

Agro-Techniques of Selected Medicinal Plants

Volume II





National Medicinal Plants Board

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Department of AYUSH, Ministry of Health & Family Welfare, Government of India, Room No. 309, 3rd Floor, AYUSH Bhawan, B-Block, GPO Complex, INA, New Delhi – 110 023

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Disclaimer:- The agro-techniques covered in this publication are based on the reports of various institutions/organizations and may not meet agronomic requirement of a particular crop in another agro-climatic region. The National Medicinal Plants Board, therefore does not take any responsibility for any variation in the agronomic practice, crop yield and economic returns indicated in this publication.
Photographs on Cover Page: Glycyrrhiza glabra (Top row) Tribulus terrestris, Evolvulus alsinoides (L to R, Second row) Bergenia ciliata, Clerodendrum serratum, Solanum surattense (L to R, Third row)

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सचिव

भारत सरकार

आयुर्वेद, योग व प्राकृतिक चिकित्सा यूनानी सिद्ध एवं होम्योपैथी (आयुष) विभाग स्वास्थ्य एवं परिवार कल्याण मंत्रालय आयुष भवन, 'बी' ब्लाक, जी.पी.ओ. कॉम्पलेक्स, आई. एन. ए., नई दिल्ली-110023

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FOREWORD

Access to health care has been recognized under the millennium development goals, as one of the main strategies to free people from extreme deprivation. We are confronted with a situation whereby, on the one hand we are battling against communicable diseases and malnutrition which are a direct fallout of poverty and on the other hand, we are facing a growing challenge from lifestyle related disorders which are largely perceived as being byproducts of affluence and westernization. Our existing health infrastructure is being put to great strain under this dual burden. Therefore, the world over it is being realized that given the complex nature of lifestyle related disorders, natural plants based medicines are most suited to deal with them. However, it is also a fact that in order to ensure efficacy, safety and quality of botanicals there needs to be adequate knowledge base on cultivation, harvesting, handling and processing of the raw material, namely medicinal plants.

- 2. Today, globally the companies and users are looking for traceability of raw materials to their origin, as it is obvious that the quality of the end product can only be as good as the quality of the components that go into the product. The best way to ensure this is to grow medicinal plants under conditions which follow recognized best practices. For this to become a reality, the importance of the knowledge of the correct agro-techniques to produce quality raw material cannot be ignored.
- According to a study conducted by the NMPB, about 6,000 higher plants are used in the folk and
 documented systems of medicines in India. However, the requirement is being met largely from wild
 sources. Therefore, development of agro-techniques for cultivation of these plants is very important to
 reduce burden on natural resources.
- 4. In this direction, NMPB has already published agro-techniques of 50 species in Volume 1 titled "Agro-techniques of Selected Medicinal Plants". The present publication Volume 2 covers another 32 species. These agro-techniques have been developed through various Agriculture / Horticulture universities and R&D institutions, and will go a long way in disseminating scientific information to the farmers and all others concerned, who are keen to take up cultivation of medicinal plants as well as to researchers to further take up R&D work in this field.
- This book will fill this critical void in the programme for the promotion and cultivation of medicinal plants.
- 6. The formulation and implementation of the projects on the development of agro-techniques and its outcome in the form of this book is the result of the untiring efforts of Scientists in different organizations, and the officials of the National Medicinal Plants Board; I would accordingly like to compliment them for their work.

(N. Sanyal)

New Delhi 10th March, 2014

Acknowledgement

There is resurgence of use of traditional medicine across the globe. According to an estimate, the global market of traditional therapy stood at \$60 billion in 2002 and is estimated to touch US\$ 5 trillion by 2050. The Indian systems of medicines use medicinal plants as the main raw material and their accelerated growth is pushing strongly the demand for medicinal plants. It is getting difficult to meet the ever-increasing demand sustainably through wild collection. Therefore, cultivation of medicinal plants has occupied central stage for the development of the sector.

The cultivation of medicinal plants offers opportunities for crop diversification and income generation to the farmers. However, development of sound agro-techniques for the plants that have traditionally been collected from forests has been a major challenge in promoting their cultivation. It is in this background that a need was felt to develop agro-techniques for some of the important medicinal plants by involving key R&D institutions and Universities in the country. Accordingly, Department of AYUSH, Govt. of India decided to support studies for development of agro-techniques under the "Central Sector Scheme for Development of Agro-techniques and Cultivation of Medicinal Plant" specifically for those plants that are used in AYUSH systems of medicine.

Projects were, therefore, allocated to 33 scientific organizations consisting of agriculture/horticulture Universities and the R&D institutions of Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR) *etc.* which have infrastructure and expertise for development of agro-techniques of 115 medicinal plants. The performance and progress of the projects was monitored by the Project Evaluation Committee (PEC) set up by the Department.

Out of the 115 plants, agro-techniques of 50 medicinal plants were published entitled as "Agro-techniques of Selected Medicinal Plants" (Volume – I) and 32 medicinal plants have now have been selected for the publication as the Volume-II. The Agro-techniques of medicinal plants selected for this publication are based on the reports received from different organizations/institutions. Development of Agro-techniques of such plants is an attempt of NMPB towards promoting medicinal plants cultivation through standardized Agro-techniques and thereby to make available to the industry the raw material of quality and standardized chemical ingredients. This would not have been possible without the efforts of Principal Investigators (PIs) and Project Staff in the respective organizations that were assigned the projects for development of Agro-techniques. The National Medicinal Plant

Board acknowledges the contribution of all the PIs, Co-PIs and their respective Organizations as this publication is primarily based on the reports provided by them. Some information on plants regarding their morphological characters, therapeutical characters, chemical constituents and taxonomical characters have also been taken from the published literature of Ayurvedic, Homoeopathic, Unani, India formularies/pharmacopeias, Wealth of India *etc*.

The Agro-technique developed by an institution located in a particular geographical area is the outcome of its best scientific efforts in a particular context. Therefore, the findings given are only indicative and may not meet the exact agronomic requirement of a particular crop in another agro-climatic region, as no agro-technique can suit all the diverse climatic regions. Therefore, anyone seeking to enter into cultivation as a commercial activity may be well advised to revalidate the agro-techniques from an R&D institution/University, located in the region, where cultivation is to be undertaken. Further, we also need to consider the fact that there is a certain inevitable time lag between the time of study and time of publication.

National Medicinal Plants Board expresses its gratitude to Ministries of Environment and Forests, Agriculture, Commerce and Industry, Science & Technology, Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR), Indian Council of Forestry Research & Education (ICFRE), Indian Council of Medical Research (ICMR), Central Council for Research in Ayurveda & Siddha (CCRAS), Central Council for Research in Unani Medicines (CCRUM), Agriculture and Processed Food Products Export Development Authority (APEDA), Indian Institute of Forest Management (IIFM) and individual experts in the field who participated in the meetings of the Expert Committees and provided their valuable inputs on the draft text, which went through several stages of refinements and improvements before finalization.

I would also like to extend my thanks and also wish to place on record the guidance and encouragement received from Sh. Anil Kumar, Former Secretary, Department of AYUSH, and my predecessors Shri R.B.S Rawat, Shri B.S. Sajwan, and Shri Bala Prasad, former Chief Executive Officers, NMPB who have put in untiring efforts in initiating and supervising the standardization and compiling of agro-techniques. National Medicinal Plants Board gratefully acknowledges the technical support received from Dr. D.C. Katoch, Joint Advisor (Ayurveda) in steering these agro-techniques for publication. I also acknowledge the valuable contributions made by Dr. Rajendra Gupta, Agricultural Scientist (Retd.), NBPGR; Dr. Baba Brindavanan, Dabur India Limited; Dr. S.K. Pareekh, Principal Scientist, NBPGR; Dr. Mayaram Uniyal, Ayurvedic Expert, Government of Uttarakhand, Dehradun; Dr. V.K. Singh, Former Deputy Director, CCRUM for their technical inputs and overall support in publication of these guidelines. In particular, contributions by Dr. Kavita Tyagi, Consultant (Agronomy) is sincerely acknowledged for undertaking editing of the whole documents. I would like to convey thanks to my colleagues in the NMPB Mrs. Meenakshi Negi, Deputy

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(Jitendra Sharma)
Chief Executive Officer, NMPB

New Delhi 27th Feb., 2014

Abbreviations

ASU Ayurvedic, Siddha and Unani

AYUSH Ayurveda, Yoga & Naturopathy, Unani, Siddha & Homoeopathy

@ at the rate ofBA Butyric acid°C Degree Celsius

CCAU Chaudhary Charan Singh Agricultural University
CIMAP Central Institute of Medicinal and Aromatic Plants

cm Centimeter

DAP di-ammonium phosphate

Dicho Dichotomous
DP Di-phenyl
DW Dry Weight

EC Emulsion Concentration FYM Farm Yard Manure FW Fresh Weight

FWB Fresh Weight Biomass

GA₃ Gibberellic acid

gm Gram

ha $Hectare = 10000 \text{ m}^2$ IAA Indole acetic acid IBA Indole butyric acid

K Potassium

K₂O Potassium Oxide

kg Kilogram lit Litre Metre m Miligram mg Mililiter m1 Milimeter mm Micro metre μm Micro gram μg msl Mean sea level MT Metric tones N Nitrogen

NAA Naphthalene acetic acid

NMPB National Medicinal Plants Board NPK Nitrogen + Phosphorous + Potassium

O Oxygen

ABBREVIATIONS

 $\begin{array}{ll} P & Phosphorous \\ P_2O_5 & Phosphate \end{array}$

pH acid/alkali value of soil (below 7 pH – acidic; above 7 pH- alkali)

PPM Parts Per Million

Sps Species

sqm Square metre TRF Triademophon

t Tonne

WDP Wettable Dispersible Powder

ZnSO₄ Zinc Sulphate

Introduction

India has 15 Agro-Climatic zones and medicinal plants are distributed across all biogeographic regions, diverse habitats and landscapes. Around 70% of India's medicinal plants are found in the tropical areas and around 30% in the temperate and alpine areas. World Health Organization (WHO) has estimated that approximately 80% of the world population still relies on traditional medicines, which are mostly plant-based drugs. About 6198 species of plants are estimated to be used for human and veterinary health care in the country, out of which about 2,700 plants species are reported to be used in the codified Indian Systems of Medicine *viz*. Ayurveda (1800 species), Siddha (500 species), Unani (400 species) and Amchi (300 species). In addition to their use in preparation of traditional medicines, the medicinal plants are being used in preparation of various pharmaceuticals and health products under the modern system of medicine.

The global resurgence of interest in complementary and alternative systems in general and in Indian Systems of Medicine in particular is increasing the demand of Ayurvedic, Siddha and Unani (ASU) drugs, which use mostly medicinal plants as raw materials. Medicinal plants have so far largely been collected from wild resources. Moreover, the plant material collected from these sources is replete with the problems of adulteration and misidentification. Therefore, cultivation of genuine, authentic variety of medicinal plants may be the only way to have raw material of required quality. The non-availability of proper techniques and authentic planting material are the main constraints in cultivation of medicinal plants.

National Medicinal Plants Board is striving hard to promote and propagate the Medicinal Plants for inter-alia ensuring sustainable supply of raw material to Ayurveda, Siddha and Unani (ASU) industry. Keeping in view the need of development of Agrotechniques, the Department of AYUSH implemented "Central Scheme for Development of Agrotechniques and Cultivation of Medicinal Plants" through reputed scientific institutions, engaged in this area and with expertise in this field.

This book has been complied in continuation of the "Agro-techniques of Selected Medicinal Plants" (Volume-1) which included agro-techniques of fifty plants, primarily for growers and research workers with the aim to provide standardized cultivation techniques. This book contains thirty two important medicinal plants, which were not covered in the first Volume.

Need for Agro-techniques

Medicinal plants have so far been collected from wild resources. However, the plant material collected from these sources is replete with the problems of adulteration and misidentification. Further, the plant material collected from the wild may also be contaminated by other species or parts thereof. The wild varieties also differ with respect to the presence of the active constituents from area to area. All such conditions may have adverse consequences on the quality and efficacy of the ASU drugs. In view of this, cultivation of genuine, authentic variety of plants may be the only way to have raw material of required quality. However, cultivation of these plants has never been easy and commercially viable. This is the basic reason for their exploitation from wild sources. Non-availability of proper techniques and authentic planting material are also some of the main constraints.

The safety and quality of medicinal plant materials and finished products depend on various factors like genetic makeup, environmental conditions, collection and cultivation practices, harvest and post-harvest processing, transport, storage practices *etc*.

The Agro-techniques included in this book provide information on propagation material, nursery technique (raising propagules, propagule rate and pre-treatment), planting in the field (land preparation & fertilizer application, transplanting & optimum spacing, intercropping, interculture & maintenance practices, irrigation practices and disease & pest management), harvest management (crop maturity & harvesting, post harvest management, viability of seed, chemical constituents, yield & cost of cultivation).

The medicinal plants are the basic source of raw-material for preparation of Ayurvedic medicines. Therefore, the quality of Ayurvedic products critically depends upon the quality of raw-material. By adopting good agro-technique of medicinal plants, the safety and quality of medicinal plant materials and finished products could be assured.

Good Agricultural Practices

Government of India has notified Good Manufacturing Practices (GMPs) under Drugs and Cosmetics Act, 1940. The quality of raw-material, however, depends upon the collection and cultivation practices used for procurement of medicinal plants. World Health Organization (WHO) has already published guidelines on Good Agriculture & Collection Practices of medicinal plants. National Medicinal Plants Board has also finalized guidelines for cultivation of medicinal plants and collection from wild sources. The Board has also approved Scheme for voluntary certification of standards under Good Agriculture Practices (GAPs) and Good Field Collection Practices (GFCPs) through the Quality Council of India, which is the national nodal agency for accreditation of certification bodies. Adoption of the agro-techniques available in the book would help in following Good Agriculture Practices as well as getting certificates.

Agro-techniques of Selected Medicinal Plants

Andrographis paniculata (Burm. f.) Wall. ex Nees

Syn. Justicia paniculata Burm. f.

Fam. Acanthaceae

Ayurvedic name	Kalmegh, Bhunimba
Unani name	Kalmegh, Chirayita Desi
Hindi name	Kalmegh
English name	Creat
Trade name	Kalmegh
Parts used	Dried Leaves and Tender Shoots



Andrographis paniculata

Morphological Characteristics

It is an erect, annual herb and 30-90 cm tall with upper part of stem quadrangular while the lower part nearly rounded stem. Leaves are opposite sessile or subsessile, linear-lanceolate or lanceolate, 3-8 cm long, acute, glabrous or minutely puberulous beneath and base cuneate, margin slightly undulate.

Floral Characteristics

Flowers are pedicelled, biliped, white-purple or spotted purple and solitary. Pedicel is 2.5–10 mm in size, slender and glandular pubescent. Bracts are acicular and 2.5 mm long. Calyx lobes are subacute, 2.5-3.7 mm long and glandular. Corolla is 7.5-12.5 mm in size, tube about half as long as the corolla. Filaments are hairy and anthers are purple beared at base. Fruit is a capsule, oblong, 18-20X4.5–5.0 mm, young ones sparsely glandular and hairy; when mature it is glabrous. Seeds are subquadrate, yellow to brownish in colour and rugose. Flowering and fruiting occurs in October – December (North India).

Distribution

The species is a native of tropical South-East Asia and occurs throughout hotter parts of India.

Climate and Soil

The plant comes up well in tropical and subtropical regions all over India. It is a hardy species,

therefore, can be grown in medium fertile sandy loam to clay-loam soils, possibly with irrigation. It can withstand partial shade of trees, say few hours, but it is cultivated in open fields.

Propagation Material

It can be easily raised through seed and vegetative methods. But in commercial cultivation, propagation through seed is easy and economical.

Agro-technique¹

This crop is grown during cooler climate and it remains for 120 days in field; usually, ratoon crop is also taken all over north India. Cooler climate helps plants in synthesizing more bitter ingredients.

Nursery Technique

• Raising of Nursery: Seeds are soaked in water for 24 hours and sown in the nursery beds in early September. About 650-750 gm seeds are required for raising nursery for one hectare of land. Nursery is prepared with soil, sand and organic matter in 1:1:1 ratio and sown in early September at 5 cm spacing in rows and it takes 8-10 days for germination to commence. Six weeks old seedlings are planted in field at 30X15 cm or 15X15 cm spacing. Direct sown crop is broadcasted thinly and has a seed rate of 1.5 kg/ha. It matures early, but nursery raising is preferred. For nursery beds, FYM @ 20 kg per square meter as basal dose is mixed in the soil.

Planting in the Field

- Land Preparation and Fertilizer Application: The land should be prepared well by repeated ploughing to make soil pulverized. For main field, FYM @ 20 t/ha is given as basal application. It is given NPK (75:75:50 kg/ha) in two split doses *i.e.* first at planting stage and second 40 days after plantation. Use of 5 kg Azospirillium + 5 kg Phosphobacteria per hectare has also given good results.
- Transplanting and Optimum Spacing: 10-25 cm long seedlings raised in the nursery beds during September are transplanted in the main field (after 6 weeks of sowing) at a distance of 30X15 cm between plant to plant and row to row.
- **Irrigation:** 4-6 light irrigations are required till harvesting the crop.
- **Weeding:** Since it is a herbaceous plant, the field should be free from weeds. Two to three weedings are essential during the crop season *viz.* at 20 days and 60 days after transplantation.
- **Disease and Pest Control:** It is a hardy plant and not attacked by any pest and disease.

¹ Agro-technique study carried out by Centre for Advanced Studies in Botany, University of Madras, Guindy Campus, Chennai – 600 025.

Harvest Management

- **Crop Maturity and Harvesting:** The crop matures after 120 days of sowing. It is harvested when most plants are in bloom. It is at this stage, the plants should be uprooted. However, a small lot of healthy plants should be left in the field for seed production. When the fruits become mature, these should be picked up and dried in the sun and seeds are collected. The seeds should be kept in open sun for complete drying. After this, these are stored in air-tight containers for next sowing.
- **Post-harvest Management:** After uprooting the plant, first it should be dried in the sun for two days and afterwards in the shade. This properly dried material should be packed in laminated gunny bags, lest it absorbs moisture. The harvested dry material should be stored in dark, airy and moisture-free places.
- **Viability of Seed:** One year of storage from the time of harvest.
- Chemical Constituents: The leaves contain three bitter principles; deoxyandrographolide, andrographolide and neoandrographolide. These are also present in whole plant. The leaves should yield 2.5% chemical constituents on analysis.
- **Yield and Cost of Cultivation:** The yield (whole plant) is 2.5 t/ha. It has sizeable demand and yields a reasonable profit to the growers. It is commercially cultivated in several States of India. Rs. 25000/- is the cost of cultivation for one hectare.

Therapeutic Uses

The whole herb is bitter in taste and is source of several diterpenoids of which a bitter water

soluble lactone "andrographolide" is important. The plant is acrid, cooling, laxative, antipyretic, antiperiodic, anti-inflammatory, expectorant, sudorific, anthelmintic, digestive and stomachic. It is useful in burning sensation, chronic fever, malaria and intermittent fever, inflammation, cough, bronchitis, skin diseases, intestinal worm, dyspepsia, flatulence, colic, diarrhoea, dysentery, haemorrhoids and vitiated condition of pitta. The plant is often used as a substitute for Chirayita (Swertia chirayita).



Andrographis paniculata in field



Angelica glauca Edgew.

Fam. Apiaceae

Ayurvedic name	Chorak
Hindi name	Chora, Choru, Gandrayan
Trade name	Gandrayan
English name	Angelica
Parts used	Roots/ Rhizome



Angelica glauca

Morphological Characteristics

It is a glabrous aromatic perennial or biennial herb, 1-2 meter tall. Stem is hollow. Root is thick rhizomatous. Leaves are unipinnate, bipinnate, or tripinnate, large pinna is toothed, ovate or lanceolate.

Floral Characteristics

Inflorescence is compound umbel with numerous rays. Flowers are white, yellow or purple in colour, bracteate; florets white or purple. Seeds are small in size and winged. Fruits/seeds are 1.25 cm by 0.6 cm in size.

Distribution

The plant is endangered in status, which is distributed in Western Himalaya from Kashmir to Uttarakhand, in alpine scrub and forest shades between 2700-3700 meters.

Climate and Soil

It requires cool and temperate climate. It can be cultivated between 2000-3000 meters above msl. It requires deep rich porous and moist soil with shady situations. For its ideal cultivation, the plenty of organic manure is required.

Propagation Material

Seeds and rootstock spilts.





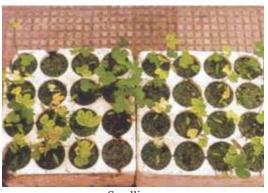


Rootstocks

Agro-technique²

Nursery Technique

• Raising Propagules: Seeds are sown immediately after harvesting during November and December inside polyhouse. Seed viability is very low and moist seeds have a better germination potential than dry seeds. Germination takes 25-40 days.



Seedlings

• **Propagule Rate and Pretreatment:** Approximately 50,000 plants or 6.2 kg seeds are required for its cultivation in one hectare land area.

Planting in the Field

- Land Preparation and Fertilizer Application: The field should be ploughed thoroughly followed by harrowing to bring the soil to a fine tilth and free from weeds. Seedlings are transplanted 45X45 cm apart in April and May. Apical portions of roots are transplanted during the rainy season at 45 cm apart. By this method, plants can be harvested within two years.
- **Green Manuring:** Sheep and goat manure is reported to be good for its cultivation. Approximately 15-20 tonnes of manure is required for one hectare of land initially, at the time of starting cultivation in lower altitudes. Manuring is done before planting. If

² Agro-technique study carried out by High Altitude Plant Physiology Research Centre (HAPPRC), HNB Garhwal University, Srinagar, Uttarakhand.

required, manuring should be done after the completion of the vegetative growth phase during October or in the winter after two or three years of cultivation. At higher elevations, where forest litter is available, it enhances growth as well as survival and yield.

- Transplanting the Seedlings to Main Field and Optimum Spacing: After four to six months growth of seedlings raised inside a greenhouse or in a small nursery, transplanting is done at the beginning of the rainy season. Raised beds are better for growth. If the site is moist or has good irrigation facilities, transplanting can be done during April and May.
- **Intercropping System:** It requires similar climatic and edaphic conditions as *Saussurea costus*, so intercropping with this plant is beneficial.
- **Intercultural and Maintenance Practices:** The intercultural operation like weeding/hoeing is carried out periodically as and when required.
- **Irrigation Practices:** Irrigation twice a week during the dry season is required.
- **Weed Control:** Weeding once a month and earthing every month during the rainy season and every two to three months during the dry season is essential.
- **Disease and Pest Control:** No disease and pests have been reported.

Harvest Management

• Crop Maturity and Harvesting: Under cultivation, harvesting can be done within two to three years. Roots are harvested during September and October when seeds become partially mature. Harvesting can be done after every two years, once the cultivation is well established and gives the maximum yield.



Seedlings

- **Post-harvest Management:** After harvesting the rhizomes, an apical portion is transplanted in a field for future crops. The remaining portion is washed with water to remove soil, and roots are cut into small pieces and put in partial shade for drying. After complete drying, roots are stored and packed in cloth bags.
- Chemical Constituents: Roots contain 1-1.5% volatile oil, valeric acid, angelic acid, lactones, sesquiterpenes, δ-α-cadinene, umbelliprenin, terpene alcohol and angelisine resin.
- Yield: At high altitudes of Garhwal, nearly 593-600 kg/ha yield is estimated under

cultivation which is greater than all medicinal plants traditionally cultivated and thus has great potential as a cash crop. For a long time the collection of this species has been done by Bhutiyas (tribes) from nature, and they still sell it as a condiment in valley villages to earn money. Nearly 15-25% *A. glauca* is sold in trade of medicinal plants by local people, especially from the Niti and Mana Valleys of Uttarakhand.

