:-Vanilla is adaptable to a wide range of soil types provided there is plenty of organic matter and proper drainage. It prefers a pH range of 6-6.5.It prefers humid moist tropical climate having temperature range of 25-32 ^{o}C. It grows well at an elevation of 700 – 1500 m with an annual rain fall of 2500 mm well distributed for a period of 9 months and a dry period for 3 months.

Seeds and sowing:-Vanilla is generally propagated by stem cuttings. Vines of 60-120 cm long are selected as planting material. The vines are coiled and buried inside the soil. Plants raised from lengthy cuttings commence early flowering whereas the plants raised from short cuttings take three to four years for bearing. Therefore, cutting with less than 5-6 internodes and 60 cm length may not be used for planting. As the availability of planting materials is a limiting factor, recently tissue cultured planting materials are made available by some private companies and spices board.

Vanilla requires support for growing. It flourishes well in partial shade. Vines may be trained on trellises or trees having low branching with a rough and small leaves. Trees like *Jatropha, Plumeria alba, Casuarina equisetifolia, Erythrina, Glyricida, Bauhinia* or Silver oak are now used for this purpose. The supports are planted at a spacing 2.5 to 3.0 m between rows and 2m within the row making a population of 1600 to 2000 per hectare. If limb cuttings are used for planting, they should have roughly 4-6 cm diameter and about 1.5 to 2 m length. The supporting saplings may be established 6 months before planting vanilla cutting. Vanilla is generally planted at a time when there is a slight wetting weather. While planting the cuttings, 3-4 basal leaves in the cutting should be removed and this defoliated portion is laid on the loose soil and covered with a thin layer of about 2-3 cm soil. The growing end is gently tied to the support for climbing by aerial roots. Artificial shade with any suitable material may be provided to the cuttings. It makes 4-8 weeks for the cutting to strike roots and to show initial signs of growth.

After cultivation:-Once established, the vines have to be given constant attention. Any operation done in the plantation should not disturb the roots, which are mainly confined to the mulch and surface layer of the soil. When the support is grown up

they are pruned early to introduce branching so as to give more shade and protection to the growing vines. If the trees are evergreen types they are to be pruned before the commencement of heavy rain to allow in more sunlight. If the vine is permitted to grow up on tree, it will rarely blossom, so long as it is growing upward . Hence the vines are allowed to grow up to 1.50 m and then tied horizontally on the branch of support and later coiled round them. This induces more flower production in this portion of the vine.

Manuring:- The pruned vegetation is chopped and applied as mulch in the plantation. The decomposed mulch is the main source nutrients to vanilla. Animal sources of manure are not generally applied. Annually, vine may be fed with 40 to 60 g N, 20 to 30 g P_2O_5 and 60-100g K_2O. The above quantity may be given in two or three splits for efficient uptake. Part of the above fertilizers may also give through foliar spray since they respond well to it.

Plant protection:-Anthracnose (*Calospora vanillae*) is the most serious disease. It attacks almost all parts. Root rot, *Fusarium betatis* var. *vanillae* is a limiting factor in certain areas. They can be controlled by spraying/drenching with 1% Bordeaux mixture. The bug, *Trioza litseae* is the major pest attacking the buds and flowers of vanilla, which is controlled by any systemic insecticide.

Harvesting:-The vines commence flowering in the second or third year depending on the length of cutting used. Due to the peculiar structure of the flower described earlier artificial pollination by hand is the rule of fruit setting. Using a pointed bamboo splinter or pin anther is pressed against stigma with the help of thumb and thus smearing the pollen over it. Generally, 85-100% success is obtained by hand pollination. The ideal time for pollination is 6 am to 1 pm. Unfertilized flowers fall off within two or three days. Normally 5-6 flowers per inflorescence and a total of not more than 10-12 inflorescence per vine are pollinated. The excess flower buds are nipped off to permit the development of good pods. Pods take six weeks to attain full size from fertilization and 4 to 10 months to reach full maturity depending upon the locations. When immature, the bean is dark green in colour, but when ripe yellowing commences from its distal end. This is the optimum time for harvesting the bean. If left on the vine the bean turns yellow on the remaining portion and start splitting, giving out a small quantity of oil, reddish brown in colour, called *the balsam of vanilla*. Eventually they become dry, brittle and finally become scentless.

The yield of vanilla varies depending upon the age of vines and the method of cultivation. Normally it starts yielding from the third year and the yield goes on increasing till the seventh or eighth years. Thereafter, it slowly declines till the vines are replanted after 14 to 15 years. Under reasonable level of management a middle aged plantation may yield 300-400 kg cured beans per hectare .

Processing:-Artificial methods are employed to cure vanilla. The aroma principle, vanillin is developed as a result of the enzyme (Beta Glucosidase) action on the glucosides contained in beans during the process of curing. Basically any curing method involves the following four stages.

1. Killing the vegetative life of the beans to allow the onset of enzymatic reaction.
2. Raising temperature to promote this action and to achieve rapid drying to prevent harmful fermentation.
3. Slow drying for the development of different fragrant substances
4. Conditioning the product by storing for few months.

The following are some of the curing methods

1) Peruvian process: Curing is done by hot water. In this process the pods are dipped in boiling water. The ends are tied and hung in the open. They are allowed to dry

for 20 days. Later they are coated with castor oil and afterwards tied up in bundles.

2) Guiana process: The pods are collected and dried in the sun till they shrivel. Later they are wiped and rubbed with olive oil. The ends are tied up to prevent splitting and then bundled.
3) Mexican process: The harvested pods are kept under shade till they shrivel. Then they are subjected to sweating. This operation is carried for 2 days depending on the weather conditions. In warm weather, pods are spread over blankets and exposed to the sun. During midday the blanket is covered over and bundles are left in the open for rest of the day. They are wrapped in blanket in the night to maintain fermentation and sweating. The pods would be wrapped in blankets when they are hot to touch. This process is repeated for 7-12 days till they become dark brown in colour, soft and flexible. They are packed in tins and sealed. The Mexican process yields 4.15 to 4.40 % of vanillin content.

When the weather is cloudy, the pods are bundled in bales and wrapped with woollen cloth covered with banana leaves. They are subject to radiation of heat by maintaining the temperature of air-oven at $50^{o}C$ for 24 hours. Thereafter, they are dried to change the colour. Then they are spread in dry place and finally packed and sent to the market.

a) The beans are cut into small pieces and are extracted with dilute alcohol which the gives the flavouring extract or vanilla essence.

Chemical constituents:-The cured vanilla beans contain vanillin, organic acids, fixed oil, wax, gum, resins, tannins, pigments, sugar, cellulose and minerals. Vanillin content of cured seed is about 2.41%. The essential oil contains aromatic carbonyls, alcohols, acids and esters.

VETIVER

Vetiveria zizanioides

Family - Gramineae (Poaceae)

Vetiver, Vetivert, Khus or Khuskhus is a densely tufted, wiry, glabrous perennial grass. It is having much branched fine roots contain a fragrant oil, which is a perfume by itself. Vetiver oil enjoys world wide reputation as one of the finest aromatic oils

Uses: Vetiver oil is light brown to deep brown in colour with a characteristic aroma and persistent odour of sweet woody note. It is used in perfumery as a fixative. It is also used for the extraction of vetiverol, vetiverone and vetiveryl acetate which are widely used aroma chemicals. The aromatic roots of vetiver are cleaned, dried and used for making mats, fans, screens, pillows and sachet bags. The plant has gained much recognition as one of the best soil binders and is being used to check soil erosion.

Soil and climate: The plant is sufficiently hardy and grows on almost all types of soils. Light soils, however, should be avoided as the roots obtained produces very low percentage of oil. Red lateritic soils with abundant organic matter are considered ideal as the roots produced are thick and contain more essential oil. Heavy soils make harvesting of the roots difficult, with a loss of the finer roots which contain most of the oil.

Khus prefers tropical and subtropical climate. It grows luxuriantly in places upto an altitude of 600m, with an annual rainfall of 1000-2000mm, day temperature ranging from 21-44^{0}C and with moderate humidity.

Seeds and sowing: The grass is capable of both vegetative and sexual reproduction. It is generally multiplied vegetatively through slips. Trim the fibrous roots and leaves from the slips and plant on raised beds at a spacing of 30-60 cm

Varieties: ODV-3, Pusa hybrid-7, hybrid-8, KS-2 and Sugantha

Manuring: Normally, vetiver crop is not fertilized on fertile soils. Farm yard manure or compost is applied at 10-15 tonnes/ha at the time of land preparation. On poor soils N, P_20_5 and K_2O may be applied each at 25-50 kg/ha. Apply N in 2-3 split doses.

Irrigation: In areas where rainfall is good and well distributed and humidity is high, irrigation is not necessary. In other areas 8-10 irrigations are required.

After cultivation: 2-3 weedings at an interval of about a month are needed during the initial period of plant growth. Earthing up after weeding is beneficial to the crop.

Plant protection: Leaf blight caused by *Curvularia trifolii* and *Fusarium* wilt affect the growth and yield of the crop, which can be controlled by repeated spraying of any copper fungicide and drenching with copper oxychloride or 1% Bordeaux mixture.

Harvesting and processing: In general, the crop is harvested after 18 months during the dry season from December to February by digging out the bush along with its roots manually. The length of the roots varies from 10-35 cm. The roots are separated from the plants, washed to remove the adhering soil and dried under shade for 1-2 days which improves the olfactory quality of the essential oil. Prolonged drying in the sun reduces the oil yield. The root yield is 3-5 tonnes/ha.

The roots can be crushed and cut into pieces before distillation. As the most valuable quality constituents are contained in the high boiling fractions, the roots must be distilled for a prolonged period ranging from 24 to 48 hours. The oil recovery

from fresh roots is 0.8-1.2% depending upon the duration of distillation. On an average 15-25 kg oil is obtained per hectare per crop.

Chemical constituents: The oil contains more than 150 complex compounds including elemol, 10-epi-eudesmol, ß-eudesmol, vetiverol, cyclocopacamphenol, vetiselinenol, khusimol , ß-vetivone, vetiverone, vetiveryl acetate etc.

YLANG YLANG
Cananga odorata* var. *genuina
Family - Anonaceae

The tree *Canaga odorata* occurs in two forms viz. *macrophylla* and *genuina* . On steam distillation of the flowers of the form macrophylla yields oil of cananga while the form genuina yields oil of ylang ylang.

Uses:-Oil of ylang ylang is highly appreciated in perfumery because of its delightfully sweet and strong odour.

Soil and climate:- The tree grows well in rich volcanic soils or fertile Sandy loams. It requires a moist tropical climate. It grows well in rich volcanic soils or fertile Sandy loams.

Seeds and sowing:- Propagation is largely by seeds. The seeds are sown in a seedbed in the month of March. After 3-4 months, the seedlings are planted in a polythene bag and watered frequently. 4-6 months old seedlings are planted in the main field at a spacing of 6m x 6 m.

After cultivation:- The plants are to be shaded in summer months. After 2 years the first bunches of flowers appear. By the beginning of the third year, the trees would have achieved a height of 2 - 3 m and then topped. This removal epical dominance encourages side shoot formation into lateral branches. Periodic pruning has to be under taken to prevent growth of the tree beyond 2-3 m height. Commercial production of flowers starts from the fourth year of planting. The economic life span goes up to 25 years for a well managed plantation. No serious pest or diseases is noticed in the plant.

Harvesting and processing:-Though the tree flowers through out the year three main flowering season are seen for commercial production of the oil. The principal season is immediately after the rainy season, a moderate harvest season during the dry season and those during the rainy season. The flowers contain more essential oil during the night, particularly just before the day break, and hence harvesting is done during the early morning hours. Flowers are manually harvested and only the fully developed yellow flowers are gathered. Great care is to be taken not to crush the flowers during harvest.

The flowers should be immediately distilled for oil since the flowers tend to fade and ferment on keeping. On an average 7-10 kg flowers are harvested per tree per year.

The first fraction of the oil contains most of the aromatic constituents of the oil such as esters and ethers, whereas the later fractions consist chiefly of sesquiterpenes which have little odour value. In the retort water is taken and heated to about $70^{o}C$ and then flowers are quickly put into the retort. Distillation is started slowly by carefully injecting live steam through the perforated steam coil. The volatile oil distils out easily and the first fraction which consists chiefly of esters and ethers are collected in the oil separator. After a while the direct steam is shut off, distillation being continued by heating with indirect steam. The fractions are cut according to specific gravity into extra (0.955), first(0.942), second (0.922) and third fractions (0.910 -0.912). The distillations continued for a period of about 18 - 22 hours. The yield of oil ranges from 2 - 2.5%.

The first fraction is the true oil of ylang ylang and the other fractions resembles the oil of cananga.

AMBRETTE

Abelmoschus moschatus

Family-Malvaceae

San: Latakasturika Hin, Guj, Ben: Mushkdana Mal: Kasthurivenda Mar: Kasthuri- bhendi Tel: Kasturi benda Tam: Varttilaikasturi Kan: Kasturi bende Ass: Gorukhiakorai

Abelmoschus moschatus Medicus syn. *Hibiscus abelmoshus* Linn. also popularly known as musk or Muskmallow, is an erect annual herb which yields musk-like scented seeds and woos everybody through its sensuous musky fragrance

Uses: Every part of this medicinal plant is used in one or the other way. Seeds are effective aphrodisiac and antispasmodic, and used in tonics. They check vomiting and are useful in treating intestinal disorders, urinary discharge, nervous disorders, hysteria, skin diseases etc. Flower infusion is contraceptive. Ambrette oil of commerce is extracted from the seeds and is used in perfumery, flavouring, cosmetic and agarbathi industries. The aromatic concrete and absolute, extracted from seeds are used as base material for preparing high grade perfumes, scents and cosmetics.

Soil and climate: Ambrette is a hardy plant, which can be grown in varied climate under tropical and subtropical conditions. It can be grown both as a rainfed crop and as an irrigated crop. It grows on well-drained loamy and sandy loam soils. Loamy soils with neutral pH and plenty of organic matter are ideal for its cultivation.

Seeds and sowing: It is propagated through seeds. The optimum time of sowing is June-July with pre-monsoon showers. The land is prepared well by ploughing, harrowing and levelling. Ridges and furrows are formed giving a spacing of 60 - 100 cm. Seed rate is 2-3 kg/ha. Seeds are soaked in water before sowing for 24 hours. Two to three seeds are sown per hole at 60 cm spacing on one side of the ridge at a depth of 1 cm and covered with a pinch of sand or loose soil. It takes 5-7 days for proper germination. After germination, extra seedlings are thinned out leaving one healthy growing plant per hole within 20 days.

Manuring: Well decomposed FYM or compost is incorporated into the soil at 10 - 15 t/ha. Fertilisers are applied at 120:40:40 kg N, P_2O_5, K_2O/ha. However, a dose 160:80:80 kg/ha is recommended for best yields of seed and oil. Phosphorus is applied fully as basal. N and K are applied in 3 equal doses at planting, 2 and 4 months after planting. Fertilizers are applied 10 cm away from the plants.

Irrigation: For irrigated crop, field is irrigated soon after sowing. Irrigation is given twice a week during the initial period and once a week thereafter. The field is kept weed free by regular weeding during the growing period

Plant protection: Musk plants suffer from pests like spider mites, fruit bores and leaf eating caterpillars. Diseases like powdery mildew and wilt are also observed on the plant. Spider mites and powdery mildew are controlled by spraying 30g wettable sulphur in 10 litres of water. Pod borers can be controlled by spraying 20ml oxydemeton methyl in 10 litres of water.

Harvesting and processing: The crop starts flowering about 75 days after sowing. The flowers set into fruits in 3-4 days and the pods take nearly a month to mature. Flowering and fruit setting extends from October to April. Harvesting is arduous. Fruits have to be plucked as soon as they attain black colour; otherwise, they split and seeds scatter. Therefore, weekly collection of pods is necessary and in all 20-25 pluckings may be required as it is a 170-180 days duration crop. The fruits are further dried and threshed to separate seeds. The seed yield is 1-1.5t /ha

. The oil is extracted from seed by steam distillation followed by solvent extraction. The concrete of solvent extraction is further extracted with alcohol to get the absolute, that is, the alcohol soluble volatile concentrate.

Chemical constituents: *The fatty oil of seeds contain the phospholipids : 2- cephalin, phosphatidylserine and its plasmalogen and phosphatidyl choline plasmalogen. Absolute contains farnesol and ambrettolic acid lactone. b- sitosterol and its b- d- glucosides are isolated from leaves. Petals contain b-sitosterol, flavonoid myricetin and its glucoside. Anthocyanins like cyanidin - 3 - sambubioside and cyanidin - 3 - glucoside are present in the flowers.*

ASPARAGUS

Asparagus racemosus

Family- Liliaceae

San, Mar, Hin, Mal: Satavari; Ben: Shatamuli, Guj: Ekalkanto, Tel: Pilligadalu, Philithaga Tam: Ammaikodi, Kilwari, Kan: Aheruballi, Ori: Manajolo

Apart from *Asparagus racemosus* Willd. *Asparagus adscendens* Roxb., *A. filicinus* Lam., *A. gonoclados* Baker, *A. officinalis* Linn. and *A. sarmentosus* Willd. are the other important medicinal plant species of the genus. *A. racemosus* Willd. is an armed climbing undershrub with woody stems and recurved or rarely straight spines.

Uses: Tuber is demulcent, diuretic, aphrodisiac, tonic, alterative, antiseptic, antidiarrhoeal, glalctogogue and antispasmodic. Aerial part is spasmolytic, antiarrhythmic and anticancer. Bark is antibacterial and antifungal. It is an excellent safe herbal medicine for ante-natal care. In Ayurvedic classics it is prescribed as a cooling agent and uterine tonic. It is the main ingredient in ayurvedic medicines like *shatavari gulam* and *shatavari ghrtam*. Besides quenching thirst, its root juice helps in cooling down the body from summer heat, curing hyper-acidity and peptic ulcer. It contains good amount of mucilage which soothes the inner cavity of stomach. It relieves burning sensation while passing urine and is used in urinary tract infections. It contains an anticancer agent asparagin which is useful against leukaemia. It also contains active antioxytoxic saponins which have got antispasmodic effect and specific action on uterine musculature. It is very good relaxant to uterine muscles, especially during pregnancy and is used to prevent abortion and pre-term labour on the place of progesterone preparations. Its powder boiled with milk is generally used to prevent abortion. It increases milk production in cows and buffaloes. Its preparations in milk helps in increasing breast milk in lactating women. Its proper use helps in avoiding excessive blood loss during periods. It clears out infections and abnormalities of uterine cavity and hence it is used to rectify infertility in women. The plant has also ornamental value both for indoor and out door decorations

Soil and climate: *Fertile moist sandy loam soils are ideal for its cultivation though it grows in a wide range of soils. Better root development is observed in soils in increased proportion of sand. However, a decline in the yield of the crop is noticed in soils containing previous year's residue of the roots.*

The plant comes up well under a wide range of tropical and subtropical climate. Asparagus plant is best grown from its tuberous roots even though it can be successfully propagated through seeds. Since root tubers are of commercial value seed propagation provides economic advantage to the farmers. Seeds usually start germinating after 40 days and average germination is 70%

Seeds and sowing:-For the cultivation of the crop, the land is ploughed well with pre-monsoon showers and seed nurseries are raised on seed beds of approximately 1m width, 15cm height and suitable length. Seed nursery should be irrigated regularly and kept weed free. With the onset of monsoon in June-July the main field is ploughed thoroughly and pits of size 30cm cube are dug at a spacing of 60-100cm.

Manuring:-The pit is filled with a mixture of top soil and well decomposed FYM or compost applied at 10 - 15 t/ha and the seedlings are transplanted. Application of N, P_2O_5 and K_2O at 60:30:30 kg/ha increases the root yield.

Afercultivation:- Regular irrigation and weeding are required to realize higher yields. Standards are to be provided for training the plant. Few pests and diseases are observed on this crop.

Harvesting:- Harvesting the crop after two years provided higher root yield than annual harvests in pots as well as in field experiments. Irrigating the field prior to harvest enables

easy harvesting of the root tubers. The average yield is 10 - 15 t/ha of fresh root tubers though yields over 60t/ha have been reported.

Chemical constituents: *Asparagus roots contain protein 22%, fat 6.2%, carbohydrate 3.2%, vitamin B 0.36%, vitamin C 0.04% and traces of vitamin A. It contains several alkaloids. Alcoholic extract yields* asparagin- *an anticancer agent. It also contains a number of antioxytocic saponins like Shatavarisn. Leaves contain rutin, diosgenin and a flavonoid glycoside identified as quercetin - 3 - glucuronide. Flowers contain quercetin hyperoside and rutin. Fruits contain glycosides of quercetin, rutin and hyperoside while fully ripe fruits contain cyanidin - 3 - galactoside and cyanidin - 3 - glucorhamnoside.*

BAEL

Aegle marmelos

Family-Rutaceae

San: Bilva, Sriphal : Hin, Mal: Koovalam Tam: Vilvam

Aegle marmelos (Linn.) Corr.ex Roxb. belongs to the citrus family. The golden coloured bael fruit resembles a golden apple and hence the generic name *Aegle*. Bael or Bengal quince is a deciduous sacred tree, associated with Gods having useful medicinal properties.