Therapeutic Uses

A. glauca is used in dyspepsia, constipations, ulcer of palate, infantile atrophy, dysentery, menorrhagia and rinderpest. Roots/rhizomes are used as a drug for wounds and gastric pains. It has stomachic, carminative, stimulant, and sudorific properties. It is useful in anorexia, spasms, flatulent colic and bronchitis. The powdered root is administered in warm water for children's stomach ailments; it also checks vomiting. It is also used for flavouring confectionery and liquors. The leaves and stem act as a stimulant, cordial and used in stomach troubles.



Aquilaria malaccensis Lam.

Syn. A. agallocha Roxb.

Fam. Thymelaeaceae

Ayurvedic name	Agaru
Unani name	Ood Hindi /Agar
Hindi name	Agar
English name	Aloewood, Eaglewood, Agarwood
Trade name	Agar
Parts used	Fragrant Resinous Wood and Oil



Aquilaria malaccensis

Morphological Characteristics

This plant is a large evergreen tree about 20 meters tall and 1.5–2.4 meters in girth with somewhat straight and fluted bole. Leaves are alternate 0.5-10 cm by 2-5 cm, oblong, lanceolate or elliptic, caudate, acuminate and glabrous with slender nerves. Venation is parallel. Petiole is 0.3-0.5 cm long. It is commercially used as fragrant and in prepation of drugs. The tree contains plenty of oleoresin and has irregular dark patches. The wood burns with a bright flame giving off pleasant smell.

Floral Characteristics

Flowers are white in colour, bisexual, pedicellate, in both axillary and terminal umbellate cymes, shortly pedunculed, perianth, companulate, lobes 5 spreading and densely pilose. Pedicels is 0.5-0.8 cm long, slender. Perianth remains persistent in fruit and 1.3-1.5 cm long, silky densely villous, connate at the base. Stamens are 10, anthers 10 with subsessile disc. Ovary is subsessile, villous and two-celled. Stigma is large, subsessile. Fruit is capsular, 3-5 cm long, obovoid, pericarp coriaceous and densely tomentose. Seeds are ovoid with a long tail.

Distribution

Bengal and North-Eastern States of India namely Assam, Meghalaya, Manipur, Mizoram,

Arunachal Pradesh and Nagaland.

Climate and Soil

This is a tropical tree which grows over high rainfall tract throughout humid regions. The region experience low temperature variations between 20°C to 28°C and relative humidity around 80%. It grows over sandy loam and slightly acidic soils.

Propagation Material

Seeds.

Agro-technique³

Nursery Technique

- Raising Propagules: Seeds mature during July-August. It loses viability soon. Thus seeds are sown within a week of collection. Raising seedlings in poly-bag is preferred. Seed germination is more than 80%.
- **Propagule Rate and Pretreatment:** 4500 plants/ha are required.

Planting in the Field

- Land Preparation and Fertilizer Application: Before transplanting of seedlings, land should be thoroughly ploughed and harrowed to bring it up-to a good tilth. FYM @ 20 t/ha may be applied at the time of land preparation supplemented with NPK @ 60:60:40 may be applied in split doses. The fertilizer level is increased with age from 3rd year onwards.
- **Transplanting and Optimum Spacing:** Seedlings when attain a height of 30-40 cm should be transplanted in the field during rainy season (April-June) at optimum spacing of 3X 3 meter.
- **Intercropping System:** Annual or biennial medicinal herbs *viz. Andrographis paniculata* (Kalmegh), *Withania somnifera* (Ashwagandh), *Rauwolfia serpentina* (Sarpagandha), *Bacopa monnieri* (Bhrami), *Piper longum* (Pippali) *etc.* may be cultivated as catch crops till the trees attain growth.
- Inter-culture and Maintenance Practices: Spading and simultaneous weeding at 90 days after transplanting is required.
- Irrigation Practices: Rainfed plantation.
- **Weed Control:** Hand weeding is done after 90 days of transplanting, thereafter Gramoxone @ 0.5 kg/ha may be applied when necessary. Glycel @ 1.5 kg/ha may be applied to eradicate weeds.

³ Agro-technique study carried out by North East Institute of Science Technology (NEIST) Jorhat 785006, Assam.

• **Disease and Pest Control:** Attack of *Heortia vitessoides* is observed during May-August. This causes defoliation of whole tree. Application of Thiodan @ 2 ml/lit at 15 days interval during infestation is found to control the pests effectively.

Harvest Management

Agar-wood develops a peculiar, persisting strong odour because of infestation by a fungal identified as *Zeuzera conferta*, it penetrates the hard wood, through wounds, injury or borers. All attempts to induce artificial infestation have failed; it is a natural phenomeon. It develops black patches and stores resinous oil which is separated through distillation of the woody chips. This oil has high value in medicine and perfumery industry.

- **Crop Maturity and Harvesting:** Time of harvesting depends on disease infestation in hard wood. Agar is regarded as a pathological product formed as result of infection. Black patches in the bark indicate occurrence of infection and can be used for harvesting hard wood to commercial use.
- **Post-harvest Management:** Wood chips or chips powdered mechanically without generating heat are soaked in water for 2-3 days and transferred to stainless steel vessel which is part of a distillation unit. The distillation is done for 30-36 hours. Oil and water is collected in a separator and stored. The oil and water ratio in the condenser is kept low on account of the high boiling point. Oil is stored in closed container preferable in Aluminum bottles.
- Chemical Constituents: The woody chips have an essential oil commonly known as Agar oil from 0.8% to 2.2% in fungal infested wood of 8-50 years old plant. The wood contains hexadecanoic acid (25.0%), pentadecanoic acid (6.7%) and oleic acid (4.9%); other constituents range from 0.1 to 2.1%.
- Yield and Cost of Cultivation (Hectare): This oil is exceptionally costly.

Therapeutic Uses

Wood is used as stimulant, aphrodisiac, tonic in diarrhea, vomiting and used in skin related ailments like wounds, injuries, pain, indigestion, heart related ailments, blood purifier against gout, impotence and urine related disorders. The plant acts as anti-inflammatory, stimulates the nervous system, antirheumatic and antiparalysis.



Aristolochia indica Linn.

Fam. Aristolochiaceae

Ayurvedic name	Isharmul
Unani name	Zarawand Hindi
Hindi name	Kiramar
English name	The Indian Birthwort
Trade name	Ishar-mul
Parts used	Leaves and Roots



Aristolochia indica

Morphological Characteristics

A ristolochia indica is a perennial creeper with a woody rootstock. Leaves are alternate, entire with more or less undulate margins, somewhat cordate, acuminate or obovate.

Floral Characteristics

Flowers constitute of greenish-white or light purplish perianth with inflorescence in axillary cymes or fascicles, 1-2 lipped, hairy within limbs dilated. Stamens are six in number, adnate and filaments are not distinguishable from the style. Anthers are adnate to column. Carpel is six locular with two ovules. The flowers are usually foetid in odour. Fruit is globose, oblong, septicidal, six valved capsule and opening from below upwards. Seeds are many in number, flat and winged.

Distribution

Plant is distributed in lower hills and plains of India, Bengal and Assam.

Climate and Soil

It grows in warm and moist climate, with temperature ranging from 20°C to 33°C, and annual

rainfall ranging 100-150 cm and spread out to a greater part of the year. It can also be cultivated over well drained sandy-loam soil rich in organic matter. It needs irrigation at lower elevation where rainfall is low.

Propagation Material

Seeds.

Agro-technique4

Nursery Technique

• Raising Propagules: Seeds mature during May-July. Germination of seed is about 80%. Seeds may be sown in rows over raised beds and 10 cm apart. Seedlings at 4-5 leaves stage can be transferred in polybags or kept in the nursery bed till it attains 15 cm height, when it is ready for transplantation. Seed viability remains at 70-80% up to one year. Seeds should be treated in Bavistin/Captan/Thiram before sowing. About 30,000 seedlings are needed for one hectare land.

Planting in the Field

- Land Preparation and Fertilizer Application: Land should be deeply ploughed and harrowed twice and made into good tilth. FYM @ 10 t/ha alongwith NPK @ 25:60:100 kg/ha during land preparation may be applied. Later N @ 25 kg/ha may be applied after planting and again at 3 months interval.
- Transplanting and Optimum Spacing: Seedlings may be raised in May-July and their transplantation done in August-September. 60X60 cm spacing is optimal requirement.
- Intercropping System: Annual herbs like chilli can be grown as intercrop.
- Inter-culture and Maintenance Practices: Hoeing and hand weedings are carried out simultaneously 45 days after planting, thereafter at 6 months interval in first year. In second year, periodicity of interculture remains same.
- **Irrigation Practices:** Usually rainfed crop, but supplementary irrigation is needed during dry seasons.
- **Weed Control:** Pre-emergence application of Pendimethaline @ 1.0 kg/ha or Simazine @ 2.0 kg/ha may be applied, thereafter hand weeding at 90 days after transplanting and later as per weed population. Application of post-emergence herbicides is not suggested.
- **Disease and Pest Control:** Leaf blight is observed in the plantation during winter season. Application of Dithane M-45 @ 3 gm/lit at 15 days interval is found to control

⁴ Agro-technique study carried out by North East Institute of Science Technology (NEIST) Jorhat – 785006, Assam.

the disease. Infestation of *Pachlioptera aristolochia* is found to attack the vines and eat on tender leaves during May-August. Application of Rogor 30 EC @ 0.02% keeps the moth away. Thiodan 35 EC @ 0.09% is also found effective against the insect.

- **Crop Maturity and Harvesting:** Crop matures after one year growth but the leaves are pruned and harvested after 180 days onwards periodically. The collection of roots is advisable after two years of age.
- **Post-harvest Management:** Leaves and roots after collection are cleaned thoroughly and all foreign matters are removed. These may be dried in shade for a week when it has 10-12% moisture and then it is ready for storage. It is packed in air tight polythene bags and stacked in bamboo or wooden crates.
- **Chemical Constituents:** Plant possesses aristolochic acid upto 0.017% and essential oil upto 0.5%. Besides, it has potassium and β-sitosterol. Two sesquiterpene hydrocarbons *viz*. ishwarane and aristolochene have been identified from the root and their structure is established.
- **Yield and Cost of Cultivation:** Estimated yield is 640 kg/ha/year in the second year and onwards.

Therapeutic Uses

The dried roots and rhizomes are used as a bitter tonic. The fresh juice of leaves and bark is used in the bowel complaints of children, diarrhoea and intermittent fevers. The root is used in skin diseases. It heals wounds and destroys the toxic effect of all poisons. In the olden days, it was used against snake-bites in Southern India. The plant possesses emmenagogue, abortifacient, anti-inflammatory, antiperiodic, diuretic and antibilious properties.



Bergenia ciliata (Haw.) Sternb.

Fam. Saxifragaceae

Ayurvedic name	Shailagarbhaja, Pashanbheda
Unani name	Zakhmehayat, Pakhanbed
Hindi name	Pakhanabhed, Pashanbheda
English name	Hairy bergenia
Trade name	Pashanabhed
Parts used	Rhizomatous Rootstock or Rhizome



Bergenia ciliata

Morphological Characteristics

This is a rhizomatic herb with fleshy leaves, growing upto 30 cm tall, having a stout creeping rhizomatous rootstock with scars and intermittent axillary buds. Plant is quite hardy and able to survive frost during winter turning reddish in colour. It is evergreen and flowers in April to June. Its flowers are white-pink and purple in colour. Stem is short. The rhizome comes out from the cervices of rocks and hangs in the air in sloppy areas. Leaves are 5-30 cm long, glabrous, sparsely hairy in margins, broadly obovate or elliptic, finely or sparsely denticulate or shallowly sinuate-denate.

Floral Characteristics

The flowers are bisexual, white, pink or purple with long cymose panicles 4-10 cm long. The fruit is a capsule and rounded in shape. Seeds are greyish in colour, minute and numerous in one capsule.

Distribution

The plant is endemic to Northern and Eastern temperate Himalayan region in Himachal Pradesh, Jammu & Kashmir, Uttarakhand and North Eastern hilly states between altitudes of

1200-3000 meter in the cold or glacial mountain rocky slopes in stone crevices. It is also found in adjoining countries like Nepal, Pakistan, Afghanistan upto Tibet and China at higher altitudes.

Climate and Soil

Plant grows well under humid, temperate climatic conditions, where temperature generally remains below 20°C. Plant grows well over sandy, slightly acidic soils with high porosity and rich in organic matter or forest humus. However due to its hardy nature, this species can be grown well over medium loamy to clay soils, supplemented with manure. It tolerates light shade and grows well under open sunny conditions. But the vegetative growth has been found better in shade.

Propagation Material

Rhizome Segments: 8-14 cm long and 23-26 gm in weight are used for direct planting; annular segments of 2 cm thickness are preferred for nursery raising.

Seeds: Seed germination is low and seed viability is very poor.

Agro-technique⁵

Nursery Technique

- **Raising Propagules:** It takes about one month to develop a mother nursery which can supply planting material for raising cultivation.
 - i) By Rhizome Segments: The crop can be raised by direct planting of 7.5-12.5 cm long rhizome segments (average weight: 23-26 gm) with 2-3 nodes as propagation material for quick and faster regeneration in the field in late summer or onset of monsoon. It is treated with 100 ppm IBA solution for two minutes. Raising crop through rhizome segments can reduce crop cycle by one year in comparison to propagation through seed sown. However, it requires large quantity of rhizome sections for planting. It is noted that the smaller rhizome segments of about 2 cm thickness can be planted at spacing of 10X10 cm in nursery. The rate of growth is slow and as it takes about 18 months time for raising plants in nursery for field planting.
 - **ii**) **By Seed Method:** The seeds are very minute in shape and exhibit poor viability and germination potential. They exhibit slightly recalcitrant nature and need to be used immediately after maturity in spring season (March-April). The seed is stratified for 15 days at 4°C to improve germination. Storing will lose viability. Seeds are sown over top surface of raised beds or poly bags over the

⁵ Agro-technique study carried out by (a) National Institute of Pharmaceutical Education and Research (NIPER), S.A.S Nagar, Mohali, Punjab, (b) Indian Institute of Integrative Medicine (IIIM), Jammu, and (c) Herbal Garden, Herbarium and Research Institute, Joginder Nagar, Govt. of Himachal Pradesh, Shimla, Himachal Pradesh.

moist layer of forest litter or farmyard manure preferably under greenhouse conditions. The seeds take 60-90 days for germination. After germination, the seedlings are picked out at two-three leaved stage and planted in fresh nursery beds at spacing of 10X10 cm and takes a season to grow large before planting in the field in next summer.

Propagule Rate and Pretreatment: About 88,000-90,000 plants are needed to plant one hectare land for which approximately 18-20 quintals fresh biomass of rhizome is required. Before planting, the rhizome segments should be treated with 100 ppm IBA solution for two minutes or soaked in plain water for two hours.

Planting in the Field

- Land Preparation and Fertilizer Application: It is a hardy plant hence it can be planted in spring as well as summer in the hills; although the best time for planting is monsoon time (July). Land preparation is as usual for growing crops in hills. Add 35 t/ha of FYM and plough the deep in the soil. After planting, make 9-12 cm raised beds or shallow ridges for intercultural operations. For proper water retention and enhancing the porosity of soil, add sufficient quantity of locally available peat moss or the forest litter. It enriches soil with useful microfauna and micorrhiza, which help growth.
- Transplanting and Optimum Spacing: The rooted plants should be transplanted in the field in 12-15 cm raised bed at a spacing of 30X30 cm. While planting in the raised beds, keep at least 5 cm space on each side of bed along the length so that three rows of plants can be adjusted.
- Intercropping System: The maximum height of plants which can be achieved under optimum growing conditions may be 30 cm with heavy leaf biomass. Intercropping is possible when the two crops growing together do not compete for same nutrients. Experimental study was also conducted by planting annual crop of *Swertia angustifolia* (Chirayita) plants in a spacing of 15 cm in straight line between the gaps of two rows which showed very encouraging results and it was concluded that because these two crops have different maturity period and crop cycle, hence they can be grown together successfully.
- Interculture and Maintenance Practices: The leaves of plants are prone to decay during rainy season. Such leaves must be removed immediately from the plants to avoid any fungal infection. The slope of water drainage can be put toward inner side of field to protect the fertile soil from washing away.
- **Irrigation Practices:** The crop should be given irrigation an interval of 15 days in summer season. Sprinkler irrigation can be tried to keep the humidity level high at canopy level.

- **Weed Control:** Broad leaved weeds and some perennial grasses are common during rainy season which should be uprooted immediately. Six weeding operation are needed
- **Disease and Pest Control:** Leaf hopper and snails generally attack the foliar part of crop. No bacterial and fungal diseases were reported. To check the disease, the extra foliar growth should be removed. Sometimes extreme frost conditions are observed in high hills which lead to leaf and flower decay.

Harvest Management

per year.

- **Crop Maturity and Harvesting:** The crops mature in autumn from the second year and onwards. However, it is recommended to harvest roots during third year.
- **Post-harvest Management:** The underground rhizomes are taken out and after removing the leaf and soil debris, they are washed thoroughly under running water and cut it into small pieces of 5 cm long and allowed to dry in partial shade for 8-10 days or till complete drying (4-6% moisture stage). The dry rhizomes are packed in gunny bags and stored in cool and dry conditions.
- **Chemical Constituents:** The rhizome of *Bergenia ciliata* contains bergenin (0.6%), gallic acid and tannic acid (14.2%), glucose (5.6%, mucilage and wax).
- **Yield and Cost of Cultivation:** The plant yields 7.0-7.2 tonnes rhizomes per hectare (dry biomass) after second year when the crop is raised through rhizome cuttings. The cost of cultivation for one hectare may come to Rs.74,455/-.

Therapeutic Uses

The drug is used as litholytic agent for urinary calculi. It is widely used in the treatment of

dysuria, cystisis, crystalluria and renal failure, vertigo and headache. The rhizomes and roots of the plant act as astringent, tonic and have anti-inflammatory effect and are applied as poultice for stiff joints, boils, abscesses and skin infections. The root powder is considered to be a mild diuretic, but in higher doses, it exhibited anti-diuretic action. Various Ayurvedic classical drugs such as Pashanabhedadi kwath, Pashanabhedadi ghrit, Pashanabhedadi Churan *etc.* are prepared from Pashanbhed rhizome.



Bergenia ciliata in field

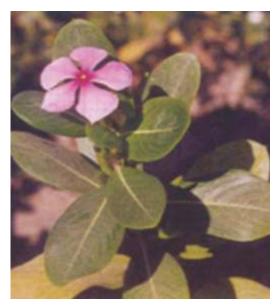


Catharanthus roseus (Linn.) G. Don

Syn. Vinca rosea Linn.

Fam. Apocynaceae

Ayurvedic name	Nityakalyani (S)
Unani name	Sada Bahar
Hindi name	Bara Massi/ Sada Bahar
English name	Periwinkle
Trade name	Sada Bahar
Parts used	Root/ Leaves



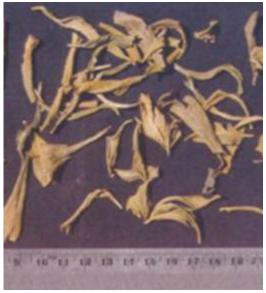
Catharanthus roseus

Morphological Characteristics

Catharanthus roseus is a perennial small herb or sub-shrub, up to 90 cm in height. Stem is erect, lax branching with flexible long branches, purple or light green. Leaves are simple, cauline, opposite, ex-stipulate, petiolate, elliptic ovate to oblong, 4-10 by 2-4 cm glabrous to pubescent, base acute or cuneate, apex obtusely apiculate and lateral nerves 10-12 pairs. Petiole is 1.0- 1.5 cm long.

Floral Characteristics

Inflorescence is recemose oraxillary or terminal cyme or solitary/paired and shortly pedicillate. Flower colour is pink/white and tubular, swollen in the region of anthers, throat of corolla-tube hairy.



Dried leaves

Androecium contains 5 stamens included in the corolla tube, filaments are very short, epipetalous, anthers forming a cone-like structure above the stigma. Gynoecium contains two

carpels, which are free below, but united in the stylar region. Ovaries are two, free and single style with dumbbell stigma. After fertilization, the carpels separate and form two fruits which form a pair of elongated follicles. Seeds are small in size and black in colour, 1000 seeds may weight 1.2 gm.

Distribution

Plant is a native of West Indies. It is distributed throughout tropical and sub-tropical parts of India. Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Madhya Pradesh and Assam are ideally suited for the cultivation of the plant.

Climate and Soil

The cosmopolitan distribution of the plant shows that it can grow in a variety of soils and climates. However, its growth is better in tropical and sub-tropical areas. The plant also grows in sub-tropical areas of northern India but the growth is slow due to extremely low temperature during the winter. It can be grown in any type of soil except those which are highly saline, alkaline or water-logged. Light soils, which are rich in humus, are preferable for large scale cultivation, since harvesting of the roots become easy. A well distributed rainfall of 100 cm or more is ideal if the plant is to be grown as a rainfed crop.

Propagation Material

Seeds (Seeds not older than one year should be used).

Agro-technique⁶

Nursery Technique

- **Raising Propagules:** Freshly harvested seeds (not older than one year) should be used. Seeds can be sown either in a nursery and then transplanted or sown directly in the field.
- **Propagule Rate and Pretreatment:** Direct sowing can be adopted during the monsoon months, particularly if large area has to be cultivated. About 2.5 kg of seeds are required per hectare. Seeds are mixed with about 25 kg of fine, moist sand to ensure even distribution. Seeds are sown in rows 45 cm apart; subsequently seedlings are thinned maintaining a distance of 30 cm between plant to plant.
- Transplanting the Seedlings to Main Field and Optimum Spacing: If seeds are scarce and irrigation facility is available, transplanting can be adopted with advantage since only about 500 gm of seeds will be enough to plant one hectare. Seeds are sown in nursery beds, two months before transplanting. An area of about 200 sqm under nursery gives enough seedlings for transplanting one hectare land. The seeds take about ten days to germinate and about 60 days to reach transplanting stage.

⁶ Agro-technique study carried out by Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh.

Transplanting is done at 45X30 cm spacing. One hectare requires about 74,000 seedlings.

Planting in the Field

- Land Preparation and Fertilizer Application: The field should be ploughed thoroughly followed by harrowing to bring the soil to a fine tilth and free from weeds. After the green manure crop is ploughed in or after the application of farmyard manure, as the case may be, the land is prepared as usual practices for any other agricultural crop. A basal dose of 250 kg of superphosphate and 65 kg muriate of potash are also incorporated in the soil. 110 kg urea is applied to the crop in two splits. First application is made 10-15 days after transplanting and the second application is made one month later. This is for an irrigated crop. When the crop is grown under rainfed conditions, half the quantities of manure and fertilizers mentioned above should be applied.
- Green Manuring: Farm yard manure at the rate of about 10 t/ha is applied in those areas where it is available at reasonable rate. If irrigation is available, it is advantageous to grow a leguminous crop, such as sunhemp or horsegram, prior to sowing or transplanting and ploughing it when it attains flowering stage. When this is done, application of farmyard manure may be dispensed with. This helps in building up the fertility of the soil. The green manure seeds should preferably be treated with bacterial inoculum, prior to sowing, to increase the development of root nodules which absorb atmospheric nitrogen and fix it in the soil. For treating seeds with inoculums jaggery solution is prepared by dissolving about 50 gm of jaggery in 500 ml of water, boiled, cooled and green manure seeds are wetted with this solution. Then, rhizobium culture (@ 300 gm/ha) is sprinkled and mixed well. The stickiness of the jaggery helps the rhizobium culture to adhere to the seeds.
- **Irrigation and Intercultural Operations:** Places where rainfall is evenly distributed throughout the year, the plants do not require any irrigation. However, the areas where the monsoon is restricted to a particular period, 4-5 irrigations once in fifteen days during February, March and April months are needed to get optimum yield. The first weeding is done after about 60 days from sowing or transplanting and the second after additional 60 days.
- **Diseases and Pest Control:** The plant is generally resistant to the attack of various pests and diseases. Occasionally, some plants have been found to suffer from 'Little-leaf' disease, resulting in stunted growth of the plant. The disease can be checked from spreading by uprooting and destroying the affected plants and spraying organic phosphorus insecticides once in 15 days when the infection is prevalent. A, die-back, caused by *Pythium aphanidermatum* Edson Fitzp., has been found to affect the crop during the monsoon. It is observed that mulching between the rows with any straw

reduces the incidence of die-back to a considerable degree. Varieties 'Nirmal' and 'Dhawal' developed by CIMAP have a high level of field resistance to the die-back disease.