Uses: Every part of the tree is medicinal and useful. The roots are used in many ayurvedic medicines for curing diabetes and leprosy. It is an ingredient of the '*dasamoola*'. The Bark is used to cure intestinal disorders. Leaves contain an alkaloid rutacin which is hypoglycaemic. Leaves and fruits are useful in controlling diarrhoea and dysentery. Fruit pulp is used to cure mouth ulcers as it is one of the richest natural source of riboflavin (1191 units/100g). *'Bael sharbat'* is prepared by mixing the fruit pulp with sugar, water and tamarind juice, which is very useful for stomach and intestinal disorders. The rind of the fruit is used for dyeing and tanning. The aromatic wood is used to make pestles in oil and sugar mills and also to make agricultural implements

Soil and climate: Bael comes up well in humid tropical and subtropical climate. It grows on a wide range of soils from sandy loam to clay loam.

Seeds and sowing: The plant is propagated mainly by seeds and rarely by root cuttings. Seeds are freshly extracted from ripe fruits after removing the pulp and then dried in sun. Seeds are soaked in water for 6 hours and sown on seedbeds, which are covered with rotten straw and irrigated regularly. Seeds germinate within 15-20 days. One month old seedlings can be transplanted into polybags which can be planted in the field after 2 months. Budded or grafted plants as well as new saplings arising from injured roots can also be used for planting. Grafted plants start yielding from the 4th year while the trees raised from seeds bear fruits after 7-10 years. Vegetative propagation by patch budding is economical. Planting is done in the main field with onset of monsoon in June-July at a spacing of 6-8m. Pits of size 50 cm^3 are dug. Pits are filled with a mixture of top soil and 10kg of well decomposed FYM and formed into a heap. Seedlings are transplanted in the middle of the heap and mulched.

Varieties: North Indian varieties are preferred to South Indian types for large scale cultivation. Twelve varieties are cultivated in North India for their fruits. *Kacha, Ettawa, Seven Large, Mirsapuri* and *Deo Reo Large* are varieties meant specially for '*Sharbat*'. Some improved selections are NB-4, NB-5,NB-9

Manuring: Chemical fertilisers are not usually applied. However NPK recommended is 480g N-320 g P and 480 g K/tree/year.The dose of organic manure is increased every year till 50-80 kg/tree of 5 years or more.

Irrigation: Regular irrigation is required during early stages of growth once established, light irrigation should be given after manuring and fertilisation and proper soil moisture may be maintained after fruitset.

After cultivation:- Regular weeding is required during early stages of growth.

Plant protection:- No serious pests and diseases are noted in the crop.Fruit canker precaution should be taken so that fruit is not hurt during plucking,also during transportation ,the fruit should be packed tightly.

Harvesting and processing:- Bael tree flowers during April. The flowers are aromatic with pleasant and heavenly odour. The fruits are set and slowly develop into mature fruits. Fruits are seen from October-March. A single tree bears 200-400 fruits.Fruits are usually packed in gunny bags, baskets or woodencrates using newspaper as cushioing material.

Roots can be collected from mature trees of age 10 years or more. Tree is cut down about 1m from the ground. The underground roots are carefully dug out. Roots with the attached wood is then marketed .

Chemical constituents: Roots and fruits contain coumarins such as scoparone, scopoletin, umbelliferone, marmelosin and skimmin. Fruits, in addition, contain xanthotoxol, imperatorin and alloimperatorin and alkaloids like aegeline and marmeline identified as N-2-hydroxy-2-[4-(3',3'-dimethyl allyloxy) phenyl] ethyl cinnamide. Roots and stem barks contain a coumarin - aegelinol. Fruit pulp is a rich source of carbohydrate, protein, fat, fibre, minerals and vitamin B and C.

BAUHINIA

Bauhinia variegata
Family-Caesalpiniaceae

San: Kancanarah, Kovidarah; Hin: Kancanar; Mal: Mandaram, Chuvannamandaram, Malayakatti, Kongu, Kongumandaram;

Uses: In traditional medicine, Bauhinia is extensively used in glandular diseases and as an antidote to poison. The drug is also reported to be useful in dysentery, diarrhoea, piles and worms. Seeds possess human blood agglutinating activity. Stem bark is hypothermic, CNS active and depressant. Bud, flower, leaf and stembark are antibacterial. Stem possesses juvenoid activity. Bark is alterative, tonic, antileprotic and antirheumatic. Root is carminative and antidote for snakebite.

Seeds and sowing: Well-drained hilly areas are ideal for the cultivation of Bauhinia. The plant is seed propagated. Seeds are formed in February-March. Seeds are to be collected from the dried pods, soaked in water for 12 hours before sowing in seedbeds. At four-leaved stage they are to be transferred to polybags. Two-month-old seedlings from polybags are used for field planting. Pits of size 60cm cube are to be taken and filled with 10kg dried cowdung mixed with topsoil and formed into a mound. On these seedlings are to be planted at a distance of 6-7.5m.

After cultivation: *Irrigation is to be given in the first year. Two weeding and application of organic manure once is required in a year. No serious pests and diseases are reported in the plant.*

Harvesting: *The plant flowers on the third year. At the end of tenth year the tree can be cut and wood used for medicinal purposes.*

Chemical constituents: *Flowers contain flavanoids-kaempferol-3-galactoside & kaempferol -3-rhamnoglucoside. Stem bark yields hentriacontane, octacosanol and stigmasterol. Stem yields* ***b****-sitisterol, lupiol and a flavanone.*

BISHOP'S WEED

Ammi majus

Family-Apiaceae

Ammi majus Linn.(greater ammi**)** is an annual or beinnial herb growing to a height of 80 to 120 cm.Greater Ammi, also known as Honey plant .

Uses: It is an annual or biennial herb which is extensively used in the treatment of leucoderma (vitiligo) and psoriasis. The compounds responsible for this are reported to be furocoumarins like ammoidin (xanthotoxin), ammidin (imperatorin) and majudin (bergapten) present in the seed. Xanthotoxin is marketed under the trade name "*Ox soralen*" and also used in "*Suntan lotion*". Meladinine is a by-product of *Ammi majus* processing, containing both xanthotoxin and imperatorin sold in various formulations increases pigmentation of normal skin and induces repigmentation in vitiligo. Imperatorin has antitumour activity. Fruit or seed causes photosensitization in fouls and sheep.

Soil and climate: A wide variety of soils from sandy loam to clay loam are suitable. However, a well drained loamy soil is the best. Waterlogged soils are not good. Being a hardy crop, it thrives on poor and degraded soils.

Ammi is relatively cold loving and it comes up well under subtropical and temperate conditions. It does not prefer heavy rainfall. Though the plant is biennial it behaves as an annual under cultivation in India. A mild cool climate in the early stages of crop growth and a warm dry weather at maturity is ideal. It is cultivated as a winter annual crop in *rabi* season.

Seeds and sowing: *The plant is seed propagated. Seeds germinate within 10-12 days of sowing. The best time of sowing is October and the crop duration is 160-170 days in north India. Crop sown later gives lower yield. Seeds being very small are mixed with fine sand or soil, sown in furrows and covered lightly with a thin layer of soil. The crop can be raised either by direct sowing of seed or by raising a nursery and then transplanting the crop. Seed rate is 2 kg/ha. The land is brought to a fine tilth by repeated ploughing and harrowing. Ridges and furrows are then formed at 45-60 cm spacing.*

Manuring: Well decomposed FYM at 10-15 t/ha and basal fertilisers are incorporated in the furrows. A fertilizer dose of 80:30:30 kg N, P_2O_5 and K_2O/ha is generally recommended for the crop while 150:40:40 kg/ha is suggested in poor soils for better yields. The furocoumarin content of *Ammi majus* is increased by N fertiliser and the N use efficiency increases with split application of N at sowing, branching and at flowering**.**

Irrigation: If winter rains fail, one irrigation is essential during November to January. As the harvesting season is spread over a long period of time, two irrigations during March and April meets the requirements of the crop.

Aftercultivation: For obtaining high yields it is essential to give one or two hoeings during November to February which keeps down the weeds.

Plant protection: *White ants and cut worms are reported to attack the crop which can be controlled by drenching with 40g carbaryl in 10 l of water. Damping off and powdery mildew are the common diseases of the crop. To control powdery mildew the crop is to be sprayed with 30g wettable sulphur in 10 l of water, whenever noticed. Drenching with 1% Bordeaux mixture will control damping off disease.*

Harvesting and processing: *The crop flowers in February. Flowering and maturity of seed is spread over a long period of two months. The primary umbels and the early maturing secondary umbels are the major contributors to yield. A little delay in harvesting results in the shattering of the seed which is the main constraint in the commercial cultivation of the crop and the main reason for low yields in India. It is reported increased yield by 50 - 60% by the application of planofix at 5 ppm at flower initiation and fruit formation stages. The optimum time of harvest is the mature green stage of the fruit in view of the reduced losses due to shattering and maximum contents of furocoumarins. The primary umbels mature first within 35-45 days. These are harvested*

at an interval of 2-4 days. Later, the early appearing secondary umbels are harvested. Afterwards, the entire crop is harvested, stored for a couple of days and then threshed to separate the seeds. The seed yield is 900-1200 kg/ha.

The processing of seed involves solvent extraction of powdered seeds, followed by chilling and liquid extraction and chromatographic separation after treatment with alcoholic HCl. Bergapten, xanthotoxin and xanthotoxol can be separated. Xanthotoxol can be methylated and the total xanthotoxin can be purified by charcoal treatment in acetone or alcohol.

Ammi majus fruit contains amorphous glucoside 1%, tannin 0.45%, oleoresin 4.76%, acrid oil 3.2%, fixed oil 12.92%, proteins 13.83% and cellulose 22.4%. This is one of the richest sources of linear furocoumarins. Furocoumarins have bactericidal, fungicidal, insecticidal, larvicidal, moluscicidal, nematicidal, ovicidal, viricidal and herbicidal activities

BLACH MUSALE

Curculigo orchioides
Family - Amaryllidaceae

San: Musali; Hin: Kalimusali, Mushali; Ben: Talamuli; Mal: Nilappana; Guj: Musalikand Tam: Nilapanai; Tel: Nelatadi Kelangu; Kan: Neladali

Curculigo orchioides Gaertn. syn. *C. malabarica* Wight, *C. brevifolia* Dryand, *Hypoxis dulcis* Stand belongs to the family Amaryllidaceae. *Musali* is a small herbaceous plant with cylindrical rootstock

Use: It is used as a rejuvenating and aphrodisiac drug. It improves complexion and is useful in general debility, deafness, cough, asthma, piles, skin diseases, impotence, jaundice, urinary disorders etc. Rootstock is the officinal part and it enters into the ayurvedic formulations like *Vidaryadighrta, Vidaryadi lehya, Marmagulika, Musalyadi churna etc.*

Soil and climate: ***The plant is found in all districts of India from near sea level to 2300m altitude, especially in rock crevices and laterite soil. It has been recorded to occur in the sub tropical Himalayas from Kumaon eastwards ascending to 1800m, the Khasia hills, Bengal, Asssam, Konkan, Kanara, the western peninsula and Madras extending south as far as a Cape Comerin.***

Seeds and sowing: The plant is propagated through tubers with crown. New propagules also emerge from leaf tips. Raised beds of convenient length and 1m wide are taken. FYM @ 20t/ha is incorporated into the soil. The tubers are planted at a spacing of 20x20cm. The soil is mulched immediately after planting.

After cultivation: The crop prefers shade and grows best as intercrop. Soil should be sufficiently moist to get maximum tuber development. Two – three weeding is essential to control weed competition.

Harvesting and processing: The plant is harvest as annual after 8 months as annual or can be harvested after two years as biennial. 1-1.5 t/ha tuber is obtained per hectare.

Chemical properties: ***Glucose, mannose, xylose and glucuronic acid from the rootstock of* C. orchioides*. The rootstock is also reported to contain glycoside, polysaccharides (hemicellulose and other polysaccharides), starch, resin, tannin, mucilage, fat and calcium oxalate. The hexane extract contains an alkaloid : lycorine, sterols including -sitosterols and sapogenin identified as yuccagenin. The flavone glycoside from the rootstock has been identified as 5,7- dimethoxy glucopyranoside. Fatty acids from* C. orchioides *root oil are palmitic, oleic, linolenic linoleic, arachidic and behenic acid. A new phenolic isolated glycoside namely, curculigoside from the rhizomes and its structure has been elucidated as 5-hydroxy-2-O- -d-glucopyranosyl benzl 1,2,6-dimethoxy benzoate.***

BRAHMI

Bacopa monnieri
Family-Scrophulariaceae

San: Brahmi, Sarasvati; Hin: Barami, Jalnim; Ben: Boihim-sak; Mal: Brahmi, Nirbrahmi; Tam: Nirpirami, Piramiyapundu;

Bacopa monnieri (Linn.) Pennell. syn. *Monniera cuneifolia* Michx., *Herpestis monniera* (Linn.) H.B. & K. belongs to the family Scrophulariaceae.

Uses: Brahmi or Thyme leaved gratiola is an important drug in Ayurveda for the improvement of intelligence and memory and revitalisation of sense organs. It is suggested

against dermatosis, anaemia, diabetes, cough, dropsy, fever, arthritis, anorexia, dyspepsia, emaciation, and insanity. It dispels poisonous affections, splenic disorders and impurity of blood. It is useful in vitiated conditions of *kapha* and *vata*, biliousness, neuralgia, ascites, flatulence, leprosy, leucoderma, syphilis, sterility and general debility. The whole plant is used in a variety of preparations like *Brahmighrtam, Sarasvataristam., Brahmitailam, Misrakasneham, etc.* In unani *Majun Brahmi* is considered as a brain tonic.

Soil and climate: The plant grows throughout the warm humid tropics up to 1200m elevation. Brahmi gets established well in water logged fields.

Seeds and sowing: The plant is propagated through stem cuttings. Ploughing 2 or 3 times prepare the land for sowing. Two to three tonnes/ha of cowdung or compost is applied and the field is again ploughed and levelled. Stem cuttings, 10cm long are spread at a spacing of 20cm. Water logging to height of 30cm is always required. Rooting may start within 15-20 days. It will spread over the field within 6 months.

After cultivation: Regular application of organic manure will take care of the manurial requirement. Weeding once in a month is required. Care should be taken to maintain water level at a height of 15cm during the growth period. No serious pests or diseases are noted in this crop.

Harvesting: Harvesting commences from sixth months onwards. Brahmi leaves can be collected once a month. After 3 years, the whole crop is harvested and removed. Fresh cultivation can be carried out in the same field.

Chemical constituents: *Leaves contain the alkaloids brahmine and hespestine. Mannitol and saponins were reported later. A systematic examination has resulted in the isolation and identification of two saponins designated as bacosides A and B. Bacoside A has chemical structure represented as 3-(a-L-arabinopyranosyl)-O-b-D-glucopyranoside-10, 20-dihydroxy-16-ketodammar-24-ene. The mixture of bacosides A and B on hydrolysis give four sapogenins, glucose and arabinose.*

CASSIA

Cassia spp.

Family - Caesalpinaceae

The genus Cassia *belonging to the family* Caesalpiniaceae *includes a number of medicinally important species. Among them* C. tora, C. occidentalis *and* C. sophera *constitute an important group of drug species.*

1. *C. tora* Linn.

Eng: Foetid Cassia; San: Cakramardah, Prapunnatah; Hin: Cakunda, Cakvat; Mal: Takara

Ben: Cakunda, Panevar; Tam: Tagarai; Tel: Tantemu; Mar: Takla, Tankil

Foetid Cassia is a very common weed in waste places, fallow ground and it is found as forest undergrowth during the rainy season. It is found throughout India and in adjoining areas. It is a herbaceous foetid annual weed, sometimes growing upto 90cm in height as an undershrub. Leaves are pinnately compound, rachis grooved with a conical gland between each of the two lowest pair of leaflets. Leaflets are in three pairs, obovate-oblong, membranous with base somewhat oblique and main nerves are of 8-10 pairs. Flowers are yellow, arranged in sub sessile pairs in the axils of the leaves. The upper ones are crowded with seven perfect stamens and three staminodes. Fruits are subtetragonous obliquely septate pods, 15-23cm long with very broad sutures. Seeds are 25-30 per pod.

The leaves and seeds are useful against worm, pruritus, leprosy, skin diseases, hepatopathy, helminthiasis, flatulence, colic, dyspepsia, intermittent fevers, constipation, ophthalmopathy, cough, bronchitis, cardiac disorders and haemorrhoids (Warrier *et al*, 1994). In skin diseases seeds may be used with the latex of *Euphorbia hirta*, cow's urine, curd, lime juice, castor oil, *Eclipta prostrata*, *etc* or in the form of poultice. The seeds may be used for arthritis, gout and sciatica. An oil called *"Chakramardha*" prepared by boiling *C. tora* plants with *Eclipta prostrata* and then heating with sesame oil is widely used for ring worm. In Ayurveda, the plant is used in *"Dadrughani Vati*" and "*Pamar*i *Taila"* (Thakur *et al*, 1989). The root rubbed into paste with limejuice is said to be a specific for ringworm (Nadkarni, 1998). Leaves used as poultice hasten suppuration and also forms a remedy in gout, sciatica and pains in the joints (Nadkarni, 1954; Aiyer and Kolammal, 1964; Kurup *et al*, 1979). The other important formulations using the drug are *Maharajaprasarini taila, Yastimadhukadi taila, Surasadi taila, etc* (Sivarajan *et al*, 1994).

The leaves contain chrysophanol, aloe-emodin, rhein and emodin. Seeds give a glycoside rubrofurasin-6β-gentiobioside, chrysophanol, physcion, emodin, aloe-emodin, rhein, aloe-emodin monoglucoside, physcion diglucoside, chrysophanol diglucoside and chrysophanol triglucoside. Plant contains glucose too (Husain *et al*, 1992). Seeds contain oleic, linoleic, palmitic and lignoceric acids (Suba-Jois *et al*, 1930; Wilkinson *et al*, 1970). Roots of this plant contain 1, 3, 5-terhydroxy-6, 7-dimethoxy –2-methyl anthraquinone and leucopelargonidin (Tiwari *et al*, 1972). Leaves yeild kaempferol-3-diglucoside. A new yellow pigment torachrysone has been isolated (Joshi *et al*, 1976). Seeds have been used as a purgative, probably due to the presence of emodin and anthraquinone glycosides. Antifungal effect is due to chrysophanol and chrysophonic acid –9-anthrone (Acharya *et al*, 1974; Yogindernath *et al*, 1962; Narayana *et al*, 1956). The leaves and seeds are acrid, thermogenic, laxative, depurative, antiperiodic, anthelmintic, liver tonic, ophthalmic, expectorant and cardiotonic. Plant is antiviral, spasmolytic and diuretic.

2. *C. occidentalis* Linn.

Eng: Stinking weed, Negro coffee; San: Kasamardah; Hin: Kasondi; Ben: Kalkashunda; Mal: Naattu Takara, Ponnaviram; Tam: Paeyaavarai, Thagarai; Tel: Kasinda.

The Negro coffee or Stinking weed is found throughout India, growing abundantly on waste lands immediately after the rains. It is an offensively odorous undershrub with furrowed subglabrous branches. Leaflets are 3-5 pairs. Flowers are yellow, arranged in short peduncled few flowered racemes. Fruits are cylindrical or compressed, transversely septate glabrous pods containing 20-30 seeds. Seeds are ovoid, compressed, hard, smooth and skin dark olive green or pale brown.

The plant is useful in vitiated conditions of *vata* and *kapha*, cough, bronchitis, constipation, fever, epilepsy and convulsions. The roots are useful in inflammation, diabetes, strangury, elephantiasis, ringworm, colic, flatulence, dyspepsia, epilepsy, convulsions and scorpion sting. The leaves and seeds are used in leprosy, erysipelas, pruritus, wounds and ulcers, cough, bronchitis, hiccough, asthma, pharyngodynia, fever and hydrophobia (Warrier *et al*, 1994). A paste made out of roots is considered as a specific remedy for ringworm, eczema and other skin ailments (Aiyer amd Kolammal, 1964). Bark, roots, leaves and seeds are used in medicine. The drug is an ingredient of *Surasadi taila* (Sivarajan *et al*, 1994).

The plant contains emodin, physcion, chrysophanol, sitosterol and a xanthone-cassiollin. Seeds contain phytosterolin and 3-methyl-6-methoxy-1, 8-dihydroxy anthraquinone. Flowers contain physcion-β-D-glucopyranoside. Roots contain phytosterol, 1, 8-dihydroxy anthraquinone, α-hydroxy anthraquinone, quercetin, 1, 4, 5-trihydroxy anthroquinone derivatives, namely, islandicin, helminthosporon and xanthorin, a xanthone derivative-cassiollin. Leaves contain flavonoids- matteucinol-7-rhamnoside and jaceidin-7-rhamnoside. The plant is febrifuge, purgative, diuretic and tonic. Seed and leaf are bitter, sweet, acrid, thermogenic and depurative and used in skin diseases. Root is an antidote for snakebite (Husain *et al*, 1992).

3. *C. sophera* Linn.

Eng: Senna sophera; San: Kasamardar; Hin: Kascenda; Mal: Ponthakara; Tam: Naavarai, Sularat; Tel: Kondakashinda; Mar: Kasodi

Senna sophera is a diffuse undershrub with yellow flowers found throughout India. The sepals are broad and obtuse. 6-7 stamens are antheriferous and rest reduced to staminoids. Pods are usually dehiscent and transversely septate. Leaves are almost glabrous. Pods are compressed, torulose and with thickened margins. Leaflets are 5-10 pairs, oblong lanceolate and about 2.5cm long. Pods are more or less turgid (Gamble, 1995).

It is recommended against cough, asthma and other respiratory ailments. It helps to regain the balance of the three doshas - *vata, pita* and *kapha*, improves digestion, clears throat and purifies blood. Leaf is used in ringworm problems. The plant is used in bronchitis. Bark is used for skin diseases. This is used to prepare the drug "*Kasamardah*". This drug is an ingredient of *Surasadi taila* (Sivarajan *et al*, 1994).

The leaves contain 3, 5, 3', 4', 5'-penta-hydroxy-7-methoxy flavon–8-C-L-rhamnopyranoside (Husain *et al*, 1992). Flowers contain anthraquinone and flavonol glycoside. Leaves contain new flavonol-8-C-glycoside (Asolkar *et al*, 1992). The plant is spasmolytic. Alcoholic extract of leaves is intestinal and bronchial muscle relaxant.

CASTOR

Ricinus communis

Family-Euphorbiaceae

San: Erandah, Pancangulah; Hin: Erandi, Erand; Ben: Bherenda; Mal: Avanakku

Castor is a perennial evergreen shrub.

Uses: It is considered as a reputed remedy for all kinds of rheumatic affections. They are useful in gastropathy, constipation, inflammations, fever, ascitis, strangury, bronchitis, cough, leprosy, skin diseases, vitiated conditions of *vata*, colic, coxalgia and lumbago. Castor oil is an excellent solvent of pure alkaloids and as such solutions of atropine, cocaine, etc. is used in ophthalmic surgery. It is also dropped into the eye to remove the after-irritation caused by the removal of foreign bodies.

Soil and climate: *Castor is cultivated both in the plains and the hills. As it has deep root system it is hardy and capable of resisting drought. It does not withstand water logging and frost. It requires hard dry climate for proper development of fruits and seeds. It requires a well-drained soil, preferably sandy loam or loamy sand. High soil fertility is of less importance as compared to the good physical condition of the soil. It cannot tolerate alkalinity. It is generally grown in red loamy soils, black soils and alluvial soils.*

Seeds and sowing: The plant is seed propagated. The seed rate required is 5-12 kg/ha (pure crop) and 3 kg/ha (mixed crop). Seeds are to be sown on a hot bed early in March. The suitable season of growing is *kharif* season. The crop is usually sown in April and planting is done in early July. The land is to be ploughed 2-3 times with the onset of rains and is repeated after rain. The spacing recommended is 60x90cm in case of pure crop. It is seldom cultivated as pure but usually grown mixed with crops such as jowar, arhar, chilly, groundnut, cotton, etc.

Manuring: 10-15t FYM/ha and 50 kg N, 50kg P_2O_5 and 20kg K_2O/ha is recommended. Addition of neem cake is beneficial for higher oil content.

After cultivation: There should be sufficient moisture in the field at the time of sowing. A month after planting, weeding and earthing up is to be done.

Plant protection: The plant is attacked by hairy caterpillar, castor semi-looper, castor seed caterpillar, etc. which can be managed by integrated pest management measures. Spraying with Bordeaux mixture 2-3 times at 15 days interval can control the leaf blight disease occurring in castor.

Harvesting: Harvesting of ripe fruits can be done from the end of November till the end of February. The fruit branches are picked when they are still green to avoid splitting and scattering of the seeds. The pods are to be heaped up in the sun to dry. Then the seeds are to be beaten with stick and winnowed. Roots, leaves, flowers, seeds and oil constitute the economic parts. The average yield is 500-600kg/ha

Chemical constituents: The bean coat yields lupeol. Roots, stems and leaves contain several amino acids. Flowers contain apigenin, chlorogenin, rutin, coumarin and hyperoside. Castor oil is constituted by several fatty acids. Seed coat contains lipids and higher amounts of phosphatides and non-saponifiable matter than seed kernel.

CATECHU

Acacia catechu

Family- Mimosaceae

San:Khadirah; Hin:Khair, Khaira; Ben: Kuth; Mal: Karingali; Tam: Karunkali; Tel: Sandra, Khandiramu; Kan: Kaggali

A. catechu is a moderate sized deciduous tree, 9-12m in height with dark greyish or brown rough bark and hooked short spines.

Uses: It is used as a blood purifier and against leoprosy and leucoderma. Catechu or Cutch tree bark is useful in melancholia, conjunctivitis and haemoptysis. The bark is anthelmintic, antipyretic, antiinflammatory and antileprotic. The flowers are antigonorrhoeic. It is useful for the treatment of catarrh, cough, pruritus, skin diseases, foul ulcers and wounds. The gummy extract of the wood is also useful against skin diseases.

Soil and climate: It requires hot tropical climate. Catechu is suited to hilly areas and rocky places. It grows wild in places up to an elevation of 2000m MSL. It grows in all types of soils excepted waterlogged situations.

Seeds and sowing: The plant is propagated by seeds. Seeds are soaked in water for 6 hours and sown in seedbeds. Seeds germinate within a month. At four-leaf stage, seedlings are planted in polybags. Two months old seedlings from the polybags are used for transplanting. Pits of size $50cm^3$ are taken at a distance of 5m between plants and filled with topsoil, sand and dried cowdung in 1:1:1 ratio. Seedlings are planted in these pits. Application of organic manure every year during the rainy season is beneficial. Regular weeding is to be carried out. Pruning of branches and tender shoots developing from the base of the plant can be done from second year onwards. Tree is to be grown as single stemmed one.

Harvesting and processing: Flowering and fruiting commences from fourth year onwards. At the end of tenth year, the tree can be cut and heartwood collected

Chemical constituents: Heartwood contains kaempferol, dihydro kaempferol, taxifolin, iso rhamnetin(+)-afzelchin, a dimeric procyanidin, quercetin, (-)epi-catechin, (-)catechin, fisetin, quercetagetin and (+)-cyanidanol. The main constituent of heartwood is catechin and catechu tannic acid. Catechin is a mixture of at least four isomers, *L*(-)epicatechin being one of them.

CHEBULIC MYROBALAN

Terminalia chebula

Family-Combretaceae

San, Ben: Haritaki; Hindi: Harara, Harir, Har; Mal: Kadukka; Ass: Hilikha

Chebulic myrobalan is a medium deciduous subtropical tree, the fruit of which is a common constituent of *Triphala* capable of imparting youthful vitality and receptivity of mind and sense.

Use: It is a major constituent in the ayurvedic preparations like *Abhayarishta, Abhaya modak, Haritaki khand, Triphaladi churnam and Agastya rasayanam*. In allopathy it is used in astringent ointments. In unani system it is used as a blood purifier. The pulp of the fruit is given in piles, chronic diarrhoea, dysentery, costiveness, flatulence, asthma, urinary disorders, vomiting, hiccup, intestinal worms, ascites and enlarged spleen and liver. Powder of the fruit is used in chronic ulcers and wounds, carious teeth and bleeding ulceration of the gums. The bark is a good cardiac tonic. The fruit is valuable for its tannins and dyes. The wood is used for building purposes, agricultural implements, plywood and match box industries. It is also grown as a shade tree.

Soil and climate: Young plants prefer shade while the matured plants tolerate light frost and drought. It grows well in hilly areas. Deep fertile forest soils are preferred though it can tolerate well-drained lateritic soils also.

Seeds and sowing: This is propagated through seeds. Natural multiplication happens rarely due to the poor seeds germination. Pre-soaking of seeds in water for 48 hours before sowing in seedbeds give better germination. The hard seed coat is removed before sowing. The seedbeds should be covered with straw after sowing. It is watered immediately. Usually it takes 3-5 months to germinate. It can be transferred to polybags at two leaves stage. One-year-old seedlings are ready for transplanting. For transplanting, $50cm^3$ pits are taken at a spacing of 8m.

After cultivation: Organic manure, added regularly, promotes growth. Irrigation is required during first year. Weeds should be removed regularly. This plant grows slowly. It fruits within 6-7 years. This is continued for many years. It is coppiced well. Fruits are to be collected immediately after falling down or the fallen fruits are to be covered with soil to protect it from pests. Fruits are dried well in sun and used or stored.

Chemical constituents: Kernel oil of *Chebulic myrobalan* contains 6 fatty acids *viz*. palmitic, stearic, oleic, linoleic, arachidic and behenic acid. The fruits contain chebulinic acid, tannic acid, gallic acid, chebulin and tannin. Leaves contain terpenes and saponins. β-sitosterol is present in the bark

CINCHONA

Cinchona spp.

Family-Rubiaceae

San: Cinchona, Kunayanah Hin: Kunain Mal: Cinchona, Quoina Tam: Cinchona
The term cinchona is believed to be derived from the countess of cinchon who was cured of malaria by treating with the bark of the plant in 1638.

Uses: Cinchona, known as Quinine, Peruvian or Crown bark tree is famous for the antimalarial drug *'quinine'* obtained from the bark of the plant. Commercial preparations contain cinchonidine and dihydroquinine. They are useful for the treatment of malarial fever, pneumonia, influenza, cold, whooping couphs, septicaemia, typhoid, amoebic dysentery, pinworms, lumbago, sciatica, intercostal neuralgia, bronchial neuritis and internal hemorrhoids. Besides, they are used in insecticide compositions for the preservation of fur, feathers, wool, felts and textiles.

Soil and climate: The plant widely grows in tropical regions having an average minimum temperature of 14°C. Mountain slopes in the humid tropical areas with well-distributed annual rainfall of 1500-1950mm are ideal for its cultivation. Well-drained virgin and fertile forest soils with pH 4.5-6.5 are best suited for its growth. It does not tolerate water logging.

Seeds and sowing: Cinchona is propagated through seeds and vegetative means. The commercial plantations are raised through seeds. Vegetative propagation techniques such as grafting, budding and softwood cuttings are also employed. *Cinchona succirubra* is commonly used as root stock in the case of grafting and budding. Hormonal treatment induces better rooting. Seedlings are first raised in nursery under shade. Raised seedbeds of convenient size are prepared, well decomposed compost or manure is applied, seeds are broadcasted uniformly at $2g/m^2$, covered with a thin layer of sand and irrigated. Seeds germinate in 10-20 days. Seedlings are transplanted into polythene bags after 3 months. These can be transplanted into the field after 1 year at 1-2m spacing. Trees are thinned after third year for extracting bark, leaving 50% of the trees at the end of the fifth year.

Plant protection: The crop is damaged by a number of fungal diseases like damping off caused by *Rhizoctoria solani*, tip blight by *Phytophthora parasatica*, collar rot by *Sclerotiun rolfsii*, root rot by *Phytophthora cinnamomi*, *Armillaria mellea* and *Pythium vexans*. Field sanitation, seed treatment with organo-mercurial fungicide, burning of infected plant parts and spraying 1% Bordeaux mixture are recommended for disease control.

Harvesting: Harvesting can be done in one or two phases. In one case, the complete tree is uprooted, after 8-10 years when the alkaloid yield is high. In another case, the tree is cut about 30cm from the ground for bark after 6-7 years so that fresh sprouts come up from the stem to yield a second crop which is harvested with the under ground roots after 6-7 years. Both the stem and root are cut into convenient pieces; bark is separated, dried in shade, graded, packed and traded. Bark yield is 9000-16000kg/ha.

Chemical constituents: Over 35 alkaloids have been isolated from the plant, the most important among them being quinine, quinidine, cinchonine and cinchonidine. These alkaloids exist mainly as salts of quinic, quinovic and cinchotannic acids. The cultivated bark contains 7-10% total alkaloids of which about 70% is quinine. Similarly 60% of the total alkaloids of root bark are quinine. Quinine is isolated from the total alkaloids of the bark as quinine sulphate.

COMMON INDIGO

Indigofera tinctoria

Family-Papilionaceae (Fabaceae)

San:Nilini, Ranjani, Nilika, Neelam, Aklika, Asita, Bhadra; Mal: Neelamari

Common indigo or Indian indigo is a branching shrub which grows up to 2m high.

Uses: Nili is a reputed drug produced from this plant, which is used in ayurveda for the promotion of hair growth and it forms a major ingredient of preparations like *nilibhringadi oil*. This is the original source of natural indigo. Nili is purgative in action, bitter, hot, cures giddiness, abdominal enlargement, gout and intestinal obstruction.

Soil and climate: *The Indian indigo requires good sunlight and grows well in plains as well as hilly areas. Sandy loams soils are the best. Clayey soil where water logging is likely is unsuitable. It can withstand temp upto 40^{o}C provided adequate soil moisture could be maintained. It can be sultivated in coastal sandy soils.*

Seeds and sowing*: This is usually propagated by seeds. Seeds are very small and the seed rate is 3kg/ha. Seeds are mixed with sand and ground gently to break the seed coat. An alternate method for enhancing germination is dipping the seeds in boiling water for a second. After pretreatment seeds are broadcasted. Broadcast the seeds preferably mixed with sand 2 or 3 times its volume to ensure uniform coverage. The seedbeds should be covered with straw and irrigated. Seeds germinate within 15 days. Seedlings are ready for transplanting after one month. For the land preparation, the soil is brought to fine tilth by ploughing 2 or 3 times.*

After cultivation: *Cattle manure should be applied at the rate of 10t/ha as basal dressing and incorporated into soil along with last ploughing. The best time for sowing is September-October. Weeding has to be done two times; 3 weeks after sowing and 6 weeks after sowing. Plants start flowering 2-3 months after sowing.*

Harvesting: *It is done by cutting the plants at this time, at a height of about 10cm from ground level. Irrigate plants after harvest. Subsequent harvests can be made at 1.5-2 months interval. Four to five cuttings can be taken in a year depending on the growth. A few plants per plot are left without cutting to set seeds. Ripe pods are to be harvested in the early morning to prevent loss of seeds by shattering during harvest.*

Chemical constituents: *A blue dyestuff is obtained from the indigo plant which does not exist ready formed, but is produced during fermentation from another agent existing in the plant, known as indican. Indican is an yellow amorphous material with a nauseous bitter taste with an acid reaction, readily soluble in water, alcohol and ether. An artificial product indigotin is manufactured chemically and used as a substitute. Indirubin is another component of the plant.*

COOMB TEAK

Gmelina arborea

Family- Verbenaceae

San: Gumbhari; Hin:Gamari, Jugani-chukar; Mal: Kumizhu, Kumpil; Guj: Shewan

Coomb teak, Candahar tree or Kashmeeri tree is a moderate sized, unarmed, deciduous tree which is a vital ingredient of the "***dasamula***" (group of ten roots).

Uses: The whole plant is medicinally very important. It promotes digestive power, improves memory, overcomes giddiness and is also used as an antidote for snake bite and scorpion sting. Roots are useful in hallucination, fever, dyspepsia, hyperdipsia, haemorrhoids, stomachalgia, heart diseases, nervous disorders, piles and burning sensation. Bark is used in fever and dyspepsia. Leaf paste is good for cephalagia and leaf juice is a good wash for foul ulcers and is also used in the treatment of gonorrhoea and cough. Flowers are recommended for leprosy, skin and blood diseases. The fruits are used for promoting the growth of hair and in anaemia, leprosy, ulcers, constipation, strangury, leucorrhoea, colpitis and lung disease.

Wood is one of the best and most reliable timber of India. It is used for making furniture, planks, carriages, printing boxes, musical instruments, shafts, axles, picture frames, jute bobbins, calipers, ship buildings, artificial limbs etc.

Soil and climate: Coomb teak is a sun loving plant. It does not tolerate drought. But it grows in light frost. Rainfall higher than 2000mm and loose soil are ideal.

Seeds and sowing: The best method of propagation is by seeds but sometimes propagated thriugh stem cuttings also. Seed formation occurs in May-June. Seeds are dried well before use. They are soaked in water for 12 hours before sowing. Seed rate is 3kg/ha. Seeds are sown in nursery beds shortly before rains. Seeds germinate within one month. Seedlings are transplanted in the first rainy season when they are 7-10cm tall. Pits of size $50cm^3$ are made at a spacing of 3-4m and filled with sand, dried cow dung and surface soil, over which the seedlings are transplanted.

After cultivation: 20kg organic manure is given once a year. Irrigation and weeding should be done on a regular basis.

Plant protection: The common disease reported is sooty mould caused by *Corticium salmonicolor*, which can be controlled by applying 1% Bordeaux mixture. Stem borer caterpillar is seen infesting in some areas.

Harvesting: The tree grows fast and may be ready for harvesting after 4 or 5 years. However, 7-10 year old trees are cut and root and heartwood extracted.

Chemical constituents: Roots and heart wood of Coomb teak are reported to contain gmelinol, hentriacontanol, *n*-octacosanol and β-sitosterol. The roots contain sesquiterpenoid and apiosylskimmin, a coumarin characterised as umbelliferone-7-apiosyl glucoside and gmelofuran. The heartwood gives cetyl alcohol, cluytyl ferulate, lignans, arboreol, gmelonone, 6'-bromo isoarboreol, lignan hemiacetal and gummidiol. Leaves yield luteolin, apigenin, quercetin, hentriacontanol, β-sitosterol, quercetogenin and other flavones. Fruits contain butyric acid, tartaric acid, and saccharine substances.

COSTUS

Costus speciosus

Family-Zingiberaceae

San: Pushkara, Kashmeera, Kemuka; Hin: Kebu, Keyu, Kust; Mal: Channakkizhangu, Channakoova; Tam: Kostam

Costus speciosus (Koenig.) Sm. consists of two varieties viz., var. *nepalensis* Rose., found only in Nepal and Arunachal Pradesh and var. *argycophyllus* Wall.,

Uses: Costus is one of the plants that contains diosgenin in its rhizome. Diosgenin is the starting material in the commercial production of steroidal hormones. The rhizomes are useful in vitiated conditions of *kapha* and *pitta*, burning sensation, flatulence, constipation, helminthiases, leprosy, skin diseases, fever, hiccough, asthma, bronchitis, inflammation and aneamia. It is used to make sexual hormones and contraceptives

Soil and climate: *Costus can be raised under a wide range of agroclimatic conditions. It prefers sandy loam soil for good growth.*

Seeds and sowing: Propagation is by rhizomes. The best season for planting is April-May. The seed rate recommended is 2-2.5t/ha. The spacing adopted is 50x50cm. After an initial ploughing FYM or poultry manure should be applied at the rate of 10t/ha and the field is to be ploughed again irrigated and prepared to obtain a fine seed bed. Furrows are opened and the rhizome pieces are placed horizontally at a depth of 8-10cm and covered with soil. Care is taken to place the eye buds facing upwards. After 70-75 days about 90-95% sprouting is obtained.

Manuring: Application of 5t/ha of poultry manure and fertilizers at the rate of 60kg P_2O_5 and 40kg K_2O /ha as a basal doze, along with 80kg N/ha applied in 3 equal split dozes gives good yields.

Irrigation: Desiccation of the young sprouts have been observed in the hot summer months, necessitating liberal water supply during the period. As September-November is the period of maximum tuberization at least two irrigations should be given at that time. One during the sprouting period of the crop followed by two more keeps the crop fairly free of weeds.

Harvesting: Crop is harvested at the end of seven months. Harvesting includes 2 operations, cutting the aerial shoots and digging out the rhizomes.

Chemical constituents: *Tubers and roots contain diosgenin, 5-a-stigmast-9(11)-en-3-b-ol, sitosterol-b-D-glucoside, dioscin, prosapogenins A and B of dioscin, gracillin and quinones. Various saponins, several aliphatic esters and acids are reported from its rhizomes, seeds and roots. Seeds, in addition, contain a-tocopherol.*

DATURA

Datura metel

Family- Solanaceae

San: Dhustura Hin.: Kaladhatura Ben: Dhatura Mal: Ummam Kan; Dattura Tam: Vellummattai Tel: Tellavummetta

The genus *Datura* consists of annual and perennial herbs, shrubs and trees. Three species,viz, *Datura metel* Linn., *D. stramonium* Linn. *and D. innoxia* Mill. are medicinally important. *D. innoxia* mill. and *D. metel* Linn. (var. *alba*, and var, *fastuosa*) are the choice drug plants, rich in hyoscine. *D. metel* Linn. is the most common in India.

Uses: Downy datura or thorn apple is an erect branched under shrub whose intoxicating and narcotic properties have been made use of by man from ancient time. The plant and fruit are spasmolytic, anticancerous and anthelmintic. Leaves and seeds are inhaled in whooping cough, asthma and other respiratory diseases. Root, leaf and seed are febrifuge, antidiarrhoeal, anticatarrhal and are used in insanity, cerebral complications and skin diseases. Leaf is antitumour, antirheumatic and vermicide. Flower is antiasthamatic, anaesthetic and is employed in swellings and eruptions on face. Fruit juice is used in earache and seed decoction in ophthalmia. For the rheumatic swellings of joints, lumbago, sciatica and neuralgia, warm leaf smeared with an oil is used as a bandage or sometimes the leaf is made into a poultice and applied.