Harvest Management

- **Crop Maturity and Harvesting:** The crop is harvested after about 12 months from sowing. The crop is cut at about 7.5 cm above the ground and dried in shade. The field is then copiously irrigated and when it reaches at proper moisture level, it is ploughed and the roots are collected. The roots are washed thoroughly and dried in shade. If there is demand for leaves, two leaf-stripping can be taken, the first one after 6 months and the second one after 9 months from sowing.
- **Post-harvest Management:** After harvesting, the whole plant is dried in shade. At this stage, light threshing will separate the seeds, which can be used for the next sowing. The leaves and stems are also then separately collected. Seeds collected this way will have fruits of various degrees of maturity and hence will have poor percentage of germination. It is, therefore, advisable that only mature pods should be collected during two or three months before the crop is harvested.
- Chemical Constituents: At present, more than 100 alkaloids have been isolated from the various parts of the plant, of these vinblastine (VLB) and vincustine (VCR) present in its leaves, and ajmalicine, present in its roots are medicinally important. VLB is used in the treatment of Hodgkins disease, non-Hodgkin lymphomas, testicarcinomas, and sometimes against breast cancer and chorio-carcinomas. VCR is used against acute leukemia, Hodgkins disease, non-Hodgkin lymphomas, rhabdomyosascomas, Wilm's tumors in children and breast cancer. Ajmalicine is used for the treatment of hypertension.
- **Yield:** Under irrigated conditions, about 1.5 tonnes of leaves, and 0.5 tonnes of roots on air-dry basis are obtained per hectare. The yield of leaves and roots under rainfed conditions is 0.75 t/ha each on air-dry basis. Rs. 25000/- is the cost of cultivation for one hactare.

Therapeutic Uses

Plant is used in cancer and diabetes; root paste is used in septic wounds; root decoction is used in fever; leaves are used in menorrhagia; leaf juice is used in blood dysentery. The decoction of leaf is used for babies in gripping pain while the latex is useful in scabies. Plant contains hypotensive, sedative and antiviral activities.



Centella asiatica (Linn.) Urban

Syn. Hydrocotyle asiatica Linn.

Fam. Apiaceae

Ayurvedic name	Mandookparni
Unani name	Khulakudi, Brahmi
Hindi name	Brahmi
English name	Asiatic Pennywort, Indian Pennywort, Gotu Kola
Trade name	Brahmi
Parts used	Whole Plant, Mainly Leaves



Centella asiatica

Morphological Characteristics

The plant is a small trailing herb. It is the only species of *Centella* found in India. Stem is glabrous, pink striated and rooting at nodes. Leaves are fleshy, orbicular to reniform and dentate. Petiole is long, smooth on upper surface and hairy below.

Floral Characteristics

Flowers are pink and white in fascicled umbels. The fruits are oblong, dull brown, laterally compressed, pericarp hard, thickened and woody white.

Distribution

The plant occurs in marshy places throughout the country in tropical and subtropical regions.

Climate and Soil

Plant naturally grows over moist, fertile, loose, sandy loam and clayey soil. Thrives best in monsoon periods in well drained beds.

Propagation Material

The plant is propagated by rooted suckers and seeds.



Nursery Technique

- **Raising Propagules:** The plants grow well under shade and can tolerate heavy shade. One-node stem cuttings can be planted. The root develops from the nodes.
- **Propagule Rate and Pretreatment:** 300 kg rooted suckers are needed to plant one hectare land. No specific pretreatment is required.

Planting in the Field

- Land Preparation and Fertilizer Application: The field should be prepared well by giving one ploughing and two harrowings, followed by planting. Manure (FYM) at the rate of 20 t/ha should be mixed thoroughly with the soil at the time of field preparation. NPK fertilizers @ 100:50:50 kg/ha in 4 split doses are given.
- **Transplanting and Optimum Spacing:** The planting can be done in February-March at a spacing of 45X45 cm with irrigation. It is an irrigated crop.
- **Intercropping System:** The plant can be grown as pure crop in orchards of Mango and other trees.
- **Interculture and Maintenance Practices:** There is a profuse growth of weeds in the beds; hence it requires continuous hoeing and weeding. During monsoon months, it is essential to prevent water logging in the beds.
- **Irrigation Practices:** During dry months fortnightly irrigation is needed and needs drainage during rainy season.
- **Disease and Pest Control:** No disease, pests or any other physiological disorder was observed in the experimental plantation.

Harvest Management

- **Crop Maturity and Harvesting:** The crop matures in 90 days period after planting. It is harvested through hand-cutting at fully grown leaf stage. The leaves are harvested in sunny weather to facilitate drying.
- **Post-harvest Management:** Unwanted material is sorted out from the crop before the harvested material is dried in shade.
- Chemical Constituents: Asiatic acid, asiaticoside, madecassic acid, brahmic acid,

⁷ Agro-technique study carried out by Institute of Minerals and Materials Technology (IMMT) Bhubaneswar – 751013, Orrisa.

thankuniside, centellose. Total triterpinoids are in leaves and they are approximately 1.0% of leaves.

• **Yield and Cost of Cultivation:** As a pure crop, 10-12 t/ha/years yield is obtained by 3 harvests in a year. After second year, the yield begins to decline, needing fresh planting. Rs. 40000/- is the cost of cultivation for one hectare.

Therapeutic Uses

The whole plant has therapeutic values. It is used as nervine tonic, for improving memory and mental disorders. It is anti-leprosy, diuretic, stomachic and used in insomnia, asthma, abdominal disorders and fever. Decoction of the plant is given in the treatment of leprosy.



Centella asiatica in field



Chlorophytum arundinaceum Baker

Fam. Liliaceae

Ayurvedic name	Musli Bhed
Unani name	Musli Safed, Biskandri
Hindi name	Safed Musli
English name	India Spider Plant
Trade name	Safed Musli
Parts used	Tuberous Root



Chlorophytum arundinaceum

Morphological Characteristics

It is a perennial herb with a short hard root stocks; roots often thick, fleshy and cylindrical. The leaves are 15-35 cm long and oblanceolate. The plant is considered endangered species in the country.

Floral Characteristics

Inflorescence is dense; flowers are arranged in raceme and shortly branched. Flowers white, anthers as long as or longer than the filaments and yellow in colour. Bracts are usually long and over topping the shortly pedicelled buds. Cells of the orbicular capsule are 3-4 seeded and black coloured.

Cluster of underground tuberous root

Dried root pieces

Distribution

Plant is distributed sparsely over Eastern India, mainly Bengal, Sikkim, Bihar, Assam and few places in Orissa and Meghalaya.

Climate and Soil

A tropical and subtropical climate with humid atmosphere is suitable for its growth. Temperature 20°C-25°C, rainfall 150-200 cm and relative humidity around 70% is suitable for its better performances. Sandy-loam and organic matter rich in clay loam soil is suitable for the plant.

Propagation Material

Seed and root tubers.

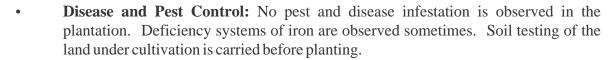
Agro-technique⁸

Nursery Technique

- Raising Propagules: Root stocks @ 7-10 quintals are required per hectare. Germination of untreated seeds is about 9-12%. Seed treatment with concentrated sulphuric acid for half an hour, followed by treatment of Gibberellic acid (GA) 100 ppm enhances germination upto 38%.
- **Propagule Rate and Pretreatment:** 45000-50000 seedlings per hectare as a mono crop; whereas 30000-40000 seedlings are required for plantation with *Cajanus cajan* (Pigeonpea) as a shade plant.

- Land Preparation and Fertilizer Application: Land should be ploughed, harrowed 2-3 times to make it to good tilth. FYM @ 20 t/ha may be applied during land preparation. NPK @ 90:30:30 kg/ha is recommended; of this, N is split in 3 doses. The first split of 30 kg N with entire quantity of P and K may be applied at the time of land preparation and rest of Nitrogen be applied after 3 and 6 months of planting.
- **Transplanting and Optimum Spacing:** Seeds may be sown in line during March in raised beds 10 cm apart. Frequent watering is necessary. By May-June seedlings are ready for transplantation. Shade must be provided in the plantation. 60X30 cm is recommended optimum spacing.
- **Intercropping System:** *Cajanus cajan* is found as a good intercrop providing shade to the growing plants.
- **Interculture and Maintenance Practices:** Hand weeding and hoeing at 4 months interval in first year; thereafter, twice in a year will keep the fields free from weeds.
- Irrigation Practices: Largely rain fed irrigated in dry season only or as required.
- Weed Control: Weed control is required at 45 days after planting and thereafter at 4 months interval. Pre-emergence application of Simazine 2.0 kg/ha or Pendimethaline @ 1.0 kg/ha is followed by hand weeding.

⁸ Agro-technique study carried out by North East Institute of Science Technology (NEIST) Jorhat – 785006, Assam.



Harvest Management

- **Crop Maturity and Harvesting:** One year; harvesting time April May.
- **Post-harvest Management:** Uprooting by hoe. Tubers must be cleaned from foreign material and then dried under shade for 15-20 days before packing in clean sacks and stored over wooden pallets.
- **Chemical Constituents:** Plant contains Sapogenine (0.1%), high percentage of starch, carbohydrate, sugar and minerals like magnesium, potassium and tannin.
- **Yield and Cost of Cultivation:** 500-800 kg dry root yield in second year after planting. Rs. 40000/- is the cost of cultivation for one hectare.

Therapeutic Uses

Tubers having medicinal value are used as general tonic, containing the steroid sapogenine (1-2%), protein (10-20%) and calcium. Tubers are fat free. The tubers have high approdisiac property. It is also useful in diseases like renal calculus, leucorrhoea and diabetes.



Cineraria maritima Linn.

Syn. Senecio maritima DC.

Fam. Asteraceae

Hindi name	Cineraria
Trade name	Dusty miller, Silver Dust
Parts used	Leaves



Flowers of Cineraria maritima

Morphological Characteristics

Plants are usually annual herbs, but in suitable growing conditions turn into perennials. Roots are branched. Tap root is yellow in colour in young plants, but on maturity turn into light brown. Stem is erect, branched, solid and cylindrical, covered by wooly white hairs and appears silvery in colour. Leaves are cauline; 8.5-9.5X6.5-7.5 cm in size, surface wooly, silvery and white in colour with unicostate reticulate venation and petiolate. Petiole 3.0-3.5 cm long, exstipulate. The leaves are growing above ground, ovate spathulate, but on maturity these become pinnatifid with oblong and obtuse segments; lobes narrow at the base, but widening and toothed towards the apex.

Floral Characteristics

Inflorescence is a capitulum, 9-13 mm in diameter and arranged in corymbose branched raceme. Each capitulum is subtended by 12-14 involucres. Capitulum consists of two types of florets: ray and disc florets. Ray florets are peripheral, pistillate, zygomorphic, and epigynous. Pappus is hairy. Petals are 5, gamopetalous, ligulate and yellow in colour. Disc florets are in central, bisexual, actinomorphic, epigynous, tubular, aestivation valvate and yellow in colour. Stamens are 5, epipetalous, syngenesious, dithecous, introrse and opening by longitudinal

slits. Pollen grains are rounded and exine rough, $24-35~\mu m$ in diameter. Gynoecium is unicarpellary, unilocular, syncarpous, placentation basal, ovary, inferior, style simple 0.5-0.6~mm long and stigma bifid. Ovule is anatropous with basal placentation. Fruit are achenes, 1.0-1.3~mm long and ribbed.

Distribution

This is an exotic species native to Western and Central Mediterranean regions where it grows in arid, scrub like habitats. So far this plant is not reported to grow wild in India. Some limited commercial cultivation of the plant has been taken up in Nilgiri hills.

Climate and Soil

C. maritima requires warm sunny site in cooler sub-tropical to temperate climate. Plants are fairly drought tolerant. Excessive rainy conditions are not suitable for the growth of this plant. On the basis of growth behaviour, alluvial, sandy and hilly soils have been found suitable for its cultivation. Fields should be well drained and there should not be any water logging in the field.

Propagation Material

Plants may be grown both from stem cuttings as well as from seeds. Growing from seeds was found to be better method of propagation in sub-tropical conditions, since most stem cuttings did not survive after initial sprouting. However, in Nilgiri area plants are usually multiplied by splitting the rooted branches that grow from the base of the plants.

Agro-technique⁹

Nursery Technique

- Raising Propagules: At sub-tropical conditions, plants should be raised from seeds. Achenes (seeds) sown in December exhibit maximum germination. However, in temperate conditions, plants may also be raised or multiplied through splitting of the rooted branches.
- **Propagule Rate and Pretreatment:** Seeds are small; therefore, before sowing they should be mixed with dry soil or sand and may be sown by broadcasting in raised nursery beds. After broadcasting, seeds should be covered with thin layer of soil. During germination stage, watering is required every alternate day for two weeks and thereafter the frequency of watering may be reduced to twice a week till the plants grow tall and are suitable for transplanting. Seeds sown in the month of December produce seedlings that become ready after one month for transplanting. Seedlings should be transplanted in the field in late January or early February when they are about 5.0 cm in height.

⁹ Agro-technique study carried out by Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh.





Transplanting stage of the seedlings

- Land Preparation and Fertilizer Application: Before planting the seedlings, the land should be ploughed and harrowed several times and leveled. Weeds, roots and stubbles are removed. During the cultivation, no chemical manure is applied and only farmyard manure is used. For good growth of the plants approximately 10 t/ha farmyard is required that can be divided into two doses of 5 t/ha each. First application should be just before the transplanting and second before flowering.
 - Transplanting and Optimum Spacing:

 Seedlings should be transplanted in the Establishment of young plants in the field field in late January or early February when they are about 5.0 cm tall. Immediately after transplanting, the fields should be properly irrigated. Plants exhibited good growth when the inter plant spacing in rows was 30 cm apart.
- Intercropping System: *C. maritima* plants grow usually upto 90 cm tall and require ample sunlight for its proper growth and flowering. Therefore, the plant for intercropping should be short and not of spreading type so that the plants may get proper sunlight. Some of the suitable plants that can be grown as intercrop are Kalmegh (*Andrographis paniculata*), Sadabahar (*Catharanthus roseus*), Sarpagandha (*Rauwolfia serpentina*), *Mentha* species, Garlic (*Allium sativum*), Onion (*Allium cepa*) and Chili (*Capsicm annuum*) etc.

- **Interculture and Maintenance Practices:** Regular monthly weeding is necessary for proper growth of plants.
- **Irrigation Practices:** Immediately after the transplanting of seedlings, the fields should be properly irrigated, followed by weekly irrigation for one month. Afterwards, frequency of irrigation should be reduced to once or twice in a month depending upon the atmospheric humidity.
- Weed Control: Regular monthly weeding is required. It should be done manually.
- **Disease and Pest Control:** The experimental fields showed no pest or disease on the crop.

Harvest Management

• **Crop Maturity:** Leaves are used for the preparation of eye drops. Leaf yield was observed to be more before the bud initiation. Therefore, plants should be harvested before bud emergence for optimum yield of leaves. *C. maritima* plants, at the sub-tropical conditions, take about 18 months to produce seeds to complete its life cycle.



Mature Crop

- **Post-harvest Management:** Leaves should be harvested before flower bud formation. Harvested mature leaves should be properly shade dried for about two weeks and stored in plastic sacks and sealed. These sacks should be kept in dry, dark and cool rooms.
- **Chemical Constituents:** Cinalbicol ($C_{15}H_{20}O$) and cinariolide ($C_{15}H_{18}O_2$) are the two constituents identified from the oil of *Cineraria*.
- **Yield and Cost of Cultivation:** In sub-tropical conditions estimated yield is obtained 1.5-2.0 t/ha of dried leaves. Rs. 25000/- is the cost of cultivation for one hectare.

Therapeutic Uses

Leaf extract is used in the preparation of Homoeopathic eye drops, useful in eye infections, conjunctivitis, blood congestion, removal of cataract and corneal opacity.



Clerodendrum serratum (Linn.) Moon

Syn. Rotheca serrata (Linn.) Steane & Mabb.

Fam. Lamiaceae

Ayurvedic name	Bharangi
Unani name	Bharangi
Hindi name	Bharangi
English name	Blue-flowered Glory Tree,
Trade name	Bharangi
Parts used	Roots and Leaves



Clerodendrum serratum

Morphological Characteristics

It is a small shrub, 2-4 meter tall bearing opposite leaves and having woody rootstock. The plant has quadrangular, glabrous branches. Leaves are large and ovate or oblong, usually ternate whorled, coarsely and sharply serrate, glabrous and pale beneath with six pairs of lateral nerves.

Floral Characteristics

Flowers are large pinkish-white in colour and numerous appearing in May to August month. It has a stout deflexed compressed pedicel in lax, dichotomous, long terminal panicles. It has leafy bracts. Calyx is cup shaped 5 mm long. Corolla is pale to pinkish blue with tube about 6-7 mm long; the lower larger lip like lobe is sky blue in colour. Stamens are long, exerted, curved and bluish. The drupes are 1-4 lobed, bluish-black and glossy.

Distribution

The plant is distributed over scrub forests throughout the tropical and sub-tropical parts upto 1500 m particularly in Bengal, Orissa and peninsular India.

Climate and Soil

Light to medium, particularly in laterite or red loam soils. It grows all over tropical and sub tropical regions.

Propagation Material

Stem cuttings of semi hard wood.

Agro-technique 10

Nursery Technique

- **Raising Propagules:** The stem cuttings are raised in polybags in the month of May and after establishing, the same may be transferred to the field.
- **Propagule Rate and Pretreatment:** Stem cutting to be treated in IBA 400 ppm for early sprouting.

Planting in the Field

- **Land Preparation and Fertilizer Application:** Ploughing and harrowing of field is done to bring the soil to fine tilth. Pits of 60X60X60 cm are prepared and organic manure (FYM) is mixed with NPK 75:75:75 gm per pit should be applied before transplanting the sprouted cuttings.
- **Transplanting and Optimum Spacing:** The stem cuttings are raised in polybags and after establishing the same may be transferred in the field at 2.0X2.0 meter spacing during rainy season.
- **Interculture and Maintenance Practices:** Weeding should be done as and when required.
- **Irrigation Practices:** In winter irrigation has to be given at 30-40 days interval and during summers at 10-20 days interval.
- **Control:** 2-3 manual weedings per annum are required.
- **Disease and Pest Control:** Formation of sooty larval and mealy bugs is observed and can be controlled through use of suitable pesticides.

Harvest Management

- **Crop Maturity and Harvesting:** Flowering takes place in next summer season and root could be dug out in autumn *viz*. 18 months age or over.
- **Post-harvest Management:** Shade drying of roots is desirable.
- Chemical Constituents: Root-bark yields saponine, mannitol and stigmasterol.
- **Yield and Cost of Cultivation:** 1.5-2.0 t/ha on dry basis. Rs. 12000-15000/- is the estimated cost of cultivation for one hectare.

Therapeutic Uses

Root is useful in asthma, cough and scrofulous affections. It is given in fever and is useful in sinusitis. Juice of leaves is used with ghee as an application to herpetic eruptions and pemphigus. Leaves are vermifuge and bitter tonic. The root is one of the five ingredients of Brahata panchamool and has a large demand. The plant is considered as antitoxic, antiseptic, astringent and styptic.

¹⁰ Agro-technique study carried out by (a) Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra, (b) SKN College of Agriculture, Rajasthan Agriculture University, Johner, Rajasthan.

Cryptolepis buchananii Roem & Schult.

Fam. Asclepiadaceae

Ayurvedic name	Krishna sariva
Hindi name	Karanta
English name	Indian Sarsaparilla
Trade name	Shyamlata
Parts used	Roots, Mature Stem



Cryptolepis buchananii

Morphological Characteristics

It is a large climbing shrub with glabrous, shining leaves. Stem is cylindrical; branches pale, glabrous, milky latex present, basal portion black and dotted. The external surface of the root is dark brown or blackish with few transverse cracks. Bark adheres closely to the wood and is odourless. Leaves are 7.5 – 12.5 cm X 3.8 – 6.3 cm in size, elliptic, oblong or oblong – lanceolate, apex retuse or acute, apiculate, green above and whitish beneath.

Floral Characteristics

Flowers are pale greenish-yellow in short axillary panicled cymes and bracteate. Bracts are ovate-lanceolate with scarious margins. Calyx is lobed, ovate and acute; corolla is lobed, lobes 0.6 cm long and linear or linear-lanceolate. Fruit is a follicle, 2.5-10 cm long, stout, straight, terete and tapering. Seeds are 0.5 cm long in size, ovate-oblong, compressed and black in colour.

Distribution

The plant is distributed all over tropical and sub-tropical regions in India.

Climate and Soil

The crop prefers well-drained sandy-loam acidic soils with abundant organic matter (4.5 to

6.0). It grows well in subtropical warm climate with well distributed rainfall. It prefers shady places and needs support for crawling and spreading and climbing.

Propagation Material

Seeds.

Agro-technique¹¹

Nursery Technique

- **Raising Propagules:** A nursery is raised by sowing seeds in the raised beds during last week of April.
- **Propagule Rate and Pre-treatment:** Ten kg seeds are to be sown in nursery and are sufficient for producing seedlings for transplanting in one hectare area. No pre-treatment of seed is required.

- Land Preparation and Fertilizer Application: One deep ploughing or disking, followed by 2-3 harrowing are sufficient for land preparation. Application of both organic and inorganic fertilizers is essential to ensure a good crop growth. Organic manure (FYM) @ 10 t/ha should be applied one month before planting. Inorganic fertilizers NPK @ 130:100:60 kg/ha has been found optimum for this crop. Half of nitrogen and full dose of phosphorus and potash should be applied as basal dose. Rest half of nitrogenous fertilizers should be applied in two split doses, one at the time of first earthing-up and the other at the time of second earthing-up (60 days after planting).
- Transplanting and Optimum Spacing: During the second week of June seedlings get ready for transplantation. Plants should be transplanted at the spacing of 60 cm row to row and 60 cm plant to plant. Approximately 27,000 plants are required for one hectare land.
- **Intercultural and Maintenance Practices:** Earthing up should be carried out twice, the first at 45 days and the second at 60 days interval after planting / establishment of seedlings.
- Irrigation Practices: Grown under rain fed conditions.
- **Weed Control:** To reduce the crop-weed competition during the early stages of crop growth, 2-3 manual/hand weeding at 60 days, 90 days and 120 days after planting are recommended.
- **Disease and Pest Control:** No disease or pests was observed. However, blue beetle (*Corynodes perigrinus*) is observed sometime on leaves and the beetle eats leaves. It can be controlled with the use of suitable insecticide.

¹¹ Agro-technique study carried out by (a) GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand and (b) N.B.P.G.R., Regional Station, Shillong, Meghalaya.

Harvest Management

- **Crop Maturity and Harvesting:** The crop should be harvested in the month of August-September. But seed can be collected from plants older than three years.
- **Post-harvest Management:** After harvesting the branches should be sun dried till the moisture content is reduced to 10%. Only the dried materials are to be stored.
- **Chemical Constituents:** Stems posses alkaloids, buchananine identified as 6-O-nicotinoyl-alpha glucopyranose and 1, 3, 6-O-trinicotinoyl-L-glucopyranaose.
- **Yield and Cost of Cultivation:** A good crop yields around 17.74 tonnes of dry herbage. Rs. 42,561/- is the estimated cost of cultivation for one hectare for 12 months crop duration.

Therapeutic Uses

Root is demulcent, alterative, tonic and is useful in loss of appetite, fever and skin diseases. It is considered as a blood purifier and extensively used in skin diseases and leprosy. It is prescribed to children for rickets.



Cryptolepis buchananii in field



Eclipta alba (Linn.) Hassk

Syn. E. prostrata Linn.

Fam. Asteraceae

Ayurvedic name	Bhringaraja
Unani name	Bharangi
Hindi name	Bhangara, Bhringraj
English name	Trailing Eclipta Plant
Trade name	Bhangara
Parts used	Whole plant



Eclipta alba

Morphological Characteristics

It is an erect or prostrate, branched (occasionally rooting at nodes) annual herb upto 30-40 cm high. Stem is cylindrical or flat, rough due to appressed white hairs, nodes distinct and greenish occasionally brownish. Leaves are opposite, sessile to sub-sessile 2.0 to 6.2 cm long, 1.5-1.9 cm wide, oblong, lanceolate, sub-entire, acute to sub-acute and strigose with appressed hairs on both surfaces.

Floral Characteristics

Flowers are white, solitary or two on unequal axillary peduncles involucral bracts are about 8 in number, ovate, obtuse or acute and strigose with oppressed hairs. Disc flowers are tubular. Corolla is often 4 toothed. Stamens are 5, filament epipetalous, free, anther united into a tube with base obtuse. Pistil is bicarpellary. Ovary is inferior and unilocular with one basal ovule. Fruit is achenial cypsela, one seeded, cuneate, with a narrow wing and brown in colour.

Distribution

The plant is distributed throughout India, ascending upto 2000 meter in moist places.

Climate and Soil

The plant is found to grow wild in a variety of soils viz. sandy to clay soil and vary common on

damp wastelands, low waterlogged areas, roadsides, paddy and other crop fields, preferably in warm climate.

Propagation Material

Seed and stem cuttings.

Agro-technique¹²

Nursery Technique

Raising Propagules: Propagules could be raised both from seed as well as stem cuttings. Seed is preferred for raising plantation. Seed germination is 75-85% when freshly collected mature seeds are sown in a well prepared nursery. The best time is February–March or rainy season. Seedling can be transplanted in April-May or August under the climatic conditions of North Eastern India, where rainfall is well distributed. Any delay in



Flower of Eclipta alba

transplanting results in poor vegetative growth that can lower yield of biomass significantly.

• **Propagule Rate and Pretreatment:** 450-500 gm seeds or 25,000 propagules plus 10% for gap filling are required for one hectare. No pre-treatment of seed is necessary.

- Land Preparation and Fertilizer Application: The soil should be ploughed and cross ploughed to a fine tilth. The field should be well prepared and made weed-free before transplanting. NPK @ of 30:40:20 kg/ha and FYM @ 15 t/ha should be applied as basal dose during land preparation.
- **Transplanting and Optimum Spacing:** Best time of transplanting of propagules is April-May in the climatic condition in North Eastern India. However, it can be planted in August, where nursery is established in rainy seasons. The optimum spacing is 20X20 cm.
- **Intercropping System:** It is a mono-crop.
- **Intercultural and Maintenance Practices:** *Eclipta alba* is 3 months crop. 1st intercultural operation with 20 kg nitrogen after 20-30 days of transplanting, while 2nd intercultural operation with 10 kg nitrogen @ 50 days after transplanting may be adopted for optimum crop growth and yield of biomass.

¹² Agro-technique study carried out by North East Institute of Science Technology (NEIST) Jorhat, Branch Itanagar, Arunachal Pradesh.



- **Irrigation Practices:** As and when necessary.
- Weed Control: Manual weeding is preferable, whenever necessary.
- **Disease and Pest Control:** No disease in particular was observed except certain insect attack during early stage of crop growth which can be controlled by applying 0.30% Rogor 30 EC fortnightly by foliar spray (2-3 times).

Harvest Management

- **Crop Maturity and Harvesting:** 3 months; the best time and stage for harvesting is 90 days after transplanting or at early flowering stage.
- **Post-harvest Management:** Above ground parts should be cleaned; shade dried, packed in gunny bags and kept in cool and dry place. Care needs to be taken so that there should not be any fungal infection during storage.
- **Chemical Constituents:** The plant contains an alkaloid ecliptine; other chemicals identified are wedelolactone, demethylwedelolactone, wedelic acid, apigenin, luteolin, b-amyrin, *etc. Eclipta* saponin C, a new triterpenoid glucoside, was isolated together with daucosterol and stigmasterol-3-O-glucoside.
- **Yield and Cost of Cultivation:** 8 t/ha (FWB) during 1st cropping (April-July) and 3 t/ha (FWB) of ration crop (August-September). On drying, the herb loses 60% of moisture. Rs. 15750/- is the estimated cost of cultivation for one hectare.

Therapeutic Uses

The whole plant is used as antiseptic, febrifuge, tonic, deobstruent in hepatic and spleen enlargement and is emetic. In combination with aromatics, the juice is given in anemia, catarrh and cough. The plant is also used as scalp tonic for promoting hair growth. Bhringaraj is commonly used as deobstruent to promote bile flow and to protect the liver parenchymatous tissue in viral hepatitis and other conditions involving hepatic enlargement. The fresh juice of the leaves is given in the treatment of edema, fevers, liver disorders, and rheumatic joint pains; it is also used to improve the appetite and to stimulate digestion. The juice is given with honey to treat upper respiratory congestion in children. The hair oil is prepared from boiling the fresh leaves with either coconut or sesame oil renders the hair black and lustrous.



Embelia ribes Burm. f.

Fam. Myrsinaceae

Ayurvedic name	Viavidang,Bai bidang Krimighna, Chitramandula, Valle
Unani name	Baobarang, Babrang
Hindi name	Baberana, Wawrung
English name	Embelia
Trade name	Vidanga
Parts used	Berries, Roots



Embelia ribes

Morphological Characteristics

It is a large scandant shrub with long branches, slender, flexible, terete and long internodes. The bark is studded with lenticels. Leaves are coriacous, 5X2-4 cm long, elliptic or elliptic-lanceolate, shortly and obtusely acuminate, entire, glabrous on both sides, shining above, pales and somewhat silvery beneath, base rounded or acute and main nerves numerous. Petioles are more or less margined and glabrous.

Floral Characteristics

Flowers are small, greenish-yellow, numerous in lax panicled racemes. Calyx is minute, sepals connate, broadly triangular, ovate and ciliate. Petals are 5 and free. Stamens are 5, but shorter than the petals. Flowering time is February. Fruits are 2.4-4.0 mm in diameter and globular with warty surface, smooth, succulent. The colour of fruit is dull black and rarely dull red.

Distribution

The plant is found in moist and shady places upto an altitude of 1500 meter.

Climate and Soil

Tropical and subtropical climate is required for the cultivation of this crop. Medium black well drained soils are best suited for the crop. The optimum temperature required for the crop is 18°C-35°C, with annual precipitation of 700 to 1500 mm.



Propagation Material

E. ribes is propagated through seeds.

Agro-technique 13

Planting in the Field Land Preparation and Fertilizer Application: Crop is raised through direct sowing of seeds in the field during June-July. The field is well ploughed followed by harrowing to bring the soils to a fine tilth and free from weeds. The application of organic manure (FYM) at the rate of 5-10 t/ha is recommended.

- Transplanting and Optimum Spacing: Seeds are sown directly in the field at optimum spacing of 1.0 X1.0 meter.
- **Intercultural Operations:** The interculture operations like weeding, protective irrigation, support or staking are to be done periodically as and when required.
- **Disease and Pest Control:** No major disease and pest is noted. However, in case of severe infestation bio-control measures are to be adopted.

Harvest management

- **Crop Maturity and Harvesting:** The crop matures after 5-6 months of its sowing and the fruiting starts in October-November, when these are plucked and stored after shade drying.
- **Chemical Constituents:** Seeds of *Embelia ribes* contain embelin 2.5–3.1%; quercitol 1.0%; fatty ingredients 5.3% and alkaloid schristembine, a resinoid, tannins and minute quantity of volatile oils.
- **Yield and Cost of Cultivation:** The crop yield is 190-200 kg seeds per hectare. Rs. 42500/- is the cost of cultivation for one hectare.

Therapeutic Uses

The fruits of *Embelia ribes* known in commerce as Baibidang are recommended for relieving headache, rhinitis, haemorrhage, epilepsy and insomnia. The decoction of dried fruits is used for fever and for chest and skin disease. Paste is applied for skin infection. The drug also exhibits significant anti-fertility, antipyretic and antibacterial activity. The fruit powder, when taken with milk, followed by a purgative has been one of the ancient remedies to get rid of tapeworms. An infusion of the roots is given in the treatment of cough and diarrhoea. Fruits show antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*. Embelin, which is one of the active principles of the drug, is reported to possess a property of colouring silk and woolen fabrics.

Note: The fruits of *Embelia tsjeriam-cottam* A. DC. are sometime mixed while marketing, which are 4-5 mm in diameter and have characteristic oil gland not found in *E. ribes*.

¹³ Agro-technique study carried out by Dr. Punjabrao Deshmukh Krishi Vidyapeeth (DPRDKV), Krishi Nagar, Akola, Maharashtra.

Evolvulus alsinoides Linn.

Syn. Convolvulus alsinoides Linn.

Fam. Convolvulaceae

Ayurvedic name	Vishnugandhi, Shankhapushpi
Unani name	Sankhaholi
Hindi name	Phooli, Sharikha-pushpi
English name	English Speed-wheel
Trade name	Shankhapuspi
Parts used	Whole Plant



Evolvulus alsinoides

Morphological Characteristics

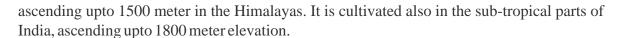
It is an annual/perennial herb with prostrate spreading branches in all directions. The root system is deep. Leaflets are 2.5-5 cm long, elliptical, oblong and rounded at base. Leaves are densely clothed with white appressed and long spreading hairs. In nature, seedlings appear after 2-3 showers during July-August. Generally, the seedlings are abundant under the canopy of trees or shrubs. The young seedling grows straight and produces lateral branches during first week of August. The lateral branches spread in all directions. The flowering starts during first week of August. Fruit formation takes place in the last week of August, while flowering still continues. The dispersal of the seeds takes place from September to December. Plant dries during November – December.

Floral Characteristics

Flowers are blue in colour and axillary in position. They are either solitary or in pairs on the long stalk. Styles are two and each is bifid. Fruit is globose with four-valved capsule containing dark brown to black smooth seeds. The flower colour varies from dark purple to whitish-purple.

Distribution

Plant is commonly found growing in open and grassy places, almost throughout India,



Climate and Soil

The plant prefers shady and humid climatic conditions. Growth is slow and becomes restricted when the environmental conditions become unfavourable.

Propagation Material

Seeds: Collected during October-November from natural habitats.

Agro-technique¹⁴

Nursery Technique

- **Raising Propagules:** Mechanically scarified seeds are sown @ 2 seeds in each polybag at 0.5 cm depth during June-July to raise nursery.
- **Propagule Rate and Pretreatment:** It has hard seed coat, for the removal of hard seed coat; the seeds are subjected to mechanical scarification which gives 80% germination. 190 gm seeds are required for planting one hectare area.

- Land Preparation and Fertilizer Application: The land should be prepared as for vegetable growing and made weed free and planked to a uniform level. For maximum yield, farm yard manure at the rate of 10 tonnes per hectare should be applied.
- **Transplanting and Optimum Spacing:** The seedlings are transplanted during late July-August at 25X25 cm spacing under field conditions.
- **Intercropping:** Study revealed that intercropping did not cause any adverse effects on the growth of *Commiphora wightii* and *Evolvulus alsinoides*, when both are grown together. Non-significant results were observed when this plant is intercropped with other crops/medicinal plants such as *Pennisetum glaucum* (Pearl millet), *Cyamopsis tetragonoloba* (Guar bean), *Vigna radiata* (Moong bean), *etc.*
- **Irrigation:** Five days irrigation schedule was found to be suitable for obtaining maximum growth and biomass yield under dry field conditions. However, in case of rains, the irrigation schedule may be changed accordingly.
- Weed Control: Manual hand weeding and hoeing is required at an interval of 15-20 days during entire crop season.
- **Disease and Pest Control:** No serious insects and pests are observed on the crop.

¹⁴ Agro-technique study carried out by Department of Botany, Jai Narain Vyas University, Jodhpur, Rajasthan.

Harvest Management

- **Crop Maturity and Harvesting:** It is a rainy season crop and takes about four months to complete its life cycle. The seedlings transplanted in the month of July attain its full growth during September-October. This is the appropriate time for harvesting the plant.
- **Post-harvest Management:** Fresh herbage is perishable and should be stored in gunny bags for marketing after proper drying.
- Chemical Constituents: Plant contains an alkaloid evolvine; β -sitosterol, stearic, oleic and linoleic acid, betaine, pentatriacontane and triacotane.
- **Yield and Cost of Cultivation:** As a pure crop, 18.6 quintal (fresh herbage) per hectare is obtained which is reduced to $1/3^{rd}$ after drying. The dry herb is stored in cool and dry places. Rs. 5930/- is the cost of cultivation for one hectare.

Therapeutic Uses

The whole plant is used in form of decoction in nervous debility and loss of memory. The plant is also useful as blood purifier and in bleeding piles. The fresh flowers with sugar are eaten as a brain tonic. The leaves are made into cigarettes and smoked in chronic bronchitis and asthma. It also improves complexion, voice and cures from intestinal worms. It promotes 'medha', the power of memory.



Fumaria parviflora Lam.

Fam. Fumariaceae

Ayurvedic name	Pittapapra
Unani name	Shahtaraa
Hindi name	Shahatra, Pitpapra
English name	Fumitory
Trade name	Pitpapra
Parts used	Whole Plant



Fumaria parviflora

Morphological Characteristics

It is an annual, much branched, diffusely spreading herb with watery latex. It shows much variation in height; *i.e.* 15-60 cm. Leaves are glaucous, segments linear or oblong linear, pointed at the tip, rarely broader than 1 mm short.

Floral Characteristics

Flowers are small, rose to purple in colour, borne in racemes of 15-20 flowers. Racemes are very often sessile and short. The fruit is slightly elongated and bracts are much longer. Sepals are absent or minute (about 0.5 mm long), triangular-ovate acuminate and whitish. Corolla is very small, about 4 mm long, white; upper petal with narrow wings, inner petals with a purple or greenish tip. Fruit is 2 mm long and slightly broader, subround-obovate, very obtuse or subtruncate, obscurely short articulate, rugose when dry and one seeded. Seeds are dark brown in colour having a bitter acrid and astringent taste.

Distribution

Plant is a native of Europe commonly found over the greater parts of India as a winter season weed, mostly in wheat field.

Climate and Soil

Farm land and sunny situation are favourable for its cultivation. It can be grown successfully

on a wide range of soils. However, it thrives best on well drained, loose and friable sandy-loam soils. The favourable pH of soil is 6.5-7.5. It is a cool weather crop and grows best at mean monthly temperature of 15-25° C. The optimum temperature for germination is about 20-26° C. The plants withstand low temperature, but not below 10° C. Those plants grown in temperature below 10° C, become stunted and bushy in appearance. It can be grown in open sun and lower rainfall areas with irrigation facilities.

Propagation Material

The crop is raised through seed. Mature seeds are collected in the month of March-April.

Agro-technique¹⁵

Nursery Technique

Crop raised by direct sowing.

- Raising Propagules: Seeds are directly sown in the field at a distance of 30X15 cm apart at 0.5–1.0 cm depth during November in moist soil. This is followed by irrigation after 8-10 days of sowing. Broadcasting is not recommended due to high seed rate as well as inconvenience in cultural operations and harvesting. The seeds germinate in about 12-15 days after sowing.
- **Propagule Rate and Pretreatment:** Before sowing, the seeds should be treated with Thiram or Captan @ 2-3 gm/kg of seeds to avoid damage from fungal diseases. About 4-5 kg seeds are sufficient for planting one hectare land area.

- Land Preparation and Fertilizer Application: Pitpapra does not require heavy fertilizers. Well rotten FYM @ 12-15 t/ha should be applied at the time of field preparation. This should be supplemented with a fertilizer dose of 40 kg N, 50 kg P_2O_5 and 20 kg K_2O /ha.
- **Transplanting and Optimum Spacing:** It has been observed at Jobner (Rajasthan) that 2.25 lakhs plants/ha can be accommodated at 30X15cm spacing.
- **Intercropping:** The crop can also be grown as an intercrop with wheat and barley.
- Interculture Operations: About two weeding and hoeing are required for proper soil aeration. First weeding and hoeing should be done at 35 days after sowing and second at 60 days. In order to maintain optimum plant population, thinning can be done at the time of first hoeing and weeding.
- **Manure and Fertilizers:** The basal dose 40 kg N, 40 kg P₂O₅ and 40 kg K₂O per hectare should be applied before sowing. Besides basal dose, 40 kg of N should be applied as top dressing after 35-40 days of sowing.

¹⁵ Agro-technique study carried out by SKN College of Agriculture, Rajasthan Agriculture University, Johner, Rajasthan.

- **Irrigation Practices:** Under Jobner (Rajasthan) conditions, 5 irrigations are sufficient to get maximum return of Pitpapra. First irrigation should be given before land preparation and sowing should be done at optimum moisture condition of the soil. If soil moisture is insufficient for germination, another light irrigation may be given after 8-10 days of sowing. Subsequent irrigations are given at an interval of 18-20 days. The last irrigation should be given at seed formation stage.
- Weeding Control: Care should be taken to keep the field free of weeds especially during early stages when growth of the crop is slow. For an effective control of weeds in Pitpapra, two weeding at 35 and 60 days after sowing are sufficient. Weeding can be done manually because use of herbicides can deteriorate the quality of raw material, which is used for preparation of medicines.
- **Disease and Pest Control:** No infestations of diseases, insect-pests and nematode have been observed.

Harvest Management

All plant parts of Pitpapra are medicinally important. Therefore, in order to get maximum biomass, the harvesting should be done before starting of senescense or withering. It helps to retain maximum alkaloids in the produce.

- **Crop Maturity and Harvesting:** The crop requires about 65-70 days for flower initiation, which continues for next 20-25 days. Fruiting starts at 85-90 days after sowing. The crop is ready to harvest after 100-110 days of sowing. However, for seed purpose, the crop needs additional 15-20 days.
- **Post-harvest Management:** The harvesting can be done by uprooting the whole plant at maturity. For safe and easy uprooting, a light irrigation can be provided before harvesting, if soil moisture content is high, the harvested crop should be kept for a day in sunlight to reduce the moisture level. Further, drying of the produce should be done in a shaded place. It takes 3-5 days to dry the produce. During drying, the crop should be upturned 1-2 times for preventing from fungal infection. Improper and delayed drying changes the colour to black or brown, which lowers its quality and fetches lower price. Dried biomass can be packed in gunny bags and stored at cool and dry place. For seed purpose, the above ground portion should be harvested by sickle at seed maturity. After thrashing and winnowing, the seed should be packed in polythene /cloth bags and stored at cool and dry place.
- **Chemical Constituents:** Protopine, cryptopine, d-bicuculline, L-aldumine, fumaridine, fumaramine and d-hydrastine are the chief alkaloids of Pitpapra.
- **Yield and Cost of Cultivation:** Under optimum conditions, a fresh biomass of 2.5-3.0 t/ha can be obtained after drying. Rs. 21000/- is the cost of cultivation for one hectare and the gross return obtained in terms of profit is Rs. 29000/ ha.

Therapeutic Uses

The plant is bitter in taste, cooling and expectorant. It increases 'Vata', removes indigestion, biliousness, fever, burning of the body, fatigue, urinary discharges, vomiting, thirst, enriches the blood and is useful in leprosy. The leaves are bitter and cooling. They cure bilious fever, blood diseases and allay thirst. The dried plant is regarded as efficacious in low fever, and is also used as an anthemintic, diuretic, diaphoretic and aperients and to purify the blood in skin diseases.



Glycyrrhiza glabra Linn.

Syn. Loquiritae officinalis Moench

Fam. Fabaceae

Ayurvedic name	Yashtimadhu,
Unani name	Mulethi, Asl-us-soos
Hindi name	Mulathi
English name	Liquorice
Trade name	Mulhatti, Liquorice
Parts used	Roots and Stolon



Glycyrrhiza glabra

Morphological Characteristics

It is a perennial under shrub, reaching up to 120 cm height under cultivation. The stolon crown gives rise to a number of long semi-woody stems which bear compound pinnate leaves. Stolon is nearly cylindrical, upto 2 cm in diameter. Outer surface is yellowish-brown or longitudinally wrinkled with patches of cork. Its odour is characteristics and taste is sweet.

Floral Characteristics

Flowers are pale blue in colour and flowering occurs from 2-3 years of planting onwards. Pod is 2.0 - 2.5 cm long with 2 to 5 seeds.

Distribution

The plant thrives in a dry and sunny climate and is cultivated in the sub-tropical and warm temperate regions, chiefly in the Mediterranean region.

Climate and Soil

It grows well in sub-tropical climate in North-West India. Mulethi is a hardy plant and grows over rich forest soils, ranging from pH 5.5 to 8.2. In nature, it has wide distribution from dry cold temperate parts of Asia to Mediterranean climates, where annual temperature varies from 25°C in summer and 5°C in winter season.

Sandy-loam fertile soils with pH 6.0 to 7.5 have been found to promote good root development in India. The plant thrives in cultivation, where the locality receives 50- 100 cm rainfall annually and cultivation is supported with irrigation.

Propagation Material

Propagation is usually carried through stolons cuttings of about 10-15 cm. Seed can be used, but seed-set is poor in India and seed germination is low. Vegetative method of propagation is, thus recommended. A variety "Haryana Mulhatti-1" released from Ch. Charan Singh Haryana Agricultural University, Hissar is recommended.

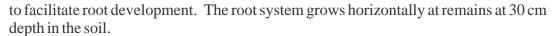
Agro-technique¹⁶

Nursery Technique

- **Raising Propagules:** The old crown of roots dry out in autumn may be divided into 10-15 cm long pieces having 2-3 buds. These are used as planting material. It could be placed in furrows mode in rows at planting. The crop remains in the field for 3-4 years duration for proper growth of stolon for high yield. It requires 300 kg of planting material for one hectare land.
- **Propagule Rate and Pre-treatment:** It was found that the capacity of seeds to germinate differ with the stages of their maturation. During milky waxy ripe stages, the seeds have poor germination capacity and the shoots have low survival capacity, but if seeds are collected in July, they show highest germinating capacity. This is a long duration crop and the preparation of field should be of good tilth and the fields be leveled well to avoid stagnation of water. It was observed in a particular case that scarified seeds germinated slowly and their germination reached upto 29.4% with the 75% survival.