The alkaloids of pharmaceutical interest present in the plant are hyoscyamine, hyoscine and meteloidine. Datura is the chief commercial source of hyoscine available from natural source. Hyoscine, in the form of hyoscine hydrobromide, is used as a pre-anaesthetic in surgery, child birth, ophthalmology and prevention of motion sickness. It is also employed in the relief of withdrawal symptoms in morphine and alcoholic addiction, paralysis agitans, post-encephaletic parkinsonianism and to allay sexual excitement. Hyoscyamine and its salt hyoscyamine sulphate and hyoscyamine hydrobromide are used in delerium, tremour, menia and parkinsonianism

Soil and climate:- Datura grows on majority of soils, however, alkaline or neutral clay loam soil or those tending to saline-alkaline reaction rich in organic matter are ideal for vigorous growth. The clayey, acidic, water-logged or moisture deficient soils do not suit this crop.

It grows well in a wide range of climate from tropical to temperate conditions. The plant thrives best in areas of low rainfall where winter and monsoon rains are followed by long dry periods. Areas with annual rainfall below 1000mm with mean temperature of 10-15^{o}C in winter and 27 - 28^{o}C in May-June are ideal. The crop cannot stand frost, high rainfall or high temperature in the plains in May-June.

Seeds and sowing: The plant is propagated by seeds but it is characterised by poor and often erratic seed germination which can be improved either by leaching out the inhibitor from the seeds or by alternate freezing and thawing of seeds. The optimum season for raising the crop is Rabi in tropical and subtropical areas while *Kharif* in temperate areas. The seeds can be broadcast -sown or seedlings can be raised in nursery and then transplanted. Seed rate is 7-8 kg/ha for broadcasting and 2-3 kg/ha. for transplanting. The field is ploughed and disced adequately to produce fine seed bed. In the case of direct seeding, seeds are drilled in rows taken 45-60 cm apart. The plants are thinned to keep a spacing of 30-45 cm at the time of first weeding. In the case of transplanting 4-6 weeks old seedlings are planted at 45-60 x 30-45 cm spacing.

Varieties:- Two varieties are often noted in *D. metel* Linn., namely the white flowered var. *alba* and purple flowered var. *fastuosa*

Manuring:- Application of organic manure at 10-15 t/ha and fertilisers at 60:40:40 kg N, P_2O_5 and K_2O/ha is recommended for the crop for better growth and yield N may be

applied in 3-4 equal split doses at planting and after each weeding which is required 2-3 times during the growing season. Application of micronutrients is reported to improve the alkaloid contents.

Irrigation:-field should be irrigated immediately after sowing or planting if soil moisture is inadequate. Thereafter 3-4 irrigations may be given if sufficient rainfall is not received.

Plant protection: No major insect pest is known to attack this crop. However, leaf spot, wilt and mosaic diseases cause damage to this crop. Leaf spot is caused by *Alternaria tennuissima* and is characterised by brown round to oval spots, becoming necrotic at later stage which leads to withering and drooping of leaves. Wilt is caused by *Sclerotium rolfsii* and it starts with dropping of leaves and finally wilting of the entire plant. Root and foot wilt, caused by *Corticium solani,* appears as damping off of seedlings and mature plants. Datura distortion mosaic is characterised by yellowing of the veins followed by inward rolling and distortion of leaves with a reduction in plant size. For reducing the impact of these diseases, field sanitation, use of resistant varieties, crop rotation for 3-4 years and fungicide application should be resorted to.

Harvesting and processing: For the purpose of leaf and top, harvesting is done as soon as flowering starts. Entire top containing leaves and twigs is cut, dried in shade and stored in gunny bags. For seed and fruit, fully grown fruits, still green are picked 2-3 times before final harvest when the entire plant is cut from the base and dried in the open. The dried fruits are then thrashed with a stick to separate the seeds. The seed yield is 1-1.5 t/ha.

Chemical constituents:-The alkaloids hyoscyamine and hyoscine (scopolamine) and meteloidine are found in all parts of the plant. The total alkaloid content is 0.26 - 0.42 % Fruits contain daturaolone and daturadiol while roots contain additionally ditigloyloxy tropane derivatives, tigloidine, apohyoscine, norhyoscine, norhyocyamine, cusiohygrine and tropine. The physiological effects of hyoscyamine are qualitatively the same as those of its recemic derivative atropine. This is relatively more active in its paralysing affect on nerve endings and less active in its stimulant action on the central nervous system. The sedative and hypnotic action of hyoscyamine is weaker than that of hyoscine.

DESMODIUM

Desmodium gangeticum

Family-Fabaceae

San: Anshumati, Salaparni; Hin, Ben: Salpani; Mal: Orila; Tam:Pulladi; Tel: Gitanaram; Kan: Murelehonne; Mar: Darh; Guj: Salwan; Ori: Salaparni

Desmodium gangeticum (Linn.) DC. syn. *Hedysarum gangeticum* Linn., *Desmodium gangeticum* var. *maculatum* (Linn.) Baker., is an erect diffusely branched undershrub, 90-120cm in height. Desmodium is a small shrub, which is the chief of the ten ingredients in the *Dasamula kwatha* of Hindu medicine.

Uses: Roots are useful in vitiated conditions of *vata*, anorexia, dyspepsia, haemorrhoids, dysentery, strangury, fever, gout, inflammations, cough, asthma, bronchitis, cardiopathy and debility. The unani preparation "*Arq dashmul*" contains these roots. It is considered a curative for leucorrhoea and for pains due to cold .

Soil and climate: Although it can grow on all types of soils, waterlogged and highly alkaline soils are not suitable. Light sandy loam is preferred for commercial cultivation Desmodium can grow in a variety of climate and soils. However, it prefers tropical and subtropical climatic conditions.

Seeds and sowing: It is propagated through seeds. Seeds can be planted directly in the field or seedlings raised on the nursery beds and transplanted. Transplanting always gives better results in commercial cultivation, as it gives assured crop stand. Planting is done at a spacing of 40x20cm on flat beds or ridges.

After cultivation: Organic manures are applied at the time of land preparation and thoroughly mixed with the soil. A little quantity of phosphatic and nitrogenous fertilizers each at 10kg/ha are also applied for better crop growth. The inter-row spaces between plants, both in the field and nursery should be kept free from weeds by frequent weeding and hoeing as the plant suffers from weed competition, especially during early stages of growth. Manual hand weeding is usually done. Irrigation of seedlings just after planting is good for crop establishment. Although it can be cultivated as a rainfed crop under humid tropical conditions, irrigation every month is beneficial during summer.

Harvesting: The root is the economic part and harvesting can be commenced after 8-9 months. About 500- 700kg roots can be harvested from a hectare of land per year.

Chemical constituents: *The root contains gangetin, gangetinin, desmodin, N,N-dimethyl tryptamine, hypaphorine, hordenine, candicine, N-methyl tyramine and b-phenyl ethyl amine.*

FENUGREEK

Trigonella foenum-graecum

Family-Fabaceae

San: Methika, Methi, Kalanusari; Hin: Meti, Mutti; Ben, Mar: Methi; Mal: Uluva

It is an annual herb, 30-60cm in height. Fenugreek or Greek Hayes is cultivated as a leafy vegetable, condiment and as medicinal plant.

Uses: The leaves are refrigerant and aperient and are given internally for vitiated conditions of *pitta*. Seeds are used for fever, vomiting, anorexia, cough, bronchitis and colonitis. An infusion of the seeds is a good cool drink for small pox patients. Powdered seeds find application in veterinary medicine. An aqueous extract of the seeds possesses antibacterial property

Soil and climate: Fenugreek can be grown on a wide variety of soils but clayey loam is relatively better. The optimum soil pH should be 6-7 for its better growth and development. It has a wide adaptability and is successfully cultivated both in the tropics as well as temperate regions. It is tolerant to frost and freezing weather. It is cultivated in *rabi*. It does well in places receiving moderate or low rainfall areas but can not withstand heavy rainfall area.

Seeds and sowing: Land is prepared by ploughing thrice and beds of uniform size are prepared. Broadcasting the seed on the bed and raking the surface to cover the seeds is normally followed. But to facilitate intercultural operations, line sowing is also advocated in rows at 20-25cm apart. Sowing in the plains is generally in September-November while in the hills it is from March. The seed rate is 20-25kg/ha and the seeds germinate within 6-8 days.

Varieties: Some of the improved cultivars available for cultivation are *CO1* (TNAU), *Rajendra Kanti* (RAU), RMt-1 (RAU) and *Lam Selection-1* (APAU).

Manuring: Besides 15t of FYM, a fertiliser dose of 25:25:50kg NPK/ha is recommended. Entire P, K and half N are to be applied basally and the remaining half N 30 days after sowing.

Irrigation: First irrigation is to be given immediately after sowing and subsequent irrigations at 7-10 days interval.

After cultivation: Hoeing and weeding are to be done during the early stages of plant growth and thinning at 25-30 days to have a spacing of 10-15cm between plants and to retain 1-2 plants per hill.

Plant protection: Root rot caused by *Rhizoctonia solani* is a serious disease and can be controlled by drenching carbendazim 0.1% first at the onset of the disease and another after one month of first application.

Harvesting and processing: In about 25-30 days, young shoots are nipped off 5cm above ground level and subsequent cuttings of leaves may be taken after 15 days. It is advisable to take 1-2 cuttings before the crop is allowed for flowering and fruiting when pods are dried, the plants are pulled out, dried in the sun and seeds are threshed by beating with stick or by rubbing with hands. Seeds are winnowed, cleaned and dried in the sun. They may be stored in gunny bags lined with paper. A yield of 1200-1500kg of seeds and about 800-1000kg of leaves may be obtained per hectare in crops grown for both the purposes

Chemical constituents: *Seeds contain the sapogenins - diosgenin, its 25-epimer (yamogenin), tigogenin, gitogenin, yuccagenin, 25-2-spirosta-3,5-diene and its b-epimer. Seeds also contain a C_{27}-steroidal sapogenin peptide ester, fenugreekine. Seeds, in addition, contain 4-hydroxyleucine and the saponins, fenugrins A-E and two furostanol glycosides.*

GARLIC

Allium sativum
Family-Liliaceae

San: Lasunah, Rasonah; Hin:Lasun, Lahasun; Ben: Lashan; Mal: Vellulli; Kan: Belluli; Tam: Vellaipuntu; Mar: Lasunas; Ass: Naharu; Tel:Vellulli, Tella-gadda; Garlic is a scapigerous foetid perennial medicinal herb It is one of the important bulb crops used as a spice or condiment with medicinal value throughout the world. It possesses high nutritive value.. *A. sativum* Linn. syn. *A. porrum* Linn., *A. cepa* Linn., *A. ampeloprasum* Linn, *A. ascalonicum* Linn., *A. leptophyllum* Wall., *A. macleanii* Baker., *A. schoenoprasum* Linn.and *A. tuberosum* Roxb. are some of the species under the genus.

Uses: Its preparations are useful in vitiated conditions of *kapha* and *vata*, cough, whooping cough, bronchitis, asthma, fever, facial paralysis, flatulence, colic, constipation, atonic dyspepsia, helminthiasis, duodenal ulcers, pulmonary and laryngeal tuberculosis, opthalmopathy, cardiopathy etc.

Soil and climate: *Garlic requires well-drained loamy soils rich in humus, with fairly good content of potash. It can be grown under a wide range of climatic conditions. It prefers moderate temperature in summer as well as in winter. Short days are very favourable for the formation of bulbs.*

Seeds and sowing: Garlic is propagated through cloves or bulblets. In the hills, sowing is done in April and May. Types with bold and compact cloves and thick white covering sheath are preferred for planting. Garlic may be broadcasted, planted in furrows or dibbled at the rate of 150-200kg cloves/ha. In furrow planting, cloves are dropped 7.5-10cm apart in furrows 15cm deep and covered lightly with loose soil. Cloves may be dibbled 5 to 7.5cm deep and 7.5cm apart in rows that are 15cm apart with their growing end upwards and then covered with loose soil.

Varieties: *Ootty-1*

Manuring: A basal dose of 60kg N and 50kg each of P_2O_5 and K_2O are applied along with 25t/ha of FYM. 60kg N is given as topdressing 45 days after planting.

Irrigation:-First irrigation is given immediately after sowing and subsequent irrigations are given at 10-15 days interval depending upon the soil moisture availability. The last irrigation should be given 2-3 days before harvesting to facilitate easy harvest and minimum damage to bulbs.

After cultivation: First weeding and hoeing is to be done at one month after sowing followed by a second weeding one month after first inter-culture. Hoeing at about two and a half months from sowing loosens the soil and helps in setting of bigger and well-filled bulbs.

Plant protection: Garlic is attacked by *Thrips tabacii* which causes withering of leaves. Spraying Dithane M.45 at fortnightly intervals at 2.5g/l of water could control leaf spot caused by *Alternaria solanii*.

Harvesting and processing: Garlic is harvested when the tops turn yellowish or brownish and show signs of drying up. The plants are uprooted, tied into small bundles and kept in shade for 2-3 days for curing. Average yield of garlic is 6-8t/ha.

Chemical constituents: Garlic bulb is reported to contain volatile oil, alliin (S-allyl-*L*-cysteine sulfoxide), S-methyl- *L* -cysteine sulfoxide and allinase. It is rich in vitamins like thiamine, riboflavin and niacin. Volatile oil contains allicin (diallyl thiosulphinate), an active odour principle of garlic. Other major compounds present are diallyl disulphide, diallyl trisulphide, allyl methyl trisulphide and allyl methyl disulphide.

GYMNEMA

Gymnema sylvestre

Family-Asclepiadaceae

San: Mesasrngi, Madhunasini; Hin: Gudmar, Merasimgi; Mal: Chakkarakolli, Madhunasini;

Uses: Gymnema**,** Australian Cowplant, Small Indian Ipecacuanha or Periploca of the woods is a woody climber. It is reported to cure cough, dyspnoea, ulcers, and pain in the eyes. The plant is useful in inflammations, dyspepsia, constipation, jaundice etc. Root has long been reputed as a remedy for snakebite. The drug is used to strengthen the function of heart, cure jaundice, piles, urinary calculi, and intermittent fevers The drug enters into the composition of preparations like *Ayaskrti, Varunadi kasaya, Varunadighrtam, Mahakalyanakaghrtam,* etc.

Seeds and sowing:: The plant can be propagated both by seeds and stem cuttings. Seedlings are to be raised in polybags. Pits of size $50cm^3$ are to be taken, filled with 10kg dried cowdung or FYM and covered with topsoil. On these pits about 3-4 months old seedlings are to be transplanted from polybags.

After cultivation: The plants are trailed on to poles or other supports. The plant will attain good spread within one year. Regular weeding, irrigation and organic manure application are beneficial. No serious pests or diseases are reported.

Harvesting: Leaves can be collected from the first year onwards at an internal of one week. This can be continued for 10-12 years. Fresh or dried leaves can be marketed.

Chemical constituents: *Nonacosane and hentriacontane were isolated from the hexane extract of leaves. An alkaloid gynamine which is a trace constituent was isolated and identified. Antisweet constituent of the leaves has been found to be a mixture of triterpene saponins. These have been designated as gymnemic acids A,B,C and D which have the gymnemagenin and gymnestrogenins as the aglycones of gymnemic acid A and B and gymnemic acid C and D, respectively. These are hexahydroxy triterpenes the latter being partially acylated.*

INDIAN BEECH

Pongamia pinnata

Family- Papilionaceae (Fabaceae)

San: Karanj; Hin: Karanja, Dittouri; Ben: Dehar karanja; Mal: Ungu, Pongu

Pongamia pinnata (Linn.) Pierre syn. *P. glabra* Vent., *Derris indica* (Lam.) Bennet, *Cystisus pinnatus* Lam. Indian beech, Pongam oil tree or Hongay oil tree is a handsome flowering tree with drooping branches, shining green leaves laden with lilac or pinkish white flowers

Uses: The whole plant and the seed oil are used in ayurvedic formulations as effective remedy for all skin diseases like scabies, eczema, leprosy and ulcers. The roots are good for cleaning teeth, strengthening gums and in gonorrhoea and scrofulous enlargement. The bark is useful in haemorhoids, beriberi, ophthalmopathy and vaginopathy. Leaves are good for flatulence, dyspepsia, diarrhoea, leprosy, gonorrhoea, cough, rheumatalgia, piles and oedema. Flowers are given in diabetes. Fruits overcome urinary disease and piles. The seeds are used in inflammations, otalgia, lumbago, pectoral diseases, chronic fevers, hydrocele, haemorrhoids and anaemia. The seed oil is recommended for ophthalmia, haemorrhoids, herpes and lumbago. The seed cake is suggested as a cheap cattle feed. The plant enters into the composition of ayurvedic preparations like *nagaradi tailam, varanadi kasayam, varanadi ghrtam* and *karanjadi churna.*

Soil and climate: The plant comes up well in tropical areas with warm humid climate and well-distributed rainfall. It grows well from plains to and altitude of 1000m above MSL. Though it grows in almost all types of soils, silty soils on riverbanks are most ideal. It is tolerant to drought and salinity. The tree is used for afforestation, especially in watersheds in the drier parts of the country.

Seeds and sowing:-It is propagated through seeds and root suckers. Seed setting is usually in November. Seeds are soaked in water for few hours before sowing. Raised seedbeds of convenient size are prepared, well rotten cattle manure is applied at $1kg/m^2$ and seeds are uniformly broadcasted. The seeds are covered with a thin layer of sand and irrigated. One-month-old seedlings can be transplanted into polybags, which after one month can be planted in the field. Pits of size $50cm^3$ are dug at a spacing of 4-5m, filled with topsoil and manure and planted.

Manuring: Organic manure is applied annually.

After cultivation: Regular weeding and irrigation are required for initial establishment.

Harvesting: The trees flower and set fruits in 5 years. The harvest season extends from November- June. Pods are collected and seeds are removed by hand. Seed, leaves, bark and root is used for medicinal purposes. Bark can be collected after 10 years.

Chemical constituents: The plant is rich in flavonoids and related compounds. Seeds and seed oil, flowers and stem bark yield karanjin, pongamin, pongaglabrone, kanugin, desmethoxykanugin and pinnatin. Stem-bark gives pongachromene, pongaflavone, tetra-O-methylfisetin, glabra I and II, lanceolatin B, gamatin, flavones and α-sitosterol. Heartwood yields chromenochalcones and flavones. Flowers are reported to contain kanjone, gamatin, glabra saponin, kaempferol etc.

INDIAN GOOSEBERRY

Phyllanthus emblica
Euphorbiaceae

San: Amalaka, Adiphala *Hin, Mar: Amla* *Mal, Tam: Nelli*

Indian gooseberry is a medium sized tree

Uses: The fruit is useful in haemorrhage, leucorrhaea, menorrhagia, diarrhoea and dysentery. It goes in combination in the preparation *of triphala, arishta, rasayan, churna* and *chyavanaprash. Sanjivani* pills made with other ingredients is used in typhoid, snake-bite and cholera. The green fruits are made into pickles and preserves to stimulate appetite. Seed is used in asthma, bronchitis and biliousness. Leaves are also useful in conjunctivitis, inflammation, dyspepsia and dysentery. The bark is useful in gonorrhoea, jaundice, diarrhoea and myalgia. The root bark is astringent and is useful in ulcerative stomatitis and gastrohelcosis. Liquor fermented from fruit is good for indigestion, anaemia, jaundice, heart complaints, cold to the nose and for promoting urination. The dried fruits have good effect on hair hygiene and used as ingredient in shampoo and hair oil. The fruit is a very rich source of Vitamin C (600mg/100g) and is used in preserves as a nutritive tonic in general weakness .

Soil and climate: Gooseberry is quite hardy and it prefers a warm dry climate. It needs good sunlight and rainfall. It can be grown in almost all types of soils, except very sandy type.

Seeds and sowing: *Amla* is usually propagated by seeds and rarely by root suckers. Modified ring, patch and shield buddingaswell as soft wood grafting is now extensively practiced. The seeds are enclosed in a hard seed coat, which renders the germination difficult. The seeds can be extracted by keeping fully ripe fruits in the sun for 2-3 days till they split open releasing the seeds. Seeds are soaked in water for 3-4 hours and sown on previously prepared seedbeds and irrigated. Excess irrigation and waterlogging are harmful. One-month-old seedlings can be transplanted to polythene bags and one year old seedlings can be planted in the main field with the onset of monsoon. Pits of size 50 cm^3 are dug at 6-8m spacing and filled with a mixture of top soil and well rotten FYM and planting is done. *Amla* can also be planted as a windbreak around an orchard.

Varieties: Banarasi, Chakaiya, Francis, Kanchan, Krishna, Balwat, NA-6, NA-7, NA-9, Anand-2, BS-1,

Manuring: 1000g N, 500gP2O5 and 750g K2O per plant/ year. The fertilizer should be given in two split doses, viz. April-May & Sept-Oct.

Irrigation: Irrigation should be given to youg plants at 10 days interval during summer. To fruit bearing plantation, first irrigation should be given just at the time of fertiliser application and then at 15 days interval after fruit set (April) till onset on monsoon. Avoid irrigation during floering period.

Plant protection: Rust disease caused by *Ravellenia emblica* appears during July to September. This disease can be controlled by spraying 0.2% Zineb. Fruit rot caused by *Pencillium islandium* can be managed by treating the fruits with sodium chloride. If the fruits show necrosis due to boron deficiency, spray borax at 0.05-0.06%. To control bark eating caterpillar (*Indarbela tetraonis*), inject kerosene oil or Dichlorvos or Endosuphan at 0.05%. The shoot gall maker (*Betousa stylophora*) is contolled by pruning gall twigs and spraying with 0.05% monocrotophos. During the rainy season, aphids (*Cerciaphis emblica*), scale insects and anar butterfly (*Virachola isocrates*) are the other common pests.

Harvesting: Planted seedlings will commence bearing from the 10^{th} year, while grafts after 3-4 years. The vegetative growth of the tree continues from April to July. Along with

the new growth in the spring, flowering also commences. Fruits will mature by December-February by vary substantially with varieties. Fruit yield ranges from 30-50kg/tree/year when full grown. Small sized fruts are used for making ayurvedic medicines. The fruits can be stored up to 15-20 days at low temp, but can be preserved for longer periods in 10-15% salt solution.

Chemical constituents: *Amla* fruit is a rich natural source of vitamin C(750-80 mg/100gram pulp. It also contains cytokinin like substances identified as zeatin, zeatin riboside and zeatin nucleotide. The seeds yield 16% fixed oil, brownish yellow in colour. The plant contains tannins like glucogallia, corilagin, chebulagic acid and 3,6-digalloyl glucose. Root yields ellagic acid, lupeol, quercetin and β- sitosterol.

Ironwood tree

Mesua nagassarium

Family-Clusiaceae

San: Nagapuspah, Nagakesarah; Hin: Nagakesar; Mal: Nagappuvu, Nagachempakam, Nanku, Vayanavu, Churuli, Eliponku;

Uses: Mesua or, commonly known as *Nagapushpam* is an important medicinal plant which finds varied uses in Ayurveda, Siddha and Unani. Leaves are used in the form of poultice that is applied to head in severe colds. Bark and roots in decoction or infusion or tincture is a better tonic and are useful in gastritis and bronchitis. Fixed oil expressed from seeds is used as an application for cutaneous affections, sores, scabies, wounds, etc. and as an embrocation in rheumatism. Dried flowers powdered and mixed with ghee, or a paste made of flowers with addition of butter and sugar, are given in bleeding piles as well as dysentery with mucus. In Ayurveda, it is an ingredient of "*Nagakeshara-adi-Churna*", used for bacillary dysentery and in "*Naga Keshara Yoga*", for piles. In Unani system, the drug is an ingredient of large number of recipes like, "*Jawarish Shehryaran*" a stomach and liver tonic, "*Hab Pachaluna*", an appetiser, "*Halwa-i-supari pack*" a general tonic,.

Soil and climate: The plant prefers plains, riverbanks or places which do not experiences moisture stress for its luxuriant growth. Silty loam soil is suitable for its cultivation.

Seeds and sowing: The plant is propagated by seeds. Seed formation occurs in November-March. Seeds are to be collected and sown in seedbeds or polybags. 3-4 months old seedlings are used for transplanting. Pits of size $45cm^3$ are to be taken at a distance of 3-3.5m and filled with a mixture of 10kg FYM, sand and topsoil and made into a mound. Seedlings are to be transplanted into small hand pits taken on these mounds.

After cultivation: FYM is to be applied twice a year. Regular irrigation and weeding are to be done.

Harvesting: The tree flowers in the fourth year. Flowers can be collected, dried in the sun and marketed

Chemical constituents: Seed oil gives 4-phenyl coumarin analogues-mesuol, mammeigin, mesuagin, mammeisin and mesuone. Bark gives ferruols A and B. Heartwood gives xanthones-euxanthone, mesuaxanthones A and B and a tetroxygenated xanthone named ferraxanthone. Seed oil is rich in oleic, stearic and palmitic acids. Linoleic, arachidic and linolenic acids are also present.

LEADWORT

Plumbago spp.

Plumbaginaceae

The genus *Plumbago* is a popular and medicinally very important group of plants. Three species, namely *P. rosea* (Rosy-flowered Leadwort; Chettikkoduveli, Chuvannakotuveli;), *P. zeylanica* (White flowered Leadwort, Vellakotuveli) and *P. auriculata* (Blue flowered Leadwort; Neelakotuveli) have been identified. Among these *P. rosea* and *P. zeylanica* are important ones.

Uses: Plumbago, in general is an esteemed remedy for leucoderma and other skin diseases. The synonyms of fire like *agnih, vahnih*, etc. are attributed to this drug to indicate the very burning action of the root, causing blisters on the skin (*daranah*). The drug is used only after adequate curing and purification. Root is the economic part and it enters into the composition of preparations like *Citrakasavam, Dasamularista, Gulgulutiktaka kasaya, Yogarajachurna, etc.*

Soil and climate: The plant is grown in tropical to subtropical ecosystems. Warm humid tropical climate is most suited. They come up well in almost all types of deep and well drained soils.

Seeds and sowing: It is propagated by stem cuttings. Three stem cuttings of size 15cm long are planted in polybags of size 14x10cm. IAA and IBA treatments will improve rooting of cuttings. The land is to be ploughed well. About 4 tonnes of FYM are to be applied, mixed thoroughly and seedbed of size 1m breadth, 15cm height and convenient length are to be prepared. On these beds pits are taken at a distance of 25cm and the rooted plants are transplanted from the polybags.

After cultivation: Regular irrigation and weeding are to be carried out. In the second year with the onset of monsoon, seedbeds are again refreshed after adding about 4 tonnes of FYM. Earthing up is to be carried out

Harvesting: At the end of second year tubers are harvested when it contains maximum content of plumbagin. Care should be taken to wear gloves; else the phenols present in the roots will cause burning sensation. The collected tubers are washed, tied into bundles and marketed. Plumbago yields about 7-10t tubers/ha with good management.

MALABAR NUT

Adhatoda beddomei
Family- Acanthaceae

San:Vasaka, Vasa; Hin:Adusa; Mal:Chittadalotakam; Tam:Adutota; Tel:Addasaramu

Malabar nut or Adhatoda is a large evergreen glabrous perennial shrub, 1.2m in height. Another plant *Adhatoda zeylanica* Medicus, syn. *Adhatoda vasica* Nees, *Justicia adhatoda* Linn. of the same genus is a very closely related plant which is most commonly equated with the drug *VASA*. This is seen growing wild almost throughout India while *A. beddomei* is seen more under cultivation, which is called *Chittadalodakam* in Malayalam because of its smaller stature, smaller leaves and flowers.

Uses: It is cultivated for medicinal uses, fencing, manure and as an ornamental plant in pots also. The shrub is the source of the drug *vasaka* well known in the indigenous systems of medicines for bronchitis. Vasaka leaves, flowers, fruits and roots are extensively used for treating common cold, cough, whooping cough, chronic bronchitis and asthma. It has sedative, expectorant, antispasmodic and anthelmintic actions. The juice of the leaves cures vomiting, thirst, fever, dermatosis, jaundice, phthisis, haematenesis and diseases due to the morbidity of *kapha* and *pitta*. The leaf juice is especially used in anaemia and haemorrhage, in traditional medicine. Flowers and leaves are considered efficacious against rheumatic painful swellings and form a good application to scabies and other skin complaints. Many ayurvedic medicines are traditionally prepared out of vasaka *like vasarishtam, vasakasavam* and *vasahareethaki*, which are effective in various ailments of respiratory system.

Soil and climate: Vasaka is seen almost in all types of climate. It prefers loamy soils with good drainage and high organic content. It can be grown well both in hilly and plain lands. It can tolerate high temperature, but is sensitive to frost. It can withstand drought to a great extent.

Seeds and sowing: Commercial propagation is by using 15-20cm long terminal cuttings. This is either grown in polybags first, then in the field or planted directly. The plant is cultivated as a pure crop or mixed with plantation crops. The land is ploughed repeatedly to a good tilth and the surface soil is broken upto a depth of 15cm and mixed with fertilizers. The beds are prepared with 1m breadth and 3-4m length. The cuttings are planted during April-May into the beds at a spacing of 30x30cm.

Manuring: FYM is given at 5-10t/ha in the first year. Regular irrigation and weeding are necessary.

Harvesting: Mature leaves can be harvested after one year**.** Harvesting of whole plant is done at the end of second or third year. Roots are collected by digging the seedbeds. Stems are cut 15cm above the root. Stems and roots are usually dried and stored.

Chemical constituents: *Leaves yield essential oil and an alkaloid vasicine. Stem and roots contain vasicinol and vasicinone. Roots also contain vasicoline, adhatodine, anisotine and vasicolinone. Several alkaloids like quinazoline and valicine are present in this plant.*

GINGER

Zingiber officinale

Family-Zingiberaceae

San: Ardrakam Hin: Adrak, Mal: Inchi, Erukkilannu Tam: Inci

Ginger is a slender perennial herb with robust branched rhizome borne horizontally near surface soil.

Uses: The dried rhizomes are esteemed for its flavour, pungency and aroma. The essential oil and oleoresin extracted from the rhizome is used in the manufacture of flavouring essences and in perfumery. Taken internally, it is a stimulating carminative and externally it is used as a rubefacient and counter irritant.

Soil and climate: The plant prefers a rich soil with high humus content. The crop cannot withstand waterlogging and hence soils with good drainage are preferred for its cultivation. It requires a warm and humid climate. It thrives well from mean sea level to 1500 m. A well distributed rainfall of 1500-3000 mm during the growing season and dry spells during land preparation and harvesting are congenial.

Seeds and sowing: The seed rhizome is 2.5-5 cm long having at least one good bud. They are preserved in covered pits. Smoking of seed rhizome is also practised to enhance germination and ward off pests and diseases. Rhizomes with less fibre, which varies from 1.7-9.0%, have a higher demand. A good tilth is required in order to produce good shaped rhizomes in hard soils they are often malformed. Rhizome seeds at the rate of 1000-1500 kg/ha are planted on raised beds at 20-30 cm spacing and 5-10 cm deep. Land is prepared during April-May.

Varieties: Varieties preferred for green ginger are' Rio-de Janeiro', 'China' and 'Wyanad local' and for dry ginger are 'Maran', 'Wyanad', 'Manantody' and 'Valluvanad. In Taiwan 'Ta-Kuang' and 'Chu-chiang' are cultivated.

Manuring: Ginger benefits greatly from the application of organic manures. 25-30 tonnes/ha of cattle manure or compost is applied at planting. Fertilizers are applied at 75:50:50 kg N, P_2O_5 and K_2O/ha. Full dose of P and half of K may be applied as basal dose. Half dose of N may be applied 2 months after planting and the remaining quantity of N and K may be applied 4 months after planting. Being an exhausting crop, ginger is not cultivated continuously in the same and hence crop rotation crop is practised.

After cultivation: Mulching is an essential operation for high yield. Application of leaf mulch during planting and after each topdressing followed by earthing up, using a total of 20 tonnes of green leaves/ha is essential..

Plant protection: Rootknot nematode (*Meloidogyne incognita*) and shoot borer (*Dichocrosis punctiferalis*) attack the crop. Shoot borer can be cxontrolled by spraying dimethoate or quinaplhos at 0.05%.

Leaf spot caused by *Colletotrichum zingiberis* and *Phyllosticta zingiberi*, rhizome soft rot caused by *Pythium aphanidermatum* and bacterial wilt caused by *Pseudomonas solanacearum* are the common diseases of ginger. Leaf spot can be controlled by spraying with 0.2% thiram. Soft rot can be prevented by treating seed rhizomes with any copper-based fungicide. Whem incidence of the disease is noted in the field, dig out the affected the plants and drench the beds with Cheshunt compound or 1% Bordeaux mixture.

Harvesting and processing: For vegetable and preserved ginger, the crop can be harvested from 6 monthsand for dry ginger, harvesting is done during 8-9 months after planting. The yields vary from 20-30 t/ha fresh ginger, which produces 20-30% of dried ginger. Irrigated crops have produced yields as high as 40 t/ha.

For the production of dried ginger, the rhizomes are cleaned of dirt and roots and washed in water, carefully scraped and dried in the sun for 5-6 days. The scraped or peeled

ginger is known as *uncoated ginger* and that with the epidermis still attached as *coated ginger*. The rhizomes are sometimes bleached by sulphur fumes or lime water. The dried rhizomes may be powdered to produce ground ginger. The essential oil is generally obtained from un-scraped powdered ginger. Steam distillation for 10-15 hours yields 1.0-2.7% oil. Ginger oleoresin is obtained by solvent extraction of powdered, dried ginger. The average yield is 4.5-6.5%.

Chemical constituents: The essential oil is a pale yellow liquid with a warm spicy sweet strongly aromatic odour and sharp pungent flavour. The chief constituent is a sesquiterpene, called zingiberene. The pungent principle of ginger is zingerone.

GLORY LILY

Gloriosa superba
Family-Liliaceae

San : Langali, Visalya, Agnishika,Shakrapushpi, Garbhaghatini, Hin : Kalihari
Mal: Menthonni, Tam: Akkinichilam

Glory lily is a glabrous herbaceous climber, which yields different types of troplone alkaloids of medicinal importance. The genus has importance in the ornamental horticulture due to its bright flowers and wiry climbing stem.

Uses: The roots and rhizomes are used in traditional system of medicine. Its abortifacient and antipyretic properties have been mentioned in ancient classics "*Charaka*". The name *Garbhaghatini* is due to this abortifacient activity. They are useful in the treatment of inflammations, ulcers, scrofula, hemorrhoids, pruritus, dyspepsia, helminthiasis, flatulence, intermittent fevers and debility. The root is given internally as an effective antidote against cobra poison. A paste of the root is also used as an anodyne; applications in bites of poisonous insects, snakebites, scorpion sting, parasitic skin diseases and leprosy

Soil and climate: *G. superba* is a shallow rooted plant and grows well in a variety of soils either clay or sand through out India. It grows well in a light porous soil with good drainage. For vigorous growth, greater blooms and strong tuber, a mixture of soil, sand and compost manure is recommended. This is a rainy season plant and sprouts well in warm, humid and tropical conditions. It should be grown in sun as the plants in shade become weedy and thin and move towards light.

Seeds and sowing: The propagation is mainly by tubers, by division of rhizomes. Seeds remain dormant for 6-9 months and due to hard seed coat, about 20-30 days are required for germination and seeds may take 3-4 years before it matures to flower. Treatment of seeds by gibberellin (1-3ppm) resulted in higher yield of colchicine in the plant and higher production of tubers. The seeds and rhizomes are sown usually in the last week of June to mid July. The rhizomes are planted by splitting carefully into two from their 'V' shaped joints (two buds being at the extreme end of each rhizome) in lines 20cm apart at a distance of 20cm (while seeds are sown in lines at a distance of 4-6cm apart).

After cultivation: They are watered regularly when the plants are growing. After green shoots appear 2-3 showers are weekly. The irradiation of the plant at 42% natural sunlight intensity increased the production of tuber and colchicine.

Harvesting and processing: They usually takes 6-10 weeks to flower after sprouting and then set on fruits. The fruits ripen at the end of October and after that aerial shoot eventually dies, leaving the fleshy tubers underground. The tubers are dug out with great care. An individual plant produces 50g tubers on an average. The average yield is around 4000-5000kg of rhizomes and 1000 kg of seed per hectare. The content of colchicines is usually 0.358% and 1.013% in tubers and seeds, respectively.

Lixivation of the material is done with 70% ethyl alcohol. Concentrated under vacuum to one third of its volume and extracted with chloroform for colchicine and related substances-concentration of the aqueous phase to syrup, which is extracted, 6-8 times with a mixture of $CHCl_3$ - alcohol (4:1) to yield colchicoside.

Chemical constituents: The major alkaloids are colchicine, 3-demethyl colchicine and colchicoside. There is another alkaloid gloriosine which promises to be even more effective than colchicine in plant breeding for inducing polyploidy.The flowers, leaves and tubers contain colchicine, superbin, N-formyl deacetyl colchicine, demethyl colchicine and lumicolchicine. Tubers also contain gloriosine. Leaves in addition, contain chelidonic acid, 2-hydroxy-6-methoxy benzoic acid and β-sitosterol glucoside. Colchicine, demethyl colchicine and colchicoside have been reported from seeds.

GREATER GALANGAL

Alpinia galanga

Family-Zingiberaceae

San: Sugandhamula, Rasna; Hin:Kulainjan; Mal:Aratta, Chittaratha; Tam : Arattai

The *greater galangal, Java galangal* or *Siamese ginger* is a perennial aromatic rhizomatous herb with non-tuberous pungent rootstock. It grows to a height of 1.5m and produces around 24 suckers per clump/year

Uses: The rhizomes are used in bronchial infections and as a carminative. They are also useful in treatment against rheumatoid arthritis, inflammations, stomatopathy, pharyngopathy, cough, asthma, hiccough, dyspepsia, stomachalgia, obesity, diabetes, cephalagia, tubercular glands and intermittent fevers.

Soil and climate:-Siamese Ginger comes up well in tropical climate with an annual rainfall ranging from 1500-3000cm. It grows on a wide range of climates and soils. Well-drained hilly areas and places of 1400m high altitude are good for its cultivation. Fertile red loams to forest soils are suitable.

Seeds and sowing: *This is propagated through rhizomes. Rainfed crop is planted with the onset of monsoon in May – June. Irrigated crop can be planted any time. The field should be ploughed to a good tilth. All the stones and pebbles should be removed. Seedbeds are prepared at 1m breadth, 15cm height and of convenient lengths. Take small pits on the seedbed and plant 5 cm long rhizome bits. Cover rhizome with FYM and mulch the seedbed with leaves or straw. The optimum spacing is 30X20cm under good fertility and 40X30cm under poor fertility conditions. Seedbeds are covered with dried leaves. Fresh healthy disease free rhizome bits with at least one shoot is used for planting. Seed rate is 1000 – 1500 kg/ha.*

Varieties: *At present, only local types are available for cultivation.*

Manuring: *Incorporate FYM at 10-15t/ha at the time of bed formation. Apply fertilisers at 100:50:50 kg NPK/ha/year in 2-3 split doses. Application of biofertiliser Azospirillum at 10 kg/ha and cow pea green manuring in situ are beneficial for the crop.*

After cultivation: It is irrigated immediately after planting. Carry out gap filling, if any, within one month; remove weeds two months after planting followed by top dressing, earthing up and mulching. There after no weeding is required as the crop smothers the weeds. It can be cultivated also as an intercrop in coconut or rubber plantations.

Plant protection: *Usually pests and diseases are not serious enough to take up any control measures. Occasionally shoot borers and leaf eating caterpillars and blight disease are observed.*

Harvesting and processing: Though the crop can be harvested after 18 months, the optimum stage of harvest for obtaining maximum rhizome and oil yield is 36- 42 months after planting. Cut and remove the shoot portion and carefully dig out the rhizomes and roots. Harvesting is very arduous due to strong and extensive root ramification. Separate the roots, clean the rhizomes and cut into 5 cm long pieces which are dried in sun for 3-5 days to 10% moisture for marketing. The average yield of rhizome is 23 t/ha, which on drying gives 25% recovery. The fresh rhizomes on steam distillation for 3-5 hours give 0.22 % essential oil. The oil recovery on dry weight basis is 0.93%. Root is also a significant contributor of essential oil.

Chemical constituents: The rhizome contains tannins and flavonoids, some of which have been identified as kaempferide, galangin and alpinin. Rhizomes yield essential oil containing methyl cinnamate, cineole and d-pinene and sesquiterpenoids. Fresh rhizome contain 18 monoterpenoids of which α-pinene, β-pinene and limonene as major

compounds and 17 oxygen containing monoterpenoids with cineol, terpinen-4-o1 and α-terpineol as minor compounds.

HEART'S PEA

Cardiospermum halicacabum

Family-Sapindaceae

San : Sakralata, Indravati; Hin: Kanphuti, Kapalphoti; Ben: Lataphatkari; Mal: Uzhinja

Baloon Wine or Heart's pea is a climber whose seeds have a white heart-shaped aril. This is one of the ten auspicious herbs that constitute the group *Dasapushpam*.

Uses:-The entire plant is used in medicine. The roots are useful in strangury, fever, arthritis, amenorrhoea, lumbago and neuropathy. The leaves are good for arthritis, otalgia and ophthalmodynia. The seeds are good for arthritis and fever. The plant has sedative action on the central nervous system .Roots and leaves are good for hair growth and are useful in rheumatism, nervous diseases, piles ,chronic bronchitis, fevers, hydrocele, amenorrhoea, sprains and edema. Juice of the plant is dropped into the ear in earache. The plant is found to exhibit significant diuretic and anti-inflammatory activity . The plant also shows sedative effect on central nervous system, significant analgesic, vasodepressant and anti-spasmodic effects are some of the preparations using the drug.

Seeds give an alkaloid fraction. Seed oil contained fatty acid esters of 1-cyano-2-hydroxy methyl prop-2-en-1-ol, 1-cyano-2-hydroxy methylprop-1-en-3-ol and methyl-4, 4-dimethoxy-3- (methoxymethyl) butyrate. The alkaloid fraction from seeds showed antibacterial and hypotensive activities and cardiac inhibition in anaesthetized dogs, blocked spasmogenic effects of acetylcholine histamine and 5-HT on guinea pig ileum, biphasic effect on frog *Rectus abdominis* muscle. The plant is antirheumatic and antidote for snakebite. Root is diaphoretic, diuretic, aperient, laxative, rubefacient and emmenagogue (Husain *et al*, 1992).

INDIAN BDELLIUM

Commiphora mukul

Family-Burseraceae

San: Gugulu, Mahisaksah, Koushikaha, Devadhupa; Hin: Gugal; Mal: Gulgulu

Indian bdellium is a small, armed, deciduous tree from the bark of which gets an aromatic gum resin, the ***'Guggul'*** of commerce.