- Land Preparation and Fertilizer Application: The field should be ploughed thoroughly followed by harrowing to bring the soil to a fine tilth and free from weeds. Farm Yard Manure (FYM) has been found useful for good development and growth of underground roots and should be applied at the rate of 10 t/ha at the time of field preparation.
- Transplanting the Seedlings to Main Field and Optimum Spacing: As stated, the cuttings of the underground stem/stolon of 10-15 cm length, possessing 2-3 eye buds are planted 6-8 cm deep in the soil at a distance 60X45 cm or 90X45 cm during spring seasons. The stolon begins sprouting in 15-20 days after planting. Light and frequent irrigation is necessary during spring planting until the cuttings sprout and establish themselves in the field. Once the plants grow upto 20 to 30 cm tall, the rows are raised

¹⁶ Agro-technique study carried out by (a)Indian Institute of Horticultural Research(IIHR), Bangalore and updated from published work of (b)GujaratAgricultural University University, Anand, Gujarat and (c) College of Agriculture, CCS Haryana Agricultural University, Hissar.



- **Intercropping System:** As the plant occupies the land for 3-4 years, the cultivator prefers to take a crop of carrot, potato, cabbage between the ridges during the first 2 years. However, it is considered advisable to do away with the practice and keep the area continuously clean to keep it free from weeds.
- **Irrigation Practices:** The crop requires irrigation at an interval of 30-45 days in dry summer season. The plant sheds leaves in November and one to two irrigations is given during winter season to maintain root health. In all 7-10 irrigations are given to the crop per year. It is important to avoid water-logging in the field as stagnation of water in the field will cause damping-off disease and root rotting which cause large scale damage to the growing plants.
- Weed Control: Three to four hoeing cum- weedings are required in the first year of planting and in subsequent years, two hands weeding- cum- hoeings are recommended to keep the fields weed free for healthy crop growth.
- **Pests and Diseases:** Survey of literature revealed very few reports on diseases and pests of *Glycyrrhiza glabra* caused by *Gentrospora acerino*. The plant is also reported to be affected by panash mosaic caused by virus. *G. glabra* plants were found to be affected by *Myllocerus undecimpustulatus* Faust, the insect belonging to the order Coleoptera of family Curculionidae.

Harvest Management

- **Crop Maturity and Harvesting:** It is found that high yields are obtained from 3 or 4 years of planting. Manual digging is carried for harvesting of roots. Using disc harrow for digging has proved successful and is highly economical. It over turns the soil, which is left in field for sun drying; later the roots are sorted out and cleaned. The crop is harvested in winter season *i.e.* November or December to obtain roots containing high glycyrrhizic acid.
- **Post-harvest Management:** After harvesting and removal of soil and other residual particles, the roots are cut into pieces and dried. At the time of harvest, the roots contain 50-60 percent moisture and should be dried in the sun for 2-3 days and then in shade for next 10-12 days. The dry roots should possess not more than 10% moisture when these are ready to be stored in polythene lined bags. The roots are cut into pieces of convenient size and are sorted into grades, based on thickness and stored.
- Chemical Constituents: Liquoric acid, glycyrrhizinic acid, flavonone glycosiderhamnoliquiritin, pinocembrine, prunetin, isoglabrolide and glabranine are found in roots. Total of 27 flavonoids are present in the roots, 3 were characterized as liquiritigenin, liquiritin and isoliquiritigenin. From roots, three new compounds were isolated i.e.7-acetoxy-2-methyl isoflavone, 7-methoxy-2-methyle isoflavone and 7hydroxy-2-methyl isoflavone.

• **Yield and Cost of Cultivation:** The yield of dry root at Hissar (Haryana) is recorded around 7 t/ha. While at Anand (Gujarat) 10 to 20 months crop has given an average yielded of 2.5-5.0 t/ha. Rs. 100000/- is the cost of cultivation for one hectare.

Therapeutic Uses

The plant root is a demulcent, mild expectorant and anti-inflammatory agent. An extract of the root provide relief in treating peptic ulcers. It has glycyrrhizic acid as main constituent and this has showed anti-viral and anti-inflammatory actions. The plant extract is used as a sweetener in tonic, laxative and given in sore throat and in cough remedies.



Glycyrrhiza glabra in field



Habenaria intermedia D. Don

Fam. Orchidaceae

Ayurvedic name	Riddhi, Vrddhi
Hindi Name	Riddhi
Trade name	Riddhi
Parts used	Tuber

Morphological Characteristics

Habenaria intermedia D. Don is a tuberous rooted, monopodial terrestrial orchid found at an elevation of 1500-2800 meter in Western Himalaya. Stem is terete, 25-50 cm long, bears four to many leaves; leaves are rounded at the base, long and acuminate.

Floral Characteristics

Flowers are large, greenish-white and 1-6 in an inflorescence. Petals are white and crescent shaped, recurved and adherent to dorsal sepal, lip is pale yellowish-green in colour. Life cycle of the *Habenaria* in its natural habitat starts in mid May, marked by sprouting of tubers and it comes in full bloom up to September. After fruiting, it enters into a dormant period of its life cycle in October.

Distribution

The species is well distributed in open grassland at high altitudes 1500 to 2800 meter above msl. Being



Habenaria intermedia



Flowers of Habenaria intermedia

a light demanding species, it prefers southern or eastern slopes. It is more often found in open exposed soils, a characteristic of pioneer species in succession.

Climate and Soil

It prefers loose sandy loam and brown hilly soil rich in humus content. The mean annual rainfall is 100 to 150 cm and mean annual temperature is between 10°-15° C. This species grows well in open meadows as well as along steep slopes.

Propagation Material

The orchid seeds being endospermic in nature, do not usually germinate. The vigour of seedling is also very poor. Hence, the vegetative part *i.e.* tubers are recommended for the propagation of this species.

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Nursery Technique

- Raising of Propagules: Direct raising of plant from tubers either by half or full tuber with apical portion intact gives the best results. Planting is done on raised beds in rows at an optimum spacing of 20X20 cm.
- Propagule Rate and Pretreatment: Soil treatment with pesticide or solarisation is useful to kill most of the insect pest of soil including white grubs. Cut portions of the tuber are treated with fungicide (Mercuric Chloride 0.05%). Root hormone treatment for root induction is not required.



Raising Propagules in Beds

- Land Preparation and Fertilizer Application: Sandy-loam soil rich in organic matter is suitable for the cultivation of this species. Raised beds are suitable for cultivation as these facilitate good drainage. First Ploughing is carried out just after harvest, followed by mixing of the half rotten FYM and leaf litter to the soil. Field is then left fallow for the entire winter. In May, second ploughing is carried out to make the soil more pulverized. Just before planting of *Habenaria*, the remaining half of the organic manure is added to the field. Raised beds are prepared for planting. The size of bed depends upon the size of field terrace available.
- Transplanting and Optimum Spacing: Stored tubers are planted in first week of May. In case storage facilities are not available, tubers are planted just after the harvest of crop in first week of November. Planting as a pure crop in one hectare of land, at a spacing of 20X20 cm will require 250,000 tubers.

¹⁷ Agro-technique study carried out by Non-wood Forest Products Division, Forest Research Institute, a unit of Indian Council of Forestry Research and Education (ICFRE), Dehradun, Uttarakhand.

- Viability of Seed / Planting Material: Under optimal condition of storage, tubers remain viable for a period of six months. They sprout in the next growing season (in May). Seed viability has not been tested.
- **Intercropping:** Intercropping trials with crops like *Zingiber officinale* (ginger), *Colocasia esculenta* (colocasia) and *Curcuma longa* (turmeric) will require 30,000 to 35,000 tubers per acre.
- Manure & Nutrient Requirements: Mycorrhizal association is necessary for the increasing nutrient uptake efficiency in its natural habitat. Adding of soil from natural areas along with the tubers is recommended to provide mycorrhizal association and 10-15 tonnes of FYM and leaf mould per acre are optimal for the crop growth. Inorganic fertilizer is avoided. Organic manures are added twice a year, during winter period and again during the planting season.
- **Irrigation Practices:** Frequency of irrigation depends upon the moisture content of the soil. This species is planted just before the onset of the rain. No irrigation is required during a normal rainy season. However, irrigation becomes necessary during a drought year or in case of low rainfall. During early stage of the crop, irrigation is done twice a week.
- Weed Control: Frequent weeding is required during the rainy season. Mulching of the beds by dried leaves ensure low growth of weeds, checks soil erosion and helps in moisture conservation during the dry period. This also reduces the cost of weeding operation.
- **Disease and Pest Control:** Minor attacks of white grub are common in the tubers. There are no specific fungal attacks reported in the field, but during storage, moist bulbs are susceptible to attack by rot fungus. While grub attack can be minimized by application of Phorate 10 gm or any other broad-spectrum insecticide at the time of planting as a basal treatment or manual collections or through solarisation of soil. The fungal attack can be reduced during storage by light drying of tubers under shade.

Harvest Management

- **Crop Maturity and Harvesting:** It takes about one to two months to mature the crop and harvesting is done in the second week of November after complete senescence.
- **Post-harvest Management:** Harvesting should be done at the end of October when the crop stalk and leaves are completely dried after fruiting. Storage of harvested tubers can be done in the bed itself by burying these in soil over the winter period, in a pot or brick chamber filled with sand or inside the pit on the sloppy terrace. Storage in sand and pit gives high viability of the tubers but sometimes rodent's attack and water accumulation might damage the tubers.
- **Yield and Cost of Cultivation:** By following the standard package and practices, per acre yield of tubers is 550-600 kg. Rs. 23000/- is the cost of cultivation for raising crops on one acre of land.

Therapeutic Uses

The drug belongs to the group of the "Eight Tonic Herbs", known as Ashtavarga, which is rejuvenating and age sustaining. It is used as one of the ingredients of Chywanaprasha preparation.



Leonotis nepetaefolia (Linn.) R. Br.

Syn. Phlomis nepetaefolia Linn.

Fam. Lamiaceae

Ayurvedic name	Granthiparni
Hindi Name	Hejurchei
Trade name	Barchi Buti
Parts used	Whole plant



Leonotis nepetaefolia

Morphological Characteristics

The plant is a tall and erect with height 1-2 meters. The stem is stout, obtusely quadrangular with thickened angles and deeply sulcate. Leaves are 5-15X3.5-10 cm, membranous, ovate, acute, coarsely crenate-serrate and finely pubescent on both sides and base shortly cuneate. Petioles are 2.5-10 cm long and winged in the upper part.

Floral Characteristics

Flowers are orange-scarlet, in axillary, dense, globose and many flowers are in whorls. Fruits are oblong, ovoid or obovoid, dry angular, obtuse or truncate nutlets.

Distribution

Plant is originally native to tropical and subtropical Africa; it is now naturalized all over the world. In India it grows along road sides in abandoned fields in tropical and subtropical region.

Climate and Soil

The crop prefers warm temperature of more than 30° C and well distributed rainfall of 1600-2000 mm. It also prefers sandy loam to loamy soil with sufficient humus content having pH of 4.6 to 6.5.

Propagation Material

Seeds.

Agro-technique¹⁸

Nursery Technique

• **Raising Propagules:** The crop is raised through direct sowing of seeds in the field which gives best results. For one hectare of land 20 kg seeds are required.

Planting in the Field

- Land Preparation and Fertilizer Application: Generally one deep ploughing or disking, followed by 2-3 harrowing are sufficient for land preparation. Organic manure (FYM) @ 5 t/ha should be incorporated in the main field at the time of land preparation. Inorganic fertilizers should be applied @ 100: 80: 60 kg/ha of N:P₂O₅:K₂O respectively. Half of N and doses of P₂O₅ and K₂O should be applied as basal dose. Remaining half of nitrogen should be top dressed in two splits at 60 days and 90 days after sowing.
- **Transplanting and Optimum Spacing:** In this region, June is the ideal time for sowing in the main field. Row to row distance of 30 cm and plant to plant distance 30 cm. should be maintained. Seed should be sown at 4-5 cm depth.
- **Intercultural and Maintenance Practices:** Two or three hand / manual weeding at 60 days, 90 days and 120 days after sowing should be carried out.
- **Irrigation Practices:** Grown as rainfed crop.
- Weed Control: Manual hand weeding.
- **Disease and Pest Control:** The crop is free from any serious diseases and pests except leaf rust (*Puccinia* sps.) which can be controlled by spraying Hexaconazol (5% EC) @ 5 ml/l at monthly intervals.

Harvest Management

- **Crop Maturity and Harvesting:** Keeping in view the yield of active chemical ingredients, the best time for harvesting of leaves is November and that for whole plant is March.
- **Post-harvest Management:** After harvesting the plant parts are dried in shade to bring down the moisture content to 15% and then it is cut into pieces and stored in gunny bags.
- **Chemical Constituents:** Steam distillation of seeds yield 2% of volatile oil containing linoleic acid (11.9%), oleic acid (64.6%). The leaves yield a bitter principle, fatty oil 1%, a resin, resinic acid and ash 7%.
- **Yield and Cost of Cultivation:** A good crop yields around 27 t/ha of whole plant. Rs. 29.775/- is the estimated cost of cultivation for one hactare.

Therapeutic Uses

Flowers ash is applied to burns, in ringworm and other skin diseases. Leaves are used for rheumatism and act as spasmolytic, anticancerous, antidermatophytic and mild anthelmintic.

¹⁸ Agro-technique study carried out by National Bureau of Plant Genetic Resource (NBPGR), Regional Station, Shillong, Meghalaya.

Malaxis muscifera (Lindley) O. Kuntze

Syn. Microstylis muscifera (Lindley) Ridl.

Fam. Orchidaceae

Ayurvedic name	Rishabhak/Jeevak
Hindi Name	Jeevak
Trade name	Risabhakah/Jeevak
Parts used	Bulb



Malaxis muscifera

Morphological Characteristics

This is a terrestrial and glabrous orchid less than 30 cm tall with small ovoid bulbs, underground stem and fibrous root. Roots are fibrous; bulbs ovoid; stem is 15-30 cm long, erect and swollen at base. Leaves are two elliptic-lanceolate or ovate, obtuse, unequal, arising from the base of the stem and sessile.

Floral Characteristics

Flowers are pale yellowish-green in colour; terminal racemes 8-20 cm long spikes borne in autumn season in second year and onward. It has 2-3 mm long bracts, lanceolate with acute apex. Sepals are broadly lanceolate and laterals recurved; petals are linear but shorter than sepals; lips are adnate to the base of column, sessile, ovate-rounded, abruptly pointed; basal lobes thick, obscure. Column is very short, anthers sessile on its top; pollinia ovoid and free. Fruit is a capsule, 6-8 mm long, broadly ovoid-oblong, ribbed and of light yellow colour.

Distribution

Plant is distributed throughout hilly areas in India, upto 4000 meter above msl. It is found in forests, shrubberies and grassy slopes. This plant is one of the threatened medicinal orchids inhabiting hills in India.

Climate and Soil

The plant has been observed to grow well in sandy loam soil with high organic matter. It prefers temperate climatic conditions with low rainfall.

Propagation Material

Bulbs (mother and daughter bulbs).

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Nursery Technique

- **Raising Propagules:** In nature, plants normally bears flowers and fruits during September-October. Since the seeds of *M. muscifera* are microscopic, it is hard to get seed germination under *ex-situ* and laboratory conditions. Hence, bulbs are used for raising the crop.
- **Propagule Rate and Pretreatment:** About 1,11,100 bulbs are required for planting in one hectare area. Mother bulbs after about 2 years' growth are chosen for target usage and the daughter bulbs should be used for planting subsequent crop. However, sprouting in mother bulbs is better than that in daughter bulbs younger than 1 year. Damaged bulbs are not to be used for planting.

Planting in the Field

- **Land Preparation and Fertilizer Application:** The field should be ploughed during October to make the soil well pulverized. A basal dose of 25 t/ha of farmyard manure should be applied at the time of land preparation.
- **Transplanting and Optimum Spacing:** The pseudobulbs should be planted during mid October to early November at 30X30 cm spacing accommodating about 1,11,100 plants/ha as a sole crop.
- **Irrigation Practices:** The crop requires light irrigation at the time of establishment soon after transplanting.
- **Weed Control:** Hand weeding two times at 25-30 days interval is necessary till rainy season.
- **Disease and Pest Control:** No disease or insect pest has been noticed in this crop.

Harvest Management:

• **Crop Maturity and Harvesting:** The crop attains senescence during October-November of second year which is the right time of harvesting the crop.

¹⁹ Agro-technique study carried out by Institute of Himalayan Bioresource Technology (Council of Scientific and Industrial Research), Palampur-176061, Himachal Pradesh.

- **Post-harvest Management:** The bulbs should be separated from the plants, washed and dried in shade before storing.
- **Yield and Cost of Cultivation:** Yield of fresh bulbs of *M. muscifera* is about 60 kg/ha. It loses 2/3 of weight on drying.

Therapeutic Uses

This is one of the herbs of the Asthavarga group. Its preparations are considered as tonic and rejuvenative drug. The bulb is sweet, refrigerant, aphrodisiac, styptic, antidysenteric, febrifuge and tonic. It is useful in sterility, vitiated conditions of pitta and vata, seminal weakness, internal and external haemorrhage, dysentery, fever, emaciation, burning sensation and general debility.



Mucuna pruriens (Linn.) DC.

Syn. Mucuna prurita Hook.

Fam. Fabaceae

Ayurvedic name	Kapikachu, Atmagupta
Unani name	Konch
Hindi name	Gonca, Kauncha, Kavach
English name	Cowhage, Horse-eye Bean
Trade name	Koncha, Kaunch beej
Parts used	Seeds



Mucuna pruriens

Morphological Characteristics

The plant is an annual, climbing shrub with long vines that can reach over 15 meters in length. When the plant is young, it is almost completely covered with fuzzy hairs, shed with age. The leaves are tri-pinnate, ovate, or rhomboid shaped. In young plants, both sides of the leaves are hairy.

Floral Characteristics

The flowers are arranged in axillary arrayed panicles, 15 to 32 cm long and each have two to many flowers. The accompanying leaves are about 12.5 cm long. The vines come into flowering after 120-125 days of sowing and continue to bear flowers and fruits till 180-200 days. *Mucuna pruriens* bears white, lavender or purple flowers. Its pods are about 10-20 cm long and are covered with loose white to creamish hairs that cause a severe itching if they come in contact with skin. The chemical compounds responsible for the itch are a protein, mucunain and serotinin. The seeds are shiny black, brown or spotted white in colour.

Pod Characteristics

Pods are 4 to 10 cm long, 1 to 2 cm wide at the time of maturity. The husk is very hairy and carries upto seven seeds. The seeds are round or flattened, uniform, ellipsoid, 1.0 to 1.9 cm long, 0.8 to 1.3 cm wide and 4 to 6.5 cm thick. The hilum, the base of the funiculus (connection between placenta and seeds) is surrounded by a significant arillus (fleshy seeds shell).

Distribution

Globally this species is widely distributed in the tropical regions of Asia and Pan Tropics. It is found in most part of India, upto 1000 meter elevation includes Andaman and Nicobar Islands.

Climate and Soil

The crop grows in all types of soils, but sandy loam soil with good drainage and pH between 5.50 to 7.50 is preferred. It thrives in sub-tropical to tropical climate with a minimum temperature of 15°C in winter and maximum of 38°C in summer months. The crop is seen growing in varied climate such as coastal humid climate to dry arid climate. Hence the crop is said to be highly acclimatizing and adaptive.

Propagation Material

Seeds.

Agro-technique 20

Nursery Technique

• **Raising Propagules:** The crop is raised by direct sowing of seeds in the field. The seed is treated with Captal or any other contact fungicide before planting to protect against soil borne diseases.

Planting in the Field

- **Seed Viability:** The seeds harvested from the mature fruits are viable for more than two years, recording viability of more than 90%. The germination percentage declines after 2 to 3 years of storage.
- **Land Preparation and Fertilizer Application:** The field should be ploughed well to make the soil porous to facilitate germination and sprouting of seeds. Farm yard manure at the rate of 10 to 20 t/ha at the time of land preparation is applied to the field.
- **Time of Planting:** It is 180 to 200 days duration crop and is sown in last week of June prior to onset of rainy season. The germination takes 8 to 10 days and the field is stocked with young growing vines in 9 months period. These vines need support of bamboo sticks for better growth and higher seed production.
- **Spacing:** Results from field experiments have shown that planting at a distance of 1X0.75 m/ha or 1.0X0.6 m/ha depending upon soil fertility produces 2.5 to 3.0 t/ha of seed on pandal support system.
- Manure and Fertilizers: Field experiments on the use of fertilizers have shown that

²⁰ Agro-technique study carried out by (a) Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bangalore-560089, Karnataka and updated from data generated at (b) Zandu Foundation for Health Care, Vapi (Gujarat).

75, 50 and 50 kg/ha of N, P_2O_5 and K_2O respectively produce high seed yield. They are applied preferably in 2 to 3 doses. The fertilizers P and K are applied along with FYM at the time of sowing. The crop begins to produce mature pods after 140 days and 2 to 3 pickings of pods are taken at the interval of 20 days during pod maturing. The pods are plucked when they turn brown and appear drying.

- **Irrigation:** It is given fortnightly irrigation during dry season and one irrigation per month is required in winter during pod picking.
- **Disease and Pest Control:** Sometimes, collar rot during initial stges of seedling growth has been found which can be managed by applications of 2 kg Trichorich (a formulation of trichoderma in neem cake) and 2 kg *Pseudomonas fluorescens* mixed with 500 kg FYM and applied to the root region. Amongst insect pests, the leaf eating hairy caterpillar is found to damage the crop during pre-flowering stage. To control the pest, Neem soap is recommended to be sprayed at the rate of 5 gm/lit.

Harvest Management

- **Crop Maturity and Harvesting:** The crop matures in about 140 days after sowing. Mature pods are harvested to collect seeds from the pods. At the time of harvesting the pods turn to greyish-brown in colour indicating maturity for picking. Normally 3-7 seeds are found in a pod and 5-6 pods per inflorescence are generally available. Thus, about 25-30 bunches can be harvested per plant. Normally 100 seeds weigh 90-110 gm.
- **Post-harvest Management:** The pods thus harvested from the field are dried in the sunlight for 4-7 days; the seeds are further dried in shade to reach approximately 7-8% moisture in the seeds. The seeds are normally stored in gunny bags made of jute and then covered with polythene to protect from absorption of atmospheric moisture.
- Chemical Constituents: The seeds contain high amounts of L-DOPA that is used in the treatment of Parkinson's disease. It also contains lecithin, a glucoside and a number of alkaloids including nicotine, prurienine, pruriedine, the seed kernel contain fatty oil.
- **Yield:** Seed yield is high between 2.5 to 3.0 t/ha on large scale cultivation. The L-DOPA content from the seed range between 3 to 4%. A high yielding culture called "Zhandu Kanchha" is developed through crossing and selection by Zandu Foundation of Health Care. It yields high L-DOPA (4.5%) and high seed yield; the seed is devoid of stinging hairs. Rs. 20000/- is the cost of cultivation for one hectare.

Therapeutic Uses

Seeds are used as tonic, aphrodisiac and the in treatment of Parkinson'disease. The decoction of the seeds is used in rheumatic ailments. Farmers raise it as a fodder and green manuring crop in Central and Southern Indian States.

Paederia scandens (Lour.) Merr.

Syn. Paederia foetida Linn.

Fam. Rubiaceae

Ayurvedic name	Gandha Prasarani
Unani name	Gandhali, Parsarini
Hindi name	Gandheli
Trade name	Gandha Prasarini
Parts used	Whole Plant



Paederia scandens

Morphological Characteristics

Paederia scandens is a slender, glabrous, twining shrub, foetid when bruised. Its leaves are opposite 5-15X1.8- 5.0 cm in dimension with long petiole, ovate or lanceolate, base acute or rounded. Petiole is 1.0- 2.5 cm long. Flowers are in panicles, 5-12 cm long, puberulous, cymose at the extremity and bracts are minute and ovate.

Floral Characteristics

Flowers are sessile and pedicelled; calyx is small, tube campanulate; corolla is tomentose. Fruit is crowned by the conical disk and minute calyx-teeth.