Uses: It is a versatile indigenous drug claimed by ayurvedists to be highly effective in the treatment of rheumatism, obesity, neurological and urinary disorders, tonsillitis, arthritis and a few other diseases.

Soil and climate: Guggal being a plant of arid zone thrives well in arid subtropical to tropical climate. Though they prefer hard gypseous soil, they are found over sandy to silt loam soils, poor in organic matter but rich in several other minerals in arid tracks of western India. The rainfall in the guggul growing tract may average between 100mm and 500mm while air temperature may vary between 40°C in summer and −3°C during winter.

Seeds and sowing: Plants are propagated through seeds or stem cuttings. Plants are best raised from stem cuttings from the semi-woody branch. For this purpose one metre long woody stem of 10mm thickness is selected and the cut end is treated with IBA or NAA and planted in a well-manured nursery bed during June-July months. The beds should be given light irrigation periodically. The cuttings initiate sprouting in 10-15 days and grow into good green sprout in 10-12 months. These rooted plants are suitable for planting in the fields during the next rainy season. The cuttings give 80-94% sprouting usually. Air layering has also been successfully attempted and micro propogation techniques are also available. Seed germination is very poor (5%) but seedling produce healthier plants.

After cultivation: The rooted cuttings are planted in well laid-out fields during rainy season. Pits of size $0.5m^3$ are dug out at 3-4 m spacing in rows. FYM is mixed with filler

soil and the seedlings are planted. Care should be taken to protect the new plants from white ants damage.

Manuring: Generally, the plant does not respond to fertilizers except to low level of nitrogen in very poor soils.

Aftercultivation: Removal of side branches and low level of irrigation supports a good growth of these plants. The plantation does not require much weeding and hoeing. But the soil around the bushes be pulverised twice in a year to increase their growth and given urea or ammonium sulphate at 25- 50g per bush at a time and irrigated.

Plant protection: C*ercospora* leaf spot and bacterial leaf blight were noticed to cause damage. Against leaf spot, spray 1% Bordeaux mixture. A leaf eating caterpillar (*Euproctis lanata* Walker) and White fly (*Bemisia tabaci*) are the important pests reported and can be controlled by spraying contact insecticides.

Harvesting and processing: Stem or branch having maximum diameter of about 5cm at place of incision, irrespective of age is tapped. The necrotic patch on the bark is peeled off with a sharp knife and Bordeaux paste is applied to the exposed surface of the stem or branch. A prick chisel of about 3cm width is used to make bark-deep incisions. If tapping is successful, gum exudation ensures after about 15-20 days from the date of incision and continues for nearly 30-45 days. A piece of polythene sheet can be pouched around the place of incision to collect gum. Alternatively, a polythene sheet can be spread on the ground to collect exuded gum. A maximum of about 500g of gum has been obtained from a plant. The best grade of guggul is collected from thick branches of tree. These lumps of guggul are translucent. Second grade guggul is usually mixed with bark, sand and is dull coloured guggul. Third grade guggul is usually collected from the ground, which is mixed with sand, stones and other foreign matter.

Chemical constituents: The gum resin contains guggul sterones Z and E, guggul sterols I-V, cembrene A and mukulol. Major components from essential oil of gum resin are myrcene and dimyrcene. Flowers contain quercetin and its glycosides as major flavonoid components, other constituents being ellagic acid and pelargonidin glucoside.

INDIAN CROCUS

Kaempferia rotunda

Family-Zingiberaceae

San: Bhumicampaka, Bhucampaka, Hallakah; Hin: Abhuyicampa Mal: Chengazhuneerkizhengu, Chengazhuneerkuva; Tam: Nerppicin

Kaempferia rotunda Linn. is an aromatic herb with tuberous root-stalk and very short stem.

Uses: The tubers of Indian crocus are widely used as a local application for tumours, swellings and wounds. They are also given in gastric complaints. They help to remove blood clots and other purulent matter in the body. The juice of the tubers is given in dropsical affections of hands and feet, and of effusions in joints. In Ayurveda, the improvement formulations using the herb are *Chyavanaprasam, Asokarishtam, Baladthatryaditailam, Kalyanakaghritham, etc*. The drug "*HALLAKAM*" prepared from this is in popular use in the form of powder or as an ointment application to wounds and bruises to reduce swellings.

Soil and climate: The plant is a tropical one adapted for tropical climate. Rich loamy soil having good drainage is ideal for the plant. Laterite soil with heavy organic manure application is also well suited.

Seeds and sowing: Planting is done in May-June with the receipt of 4 or 5 pre-monsoon showers. The seed rate recommended is 1500-2000kg rhizomes/ha. Whole or split rhizome with one healthy sprout is the planting material. Well developed healthy and disease free rhizomes with the attached root tubers are selected for planting. Rhizomes can be stored in cool dry place or pits dug under shade plastered with mud or cowdung. The field is ploughed to a fine tilth, mixed with organic manure at 10-15t/ha. Seedbeds are prepared at a size of 1m breadth and convenient length. Pits are made at 20cm spacing in which 5cm long pieces of rhizomes are planted.

Manuring: Pits are covered with organic manure. They are then covered with rotten straw or leaves. Apply FYM or compost as basal dose at 20 t/ha either by broadcasting and ploughing or by covering the seed in pits after planting. Apply fertilisers at the rate of 50:50:50 kg N, P_2O_5 and K_2O/ha at the time of first and second weeding. After planting, mulch the beds with dry or green leaves at 15 t/ha.

Plant protection: During heavy rainy months, leaf rot disease occurs which can be controlled by spraying 1% Bordeaux mixture.

Harvesting and processsing: The crop can be harvested after 7 months maturity. Drying up of the leaves is the indication of maturity. Harvest the crop carefully without cutting the rhizome, remove dried leaves and roots. Wash the rhizome in water. They are stored in moisture-proof sheds. Prolonged storage may cause insect and fungus attack.

Chemical constituents: *The tubers contain crotepoxide and b-sitosterol. Tuber contains essential oil, which give a compound with melting point 149^oC, which yielded benzoic acid on hydrolysis.*

INDIAN GINSENG

Withania somnifera
Family -Solanceae

San: Aswagandha, Varahakarni Hin: Asgandh, Punir Mal: Amukkuram Tam: Amukkira. Indian ginseng or Winter cherry is an erect branching perennial under-shrub

Uses: Indian ginseng is considered to be one of the best rejuvenating agents in Ayurveda. Its roots, leaves and seeds are used in Ayurvedic and Unani medicines, to combat diseases ranging from tuberculosis to arthritis. Roots are prescribed in medicines for hiccup, several female disorders, bronchitis, rheumatism, dropsy, stomach and lung inflammations and skin diseases. Its roots and paste of green leaves are used to relieve joint pains and inflammation. It is also an ingredient of medicaments prescribed for curing disability and sexual weakness in male. Leaves are used in eye diseases. Seeds are diuretic. It is a constituent of the herbal drug '*Lactare*' which is a galactagogue. It improves physical strength and is prescribed in all cases of general debility.

Soil and climate: It is a tropical crop growing well under dry climate. The areas receiving 600 to 750mm rainfall is best suited to this crop. The roots are fully developed when 1-2 late winter rains are received. Sandy loam or light red soils having a pH of 7.5- 8.0 with good drainage are suitable for its cultivation. It is usually cultivated on poor and marginal soils.

Seeds and sowing: *Withania* is propagated through seeds. It is a late *kharif* crop and planting is done in August. Seeds are either broadcast-sown or seedlings are raised in nursery and then transplanted. Seed rate is 10-12 kg/ha for broadcasting and 5kg/ha for transplanting. In direct sown crop plants are thinned and gap filling is done 25-30 days after sowing. Seeds should be treated with Dithane M-45 at 3g/kg of seeds before sowing. Seeds are sown in the nursery just before the onset of rainy season and covered with light soil. Seeds germinate in 6-7 days. When seedlings are six weeks old they are transplanted at 60cm in furrows taken 60cm apart.

Manuring: The crop is mainly grown as a rainfed crop on residual fertility and no manure or fertilizers are applied to this crop generally. However, application of organic manure is beneficial for realizing better yields.

After cultivation: One hand weeding 25-30 days after sowing helps to control weeds effectively.

Plant protection: No serious pest is reported in this crop. Diseases like seedling rot and blight are observed. Seedling mortality becomes serious under high temperature and humid conditions. The disease can be minimized by use of disease free seeds and treatment with Thiram or Deltan at 3-4g/kg seed before sowing. Further, use of crop rotation, timely sowing and keeping field well drained also protect the crop.

Harvesting and processing: Aswagandha is a crop of 150-170 days duration. The drying of the leaves and reddening of berries indicate the maturity of the crop. Harvesting usually starts from January and continues till March. Roots, leaves and seeds are the economical parts. The entire plant is uprooted for roots, which are separated from the aerial parts. The berries are plucked from dried plants and are threshed to obtain the seeds. The yield is 400-500kg of dry roots and 50-75kg seeds per hectare.

The roots are separated from the plant by cutting the stem 1-2cm above the crown. Roots are then cut into small pieces of 7-10cm to facilitate drying. Occasionally, the roots are dried as a whole. The dried roots are cleaned, trimmed, graded, packed and marketed. Roots are carefully hand sorted into four grades.

Chemical constituents: Aswagandha roots contain alkaloids, starch, reducing sugar, hentriacontane, glycosides, dulcital, withaniol acid etc.

INDIAN SARASAPARILLA

Hemidesmus indicus

Family-Asclepiadaceae

San: Anantamulah, Sariba; Hin: Anantamul, Magrabu; Ben: Anantamul; Mal: Nannari, Naruninti, Narunanti; Tam: Nannari, Saribam; Tel: Sugandipala; Kan: Namadaballi

Indian *sarasaparilla* or country *sarasaparill*a is a climbing slender plant with twining woody stems and a rust-coloured bark.

Uses: The roots are useful in vitiated conditions of *pitta*, burning sensation, leucoderma, leprosy, skin diseases, pruritus, asthma, bronchitis, hyperdipsia, opthalmopathy, hemicrania, epileptic fits, dyspepsia, helminthiasis, diarrhoea, dysentery, haemorrhoids, strangury, leucorrhoea, syphilis, abcess, arthralgia, fever and general debility. The leaves are useful in vomiting, wounds and leucoderma. The stems are bitter, diaphoretic and laxative and are useful in inflammations, cerebropathy, hepatopathy, nephropathy, syphilis, metropathy, leucoderma, odontalgia, cough and asthma. The latex is good for conjunctivitis The important formulations using the drug are *Saribadyasava, Pindataila, Vidaryadi lehya, Draksadi kasaya, Jatyadi ghrita*, etc.

Seeds and sowing: Hemidesmus is propagated through root cuttings. The root cuttings of length 3-5cm can be planted in polybags or in the field. They can be planted in flat beds or on ridges. Planting is done usually at a spacing of 50x20cm

Varieties: The Ayurvedic texts mention two varieties, viz. krsna or black variety and sveta or white variety.

After cultivation: Heavy application of organic manure is essential for good growth and root yield. Inorganic fertilizers are not usually applied. Frequent weeding and earthing up are required, as the plant is only slow growing. Provision of standards for twining will further improve the growth and yield of the plant.

Chemical constituents: The twigs of the plant give a pregnane ester diglycoside named desinine. Roots give β-sitosterol, 2-hydroxy-4-methoxy benzaldehyde, α-amyrin, β-amyrin and its acetate, hexatriacontane, lupeol octacosonate, lupeol and its acetate. Leaves, stem and root cultures give cholesterol, campesterol, β-sitosterol and 16-dehydro-pregnenolone.

IPECAC

Cephaelis ipecacuanha

Family-Rubiaceae

Ipecac is a small evergreen herb with much branched beaded roots.

Uses: It is used in powdered form or as liquid total extract, syrup and tincture. Ipecac syrup in small doses is used as an expectorant, as it is well tolerated by children. It is used in treatment of whooping cough. Ipecac with opium as in Dover's powder is used as a diaphoretic, tincture and syrup. Emetine hydrochloride in the form of injection is used for treatment of amoebic dysentery. Emetine bismuth iodide is also given orally for amoebic dysentery. Ipecac is also used as gastric stimulant and as an anti-inflammatory agent in rheumatism.

Soil and climate: Ipecac prefers an average rainfall ranging between 2000-3000mm and evenly distributed. Maximum temperature should not exceed 38°C and the minimum not below 10°C. It thrives well in tropical mild humid climates. Virgin forest soils rich in humus are ideal for Ipecac. It prefers deep medium fertile soils which are acidic and rich in humus, potash and magnesium. Soil should be well drained. As Ipecac grows only in shade, it can be cultivated as an intercrop, or planted in artificially shaded beds.

Seeds and sowing: The plant is propagated either through seeds or by root, stem or leaf cuttings. Commercial plantations are raised through seeds. Raised seedbeds of 2x6m size are made and the soil is mixed with well rotten leaf compost and sand. These are provided with shade on the top as well as on the sides. Seeds are drilled or broadcasted in the beds and watered regularly. Seeds take 3-5 months to germinate. Seed treatment with limewater for 48 hours or hydrogen peroxide improves germination. It has been observed that providing mulch or black polythene in nursery beds improves germination as well as results in control of weeds. The suitable season of planting is January-March. 8-12 weeks old seedlings are planted in production beds at a spacing of 10x10cm. A system of raising second nursery is also practiced in some areas.

Manuring: FYM and leaf compost application is required during second and third year. Super phosphate application is found to improve root growth.

Irrigation: Frequent irrigation is required. Water logging should be avoided. Both the seedbeds and production beds should be kept free from weeds.

Plant protection: Seedlings are often attacked by *Rhizoctonia* sp causing damping off in nursery. Treat the seeds with a suitable seed dressing fungicide before planting. Wilt caused by *Fusarium moniliforme* has been reported from India.

Harvesting and processing: The plants are ready for harvesting after 4 years. The roots are dug out, washed and dried in the sun. Rhizome and root are the economical parts.

Chemical constituents: Ipecac root contains 2.2-2.5% total alkaloids. The main alkaloids are cephaeline and emetine. It also contains psychotrine and psychotrine ethyl ether.

LIQUORICE

Glycyrrhiza glabra

Family-Papilionaceae (Fabaceae)

San: Yashtimadhu Hin: Jathimadh Mal: Irattimadhuram Tam:Athimadhuram ***Liquorice or Muleti is a perennial herb or undershrub about 1m high. Its dried peeled or unpeeled underground stems and roots constitute the drug***

Use: It is an important constituent of all cough and catarrh syrups. Hippocrates mentioned its use as a remedy for ulcers and quenching of thirst. Dioscorides, the father of Greek medicine described this drug in detail and considered it useful for maintaining shape of arteries and in burning stomach, trouble of liver and kidney, scabies, healing of wounds and as a remedy for eye diseases. The commercial name of the dried rhizome and root of the plant is liquorice, which is used as flavouring agent in confectionery industries, and its products are widely reported to be useful in ulcer therapy

Soil and climate: Well-drained light loam soils, which are rich in calcium and magnesium with slightly alkaline pH and free from stones, are ideal for this crop. This plant thrives well in subtropical areas with very warm summers and cool winters with a rainfall not exceeding 500mm. Semi-arid and arid areas in subtropical zones are not suitable for the cultivation of this crop. It does not tolerate high humidity and waterlogged conditions.

Varieties: There are a number of varieties among which *Spanish, Russian* and *Persian* liquorice are quite common. Commercial varieties are *Typica*, *Regel* and *Herd*.

Seeds and sowing: It can be propagated by seed, but usually multiplied vegetatively either through crown cuttings or stolon pieces. In the case of crown cuttings, 10-15cm long crown pieces with 2-3 buds are planted vertically at a distance of 0.6-0.7m in rows 1-1.5m apart. However, most of the liquorice is propagated through stolon pieces of the above size planted horizontally, preferably on ridges during spring at the same distance as above.

Manuring: This plant normally does not require much fertilizers but in deficient soils, it is better to apply 10-15 tonnes FYM per hectare before planting. The field should be immediately irrigated after planting in spring and after the crop has sprouted.

After cultivation: Space between the rows should be kept free from weeds. Short term vegetables like carrot or cabbage can be planted between the rows for additional income. In order to produce good rhizome, flowering shoots are clipped. Normally **i**t requires very little irrigation.

Plant protection: No serious disease except leaf spot caused by *Cercospora cavarae* has been reported in this crop. The disease is controlled by 1% Bordeaux mixture.

Harvesting and processing: Roots are ready for harvesting after 3-4 years. The root is dug when the top has dried during autumn (November-December). A trench 60cm deep is dug along the ridges and the entire root is lifted. Broken parts of the root left in the soil, sprout again and give another crop after 2-3 years. Thus liquorice once planted properly can be harvested for 10-15 years.

Harvested roots are cut into pieces of 15-20cm long and 1-2cm in diameter. They are washed and dried up to 6-8% moisture in the sun and shade alternately, which reduces the weight by 50%. The average yield of dried roots varies from 1-3 tonnes per hectare depending on the variety, soil and climatic conditions.

Chemical constituents: Glycyrrhizin, a triterpene glucoside that is converted to glycyrrhetinic acid on enzyme hydrolysis, is the principal constituent of *G. glabra*. Root also contains flavans, flavones, isoflavanoes and coumarins including a 4-methyl coumarin, liqcoumarin, glabridin, glabrene, 4'-O-methyl and 3'-methoxyglabridin.

LONG PEPPER

Piper longum
Family-Piperaceae

San: Pippali; Hin, Ben, Pun: Piplamul; Kan, Mal:Thippali ; Tam: Thippili; Mar: Pimpli Long pepper is a slender aromatic climber whose spike is widely used in ayurvedic and unani systems of medicine particularly for diseases of respiratory tract.

Uses: *Pipalarishta, Pippalyasava, Panchakola, Pippalayadilauha,* and *Lavana bhaskar churan* are common ayurvedic preparations made out of the dry spikes of female types. *Ittrifal fauladi, Angaruya-i-kabir* and *Majun khadar* are well known *unani* preparations of long pepper. The root is useful in bronchitis, stomach ache, diseases of spleen and tumours. Root and fruit are used in gout and lumbago. The infusion of root is prescribed after parturition to induce the expulsion of placenta. The root and fruit decoction are used in acute and chronic bronchitis and cough. It contains the alkaloid **piperine** which has diverse pharmacological activities, including nerve depressant and antagonistic effect on electro- shock and chemo-shock seizures as well as muscular incoordination.

Soil and climate: Long pepper is successfully cultivated in well drained forest soils rich in organic matter. Laterite soils with high organic matter content and moisture holding capacity are also suitable for cultivation. It is a tropical plant adapted to high rainfall areas with high humidity. An elevation of 100-1000 m is ideal. It needs partial shade to the tune of 20-30% for best growth. The natural habitat of the plant is on the borders of streams.

Seeds and sowing: Long pepper is propagated by suckers or rooted vine cuttings.15-20 cm long 3-5 nodded rooted vine cuttings establishes very well in polybags. The best time for raising nursery is March-April. Normal irrigation is given on alternate days. The rooted cuttings will be ready for transplanting in 2 months time. With the onset of monsoon in June the field is ploughed well and brought to good tilth. 15-20 cm raised beds of convenient length and breadth are taken. On these beds, pits are dug at 60 x 60 cm spacing and well decomposed organic manure at 100 g/pit is applied and mixed with the soil. Rooted vine cuttings from polybags are transplanted to these pits.

Manuring: The crop needs heavy manuring at the rate of 20 t FYM/ha every year. Application of wood ash is found to enhance crop growth and spike production. Application of heavy dose organic matter and mulching increase water retention in the soil and control weeds. Small doses of chemical fertilisers can also be used.

Irrigation:-The crop needs irrigation once a week. Sprinkler irrigation is ideal. With irrigation the crop continues to produce spikes and off-season produce will be available. However, it is reported that unirrigated crop after the onset of monsoon grows vigorously and shows much hardiness than the irrigated crop.

After cultivation: Gap filling can be done after one month of planting. *Piper longum* can also be cultivated as an intercrop in plantations of coconut, subabul and eucalyptus. Weeding has to be resorted to whenever necessery. However, care is to be taken not to break the roots of thippali, as any damage result in damping off the plants.

Plant protection: Crop losses can be heavy due to pests and diseases. Mealy bugs and root grubs, attack the plant particularly during summer. Infested plants show yellowing and stunted growth. Drenching with systemic insecticides like nuvacron or dimecron will control the pests. Adults and nymphs of *Helopeltis theivora* severely feeds on the foliage which can be controlled by 0.25% neem kernel suspension. Rotting of leaves and vines during monsoon season is caused by *Colletotrichum gloriosporiodes* and necrotic lesions and blights on the leaves during summer is caused by *Colletotrichum* and *Cercospora spp*. These diseases can be controlled by spraying of 1% Bordeaux mixture repeatedly. A virus

like disease characterised by yellowing and crinkling of leaves, stunted growth and production of spikes of smaller size and inferior quality was also recently reported.

Harvesting and processing: The vines start flowering six months after planting and flowers are produced almost throughout the year. The spikes mature in 2 months time. The optimum stage of harvest is when the spikes are blackish green. The pungency is highest at this stage. Spikes are hand picked when they become mature and then dried. The yield of dry spike is 400 kg /ha during first year, increases to 1000kg during third year and thereafter it decreases. Therefore, after 3 years the whole plant is harvested. The stem is cut close to the ground and roots are dug up. Average yield is 500 kg dry roots/ha .