Distribution

It is mainly found in lower tracts of Eastern Himalayan States *viz*. Assam, Bengal and Bihar, North East States upto 800 meter.

Climate and Soil

The crop can be grown under the hot and humid climatic conditions, where average relative humidity is high (85%) and maximum & minimum temperature varies between 16°C and 30°C

respectively and rainfall is 150-200 cm. It is cultivated in plains to a higher altitude upto 600 m above msl. Soil should be sandy-loam and acidic in nature.

Propagation Material

Vegetative propagation by cuttings.

Agro-technique²¹

Nursery Technique

- **Raising Propagules:** Cuttings may be planted in raised beds at 10 cm apart row and 5 cm within a row. Double node stem with leaves is recommended for planting in the month of August and September. Seed germination is low around 25-30%.
- **Propagule Rate and Pretreatment:** 22,400 cuttings/ha are required. Growth hormone like IBA may be used for early sprouting.

Planting in the Field

- Land Preparation and Fertilizer Application: Land should be prepared to fine tilth before planting. FYM @ 15-20 t/ha can be applied for good initial growth. NPK @ 100:50:50 kg/ha may be applied by broadcasting. A dose of nitrogen based fertilizer at 40 kg may be applied after each harvest.
- Transplanting and Optimum Spacing: Best time of transplanting sprouted cuttings is during September in Assam. Staking is to be provided when it attains a height of 90 cm or over. Optimum spacing is recommended at 60X60 cm.
- **Intercropping System:** Winter vegetables may be grown as intercrop.
- **Interculture and Maintenance Practices:** Hoeing along with weeding, is necessary at 45 days after planting; thereafter, once in a year.
- **Irrigation Practices:** It is a rainfed crop in Assam.
- Weed Control: Weeding is done at 60 and 90 days after transplantation. However, where-ever pre-emergence weedicide like simazine @ 2.0 kg/ha, or oxyflurefen @ 2.0 kg/ha is applied, the weeding could be delayed to 120 days and thereafter after each harvest.
- **Disease and Pest Control:** No pest and diseases have been observed in the trial plantation.

²¹ Agro-technique study carried out by North East Institute of Science Technology (NEIST), Jorhat – 785006, Assam.



- Crop Maturity and Harvesting: Crop matures after six months. First harvest of vines can be done at 6 months (March-April) from the date after transplantation; thereafter, at 4 months interval (July-August and October-November). Winter harvesting is not advisable.
- **Chemical Constituents:** Plant contains friedelan-3-one, β-sitosterol and epifriedelinol; the leaves and stem gave iridoid glycosides asperuloside, paederoside and scandoside; sitosterol, stigmasterol, campesterol; ursolic acid, hentriacontane, hentriacontanol, ceryl alcohol, palmitic acid and methyl mercaptan.
- **Yield:** Yield 1.2 t/ha (Dry weight basis) annually.

Therapeutic Uses

Whole plant is used in Indian System of Medicines. The plant is considered specific for treating rheumatism and all types of neurological diseases. It is extensively used in paraplegia, rheumatism and sciatica.



Paederia scandens in field



Phyllanthus amarus Schum. & Thonn.

Fam. Phyllanthaceae

Ayurvedic name	Bhui-amalaki, Tamalki
Unani name	Bhui-amla
Hindi name	Bhui Aamla
Trade name	Bhui-amla
Parts used	Whole plant



Phyllanthus amarus

Morphological Characteristics

Phyllanthus amarus is an annual herb 60 to 75 cm tall, quite glabrous. Root is stout and woody. Stems are often branched at base and angular. Leaves are numerous, sub-sessile, disticthious, stipulate and paripinnate with small leaflets. The leaflets are oblong, having nerve obscure and base rounded. Root is stout tortuous and woody.

Floral Characteristics

Flowers are very minute, shortly pedicelled numerous and axillary and yellowish in colour. Sepals are 5-6, ovate-oblong outer acute, coriaceous with pale margins; disk in both sexes of glands; male flowers 1-3 pedicelled; female flowers are solitary, larger and erect. Stamens are 3, sessile on a short column didynamous, styles minute, reflaxed very short. The fruit is capsule, minute, globose and dehiscent. Seeds are with strong parallel and transverse ribs.

Distribution

The plant is distributed throughout India mainly in trophical and subtrophical parts of Country.

Climate and Soil

The plant grows in tropical and subtropical climate over well drained sandy -loam soil for its luxurious growth.

Propagation Material

Seeds (They are viable upto six months from the time of harvest).

Agro-technique²²

Nursery Technique

- **Raising Propagules:** Seeds are sown in raised nursery beds during June after rains and seedlings later transplanted on ridges in well laid out plots.
- **Seed Rate and Pretreatment:** About 4 kg seed may be needed for raising seedlings for planting on one hectare of area. No specific pretreatment of seed is recommended.

Planting in the Field

- Land Preparation and Fertilizer Application: The soil should be ploughed, harrowed and plucked and made into a fine tilth. 20 tonnes of FYM is applied during land preparation. For nursery beds, farm yard manure at the rate of 10 t/ha is mixed in the soil along with 100 gm Azospirillum + 100 gm Phosphobacteria + 100 gm Trichoderma as basal medium. In main field 25-30 t/ha of FYM isapplied as a basal medium + 2.5 kg Azospirillum + 2.5 kg Phosphobacteria is given before transplantation.
- Transplanting and Optimum Spacing: 15-20 days old seedlings of 8-10 cm height are transplanted at 30 cm distance in rows in the field immediately after the first monsoon shower. If there is no rain; the field should be irrigated immediately after transplantation. For one hectare area about 4.0 lacs seedlings are needed at an optimum spacing of 25X25 cm.
- **Interculture and Maintenance Practices:** The crop needs hand weeding at 30 and 60 days interval after planting.
- **Irrigation:** Irrigation is required during dry season if monsoon rains is scanty. The frequency of irrigation depends on the moisture content of soil.
- **Disease and Pest Control:** Powdery mildew disease occurs during rainy season. This is controlled by spraying biopesticides like Azadirachtin, *Trichoderma viridie*, *Pseudomonas cholotorapsis etc*.

²² Agro –technique study carried out by (a) Advanced Centre in Botany, University of Madras, Chennai and updated from information generated by (b) Zandu Foundation of Health Care, Vapi (Gujarat).

Harvest Management

- **Crop Maturity and Harvesting:** The crop matures in 80-90 days when it should be harvested; it has maximum active chemical ingredients at fruiting. However, seeds collection is done after 110-120 days old crop.
- **Post-harvest Management:** Whole plant is pulled manually and shade dried. The dried herb is stored in polythene lined gunny bags at cool, well ventilated godowns.
- Chemical Constituents: The herb contains three crystalline lignans including phyllanthine and hypophyllanthine (non-bitter part). In addition, five flavonoids have been identified *viz.* quercetine, astralgin, quercitrin, isoquecitrin and rutin. Four alkaloids have also been separated. The total phyllanthin lignans range between 1 to 1.2% in the dry herb.
- **Yield and Cost of Cultivation:** A yield of 2 to 3 t/ha of dry herb is obtained. Rs. 27,500/- is the cost of cultivation for one hectare.

Therapeutic Uses

The plant is widely used to tone-up sluggish liver and also given in chronic liver condition and jaundice. In Unani medicine, the plant is used in jaundice as deobstruent, diuretic, cooling and astringent. In recent studies, the herb and its root have exhibited antiviral actions on Hepatitis-B.



Piper longum Linn.

Fam. Piperaceae

Ayurvedic name	Pippali, Pipplamul
Unani name	Filfil Daraz
Hindi name	Pippal
English name	Long Pepper
Trade name	Piplamul
Parts used	Dried Spikes and Roots



Piper longum

Morphological Characteristics

ong pepper is the fruit of *Piper longum* which is a slender, much branched, ascending herb and needs support for its proper growth. The leaves are 5-9 cm long and 5 cm wide; lower leaves are broadly ovate, deeply cordate with big lobes at the base, sub acute, entire and glabrous; upper leaves are dark green and cordate with short petiole or nearly sessile. The young shoots are drooping type.

Floral Characteristics

Flowers are unisexual arranged in erect spikes. Female spikes are 1.25-2.00 cm long arising singly from leaf axil are cylindrical, short and stout. It gives rise to multiple fruit, which is shining dark green when immature and blackish-green when fully mature. Male spikes are longer, slender and are 2.5-7.5 cm long. The male spikes are dehiscent and non-productive.

Distribution

Long pepper is a native of the Indo-Malaya region. It is found growing wild in the tropical rainforests of India. Indian long pepper is mostly derived from the wild plants, but is also grown in small area in the Khasi hills, the lower hills of West Bengal, Eastern Uttar Pradesh,

Madhya Pradesh, Maharashtra, Kerala, Karnataka and Tamil Nadu. It occurs wild in the forests of Andhra Pradesh and Andaman & Nicobar Islands as well.

Climate and Soil

The plant requires hot, humid climate and an elevation between 100 to 1000 msl. Higher elevations are not conducive to high yields. It needs partial shade for its ideal growth. Partial shade of about 20-25 % intensity is found to be optimum. The crop thrives well in a variety of soils. It is cultivated successfully in laterite soils with high organic matter content, water holding capacity and well drained fertile black cotton soil. However, light, porous and well-drained soil rich in organic content is most suitable for its cultivation.

Propagation Material

Long pepper is propagated through stem/vine cuttings at the beginning of rainy season. However, it can be easily propagated through the terminal stem cuttings obtained from one year old growth and 3-5 internodes. Vine cuttings can be rooted in polythene bags, filled with the common pot mixture. The nursery can be raised during March and April. The cuttings planted in March-April will be ready for planting in the main field by the end of May.

Agro-technique²³

Nursery Technique

- Raising Propagules: Stem/vine cuttings are transplanted soon after the setting in of monsoon rains. The best time for raising nursery is during March and April to avoid mealy-bug attack on roots, 10 % DP is to be mixed with the potting mixture. Normal irrigation may be given on alternate days. The cutting will be ready for planting where excess moisture is available by the end of May.
- Transplanting the Seedlings: The crop cannot survive in water logging conditions. Raised beds of 3.0X2.5 meter are prepared and pits are dug at a distance of 60X60 cm and dried cow-dung or farmyard manure at the rate of 100 gm/pit is applied and mixed with soil. Two rooted cuttings or suckers with roots are planted in each pit. To avoid any water stagnation in beds, channels are laid out to drain excess rainwater.

Planting in the Field

• Land Preparation and Fertilizer Application: The field needs 2-3 ploughings followed by harrowing and leveling considering the slope of land to facilitate drainage of excess water. Pippali needs heavy manuring. In soils with low fertility,

²³ Agro-technique is carried out by Directorate of Medicinal & Aromatic Plants Research (formerly it was National Research Centre for Medicinal & Aromatic Plants) DMAPR, Anand, Gujarat.

the growth of the plant is very poor. About 20 t/ha FYM or any other organic manuring is applied at the time of area preparation. In the subsequent years also a

manuring is applied at the time of area preparation. In the subsequent years also a similar quantity of FYM or organic manure is to be applied before the onset of monsoon. No chemical fertilizer has been recommended so far in this crop.

- Transplanting the Seedlings to Main Field and Optimum Spacing: Raised beds of 3.0X2.5 meter are prepared and pits are dug at a distance of 60X60 cm.
- Interculture and Maintenance Practices: In the first year, weeding is required as and when necessary. Generally two to three weedings are sufficient. Once the crop grows and covers the field, no serious problem of weed is noticed.
- **Irrigation Practices:** Irrigation is utmost essential during summer months. One or two irrigations in a week depending upon the water holding capacity of the soil, is needed. Even in the monsoon period if there is a failure of rain for quite some time, irrigation has to be given. In irrigated crop, fruit production continues even in summer months.
- **Pests and Diseases:** *Phytophthora* leaf, stem rot and anthracnose are important diseases of long pepper. Spraying of 0.5 % Bordeaux mixture at 15 days interval and soil drenching of 1.0% Bordeaux mixture at monthly interval reduce the loss caused by these diseases effectively. Application of 0.25% neem seed kernel extract or any other neem based insecticides as spray, is effective to control mealy bugs (*Helopeltis theivora*) damaging tender foliage and spikes.

Harvest Management

- **Crop Maturity and Harvesting:** Vines start flowering six months after planting. Fruits take about two months to mature from its formation. Full-grown mature fruits are harvested before ripening, when it is firm and blackish-green. Harvesting of overmatured or ripened fruits reduce the quality of the produce as well as it does not break easily after full drying. Yield of dry fruits in first year is about 100-150 kg/ha and it attains up to 0.75 -1.0 t/ha in third to fourth year. Thereafter, yield starts declining and gradually becomes uneconomic after fifth year. Therefore, it is usually cultivated as a 4 to 5-year crop.
- **Post-harvest Management:** The harvested spikes are dried in the sun for 4 to 5 days until they are perfectly dry. The dried spikes are then stored in the moisture proof containers. Besides fruits, roots and thicker basal stem portions are also collected before crop is abandoned. These are cut into small pieces of 3.0-5.0 cm long and dried. On an average about 500 kg roots are obtained per hectare.

- **Grading:** The dried thicker parts of the stem and roots are called piplamool. There are three grades of piplamool. Grade I with thick roots and underground stem, it fetches a higher price than Grade II and III which consists of either roots, stems or fragments.
- Chemical Constituents: Fruits contain about 20 % dry matter, volatile oil, resin, alkaloids (4-5% piperine) and a terpenoid substance. Root contains piperlon gumine as major alkaloid in addition to piperine.
- **Yield and Cost of Cultivation:** Yield of dry fruits in first year is about 100-150 kg/ha and it attains up to 0.75-1.00 t/ha in third to fourth year. The yield of dry spike during first year is around 0.5 t/ha. It increases upto 1.2 t/ha in the third year. After third year, the vines become less productive and should be replanted. The average yield of roots is 0.5 t/ha. Rs. 62500/- is the cost of cultivation for one hectare.

Therapeutic Uses

Plant root is used in Ayurveda as a carminative, tonic to the liver, stomachic, emmenagogue, abortifacient and aphrodisiac. Fruits contain haematinic, diuretic, digestive and general tonic properties, besides being useful in inflammation of the lever, pains in the joints, snakebite, scorpion sting and night blindness. The plant is also used in dyspepsia, abdominal pain and diuretic splenopathy, anorexia, asthma, fever and act as anti-haemorrhoidal and appetiser.



Pluchea lanceolata (DC.) Oliv. & Hiern

Fam. Asteraceae

Ayurvedic name	Rasna
Hindi name	Rasna, Roshna
Trade name	Rasna, Baisurai
Parts used	Leaves



Pluchea lanceolata

Morphological Characteristics

It is a perennial herb, occurring in Indo-Gangetic plains, 30-60 cm tall. Stem and branches are terete, slender and softly pubescent. Leaves are 2-6 cm in length, sessile, oblanceolate or oblong, coriaceous, finely silky and pubescent on both surfaces, margins entire or obscurely dentate near the apex.

Floral Characteristics

Flowers are white or purple, yellow or lilac in many headed compound corymbs. Capitulum is ovoid or campanulate, 6-7 mm in compound pubescent and corymbs. Involucre is ovoid or broadly campanulate of imbricated scales; outer involucral-scale is 2.5-4.0 mm long, 2 mm broad, 5-3 serrate, obtuse, silky pubescent, tinged with purple outside apex. The innermost scales are few, linear, scarious, subacute, slightly narrower and longer than the outer; all rigid when dry and tip of outer ones often breaking into 1-2 shallow lobes. Receptacle is flat and naked.

Distribution

Plant is found in Punjab, upper Gangetic plains, Rajasthan and Gujarat.

Climate and Soil

Plant grows in open waste lands over sandy-saline lands in low rainfall areas.

Propagation Material

Seeds.

Agro-technique²⁴

Seeds can be directly sown in field.

• **Raising Propagules:** Seedlings of crop could be produced through planting of transition zone cuttings of the plant in the main field during September-March.

Planting in the Field

- Land Preparation and Fertilizer Application: The field is ploughed and harrowed
 well, to make a fine tilth. The crop responds well to the basal application of
 nitrogenous fertilizer.
- Sowing of Seeds and Optimum Spacing: Fresh seeds collected during October-March are directly sown in rows in the field. The spacing of 90 cm plant to plant and 120 cm row to row, gives optimum crop stand of 5000 plants/ha.
- **Intercropping System:** No information available.
- **Irrigation Practices:** Rainfed crop, irrigated when required.
- **Weed Control:** Two manual weedings are required at an interval of one month each after the crop is 40 days old.
- **Disease and Pest Control:** No disease and pests have been noticed in trial plots.

Harvest Management

- **Crop Maturity and Harvesting:** The crop is manually harvested at flowering stage when chemical contents are maximum.
- **Post-harvest Management:** The harvested crop is shade dried and stored in gunny bags in air-cooled rooms for marketing.
- Chemical Constituents: Plant contains choline, pluchine taraxsterol, β and γ -sitosterol, leaves give quercetin and iso-rhamnetin.
- **Yield and Cost of Cultivation:** An average crop produces 40 t/ha of dry herb. Rs. 15000/- is the estimated cost of cultivation for hectare.

Therapeutic Uses

Whole plant is used in Ayurvedic medicine. *Pluchea lanceolata* is accepted as classical drug for arthritis. Its decoction is given for rheumatic conditions, muscular pains, edema, and fever and also applied externally as massage oil. The leaves are aperients, used as a laxative, analgesic and antipyretic.

²⁴ Agro-technique study carried out by (a) Narendra Dev University of Agriculture and Technology (NDUAT), Faizabad, Uttar Pradesh and (b) Jamia Hamdard, Hamdard Nagar, New Delhi.

Premna mucronata Roxb.

Syn. Premna mollissima Roth

Fam. Verbenaceae

Ayurvedic name	Agnimantha (Brhat)
Unani name	Arni
Hindi name	Arni, Agethu
English name	Dusky Fire Brand Bark
Trade name	Agnimanth
Parts used	Root and Root Bark



Premna mucronata

Morphological Characteristics

It is a small tree. The branches are spiny; bark is thin, pale and exfoliating; wood is light brown and scented; leaves are ovate or ovate-oblong, long-acuminate, base rounded, cordate or tapering, entire or irregularly dentate; blade 7-15 cm long; petiole 2.5 cm long.

Floral Characteristics

Flowers are arranged in terminal, corymbose, trichotomous panicles and are greenish in colour. Calyx comprised of 4 or 5 sepals, with rounded and nearly equal teeth. Corolla lobes are equal or bilabiate, upper lip retuse or emarginate, lower lip of 3 equal lobes and throat closed with white hairs. Fruit is a globose drupe, green when young, dark at maturity, 3.5-4.5 mm in diameter. The mature trees start flowering in April and fruiting in May & June.

Distribution

It is a natural inhabitant of lower and outer sub-tropical, Himalayan tracts extending from Chenab in north-west India to Bhutan in the east and extending to an elevation of 1400 meter. It is also found in dry forests tracts of South-West Bengal, Orissa and coastal Peninsular India.

Climate and Soil

The plant is well adapted to the sub-tropical hilly tracts in outer Himalayas with average

annual rainfall around 100 cm, and the tropical regions of eastern and Peninsular India. In north India, it is often found on dry slopes and large, natural, degraded soil bunds. The plant is able to thrive on average clayey or pebbled shallow soils. It has done equally well under experimental plantation on deep loamy soil with good drainage and a pH range of 7.3 to 8.0.

Propagation Material

Seed is the best propagation material, even though it has a short viability of about three months. Seeds can be collected from mature plants from mid May to June.

Agro-technique 25

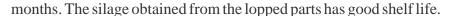
Nursery Technique

• Raising Propagules: Seed should be sown in June, preferably in poly bags, immediately after collection and drying for a few days. The pulp of the fruit withers off after drying. As the seed is hard and stony, soaking it in water for a minimum of 72 hours is necessary. Seed germination is around 70%. Mechanical or acid scarification improves seed germination to 85%. About 100 gm seed is sufficient to raise plants for one hectare of land. Vegetative propagation through air layering and root coppices should be taken up during the rainy season in the month of July.

Planting in the Field

- Land Preparation and Fertilizer Application: The land is cleared of weeds and vegetation and ploughed twice to loosen the soil. It may be left as such for few days, tilled again and planked to bring it in fine tilth. Pits, approximately of 1.0X1.0X1.0 meter size, are dug up uniformly at 4.5X4.5 meter distance in the field. 50 gm of Phorate 10 gm granules or 10 litres of 5% suspension of Chlorpyriphos in water are added to the pit as anti-termite treatment, before filling it with the soil mixture. The soil of each pit is mixed with 5-10 kg FYM, 90 gm nitrogen, 100 gm P₂O₅ and 80 gm of K₂O. The pit is filled up with this soil mixture up to the ground level. The growing plants are given 90 gm of nitrogen and 5-10 kg of organic manure after every 6 months.
- Transplanting and Optimum Spacing: Plants raised from seeds and vegetative propagation in the month of June are ready for transplantation after about 75 days when they acquire 5-7 leaves and become 25 cm tall. Transplantation at this stage has shown a sizable rate of mortality. However, plants retained in poly bags during winter season and transplanted in the following June-July months give over 90% survival rate. In all, 500 plants are required for one hectare.
- **Intercropping System:** The tree can be planted over bunds of fields which are used for growing fodder and vegetables, both in summer and winter months. In addition to its roots, which are used for medicinal purpose, the tree can be lopped for fodder in lean

²⁵ Agro-technique study carried out by National Institute of Pharmaceutical Education and Research (NIPER), S.A.S Nagar, Mohali, Punjab.



- **Interculture and Maintenance Practices:** Pruning is required in the second to fourth years for good bole development of the tree and lopping for fodder may be selectively resorted to. However, not more than 50% of foliage should be taken at one time.
- Irrigation Practices: Irrigation is required regularly after transplanting till the plants establish in field. After establishment of plantation, normal rainfall is sufficient for subsistence of crop. However, in dry season, two irrigations a month in summer and one irrigation a month in winter are required. The plants usually develop good roots system and establish in one year.
- Weed Control: Pre-emergence application of Atrazine 50% WP @ 1 kg/ha may be given before planting in field. Thereafter, 2 to 3 weedings of pits are recommended in a year.
- **Disease and Pest Control:** Termites attack is common in the initial stages. Most of the damage can, however, be prevented by treating each plantation pit with about 50 gm of Phorate 10 gm granules or 10 litres of 5% suspension of Chlorpyriphos in water before refilling the pit with soil and manure mixture. Aphids and Thrips are found to feed on *Premna* leaves. Spraying the foliage with methyl-parathion @ 2gm/lit of water per plant controls the insects effectively.

Harvest Management

- Crop Maturity and Harvesting: Plants grown from seeds start bearing flowers and fruits at the end of 4 years when they are still shrub by in appearance and about 2.5 meter tall. Flowering starts in April followed by fruiting in June. However, the bark is found to be immature with respect to constituents and seldom exceeds 4 mm in thickness even after 4 years. Trees from 8 years onwards only show optimum bark characteristics and attain a sufficient average girth of 120 cm and are appropriate for bark extraction. Hence, usually 8-year old trees are uprooted for roots. Also, the bark may preferably be harvested from the trunk and main branches using non-destructive methods. Longitudinal peels of bark about 10 cm broad and up to 20 cm long are peeled off in a semi-overlapping manner. Peeling is avoided during flowering and fruiting season and rains (July-August).
- **Post-harvest Management:** The root is dried in open sun for 2-3 days so that the moisture content comes down rapidly and possibility of fungal contamination is minimized. It is then spread out in shade (appx. 12-15 days) so that the moisture content is reduced to less than 10%. Clean and dried roots are stored in well aerated, clean, gunny bags in a cross ventilated place.
- Chemical Constituents: Bark contains aromatic bis-nor-diterpenes and some alkaloids.
- Yield and Cost of Cultivation: About 6-8 kg of root is obtained from an 8-year old

tree. Thus, about 3 tonnes of root is expected per hectare of plantation in the forest. Rs. 26900/- is the cost of cultivation for one hectare in the first year which comes down to Rs. 10,500/ha for subsequent years.