The harvested spikes are dried in sun for 4-5 days until they are perfectly dry. The green to dry spike ratio is 10:1.5 by weight. The dried spikes have to be stored in moisture proof containers. Stem and roots are cleaned, cut into pieces of 2.5-5 cm length, dried in shade and marketed as piplamool. There are three grades of piplamool, based on the thickness. The commercial drug consists 0.5-2.5 cm long, 0.5-2.5 mm thick, cylindrical pieces dirty light brown in colour and peculiar odour with a pungent bitter taste, producing numbness to the tongue.

Chemical constituents: The spike of long pepper contains 4-5% piperine, piplartin, piperolactam, N-isobutyl deca trans-2-trans-4-dienamide and piporadione alkaloides, besides 0.7 % essential oil. Roots gave the alkaloids piperine, piperlongamine (piplartine) and piperlongaminine; sesamine, methyl -3, 4, 5-trimethoxy cinnamate. Stem gave triacoutane 22, 23 - dihydrostigmasterol. Fruit essential oil contains piperidine, caryophyllene and sesquiterpene alcohol.

MANGO GINGER

Curcuma amada

Family-Zingiberaceae

San: Amrardrakam, Karpooraharidra Hin: Ama-haldi Mal: Maanga Inchi Tam: Maankai Inchi

Mango-ginger is an under exploited spice crop which grows luxuriantly in tropical soils with good drainage

Uses: The rhizome of Mango ginger is bitter, sweet sour, aromatic, cooling, appetiser, carminative, digestive, stomachic, demulcent, vulnerary, febrifuge, alexertic, aphrodisiac, laxative, diurectic, expectorant, antiinflammatory and antipyretic. The rhizome of mango-ginger is used for preparing pickles, chutney, preserve, candy, sauce and salad and in meat and other culinary preparations. The rhizome has excellent medicinal properties.

Soil and climate: It prefers laomy well drained fertile soil. Hot humid tropical climate with high rainfall more than 1500mm are essential. The crop comes up well in open conditions, but it tolerates low levels of shade and therefore partially shaded situations can also be utilised for its cultivation.

Seeds and sowing: Whole or split mother rhizomes or well developed, healthy and a disease free finger rhizome weighing 15-20 g is suitable for planting. Prepare the land to a good tilth during February – March subject to the availability of pre-monsoon showers. Prepare beds of convenient length, 1.2m wide, 25cm high with 40 cm spacing between beds. Plant during April with the commencement of pre-monsoon showers. Take small pits in the beds with spacing of 25x30cm and at a depth of 4-5 cm. Seed rate is 1500 Kg/ha.

Varieties: In Kerala local varieties are used for cultivation.'*Amba*' is a released variety from Pottangi.

Manuring: Apply cattlemanure or compost as basal dose @ 30-40 t/ha, spread over the beds and mix well. Apply NPK fertiliser @ 30:30:60 Kg/ha. Full dose of P and half dose of K may be applied 60 days after planting.

After cultivation: Mulch the crop immediately after planting with green leaves @ 15t/ha. Repeat mulching after 50 days with same quantity of green leaves.

Aftercultivation: The rhizomes germinate within 3-4 weeks. Remove weeds 45 days after planting and repeat if necessary. Earth up the crop after 60 days of planting.

Plant protection: Shoot borer (*Dichocrocis punctiferalis*) cause damage to the crop. Appearance of 'deadheart'in the field is the main symptom. Pull out the deadhearts with the larvae inside and burn it. If infestation is severe, spray Dimethoate or quinalphos at 0.05%.

Harvesting: In homesteads partial harvesting is the practice adopted to suit the family requirement for preparing chutney or for medicinal use. Drying of the leaves is the indication of harvesting time. From sixth month onwards harvesting can be done by lifting the entire plant with a spade and then cutting away the top portion. Roots and soil particles are removed from the rhizomes and it is advisable to dry the rhizomes under shade for one day before storage or transporting.

Chemical constituents: The essential oil contains α-pinene, α-and β-curcumene, camphor, cuminyl alcohol, myristic acid and turmerone. Car-3-ene and cis-ocimene contribute the characteristic mango odour of the rhizome. The colouring matter is curcumin. Numerous sesquiterpenoids of germacrone and guaiane skeletons also are present.

MEDICINAL YAMS

Dioscorea spp.

Family-Dioscoreaceae

San: Alukam Hin: Chupri alu, Khamalu Mal: Kachil, Kavattu Tam: Perumvallikkizhangu, Kappan kachil

Some of the species like *D. alata* and *D. esculenta have* been under cultivation for a long time for their edible tubers. There are about 15 species of this genus containing diosgenin. Among the above said species, *D. floribunda, D. composita* and *D. deltoidea* are widely grown for diosgenin production.

Soil and climate: *Dioscorea* species prefer a tropical climate without extremity in temperature. It is adapted to moderate to heavy rainfall area. *Dioscorea* plants can be grown in a variety of soils, but light soil is good, as harvesting of tubers is easier in such soils. The ideal soil pH is 5.5-6.5 but tolerates fairly wide variation in soil pH.

Seeds and sowing: *Dioscorea* can be propagated through tubers, single node stem cuttings or seed. Tubers normally used for commercial planting. Three types of tuber pieces can be distinguished for propagation purpose, viz. (1) crown (2) median and (3) tip, of which crowns produce new shoots within 30 days and are therefore preferred. The best time of planting is the end of April so that new sprouts will grow vigorously during the rainy season commencing in June. Land is to be prepared thoroughly until a fine tilth is obtained. Deep furrows are made at 60cm distance with the help of a plough. The stored tuber pieces which are ready for planting is to be planted in furrows with 30cm between the plants for one year crop and 45cm between the plants for 2 year crop at about 0.5 cm below soil level. The new sprouts are to be staked immediately.

Manuring: *Dioscorea* requires high organic matter for good tuber formation. Besides a basal dose of 18-20t of FYM/ha, a complete fertilizer dose of 300kg N, 150kg P_2O_5 and K_2O/ha are to be applied. P and K are to be applied in two equal doses one after the establishment of the crop during May-June and the other during vigorous growth period of the crop (August-September).

Irrigation:-Irrigation may be given at weekly intervals in the initial stage and afterwards at about 10 days interval during non-rainy periods.

After cultivation: After sprouting is complete, the plants are to be earthed up. Soil from the ridges may be used for earthing up so that the original furrows will become ridges and vice versa. *Dioscorea* vines need support for their optimum growth and hence the vines are to be trailed over *pandals* or trellis. Periodic hand weeding is essential for the first few months. Intercropping with legumes has been found to smother weeds and provide extra income.

Plant protection: The major pests of *Dioscorea* are the aphids and red spider mites. Aphids occur more commonly on young seedlings and vines. Young leaves and vine tips eventually die if aphids are not controlled. They can be controlled by spraying any contact insecticide. Red spider mites attack the underside of the leaves at the base near the petiole. Severe infestations result in necrotic areas, which are often attacked by fungi. In case of severe mite infestation, spray any acaricide – dicofol, tetradifon, chlorobenzilate or wetable sulphur at recommended doses. No serious disease is reported to infect this crop.

Harvesting: The tubers grow to about 25-30 cm depth and hence harvesting is to be done by manual labour. The best season for harvesting is Feb-March, coinciding with the dry period. On an average 50-60t/ha of fresh tubers can be obtained in 2 years duration. Diosgenin content tends to increase with age, 2.5% in first year and 3-3.5% in the second year. Hence, two-year crop is economical.

Chemical constituents: Diosgenin is the most important sapogenin used as a starting material for synthesis of a number of steroidal drugs.

NEEM

Azadirachta indica
Family-Meliaceae

San: Nimbah, Prabhadrah Hin, Ben: Nim, Nim Mal: Aryaveppu Tel: Vepa

Neem or margose tree, also known as Indian lilac is a highly exploited medicinal plant of Indian origin, widely grown and cultivated throughout India. Every part of the tree, namely root, bark, wood, twig, leaf, flower, fruit, seed, kernel and oil has been used for medicinal purposes.

Uses: *Nimbarishta, nimbadi churna* and *nimbharidra khand* are well known preparations. It is valuable as an antiseptic, used in the treatment of small pox. Extract from the leaves are useful for sores, eczema and skin diseases. Boiled and smashed leaves serve as excellent antiseptic. Neem oil is used in soaps, toothpaste and as a hair tonic to kill lice. Seed is used against snakebite. Neem derivatives are now used in agriculture, public health, human and veterinary medicines, toiletries, cosmetics and livestock production

Soil and climate: Neem grows on most kinds of soils including dry, stony, shallow, nutrient deficient soils with scanty vegetation, moderately saline and alkali soils, black cotton, compact clays and laterite crusts. However, silty flats, clayey depressions and land prone to inundation are not conducive for its growth. It tolerates wide soil pH range of 5.0 to 10.0. It brings surface soil to neutral pH by its leaf litter. It has extensive and deeply penetrating root system capable of extracting moisture and nutrients even from highly leached poor sandy soils. It grows in tropical arid regions with high temperatures, altitudes between 50m and 1000m, as little rainfall as 130mm/yr and long stretches of drought.

Seeds and sowing: Neem propagates easily by seed without any pretreatment, though it can be regenerated by vegetative means like root and shoot cuttings. Seeds are collected from June to August. These remain viable for 3-5 weeks only, which necessitates sowing within this short time. Seeds may be depulped and soaked in water for 6 hours before sowing.

Seeds are sown on nursery beds at 15x5cm spacing, covered with rotten straw and irrigated. Germination takes 15-30 days. Seedlings can be transplanted after two months of growth onwards either to polybags or to mainfield. Neem can be grown along with agricultural crops like groundnut, bean, millets, sorghum and wheat. For field planting, pits of size 50-75 cm^3 are dug 5-6m apart, filled with topsoil and well rotten manure, formed into a heap, and seedling is planted at the centre of the heap.

Manuring: FYM is applied at 10-20 kg/plant every year. Chemical fertilizers are not generally applied.

Irrigation: Irrigation and weeding are required during the first year for quick establishment.

Plant protection: More than 38 insect pests are reported on neem, which may become serious at times.

Harvesting: Flowering starts after 5 years. In India flowering is during January-May and fruits mature from May-August. The leaves are shed during February-March and a full-grown tree produces about 350 kg dry leaves and 40-50 kg berries per annum. Fresh fruits give 60% dry fruits, which yield 10% kernel, which contains on an average 45% fixed oil. After 10-15 years of growth the wood can be cut and used as timber.

Chemical constituents: Leaves contain the flavanoid quercetin, nimbosterol (β-sitosterol), kaempferol and myricetin. Seed and oil contains desacetylnimbin, azadirachtin, nimbidol, meliantriol, tannic acid, S and amino acids. Neem cake contains the highest sulphur content of 1.07% among common oil cakes.

PEPPER

Piper nigrum

Family-Piperaceae

Soil and Climate: Pepper prefers a light porous soil and well-drained soil rich in organic matter. Water stagnation in the soil, even for a very short period is injurious for the plant. So heavy textured soils in locations where drainage facilities are inadequate should be avoided.Pepper requires a warm humid climate.Though an annual rainfall of 250cm is ideal for the proper growth of the crop, it also come up well in low rainfall areas ,if the pattern and distribution of rainfall are conducive. The optimum temperature is 20-30^{0}c. It can be grown from sea level up to an altitude of 1200m but lower altitudes are preferable.

Seeds and sowing: Pepper is propagated vegetatively from cuttings. Select runner shoots produced at the base of mother plants. Keep the vines to prevent them from striking roots in the soil. Separate the runner shoots from the vines in February-March. The middle one-third portion of runner shoots are preferred for planting. The shoots are cut into pieces of 2-3 nodes in each. Leaves, if any , are to be clipped off leaving a small portion of the petioles on the stop. Dipping the lower cut end of the cuttings in 1000ppm solution of 3 Indol Butyric acid for 45 seconds wil substantially increase root formation and development. Treating the cuttings with Seradix B2 is equally effective. Plant the treated cuttings in nursery beds or preferably in polythene bags filled with potting mixture. The cuttings should be planted at least one node deep in the soil. The cuttings after planting should be kept under shade. Light and frequent watering is recommended in the nursery to maintain a humid and cool atmoshere.

Planting standards is to be taken up in April-May with the onset of premonsoon showers. For planting pepper, prepare pits on the northern side of the standards,15 cm away from it. The pit size should be 50cm^3. Fill the pits with a mixture of top soil and compost or well rotten cattle manure @5 Kg /Pit . With the onset of South West Monsoon In June-July, plant 2-3 rooted cuttings in the pits at a distance of about 30 cm away from the standards. Press the soil around the cuttings to form a small mound slopping outward and away from the cuttings to prevent water stagnation around the plants.The growing portion of the cuttings are to be trailed and tied to the standards. Provide shade to the plants if the land is exposed and if there is a break in the rainfall.Pepper comes up well as intercrops in plantations.

Varieties:-Panniyoor-1, Panniyur-2(Krishna), Panniyur –3 (Syama), Panniyur-4 (Anjana), Subhakara(KS27), Karimunda, Kottanadan, Kuthiravally, Arakulam Munda, Balankotta and Kalluvally are common cultivated varieties.

After cultivation: In the early stages tie the vines to the standards, if found necessary. Prune and train the standards in March-April every year to remove the excess growth. The effective height is to be limited to about 6m.

Manuring:-**Manuring of pepper vines is to be done in basins taken around the plants 10-15 cm deep and 75 cm radius depending upon the growth of the plants. Apply cattle manure /compost/green leaves at the rate of 10 Kg./plant/annum just at the onset of South-West monsoon and cover lightly with soil.It is desirable to apply lime at the rate of 500g/vine in April-May.Recommended nutrient dosage of pepper (3years above) is: NPK 50:50:50g/vine/Year. Apply 1/3 dose for one year old plants and ½ dose for two year old plants. The fertilisers may be applied in two split doses first in May-June and the second in August- September.**

Irrigation:-Irrigating pepper plants of panniyur –1 variety at IW/CPE ratio of 0.25 from Nov/Dec till the end of March and withholding irrigation thereafter till Monsoon break,increases pepper yield.The depth of irrigation recommended is 10mm.The water is to be applied in basins taken around the plants at aradius of 75 cm.

Plant protection**: For the control of Pollu caused by flea beetle, *Longitarsus nigripennis*, spray any of Endosulfan, Dimethoate, Quinalphos or Monocrotophos, all at 0.05%. For controllingpepper**

leaf gall thrips, Monocrotophos 0.05%, Dimethoate 0.06% or phosphamidon 0.03% may be used. For controlling soft scales, (*Lecanium spp*.), spray with Quinalphos at 0.05%. For controlling the atack of nematodes namely, *Radopholus similis* and the *Meloidogyne incognita*, apply Phorate or Carbofuran @1g a.i. per vine twice an year. For *Phytophthora* foot rot control, application of 1 kg lime per vine, application of 2 kg neemcake 4 weeks after lime application, drenching with 1% Bordeaux mixture or 0.2% copper oxy chloride at the rate of 5 to 10 litres per vine in May-June are effective. Foliar spray with 1% Bordeaux mixture may also to be given. Drenching and spraying are to be repeated. For the control of anthracnose caused by *Colletotrichum gloeosporioides*, spray 1% Bordeaux mixture or Captafol 0.1%, once before flowering and then at berry formation stage.

Harvesting and processing*:-Pepper berries become mature and ready for harvest in about 180-200 days depending upon the variety. In high altitudes this period may be more by about 30-45 days. If spikes are harvested before attaining maturity ,15-20% reduction in the weight of processed material may result. Black pepper is produced by sun drying the mature pepper berries for 3 -5 days after their separation from spikes by threshing.*

PERIWINKLE

Catharanthus roseus

Family- Apocynaceae

San: Nityakalyani; Hin: Sadabahar, Baramassi; Mal: Ushamalari, Nityakalyani Tel: Billaganeru; Tam: Sudukattu mallikai; Pun: Rattanjot; Kan: Kasikanigale

Periwinkle or Vinca is an erect handsome herbaceous perennial plant which is a chief source of patented cancer and hypotensive drugs.

Uses:- The different alkaloids possessed anticancerous, antidiabetic, diuretic, antihypertensive, antimicrobial, antidysenteric, haemorrhagic, antifibrillic, tonic, stomachic, sedative and tranquillising activities. It is known for use in the treatment of diabetes in Jamaica and India. It is useful in the treatment of choriocarcinoma and *Hodgkin's disease*-a cancer affecting lymph glands, spleen and liver. Its leaves are used for curing diabetes, menorrhagia and wasp stings. Root is tonic, stomachic, hypotensive, sedative and tranquilliser .

Soil and clmate:- It can grow on any type of soil, except those which are highly saline, alkaline or waterlogged. Light soils, rich in humus are preferable for large scale cultivation since harvesting of the roots become easy. Periwinkle grows well under tropical and subtropical climate. A well distributed rainfall of 1000 mm or more is ideal. In north India the low winter temperatures adversely affect the crop growth.

Seeds and sowing: Catharanthus is propagated by seeds. Fresh seeds should be used since they are short-viable. Seeds can be either sown directly in the field or in a nursery and then transplanted. Seed rate is 2.5 kg/ha for direct sowing and the seeds are drilled in rows 45 cm apart or broadcasted. For transplanted crop the seed rate is 500g/ha. Seeds are sown in nursery and transplanted at 45x30cm spacing after 60 days when the seedlings attain a height of 15-20cm. Nursery is prepared two months in advance so that transplanting coincides with the on set of monsoons.

Manuring: Application of FYM at the rate of 15 t/ha is recommended. An alternate approach is to grow leguminous green manure crops and incorporate the same into the soil at flowering stage. Fertilisers are recommended at 80:40:40 kg $N:P_2O_5:K_2O$/ha for irrigated crop and 60:30:30 kg/ha for rainfed crop. N is applied in three equal splits at planting 45 and 90 days after planting.

Irrigation: 4 or 5 irrigations will be needed to optimise yield when rainfall is restricted. Fortnightly irrigations support good crop growth when the crop is grown exclusively as an irrigated crop.

After cultivation:- Weeding is carried out before each topdressing. Alternatively, use of fluchloraline at 0.75 kg a.i./ha pre-plant or alachlor at 1.0 kg a.i./ha as pre-emergence to weeds provides effective control of a wide range of weeds in periwinkle crop.

Harvesting and procewsing: Detopping of plants by 2cm at 50% flowering stage improves root yield and alkaloid contents. The crop allows 3-4 clippings of foliage beginning from 6 months. The flowering stage is ideal for collection of roots with high alkaloid content. The crop is cut about 7 cm above the ground and dried for stem, leaf and seed. The field is irrigated, ploughed and roots are collected. The average yields of leaf, stem and root are 3.6, 1.5 and 1.5 t/ha, respectively under irrigated conditions and 2.0, 1.0 and 0.75t/ha, respectively under rainfed conditions on air dry basis. The harvested stem and roots loose 80% and 70% of their weight, respectively. The crop comes up well as an undercrop in eucalyptus plantation in north India. In north western India a two year crop sequence of *periwinkle-senna-mustard* or *periwinkle-senna- coriander* are recommended for higher net returns and productivity.

Plant protection: No major pests, other than Oleander hawk moth, have been reported in this crop. Fungal diseases like twig blight (top rot or dieback) caused by *Phytophthora nicotianae*., *Pythium debaryanum*, *P. butleri* and *P. aphanidermatum*; leaf spot due to *Alternaria tenuissima, A. alternata, Rhizoctonia solani* and *Ophiobolus catharanthicola* and foot-rot and wilt by *Sclerotium rolfsii* and *Fusarium solani* have been reported. However, the damage to the crop is not very serious. Three virus diseases causing different types of mosaic symptoms and a phyllody or little leaf disease due to mycoplasma-like organisms have also been reported; the spread of which could be checked by uprooting and destroying the affected plants.

Chemical constituents: More than 100 alkaloids and related compounds have so far been isolated and characterised from the plant.. These alkaloids includes monomeric indole alkaloids, 2-acyl indoles, oxindole, α-methylene indolines, dihydroindoles, bisindole and others. Dry leaves contain vinblastine (vincaleucoblastine or VLB) 0.00013-0.00063%, and vincristine (leurocristine or LC) 0.0000003-0.0000153% which have anticancerous activity. Other alkaloids reported are vincoside, isovincoside (strictosidine), catharanthine, vindolinine, lochrovicine, vincolidine, ajmalicine (raubasine), reserpine, serpentine, leurosine, lochnerine, tetrahydroalstonine, vindoline, pericalline, perivine, periformyline, perividine, carosine, leurosivine, leurosidine and rovidine.

SERPENTWOOD

Rauvolfia serpentina
Family-Apocynaceae
San: Sarpagandha Hin: Chandrabhaga Mal: Sarpagandhi, Amalpori

Among the different species of *Rauvolfia, R. serpentina* is preferred for cultivation because of higher **reserpine** content in the root Serpentwood is an erect, evergreen , perennial undershrub whose medicinal use has been known since 3000 years.