Therapeutic Uses

The root is an important ingredient of "Dasmoolarishta" a traditional Ayurvedic preparation given as cure for obstinate fevers. It has febrifuge, cardio-tonic, and stomachic properties, and is considered a nervine tonic. Traditionally, the root preparations are valued for anti-inflammatory conditions and neurological problems.



Psoralea corylifolia Linn.

Syn. Cullen corylifolium (Linn.) Medik.

Fam. Fabaceae

Ayurvedic name	Bakuchi
Unani name	Babchi
Hindi name	Babchi, Bakuchi
English name	Purple Fleabane
Trade name	Bavchi, Bakuchi
Parts used	Seeds



Psoralea corylifolia

Morphological Characteristics

B abchi is leguminous, erect, annual herb that grows 60-100 cm tall. The plant branches profusely and its stem and branches are covered with white hairs. Leaves are simple, 2.5-7.0 cm long, petiolate, rounded, with toothed margin and both sides covered with conspicuous black glandular dots. The seeds are surrounded by a sticky oily pericarp which contains psoralein.

Floral Characteristics

Flowers are axillary, blue in colour and arranged in 10-30 flowered racemes. Calyx is nearly sessile. Corolla is yellowish-blue and little exerted. Pods are 5 cm long, subglobose, slightly compressed, closely pitted and beaked; seeds are oblong, flattened dark brown and covered with a mucilaginous layer. The seeds swell when placed in water. When the seeds are rubbed they give an aromatic odour and tastes slightly bitter.

Distribution

It is mainly found in plains of Central India and Eastern part of Rajasthan, Punjab, and adjoining areas of Uttar Pradesh. It is sporadically cultivated in Rajasthan, Uttar Pradesh and Tamil Nadu States.

Climate and Soil

The crops can be grown well in sub-tropical climate receiving low to medium rainfall over a variety of soils ranging from sandy medium loam to black cotton soils. Red loamy soil with good organic matters and a pH ranging from 6.5-7.5 are good for cultivation.

Propagation Material

Seeds.

Agro-technique²⁶

Nursery Technique

- **Raising Propagules:** No propagules are raised. The crop is raised through direct sowing of seeds which germinate easily. As a sole crop 8 kg seeds are needed for one hectare area.
- **Prapagule Rate and Pretreatment:** No specific pre-treatment is required for seeds before germination.

Planting in the Field

- Land Preparation and Fertilizer Application: The land is prepared by ploughing 2-3 times with disc plough harrowed and planked to make the soil to a fine tilth before onset of monsoon. The area is divided into plots of convenient size. The main and sub-irrigation channels are laid out. NPK (Nitrogen, Phosphorous, Potassium) at the rate of 60: 60: 30 kg/ha are given as basal dose and mixed in the soil together with 10 t/ha of FYM.
- Transplanting and Optimum Spacing: Seeds are directly sown in lines at an optimum spacing of 60X30 cm to raise crop.
- **Intercropping System:** This crop can be cultivated as intercrop in tree plantation in orchards.
- **Interculture and Maintenance Practices:** Regular weeding (2-3) and hoeing operations are needed during early period of growth to control weeds.
- **Irrigation Practices:** The crop is rainfed and can stand partial drought conditions. However, 2-3 irrigations are required after sowing, depending on soil conditions and distribution of monsoon rains.
- **Disease and Pest Control:** Powder mildew is common problem during the winter months. Control measures involve spraying wettable sulphur (sulfex) at the rate of 3% at weekly interval for 3 to 4 times. Leaf roller caterpillar is another menance and is controlled by 2-3 spray of 0.2% Endosulfan at fortnightly interval.

²⁶ Agro technique study carried out by Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra.



- **Crop Maturity and Harvesting:** The crop matures after 200 days of sowing when pods turn purple in colour. The seeds are collected after complete drying of the pods.
- **Post-harvest Management:** Shade dried seeds are stored in gunny bags for marketing.
- Chemical Constituents: Psoralone and isopsoralone, isopsoralidin, corylidin, triacontane and β -sitosterol-B-D-glucoside are present in the seeds. In particular, psoralens are active principles for inducing pigmentation.
- **Yield and Cost of Cultivation:** A yield of 1.0-1.2 t/ha of seeds (dry weight) is obtained. Rs. 10,000 to 12,000/- is the cost of cultivation for one hectare.

Therapeutic Uses

Seeds are used in the treatment of leprosy, leucoderma, psoriasis and other skin diseases. Seed oil is recommended for application over scalp to treat dandruff.



Roscoea purpurea Smith

Fam. Zingiberaceae

Ayurvedic name	Kakoli
Hindi name	Kakoli
Trade name	
Parts used	Fasciculated Tuberous Roots



Roscoea purpurea

Morphological Characteristics

It is a terrestrial, herbaceous and tuberous perennial herb. Root is thick, fleshy and fasciculated. Stem is leafy, elongate, leaves 5-6, lanceolate. Flowers are few in a sessile spike borne in autumn and pale-lilac, purple or white in colour.

Floral Characteristics

Flowers are few in a sessile spike, pale lilac or white. Floral bracts are oblong, hidden in the sheaths of the upper leaves. Calyx is green and slit deeply down one side of the flower expand. Corolla tube is dilated upwards, lip 2-3 lobed; upper segment is ovate and lower lanceolate. The staminode is oblanceolate in shape, half as long as the upper segment; whereas fertile stamen is as long as the staminode. Capsule is cylindrical and varies greatly in size.

Distribution

The plant is distributed from an elevation of 1500-2500 meter in Himalayan region and Khasi hills.

Climate and Soil

The plant grows in moist shady places over sandy-loam soils rich in humus. Soils having

adequate percentage (50%) of sand has good porosity for tuber growth. It grows best in areas, which receive moderate to high rainfall and at elevation ranging from 1500-2500 meter, preferably over north slopes. Other sites with mild slope have also been found good especially, where there is a good summer rainfall. The locations, where the rainfall is scanty, but more or less flat area is preferred for cultivation, so that it can be irrigated as and when required. Tubers are very delicate and susceptible to water logging.

Fasiculated Tubers

Propagation Material

Fasiculated tubers.

Agro-technique²⁷

Nursery Technique

- **Season and Time of Raising Crop:** Planting of tubers is done in April, when soil temperature starts rising in the hills. The tubers, weighing about 4-5 gm each, are found suitable and give maximum growth and yield. The tubers are planted at the depth of 8 cm in furrows at 30 cm distance row to row and plant to plant distance is kept at 15 cm.
- **Pretreatment before Sowing:** The tubers should be dipped in 0.01% bavistin solution for ½ hour before sowing followed by shade drying to protect against soil borne fungi. The crop prefers partial shade of trees for growth.
- Method of Planting (Direct Sowing/Planting or Nursery Raising): Tuber is sown in the warm environmental conditions in the month of April.
- Time and Method of Nursery Planting: Tuber and seeds are suitable for its propagation at the spacing of 15X10 cm. However, plants raised by seeds show high mortality rate and the number of fingers formed are less which takes more time for maturity. Hence the tuber is the best part for its propagation.

Planting in the Field

• Land Preparation and Planting: First ploughing should be done with soil turning plough in the first week of March. Land having slopes should be ploughed across the slope. The field should be kept open for 15-20 days in order to receive sufficient sunlight and allows weeds to get rotted and removed. Before second ploughing, well

²⁷ Agro-technique study carried out by National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Shimla, Himachal Pradesh.

rotten FYM should be applied in the field. Second ploughing should be done in the first fortnight of April depending upon the soil moisture. Planking should be done after 2nd and 3rd ploughing to break remaining clods and make the soil friable. If sufficient winter residual moisture is not present in the soil then a light irrigation should be given before planting the tubers.

- Manure and Fertilizer Used (Basal): It grows very well in humus rich soils. FYM dose of 25-30 t/ha is recommended. It should be spread uniformly in the field and mixed well in the soil. Unlike annual crops, the entire quantity of FYM is applied in split doses. First applications of 3/4th of the total FYM is done at the time of area preparation and rest 1/4th should be applied at the time earthing which is carried out in the beginning of next rainy season.
- Days for Completion of Germination/Sprouting: Sprouting takes one month period.
- **Optimum Crop Stand/Hectare:** 32,000-40,000 plants/ha.
- Inter-cropping System (If Grown in Orchard/Plantations *etc.*): Intercropping trials were conducted in the peach and apricot orchard by adopting the same (sole crop) package of practices. The yield obtained per unit area was same as obtained from the sole crop.
- **Interculture Operations:** In areas of heavy rainfall, two earthings, one after about 30-35 days and second after the monsoon is recommended, so that tubers do not get exposed to sunlight. Hand weeding for 3-4 times is required, depending upon the intensity of weedy flora. There are no serious diseases, insect pests, nematodes noticed in trial plots. However, crops should be protected from water stagnation to avoid tuber rotting ensuring proper drainage.
- **Irrigation Practices:** The residual moisture of the winter rains is captured for the sowing. If the rains are not enough, a light irrigation should be applied before planting. Once tubers sprout, a weekly irrigation is required during summer season.
- **Weed Control:** Manual weeding at an interval of 30 days is required depending upon the frequency of weeds.

Harvest Management

- **Crop Maturity and Harvesting:** The crop takes 2 years to produce mature tubers. The tubers are harvested by digging in autumn preferably in the month of October.
- **Post-harvest Management:** The tubers are washed in running water. Mother tubers should be removed and then rest of the tubers should be dried in shade or in partial sunlight. Dried tubers can be stored in well airy gunny bags / bamboo baskets. For seed purpose, healthy fresh tubers of uniform size can be selected and stored in soil pits in cooler areas or bamboo baskets. These should be treated with 0.01% Bavistin solution for half an hour followed by shade drying before storing to protect from fungal infection.

• **Yield and Cost of Cultivation:** The cultivation trial conducted at Shimla has given 1.2-1.4 t/ha yield of fresh tubers in the first season and 2.5-3.0 t/ha in subsequent year. The difference in the yield was mainly observed due to weight and size of tubers and not due the number of tubers.

Therapeutic Uses

Kakoli is an Ashtavarga plant. Its fleshy tuberous roots are used in treatment of impotency and leucorrhoea. Its root powder is mixed with sugar and taken with milk as tonic in general debility.

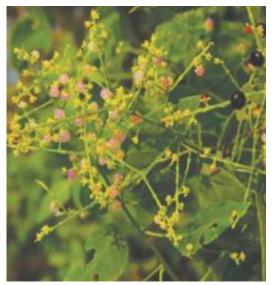


Salvadora persica Linn.

Syn. S. indica Wt.

Fam. Salvadoraceae

Ayurvedic name	Pilu
Unani name	Pilu, Miswak
Hindi name	Khara Jhal, Chota Pilu, Meswak
English name	Mustard Tree, Salt Bush Tree,
Trade name	Khara Jhal, Tooth Brush Tree
Parts used	Roots



Salvadora persica

Morphological Characteristics

Salvadora persica is a large shrub or small tree of Thar Desert. The branches are drooping, terete and glabrous. A typical desert plant grows as a mangrove perennial tree as well as under extreme saline (salt stress) and drought conditions. Thus the seeds are dispersed by the birds. The plant produces three types of fruits, *i.e.* pink, purple and white. The purple fruit bearing plants showed better seed traits, *viz.* seed weight, size, thickness, volume, density and viability and germination percentage as compared to other two types of fruit bearing plant. Hence, in the present studies seeds of purple fruit bearing plants were selected to develop agrotechniques. The leaves are shed twice in a year, *i.e.* October-November and February-March, but plant never becomes leafless throughout the year. New leaves appear twice in a year, first during April-May and second during September to December and thereafter new leaves develop slowly. During winter season (cold stress) anthocyanin pigments have been noticed in leaves. The gall formation has been commonly observed on every plant part except roots. These galls have been reported to possess some growth promoting principles.

Floral Characteristics

The plant bear flowers in September-October. The flowers are greenish-yellow borne in axillary and terminal compound panicles. Calyx is glabrous, lobes rounded; corolla is twice as long as calyx; stamens exerted; fruit is a drupe, globose, red when ripe. The plants produce



fruits with and without seeds. The fruits are formed in autumn and takes 3 months to increase in size and mature during April-May. In natural conditions the germination of seeds takes place during rainy season (July and August).

Distribution

It survives under both saline and drought conditions throughout the Indian arid zone.

Climate and Soil

It grows well under arid environment, salt stress conditions and low moisture with high temperature. Soil mixture of 1:2:1 ratio of sand, clay, FYM is best; higher clay content is preferable.

Propagation Material

Seeds collected during April-May from purple coloured healthy fruits.

Agro-technique 28

Nursery Technique

• Raising Propagules: Seeds are soaked for 24 hours in fruit pulp solution (*Salvadora persica*). They gave maximum germination and shoot growth. Two seeds are sown per polybag at 1.0-2.0 cm depth during June under nursery conditions. Thus 15 gm seeds are required for planting one hectare area at a spacing of 5 X 5 meter under field conditions.

Planting in the Field

- Land Preparation and Fertilizer Application: First ploughing of land is done in the first week of June, and left fallow for 20-25 days for solar exposure for drying weeds, aeration and facilitating decaying crop residues. Thereafter, a second ploughing is done and field leveled through planking. The crop is given NPK at 30:20:15 kg/ha plus hexameal treatment. Half of N and entire quantity of P and K are applied basally and the rest is given after 120 days.
- **Transplanting and Optimum Spacing:** Spacing of 5X5 meter is optimum for good growth under field conditions.
- **Interculture and Maintenance Practices:** Weeding and hoeing are carried out manually at 20 days after planting repeated after every 20 days in rainy season and after rains at 45 days intervals upto 3-4 years of age.
- **Irrigation Practices:** Fortnightly irrigation schedule is more suitable for increasing the collar diameter, biomass, bark & root yields and Harvest Index, while monthly irrigation is suitable for growth and height of the plant.

²⁸ Agro-technique study carried out by Department of Botany, Jai Narain Vyas University, Jodhpur, Rajasthan.

- **Weed Control:** Manual hand weeding is a better option for weed control in *S. persica* plantations.
- **Disease and Pest Control:** No serious insects, pests and nematodes were observed in this crop.

Harvest Management

- **Crop Maturity and Harvesting:** Seeded fruits require 4-5 months for maturity, *i.e.* from December to April-May. The whole plant is used medicinally, but roots are used for preparation of Meswak toothpaste. The plant may be uprooted after 2 years of growth at any time of the year for root production. The roots are separated dried.
- **Post-harvest Management:** Uprooted whole plants are separated into leaf, stem and roots with the help of stainless knife/scalpels. Stem branches and roots are used freshly. If these are not used freshly, then these should be stored in well ventilated shady places, so that moisture loss takes place continuously.
- Chemical Constituents: Root contains elemental y-monoclinic sulphur, benzyl glucosimolate, a methoxylbenzyl derivative of urea named salvadourea, m-anisic acid and sitosterol. Root bark and stem bark contain trimethylamine. Seed oil is rich in myristic, lauric and palmitic acids.
- **Yield and Cost of Cultivation:** Plantation of crop at 5X5 meter spacing in one hectare area yielded 200 kg roots after two years. Rs. 6800/- is the estimated cost of cultivation for one hectare.

Therapeutic Uses

The root contains steam-distillable oil, which has 90% Benzyl isothiocyanate, a compound responsible for decreasing dental caries and used in the preparation of Meswak toothpaste. The chemical present in the plant can control gingivostomatitis, skin infection and conjunctiva. The root bark is tonic, stimulant, emmenagogue. The stem bark is good for gastropathy.



Solanum surattense Burm. f.

Syn. S. xanthocarpum Sch. & Wendl.

Fam. Solanaceae

Ayurvedic name	Kantakari
Unani name	Katai khurd
Hindi name	Choti Kateri, Ringni
English name	Wild Eggplant, Yellow - Berried Nightshade
Trade name	Kantkari
Parts used	Whole Plant



Solanum surattense

Morphological Characteristics

Branches are spreading on the ground. The plant is very prickly diffused bright green perennial herb, somewhat woody at the base. Branches are numerous, the younger ones clothed with dense stellate tomentum, prickles compressed, straight, yellow, glabrous, shining often exceeding and 1.3 cm long. Leaves are 5-10X2.5-5.7 cm, ovate or elliptic, bearing stellate hairs on both sides (especially so beneath), sometimes becoming nearly glabrous with age. Petioles are 1.3-2.5 cm long.

Floral Characteristics

Mainly flowers are axillary but some flowers are cymes and bluish-violet in colour. Pedicels are short, curved with stellate hairy. Calyx is nearly 1.3 cm long, densely hairy and prickly, tube short, globose, lobes 11 mm long, linear-lanceolate, acute and prickly outside. Cololla is purple, 2 cm long, lobes deltoid, acute, hairy outside. Filament is 1.5 mm long, glabrous, anthers 8 mm long, oblong lanceolate and opening by small pores. Ovary is ovoid, glabrous and style glabrous. Fruits are berry, 1.3-2.0 cm in diameter, yellow or white with green veins and surrounded by the enlarged calyx. Seeds are 0.25 cm in diameter, glabrous, smooth, subreniform and yellowish-brown.

Distribution

Plant is widely distributed throughout India in dry situation as weed ascending to 1500 meter on the Himalaya, abundant by road sides and wastelands, mainly in Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh and Haryana.

Climate and Soil

It is a hardy plant. It does well over light well-drained sandy-loam to rich loamy soils having pH of 7.0-8.0. The crop can also be grown under over saline lands. Kantakari is essentially a warm season crop grown mainly in tropical and sub tropical regions. Generally a long period of warm, preferably dry weather with abundant sunshine is required. Temperature range of 21-27° C is most favourable for its growth and reproduction. In northern India, the crop is adversely affected during December-January due to frost as it causes injury to vegetative parts and recovers in the spring season.



Flowers of Solanum surattense

Propagation Material

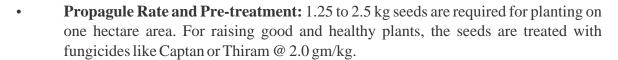
The crop is raised by seed. The seeds are yellowish-brown in colour, small in size *i.e.* 2.5 mm in diameter and glabrous. The seeds have no dormancy period and can be sown after few days of harvesting. It takes 10-15 days to germinate and the percentage of germination is around 60-70%.

Agro-technique²⁹

Nursery Technique

• Raising Propagules: Before sowing, the seeds are soaked in water for 24 hours. This facilitates germination. Seeds take 10-15 days for germination. Raising seedlings in the nursery and later transplanting in field produce good crop strand. Generally nursery beds are prepared in the size of 7.5-10 meter long, one meter width and 10-15 cm above the ground level. An area of about 500 sqm is required to raise seedlings for one hectare area. Well decomposed farmyard manure is mixed into the top soil of the nursery beds at the rate of 10 kg/sqm. The seeds are sown around 15 June in rows made at a distance of 7.5 cm at 0.5-1.0 cm depth. Seeds are mixed in the sand which helps in proper distribution of seeds. After sowing, the rows are covered with a thin layer of the mixture of well rotten FYM and fine sand. Thereafter, the beds are irrigated. Light watering is required daily.

²⁹ Agro-technique study carried out bySKN College of Agriculture, Rajasthan Agriculture University, Johner, Rajasthan.



Planting in the Field

- Land Preparation and Fertilizer Application: The field is ploughed, harrowed and planked well, to obtain a fine tilth. Well decomposed application of FYM at the rate of 12.5 tonnes and NPK 30:40:20 kg/ha as basal dose was found optimum for optimum yield.
- Transplanting and Optimum Spacing: The seedlings are ready for transplanting in 6-7 weeks after sowing in nursery beds; it has attained 10-12 cm in height and bear 4-6 leaves. Watering should be withheld 3-4 days in nursery before transplanting so that seedlings get hardened. Before uprooting, the beds are thoroughly soaked with water to facilitate easy removal of seedlings without much root injury. About 37,500 plants are recommended for planting in one hectare area by adopting 60X45 cm spacing. It gives high yield.
- Interculture and Maintenance Practices: Initially, the plants grow at slow rate and are unable to compete with fast growing rainy season weeds. Therefore, early weeding is essential to keep weeds under control. Later, the crop spreads easily and smoother weed. Thus, one hand weeding at 20 days after transplanting and second at 45 days after transplanting is recommended. The crop responds well to the application of manure and fertilizers. The crop is given 90:60:40 kg of NPK, of which 30 kg N with entire P and K is given basally before planting seedlings. Adequate supply of nitrogen increases fruit size and colour. High level of phosphorus throughout root region is essential for rapid root development and increasing number of flowers. Besides basal dose, 30 kg of N should be applied as top dressing in two equal doses *i.e.* 45 and 90 days after transplanting.
- **Irrigation Practices:** Kantkari crop is raised as a rainfed crop where the amount of annual rainfall is 400-600 mm and well distributed in the season. It requires protective irrigation when it enters reproductive phase; moisture during both growth and fruiting should be adequate for proper plant development. It has been found that three irrigations *viz.*, first twenty days after transplanting, second irrigation at flowering time and third irrigation at fruit development were found desirable to fetch the higher production.
- Weed Control: Weeds compete for moisture, nutrients, sunlight and space with the crop resulting in reduced yield and quality. The growth of Kantkari is slow at initial stage due to which it is unable to compete with fast growing weeds; therefore, in order to keep the field weed free, a shallow inter culture operation is to be done at initial

growth. Usually, two hoeing and weeding at 20 and 45 days after transplanting are needed for an effective control of weeds, proper aeration and good growth of the plants. The crop is spreading in nature and do not allow weeds to grow at later growth stages.

• **Disease and Pest Control:** No serious pest and diseases have been observed on this crop.

Harvest Management

The plants produce flowers at 50-60 days after transplanting. Generally, this period occurs in the month of October. Fruiting starts in the month of November. The plants have indeterminate growth, meaning that flowering and fruiting continues together.

- **Crop Maturity and Harvesting:** It takes about five months from transplanting for first picking of matured berries. Complete crop harvesting can be done in the month of March. The berries are harvested before its colour turns from green to yellowish. About 2 to 3 pickings are done at 20-25 days intervals. Fruits is picked manually and kept in open for sun drying. Similarly, complete plant including roots is harvested at the end of season. It should be done before abscission of leaves starts.
- **Post-harvest Management:** The whole plant should be uprooted after giving a shallow irrigation. The berries and whole herb should be dried in sun and dry herb is packed in gunny bags and stored in cool and dark place. Seed material for next crop should be obtained from fully matured and dry berries. After cleaning, seed should be treated with any fungicide, and then packed in polythene bags and kept at cool and dark place.
- Chemical Constituents: Carpesterol, solanocarpine, solasonine, solamargine and β-solamargine are the chief alkaloids of Kantkari.
- **Yield and Cost of Cultivation:** An average crop of Kantkari yields about 16-20 t/ha of dry biomass (Panchang) including 500 kg berries (dried) under good management practices. After drying, 15-20% dry matter can be obtained under these conditions. Rs. 21938/- is the estimated cost of cultivation for one hectare.

Therapeutic uses

Panchang (whole herb including roots) and berries, have anthelmintic property, useful in bronchitis, asthma, fever relieving, thirst and given in urinary concretions. The leaves have good application for piles. The fruit is laxative. Fumigations with the vapour of the burning seeds of this plant are found useful for the cure of toothache.



Tecomella undulata (Sm.) Seem.