Uses:- Its dried root is the economical part which contains a number of alkaloids of which reserpine, rescinnamine, deserpidine, ajamalacine, ajmaline, neoajmalin, serpentine, α-yohimbine are pharmacologically important. The root is a sedative and is used to control high blood pressure and certain forms of insanity. In Ayurveda it is also used for the treatment of insomnia, epilepsy, asthma, acute stomach ache and painful delivery. It is used in snake-bite, insect stings, and mental disorders. It is popular as "*Madman's medicine*" among tribals. '*Serpumsil'* tablet for high blood pressure is prepared from *Rauvolfia* roots. Reserpine is a potent hypotensive and tranquillizer but its prolonged usage stimulates prolactine release and causes breast cancer. The juice of the leaves is used as a remedy for the removal of opacities of the cornea.

Soil and climate: It grows on a wide range of soils. Medium to deep well drained fertile soils and clay-loam to silt-loam soils rich in organic matter are suitable for its cultivation. It requires slightly acidic to neutral soils for good growth. Though it grows in tropical and subtropical areas, which are free from frost, tropical humid climate is most ideal. Its common habitats receive an annual rainfall of 1500-3500 mm and the annual mean temperature is 10-38°C. It grows up to an elevation of 1300-1400m from MSL. It can be grown in open as well as under partial shade conditions.

Seeds and sowing: The plant can be propagated vegetatively by root cuttings, stem cuttings or root stumps and by seeds. Seed propagation is the best method for raising commercial plantation. Seed germination is very poor and variable from 10-74%. Seeds collected during September to November give good results. It is desirable to use fresh seeds and to sock in 10% sodium chloride solution. Those seeds which sink to the bottom should only be used. Seeds are treated with ceresan or captan before planting in nursery to avoid damping off. Seed rate is 5-6 kg/ha. Nursery beds are prepared in shade, well rotten FYM is applied at 1kg/m^2 and seeds are dibbled 6-7cm apart in May-June and irrigated. Two months old seedlings with 4-6 leaves are transplanted at 45-60 x 30 cm spacing in July -August in the main field. Alternatively, rooted cuttings of 2.5-5cm long roots or 12-20cm long woody stems can also be used for transplanting. Hormone (Seradix) treatment increases rooting .

Manuring: In the main field 10-15 t/ha of FYM is applied basally. Fertilisers are applied at 40:30:30kg N: P_2O_5 :K_2O/ha every year. N is applied in 2-3 splits.

After cultivation: Monthly irrigation increases the yield. The nursery and the main field should be kept weed free by frequent weeding and hoeing. In certain regions intercroping of soybean, brinjal, cabbage, okra or chilly is followed in *Rauvolfia* crop.

Plant protection: Pests like root grubs (*Anomala polita*), spingid moth (Deilephila nerii), caterpillar (*Glyophodes vertumnalis*), black bugs and weevils are observed on the crop, but the crop damage is not serious. The common diseases reported are leaf spot (*Cercospora rauvolfiae, Corynespora cassiicola*), leaf blotch (*Cercospora serpentina*), leaf blight (*Alternaria tenuis*), anthracnose (*Colletotrichum gloeosporioides*), die back (*Colletotrichum dematrium*), powdery mildew (*Leviellula taurica*), wilt (*Fusarium oxysporum*), root-knot (*Meloidogyne sp*.), mosaic and bunchy top virus diseases. Field sanitation, pruning and burning of diseased parts and repeated spraying of 0.2% Zineb or Mancozeb are recommended for controlling various fungal diseases.

Harvesting and processing: *Rauvolfia* is harvested after 2-3 years of growth. The optimum time of harvest is in November-December when the plants shed leaves, become dormant and the roots contain maximum alkaloid content. Harvesting is done by digging up the roots by deeply penetrating implements .

The roots are cleaned washed cut into 12-15cm pieces and dried to 8-10% moisture. The dried roots are stored in polythene lined gunny bags in cool dry place to protect it from mould. The yield is 1.5-2.5 t/ha of dry roots. The root bark constitutes 40-45% of the total weight of root and contributes 90% of the total alkaloids yield.

Chemical constituents: ***Over 200 alkaloids have been isolated from the plant. Rauwolfia serpentina root contains 1.4-3% alkaloids. The alkaloids are classsified into 3 groups, viz, reserpine, ajmaline and serpentine groups. Reserpine group comprising reserpine, rescinnamine, deserpine etc act as hypotensive, sedative and tranquillising agent. Overdose may cause diarrhoea, bradycardia and drowsiness. Ajmaline, ajmalicine, ajmalinine, iso-ajmaline etc of the ajmaline group stimulate central nervous system, respiration and intestinal movement with slight hypotensive activity. Serpentine group comprising serpentine, sepentinine, alstonine etc is mostly antihypertensive.***

SOLANUM

Solanum spp.

Family-Solanaceae

Solanums comprise a very important group of medicinal plants having multifarious uses. These plants belong to the family Solanaceae and genus *Solanum*. A number of species are reported to be medicinal which are briefly described below.

S. anguivi* Lam. syn. *S. indicum* (poison berry), *S. dulcamara* Linn.**Eng: (Bittersweet, Bitter night shade; San: Kakmachi) ***S. erianthum*, syn. *S. verbascifolium **(**San: Vidari; Hin: Asheta; Mal: Malachunda), ***S. melongena* Linn. (**Eng: Brinjal, Egg plant**)** ***S. melongena* var. *incanum* (Linn.) (**San: Brihati; Hin: Baigan; Mal: Cheruvazhuthina**)** ***S. nigrum* Linn. syn. *S. rubrum* Mill.(**Eng: Black night shade); ***S. spirale* Roxb. (**Hin: Munguskajur), ***S. stramoniifolium* Jacq. (**San: Garbhada; Hin: Rambaigan; Mal: Anachunda;) are the important species. ***S. torvum* Sw.** (Eng: West Indian Turkey Berry; Hin, Mal: Kattuchunda), ***S. trilobatum* Linn.** (Eng: Climbing Brinjal; San: Alarka; Mal: Tutavalam;) *and* ***S. viarum*, syn. *S. khasianum*** (Hin: Kantakari) are the important species.

Uses: All these species possess specific medicinal properties.

Climate and soil: They come up very well in tropical and subtropical climate upto 2000m altitude. They can be raised on a variety of soils good in organic matter.

Seeds and sowing: Propagation is by seeds. The seedlings are first raised in the nursery and transplanted to the main field 30-45 days after sowing when the plants attain 8-10cm height. During rainy season, planting is done on ridges while during summer in furrows, at a spacing ranging from 30-90cm depending upon the stature and spreading habit of the plant. The transplanted seedlings should be given temporary shade for 2-4 days during summer.

Manuring:- FYM or compost at 20-25t/ha is applied at the time of land preparation. A moderate fertiliser dose of 75:40:40 N, P_2O_5, K_2O/ha may be given. P is given as basal dose, N and K are applied in 2-3 split doses.

After cultivation: One or two intercultural operations are needed to control weeds. The plants need earthing up after weeding and topdressing. Irrigation is needed at 3-4 days interval during summer and on alternate days during fruiting period. Plants need staking to avoid lodging due to heavy bearing.

Plant protection:-Shoot borers, mealy bugs, leaf webbers and miners are noted on the crop, which can be controlled by spraying mild insecticides. Root knot nematode, wilting and mosaic diseases are also noted on the crop. Field sanitation, crop rotation and burning of crop residues are recommended.

STROBILANTHES

Strobilanthes ciliatus

Family-Acanthaceae

San: Sahacarah, Sairyakah; Hin: Karvi, Kara; Mal: Karimkurunji, Kurunji;

The genus *Strobilanthes* consists of 3 species namely,*S. ciliatus* Nees.,syn. *Nilgirianthus ciliatus* (Nees) Bremek ,*S. auriculatus* Nees. and *S. callisus* Nees.

Uses: *Strobilanthes* is an important shrub used in the treatment of rheumatism. The roots are useful in rheumatalgia, lumbago, siatica, limping, chest congestion, bronchitis, odontalgia and general debility. The leaves and bark are useful in whooping cough, fever, bronchitis, dropsy, leucoderma, leprosy, pouritus, inflammations, scrofula and fever

Soil and climate: *Strobilanthes* prefers silty loam soil, mixed with sand, for good growth. It grows abundantly in river banks, lowlands and plains. The best season of planting is May-June.

Seeds and sowing: The field is to be ploughed to a fine tilth and mixed with 5-7t/ha of FYM/compost/dried cowdung. Seedbeds of convinient length, 1.5m width and 15cm height are to be made in which 10cm long stem cuttings are to be planted at a spacing of 30cm between plants. Rooting occurs within 20 days.

After cultivation: Two weeding should be carried out at 2 months and 4 months after planting, followed by organic manure application. Irrigation is not a must but during summer months it is beneficial. Any serious pests or diseases are reported in this crop.

Harvesting: Harvesting can be done at the end of the second year. For this the plants are to be cut, roots dug out and collected. Roots are to be washed well, dried in sun and marketed. Roots, leaves and bark constitute the economic parts.

Properties: *The leaves and stem yield essential oil, which is of good medicinal value.*

STRYCHNINE TREE

Strychnos nux-vomica

Family - Loganiaceae

San: Karaskara; Hin: Kajra, Kuchila; Mal: Kanjiram; Tam: Itti, Kagodi, Kanjirai Mar:Jharkhatchura; Kan: Hemmushti, Ittangi; Tel: Mushti, Mushidi

It is a large deciduous tree, with simple leaves and white fragrant flowers. *Strychnos* is highly toxic to man and animals producing stiffness of muscles and convulsions, ultimately leading to death.

Uses: In small doses it can serve as efficacious cure forms of paralysis and other nervous disorders. The seeds are used as a remedy in intermittent fever, dyspepsia, chronic dysentery, paralytic and neuralgic affections. It is also useful in impotence, neuralgia of face, heart disease. Leaves are applied as poultice in the treatment of chronic wounds and ulcers and the leaf decoction is useful in paralytic complaints. Root and root bark used in fever and dysentery.

Soil and climate: The plant is distributed throughout India in deciduous forests up to 1200m. It is also found in Sri Lanka, Siam, Indochina and Malaysia.

The leaf fall is during December (do not shed all the leaves at a time) and new foliage appears in February. Flowering is during March - April and fruiting during May - December. Fruits take about 8-9 months to mature.

Chemical properties: Strychnine and brucine are the most important and toxic alkaloids present in the plant.

SWEET FLAG

Acorus calamus

Family- Araceae

San: Vaca, Ugragandha, Bhadra; Hin: Bacc, Gorbacc; Ben: Bach; Mal:Vayampu; Tam: Vasampu; Kan: Bajai; Tel: Vasa Vadaja

Acorus calamus Linn. is a semi-aquatic rhizomatous perennial herb.

Uses: The sweet flag is an important *medhya* drug, capable of improving memory power and intellect. It is used for the treatment of cough, bronchitis, odontalgia, inflammations, gout, epilepsy, convulsions, depression and other mental disorders, tumours, dysentery, skin diseases, numbness and general debility. The rhizome is an ingredient of preparations like *Vacaditaila, Ayaskrti, Kompancadi gulika, Valiya rasnadi kashaya, etc.*

Soil and climate: *Acorus may be cultivated in any good but fairly moist soil. It is usually grown in areas where paddy can be grown. It comes up well in clayey soils and light alluvial soils of riverbank. It is a hardy plant found growing from tropical to subtropical climates. It needs a good and well-distributed rainfall throughout the year. It needs ample sunlight during the growth period.*

Seeds and sowing: The field is laid out and prepared exactly as for rice, irrigated sufficiently and after ploughing twice, watered heavily and again ploughed in the puddle. Sprouted rhizome pieces are used for planting and pressed into the mud at a depth of about 5cm at a spacing of 30x30cm. The rhizomes are planted in such a way that the plants in the second row comes in between the plants of the first row and not opposite to them.

Manuring: FYM is to be applied at 25t/ha. Fertilisers are applied at 25:50:60 kg/ha/yr $N:P_2O_5:K_2O$. Whole of FYM and 1/3 of N, P_2O_5 and K_2O are to be added in the field during March - April as a basal dose. The remaining 2/3 of nutrients is to be given in two equal split doses at 4 months and 8 months after planting.

Irrigation: The field is to be regularly irrigated. About 5 cm of standing water is to be maintained in the field in the beginning. Later, it is to be increased to 10 cm as the plant grows. The water is drained off from the field at least two weeks before harvest.

After cultivation: The field is to be regularly weeded. About 8 weeding are to be carried out in all. At each weeding the plants are pressed into the soil.

Plant protection: The plant is attacked by mealy bugs. Both shoot and root mealy bugs can be controlled by spraying the shoot and drenching the roots of grown up plants with 10 ml Methyl parathion or 15ml Oxydemeton methyl or 20ml Quinalphos in 10 litres of water.

Harvesting and processing: The leaves start turning yellow and dry, indicating maturity. The crop is ready for harvest at the end of first year. The field is to be dried partially so that sufficient moisture is left in the soil to facilitate deep digging. The rhizome will be at a depth of 60cm and having about 30-60cm spread. Therefore, harvesting is to be done carefully. The rhizomes are to be cut into 5-7.5cm long pieces and all the fibrous roots are to be removed. Yield of rhizome is about 7-10t/ha

Chemical constituents: Rhizomes, roots and leaves yield essential oil. The important constituents of the Indian oil are asarone and its β-isomer. Other constituents are α and β-pinene, myrcene, camphene, p-cymene, camphor and linalool, sesquiterpenic ketones like asarone, calamone, calacone, acolamone, iso-acolamone, acoragermacrone, epishyobunone, shyobunone and iso-shyobunone.

TINOSPORA

Tinospora cordifolia

Family-Menispermaceae

San: Amrita, Guduchi; Hin, Ben: Giloe; Mal: Amritu, Chittamritu; Tam: Amridavalli; Kan: Amritaballi; Tel: Tivantika, Tippatige; Pun: Batindu; Ori: Gulochi

Tinospora cordifolia (Willd) Miers ex Hk. f & Thoms. syn. *Menispermum cordifolium* Willd, *Cocculus cordifolius* (Willd) DC is a climbing shrub with rough corky bark.

Uses: Tinospora is used in medicine, usually in the fresh state, though it is commercially available in the dried state. It is probably one of the most useful preparations acting as a tonic and aphrodisiac. As a tonic it is best given in infusion with or without milk. It is a popular remedy for snakebite and leprosy. It is generally prescribed in general debility, diabetes, fever, jaundice, skin diseases, rheumatism, urinary diseases, dyspepsia, gout, gonorrhoea and leucorrhoea. It is a constituent of several preparations like *guduchayado churna, gududyadi kwath, guduchilouha, amritarista, sanjivanivati, guduchi taila, amiritastak kwath*, etc.

Soil and climate: It requires a warm humid tropical climate with an annual rainfall of 2000-3000cm. It thrives well in deep fertile soils that are rich in organic matter. Acidic to neutral soils are preferred though it can come up in alkaline soils as well.

Seeds and sowing: It is propagated through stem cuttings. About 10-15cm long stem cuttings having at least 2 nodes are planted in the field or polybags. Treatment of cut ends with rooting hormones gives better results. The usual planting time is with the onset of monsoon in May-June. Usually it is planted along boundaries or nearby tall trees and allowed to trail on the trees or hedges and hence regular spacing is not followed.

Manauring: While planting, adequate amounts of organic manure are applied.

After cultivation: Once the plant is established no much management is needed.

Harvesting and processing: The stem is the most economic part. Harvesting can be commenced after one year and usually partial harvesting is followed depending on the necessity. The stem and root should be collected in hot season when the concentration of the bitter principle is the highest. A full-grown well-ramified plant may give 2-3kg vines, which are cut into smaller pieces and traded either fresh or after drying.

Chemical constituents: *The plant contains cordifol, tinosporidine, tinosporide, perberilin, heptacosanol, b-sitosterol, cordifolone, tinosporon, tinosporic acid, tinosporol, cordifolide, tinosporine, magnoflorine and tembetarine.*

TURMERIC

Curcuma longa

Family-Zingiberaceae

San: Haridra, Varavarnini Hin: Haldi, Halda Mal: Manjal, Pacca manjal, Varattu manjal Tam: Manchal

It is the most important member of genus *Curcuma*. The medicinal properties of turmeric is so well known that attempts were even made in the US to gain Intellectual Property Rights on its products.

Uses: Due to the strong antiseptic properties, turmeric has been used as a remedy for all kinds of poisonous affections, ulcers and wounds. It gives good complexion to the skin and so it is applied to face as a depilatory and facial tonic. The drug cures diseases due to morbid *vata, pitta* and *kapha*, diabetes, eye diseases, ulcers, oedema, anaemia, anorexia, leprosy and scrofula.

Soil and climate: *Turmeric is a* tropical herb and can be grown on different types of soils both under irrigated and rainfed conditions. Rich loamy soils having good drainage are ideal for the crop.

Seeds and sowing: The plant is propagated by whole or split mother rhizomes. Well developed, healthy and disease free rhizomes are to be selected. Rhizomes are to be treated with copper oxychloride fungicides and stored in cool, dry place or earthen pits plastered with mud and cowdung. The best season of planting is during April with the receipt of pre-monsoon showers. Beds of size 3x1.2m with a spacing of 40cm between beds are to be prepared. Small pits are to be taken in the beds in rows with a spacing of 25-40cm. Finger rhizomes are to be planted flat with buds facing upwards and covered with soil or dry powdered cattle manure. The crop is to be mulched immediately after planting and 50 days after first mulching.

Varieties: Duggirala, Tekurpetta, Sugantham, Kodur, Suvarna, Suguna, Sudarshana

Manuring: Cattle manure or compost is to be applied as basal dose at 20-40t/ha at the time of land preparation or by spreading over the beds after planting. Apply NPK fertilizers at 30:30:60 kg/ha. Full P and half K as basal two-third N at 30days after planting and the reamining Kand N at 60 days.

After cultivation: Weeding is to be done twice at 60 and 120 days after planting, depending upon weed intensity. Earthing up is to be done after 60 days.

Plant protection: No major incidence of pest or disease is noticed in this crop. Leaf blotch and leaf spot can be controlled by spraying Bordeaux mixture or 0.2% Mancozeb. Shoot borers can be controlled by spraying 0.05% Dimethoate or 0.05% Quinalphos.

Harvesting: Time of harvest usually extends from January-March. Harvesting is generally done at about 7-10 months after planting depending upon the species and variety. Harvested rhizomes are to be cleaned of mud and other materials adhering to them. Good fingers separated are to be used for curing.

Chemical constituents: It contains *ar*-turmerone, and *ar*-curcumene as major constituents. Some of the other compounds of oil are α-and β-pinene, sabinene, myrcene, α-terpinene, limonene, *p*-cymene, perillyl alcohol, turmerone, eugenol, isoeugenol, eugenol methyl ether and isoeugenol methyl ether.

WILD TURMERIC

Curcuma aromatica

Family-Zingiberaceae

Tam: Kastoori manjal, Kattu manjal

Wild turmeric known as *vanharidra* in Sanskrit *Jangali-haldi* in Hindi and *Kasthurimanjal* in Malayalam is rhizomatous herbaceous medicinal plant. The rhizome is an odoriferous ingredient of the cosmetics.

Uses: Rhizome of wild turmeric is used in combination with astringents and aromatics for bruises, sprains, hiccough, bronchitis, cough, leucoderma and skin eruptions. It is used for the cure of chromic skin diseases caused by impure blood. It is used as appetiser and tonic for women after childbirth. It is also useful against high fever and worm infestation.

Climate and soil: It is distributed in South East Asia. The plant grows wild in the eastern Himalayas and in moist deciduous forests of Kerala and Karnataka. It is grown as a subsistence crop in backyard, kitchen garden and interspaces of other crops in areas with good rainfall. Well-drained rich loamy soils are ideal for the drop.

Seeds and sowing: It is largely raised as a rain fed crop during May- June with the pre-monsoon showers. It is propagated vegetatively by rhizomes and by tissue culture methods. Clear the area, remove all the pebbles and stones and plough the field to good tilth. Incorporate FYM/organic manure at 10-15t/ha. Prepare raised seedbeds of 1.2m breadth and convenient length. Healthy disease free mother rhizomes with at least one germinated sprout is the planting material, which is required at 1500kg/ha. Take small pits at 60X40 cm spacing on the seedbed and plant seed rhizome with the germinating sprout facing upwards. Cover the rhizome with FYM and mulch the bed with leaves or straw.

Varieties: At present, only local types are available for cultivation

Manuring: Apply fertilisers at 100:50:50 kg NPK/ha, entire P as basal and N and K in two equal splits at planting and two months after planting.

Aftercultivation: Carry out gap filling if necessary within one month. Remove weeds 2 months after planting followed by top dressing, earthing up and mulching.

Plant protection: No serious pest and diseases are encountered in the crop.

Harvesting and processing: The crop matures in 7 months. Drying up of leaves is the indication of maturity. Dig out the rhizomes without causing damage. Remove the dry leaves and roots. The clean rhizomes are either marketed or dried and stored. The average yield of fresh rhizome is 28t/ha which on drying gives 27% recovery. The rhizome is thinly sliced and steam distilled for 3-4 hours for extracting the essential oil and the yield is 90l/ha. Oil recovery is 0.33 % on fresh weight basis and 1.05 % on dry weight basis.

Chemical constituents: Essential oil contains α-and -β-curcumene, *d*-camphene and *p*-methoxy cinnamic acid.

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