Syn. Tecoma undulata (Sm.) G. Don

Fam. Bignoniaceae

Ayurvedic name	Rohitak, Rohira
Hindi name	Rugtrora, Rohitaka
English name	Rohida Tree
Trade name	Rakhta rohida (Rohida Tree)
Parts used	Bark



Tecomella undulata

Morphological Characteristics

Tecomella undulata is a slow growing small deciduous tree with drooping branches and stellately grey-tomentose innovations otherwise glabrous. Leaves are usually opposite, 5-10 cm long, simple, narrowly oblong, obtuse and entire with undulate margins.

Floral Characteristics

Flowers are pale-yellow to deep orange, arranged in few flowered corymbose racemes on short lateral branches. Calyx is campanulate, lobes broadly ovate, obtuse and mucronate. Corolla is companulate, veined, stamens exserted, flaments glabrous, stigma 2-lamillate. Capsules are slightly curved, smooth and seeds are winged.

Distribution

Plant is distributed in drier parts of North-West and Western India extending eastwards to the river Yamuna and ascending to an altitude of 1200 meter in the outer Himalaya.

Climate and Soil

The plant prefers subtropical climate having medium to light soil.

Propagation Material

Seed.

Agro-technique 30

Nursery Technique

• **Raising Propagules:** Seeds are sown in the month of May on flat beds/raised nursery bed or polybags.

Planting in the Field

- Land Preparation and Fertilizer Application: Pits of 60X60X60 cm are to be prepared at an optimum spacing of 4 meter between row to row and 3 meter between plant to plant and filled with FYM. NPK in the ratio of 750: 600:300 gm/plant is given as single basal dose.
- **Transplanting and Optimum Spacing:** Plantation of seedlings is done at a spacing of 3X4 meter in the month of July-August.
- **Intercropping System:** Aromatic grasses / annual species of medicinal plants can be cultivated as intercrop.
- **Interculture and Maintenance Practices:** One to two harrowing is to be given in the middle space for keeping the field clean.
- **Irrigation Practices:** Irrigation may be given as per the season during winter at 30-40 days interval and summer at 20-30 days interval. After establishment of the crop, it is not necessary to give frequent irrigations.
- Weed Control: Weeding is done as and when required to keep the field weed free.
- **Disease and Pest Control:** The plants need to be protected from termites and stem borer for which suitable insecticides are used.

Harvest Management

- **Crop Maturity and Harvesting:** The crop matures after 3-4 years and should be harvested for its bark during summer (April-May).
- **Post-harvest Management:** The bark is shade dried and stored in gunny bags in dry, ventilated places for marketing.
- Chemical Constituents: Bark contains alkanes; heart wood contains iridoid glycosides 6-o-veratroyl catalposide and tecomelloside and flowers contain flavonoids.

Therapeutic Uses

Plant is anti-leucorrhoeic, used in enlargement of spleen and leucoderma; bark febrifuge, antisyphilitic, given in liver diseases. Flowers are used in diabetes.

³⁰ Agro-technique study carried out by (a) National Bureau of Plant Genetic Resources (NBPGR), Issapur Farms and (b) Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra.

Tribulus terrestris Linn.

Fam. Zygophyllaceae

Ayurvedic name	Gokhru, Gokshura		
Unani name	Gokharu, Khaar - e - Khasak Khurd		
Hindi name	Chotagokhru		
English name	Land-Caltrops, Puncture Vine		
Trade name	Gokhru		
Parts used	Entire Plant		



Tribulus terrestris

Morphological Characteristics

It is a trailing perennial, hirsute, procumbent and branched herb. The stems and branches are pilose and young parts are silky-villous. Leaves are stipulate, opposite usually unequal and abruptly pinnate. Leaflets are 5-8 in pairs with length 0.5-1.3 cm, sub-equal, oblong to linear oblong and mucronate; petiolules very short and pilose.

Floral Characteristics

Flowers are yellow, solitary, axillary, 8-12 mm in diameter and appear during July-August. Style is short and stout; ovary is bristly 5-10 lobed and with 5-12 celled; fruits are globose and spinosus produced during autumn. It consists of 5-12 woody cocci, each with two pairs of hard sharp spines, one pair longer than the other. Each coccus contains several seeds with transverse partition between them. The seeds are obliquely pendulous and have hard seed coat.

Distribution

The plant is found throughout sub-tropical parts of India, ascending upto 1000 meter as a weed along roadsides and waste places.

Climate and Soil

Gokhru requires tropical, subtropical and semiarid climate, preferably open sun with warm

temperature. The species thrives on all kinds of soil from clay- loam to light sandy-loam, and requires low rainfall. Water-logged and highly alkaline soil is unsuitable for cultivation.

Propagation Material

Seeds are used as planting material and collected during October-November.

Agro-technique³¹

Nursery Technique

- **Raising Propagules:** The crop is raised through direct sowing of seeds.
- **Propagule Rate and Pretreatment:** Approximately 1.0-2.0 kg seeds are required for planting one hectare area. These seeds are soaked in water over night and treated with 20 ppm GA₃ for 48 hours before sowing in the field during February-March.

Planting in the Field

- Land Preparation and Fertilizer Application: The field should be prepared well by giving one cross ploughing and harrowing followed by planking. Manure at the rate of 10 t/ha should be mixed with the soil at the time of field preparation. A fertilizer application of N, P and K at 60:40:40 kg/ha is recommended; the N is split in 2 doses, first applied basally and the rest after 60 days.
- **Optimum Spacing:** Optimum crop stands at a spacing of 90X120 cm per hectare is 6000 plants. It takes about 30 days to complete germination. Usually 1-2 weeding are needed to keep the crop weed-free.
- **Irrigation Practices:** The crop is essentially a rain-fed one and watering is done only during long dry spells.
- **Disease and Pest Control:** No significant pests and diseases have been observed in this crop.

Harvest Management

- **Crop Maturity and Harvesting:** It is long duration crop, remaining 240-250 days in the field. The seeds ripen in October when the crop is uprooted. Seeds and roots are separated and dried.
- **Post-harvest Management:** After harvesting the seeds and roots should be shade dried and stored in gunny bags in cool-airy godown.
- **Chemical Constituents:** The plant contains saponins, diosgenin, gitogenin, chlorogenin, ruscogenin and 2-5 D-spirosta-3-5-diene, kaemprerol, kaempferol-3-glucoside, kaemperol-3-rutinoside and new flavonoid tribuloside. Accepted range of active constituents in produce: 19-32 µg/9 kg dry weight.

³¹ Agro-technique study carried out by Jamia Hamdard, Hamdard Nagar, New Delhi.

• **Yield and Cost of Cultivation:** Yield per hectare: Fresh weight: 2.88 tonnes, dry weight: 0.738 tonnes (Accepted range of active constituents in produce: 19-32 μg/9 kg dry weight. Rs. 18000/- is the cost of cultivation for one hectare.

Therapeutic Uses

The root is an ingredient of Dashmool group of drugs. Fruit and root are used in medicine. The fruits are diuretic, aphrodisiac, emollient, expectorant, anodyne, anti-inflammatory, cardiotonic, styptic and linthontriptic properties. The leaves are astringent, diuretic, aphrodisiac, depurative, anthelmintic and tonic. They are useful in gonorrhoea, gleet, ultitis, inflammation, menorrhagia, strangury, leprosy, skin diseases, verminosis and general weakness. The seeds are astringent, strengthening and are useful in epistaxis, haemorrhages and ulcerative stomatitis. The ash of whole plant is good for external application in rheumarthritis. The roots are useful in cough, asthma, internal inflammation and anaemia.



Withania somnifera (Linn.) Dunal

Syn. Physalis somnifera Linn.

Fam. Solanaceae

Ayurvedic name	Ashvagandha	
Unani name	Asgand, Asgand Nagori	
Hindi name	Asgandh	
English name	Winter Cherry	
Trade name	Ashwagandha	
Parts used	Root, Leaf and Seed	



Withania somnifera

Morphological Characteristics

It is a dense, hairy, erect, grayish-tomentose herb or under-shrub, grows up to a height of 1.5 meter. Its all parts are covered with whitish, stellate trichomes. Branching is extensive; leaves are simple, alternate or sub-opposite, ovate, entire, basis cunate, 10 cm long. The roots are stout, long tuberous, fleshy, whitish-brown.

Floral Characteristics

The flowers are greenish-yellow and found in few flowered clusters in axils; pedicels up to 4 mm long. Calyx is 5 mm long and stellately tomentose; teeth 2.5 mm long, linear, acute and form a deltoid base. Corolla is 8 mm long, divided rather more than $\frac{1}{2}$ - way down; lobes lanceolate, acute and pubescent outside. Filaments are 3 mm long, slender, glabrous and anthers are broadly elliptic (almost orbicular), 1.25 mm long. Ovary and style are glabrous. The fruit is red-yellow berry, smooth, 6 mm in diameter, enclosed in the inflated calyx which reaches more than 25 mm diameter and is globose, slightly 5-angled, pointed with the connivent calyx-teeth and scurfy-pubescent outside. Seeds are 2.5 mm in diameter, yellow and somewhat scurfy.

Distribution

It is found throughout the drier parts in subtropical regions and upper Gangetic Plains.

Climate and Soil

Ashwagandha is grown on sub-marginal waste lands and low fertility areas. Plant grows well in red, sandy, black and loamy soil with pH 6.5- 8.0 with good water drainage. It can be cultivated upto an altitudes of 1000 meter. Ashwagandha prefers a sub-tropical climate. The

semitropical areas receiving 500-750 mm rainfall are suitable for cultivation of this crop. The crop requires dry season during the growing period. Temperature between 20° C to 35° C is most suitable for its cultivation. Late winter rains are conducive for the proper development of the plant roots.

Propagation Material

Seeds.

Agro-technique 32

• **Direct Sowing:** The seeds are sown directly in the main field by broadcasting. After receiving 1 or 2 showers, the field is thoroughly prepared, divided into plots of convenient sizes and the seeds are sown during the second week of July to August. A seed rate of 10-12 kg/ha is required for this method of planting. If rainfall is more, then the sowing can be done up to September.

Nursery Technique

- Raising Propagules: Plant to plant and row to row distance can be adjusted according to soil fertility and variety used. The population should be dense at low fertility and more distance at higher fertility land. When the seedlings are to be raised for transplanting, they should to be sown in well-prepared, raised nursery beds. The seeds are usually sown about 1-3 cm deep in June- July in nursery. The seeds in the nursery-beds are sown in lines spaced at 5 cm and covered with light soil. The germination commences within 6-7 days of sowing and within ten days from sowing it is complete. When the seedlings are 6 weeks old and sufficiently tall they are transplanted in 60X60 cm spaced in well-prepared land in July-August.
- **Prapagule Rate and Pre-treatment:** About 5 kg of seeds are required to provide enough seedlings for sowing one hectare. To avoid nursery diseases, the seeds are treated with Therum-45 at the rate of 3gm/kg of seeds before sowing. A light shower after sowing ensures good germination.

Planting in the Field

• Land Preparation and Fertilizer Application: Mostly organic manure should be applied. For organic cultivation no fertilizer should be applied. N 25 kg, P 25 kg and K 20 kg should be applied. All the quantity of P, K and 1/3N should be applied at the time of sowing or planting. Remaining N in the split doses. Ashwagandha is usually grown in fields, which are not well covered by the irrigation systems. The field on which food crops cannot be taken profitably for the above reason may be used for Ashwagandha cultivation. The soil of the field selected of Ashwagandha cultivation should be well pulverized by ploughing, disking or harrowing. The field may be then leveled. The crop of Ashwagandha does not require heavy doses of manure. In

³² Agro-technique study carried out by (a) University of Agricultural Sciences, Bangalore, Karnataka and (b) Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, Uttar Pradesh.

Madhya Pradesh, where it is grown on commercial scale, no fertilizer is applied and the crop is cultivated on only residual fertilizer. However, 200-300 kg FYM/ha may be applied. 5-6 times vermi-compost or FYM may be applied row to row.

- Transplanting and Optimum Spacing: The seedlings after 25-35 days are transplanted at distance of 20-25 cm to 10-15 cm row to row and plant to plant respectively. It may be noted that since "Asgandh" is a late rainy season the time of sowing is decided by the date of arrival of monsoon in that area.30 to 60 plants/Sqm or 3 to 6 lakhs plants per hectare should be kept when 3/4 rain have over in August or September sowing or transplanting should be completed.
- **Intercropping System:** Withania may be planted as intercrop with newly planted *Cocos nucifera* (coconut), *Mangifera indica* (mango), *Tectona grandis* (teak), *Simaruba officinalis* (simaruba), *Jatropha curcas* (jatropha), *Pinus* spp. (pine) and *Populus canadensis* (populus).
- **Interculture and Maintenance Practices:** The directly sown crop is thinned at 25 30 days to maintain a plant population of 20,000–25,000/ha. Hand-weeding at 30 days interval helps to control the weeds effectively. Total two weedings. 2nd weeding after 2 months.
- **Irrigation Practices:** Light shower after transplantation ensures establishment of seedlings. There is no need of irrigation if rainfall is at regular intervals. Excessive rainfall/water is harmful to the crop. Life saving irrigation may be applied at required intervals. Under irrigated conditions, the crop can be irrigated once in 10 days.
- **Pests and Diseases:** The early stages (seedling stage) of *Withania somnifera* caused from fungus disease like damping of fungus, seedling blight, seed rotting, die-back *etc.* Seed should be treated with thiram or capton(2-4 gm/kg) to reduce the effect of seedling blight and leaf blight. 0.3% phytolone, diethane- 78 or D-45 is also spread on crop. Leaf curl tobacco and urtches broom disease were also recognized in *Withania*. These diseases are controlled through spraying of tetra-cyclinehydrochloride at the interval of 15-20 days. Best way to uproot and burn the infected plants. Some insect diseases were also identified on *Withania*, for controlling of insect diseases, 0.5% melathyone mixed with 0.1 0.3% kithane can be used as spray at 10-15 days interval.

Harvest Management

• **Crop Maturity and Harvesting:** Harvesting starts from January and continues till March. The plants start flowering and bearing fruits from December onwards. The crop is ready for harvest in January – March *i.e.* 150 to 180 days after sowing. The maturity of crop is judged by drying out of leaves and yellow red berries. The entire plant is uprooted for roots, which are separated from aerial parts by cutting the stem 1-2 cm, above the crown. The roots are cut transversely into small pieces (7 to 10 cm). Occasionally, the roots are dried as a whole. The berries are plucked from the dried plants and are threshed to obtain the seeds.

- **Post-harvest Management:** The dried roots, entire or transversely cut into smaller pieces, have to be further water washed, cleaned, trimmed and graded. The roots are beaten with a club, which removes adhering soil and breaks off the thin, brittle lateral rootlets. Lateral branches, root crown and stem remains on roots are carefully trimmed with the help of knife.
- **Grading:** The entire product is then carefully sorted into four grades based on the thickness and uniformity of the pieces.

A-Grade: Root pieces up to 7 cm in length, solid, with 1.0-1.5 cm diameter; they

should be brittle and pure white on the inside.

B-Grade: Root pieces up to 5 cm in length, solid, with a diameter of less than 1

cm, the roots should be brittle and white on the inside.

C-Grade: Root pieces up to 3-4 cm in length, side branches solid, with a

diameter of 1 cm or less.

Lower Grade: Small root pieces, semi-solid, very thin or very thick, chopped and

yellowish on the inside.

- Chemical Constituents: The main constituents of Ashwagandha are alkaloids and withanolides (steroidal lactones), the major groups of secondary metabolites of medicinal interest. Among the various alkaloids, withanine is the main constituent. The other alkaloids are somniferine, somnine, somniferinine, withananine, pseudowithanine, tropine, pseudo-tropine, 3-a-gloyloxytropane, choline, cuscohygrine, disopelletierine, anaferine and anahytrine. Two acyl steryl glucoside *viz.* sitoindoside VII and sitoindoside VIII have been isolated from root. The leaves contain steroidal lactones, which are commonly called withanolides. The withanolides have C28 steroidal nucleus with C9 side chain, having six membered lactone rings.
- **Yield and Cost of Cultivation:** On an average yield from one hectare area under commercial cultivation is an approx 0.5-0.7 tonnes of dried roots and 30-40 kg seeds. Rs. 25000/- is the cost of cultivation for one hectare.

Therapeutic Uses:

The drug is rejuvenating agent; mainly used in Ayurvedic and Unani preparations. The plant has anti-tumor, anti-inflammatory, anti-bacterial, fungicidal, anthelmintic, anti-convulsant, anti-stress, immunomodulatory and anti-pyretic properties. It is also used in insomnia, weakness, ulcers and painful swellings as aphrodisiac and in leucoderma. The paste prepared out of its leaves is used for curing inflammation of tubercular glands and that of its roots for curing skin diseases, bronchitis, ulcer and dyspepsia and eye diseases. The fruits and seeds of Ashwagandha are diuretic in nature. The leaves are reported to contain anthelmintic and febrifuge properties. An infusion of the bark is given for asthma.



Glossary

Glossary of botanical terms

Abaxial : Located from the side away from the axis

Abscisic acid : Plant hormone that inhibits growth

Achene : Single seeded, unicellular, dry, indehiscent fruit also called

caryopsis

Acicular : Needle like

Acuminate : Long, pointed, gradually tapering towards apex

Adaxial: Located on the side towards the axis. The adaxial surface of

a leaf is the upper side

Aerial root: An aerial root is a plant's root that is produced above the ground

Agriculture: It is the science of farming, including growing plants and

raising animals

Airspace : These are the inter-cellular gaps within the spongy mesophyll

of leaves

Amplexicaule : Encircling of the node by leaf bases

Annual : An annual is a plant that goes through its entire life cycle

within a year

Apex : Tip, uppermost part

Apices(apex) : Top

Arable : Arable land is suitable for growing crop plants

Arcuate : Leaves with arcuate venation have veins that are curve

towards the apex (Tip)

Areole : Areoles are circular clusters of spines on a cactus

Aristate : Ending in bristle or awn

Articulate : Jointed

Auxin : Growth hormone found in plants

Awn : Bristle-like extension of a plant near its tip

Axillary bud: The axillary bud is a bud that develops in the axil (The angle

between the stem and the leaf) of leaf

Bark : Outer covering of stem and roots of woody plants

Berry: Small juicy, fleshy, stoneless fruit that contains one or many

seeds

Biennial: Plant which takes two years to complete the full life cycle

Bilateral: Two sides

Birch : These are broad-leafed, deciduous trees and shrubs with

paper like bark

Bladder : Small air-filled sac Blade : Narrow flat leaf

Bract: Reduced leaf-like structure associated with a flower

Bracteole: A small bract or leaf like structures below perianth in a flower

Bud : A small developing part of a plant that will grow into a

flower, a new leaf or a stem

Bud scale : Modified leaf that covers and protects the bud

Bulb : An underground stem usually globular, that has fleshy leaves

emerging from the top and roots emerging from the bottoms

Bulbils: Vegetative propagative spherical structure arising at the leaf

base

Bulblet : A small bulb that grows from another bulb (for vegetative

propagation)

Caducous:Falling soonCampanulate:Bell-shaped

Canopy : It consist upper part of the trees of a rain forest
Capitulum : Head-shaped inflorescence, as in Asteraceae

Capsule : It is a seed pod that opens when it is dry and the seeds are

mature

Carpel: Female reproductive organ of a flower

Caudex : An enlarged, woody base of the stem on some plants

Cauline : Arising from stem

Clade: A Clade is the group of all the organisms that share a

particular common ancestors

Cladodes : Modification of dwarf branches into leaf-like structure

Clasping : Wrapping

Cleft: A cleft leaf is one in which the margins between the irregular

teeth go more than half way to the mid rib

Comose : With long, white bunch of hair

Coppice shoots: It is a shoot that arise from an adventitious or dormant bud on

a branch or stem of a plant

Coquina : It is a type of lime-stone that is mostly made of shells and

shell fragments

Cordate : Heart-shaped

Coriaceous: Thick, stiff, leathery

Corm: A stem modification, underground spherical in shape with

reserve food material

Corona : Bundle of hair between corolla and stamens arising from base

of the corolla

Crenate : A crenate leaf has margins (edges) shaped like rounded teeth

Crisped: Tightly curled margin

Crystals
 Culm
 Elongated straw or hollow stem of grasses
 Cuneate
 Wedge-shaped, tapering towards base

Cuspidate : Tapering to long point at tip

Cyme: Arrangement of flowers with older flower on top and younger

flower towards base

Deciduous: Plants lose their leaves seasonally, usually for the dry season

Dehiscent Fruit: A fruit splits open when it is mature, causing the dispersal of

its seeds

Diadelphous: Stamen divided into two groups 9+1 as in Fabaceae

Dicho.venation: It is a pattern of a leaf veins in which the veins branch in two

over and over again

Didymous: Two-sized (filament of stamens)

Dimorphism: Two forms

Dioceous : Male and female flowers on different plants

Dirt : Another name of soil

Discoid : Disc-shaped

Dispersal: It is a process in which an organism spreads out

geographically

Dominant: It is the most abundant species in an area

Dormancy: It is a period in which a plant has no active growth in

response to harsh environmental conditions

Elater: A cell or a part of a cell which assists in dispersing spores

Ellipsoid : Eclipse-shaped

Emarginate: Deeply and irregularly notched at apex

Embryo: An embryo is a developing plant still inside the seed

Entemophylous: Pollinated by insects

Endemic: Endemic plants are native to an area and are only found in that area

Entire : Even margin, complete margin, no cut or lobation on margin

(of leaves)

Epigynous: Ovary seated above perianth

Epiphytes : A plant which grows upon another plants

Exstipulate: Without stipule, a leafy structure at the base of leaf

Extrose : Facing outward

Fascicled: Clustered at one point

Fertilizer: A material, added to soil to increase fertility and output

Fibrous root: A fibrous root is a type of root of a plant that has a lot of side

branching

Fluted : Hollow
Foliage : Type of leaf

Follicle : Dry dehiscent fruit opening only by ventral suture

Fragrant : Emitting sweet smell

Gamo petalous
 Gamo sepalous
 Gamo tepallus
 Glabrous
 Petals united with each other
 Perianth united with each other
 Without any hairy structure

Graft: A shoot or bud that has been joined to another plant

Gregarious: Very long – robust, profuge

Gynaecium: Female part of flower having ovary, style and stigma

Habit : The general growth pattern of a plant

Habitat : A space suitable for the survival and reproduction of an

organism

Haustorial root : Root absorbs water and nutrients from another plant (not

from soil)

Heart wood : Central hardest part of wood/trunk

Hormone: It is a chemical in plant that regulates the plant's growth,

reproduction and another functions

Humus: Humus is the rich organic portion of the soil

Hydric : These are environmental conditions which are very wetHypogynous : Ovary inferior, sepals, petals and stamen above the ovary

Imbricate : Arrangement of corolla with two outer, one inner, and two

with one side outer other side inner

Imparipinnate: Leaflet in odd number on top

Indehiscent : A fruit that remains closed at maturity is indehiscent

Indigenous: An organism is one that leaves naturally in a particular reason

and were not introduced there by man

Inferior ovary : An ovary located below the flower parts

Inflorescence: Arrangement of flowers

Lanceolate : Shape of convex lens

Lateral : Near or from the side of an organism

Latex : Oozing milky sap or milky sap inside plant tissue

Leaflet : In a compound leaf the individual blades are known as leaflets

Lemma : A bract in a grass speculate that is located below the stamens

and pistil of the flower

Lenticellate : Slit-like raised cortical structure on the branches

Liana : It is a woody climbing wine that grows on tree trunks in order

to reach sun light in the rain forest

Linear : Very narrow, like a line

Loam: It is a type of rich crumbly soil that contains an almost equal

amount of sand and silt, plus a small amount of clay

Lomentum: Single seeded cell of pod, septate, and constricted between

two seeds

Mesophyte : A plant that has moderate water requirements

Mineral: A mineral is a naturally occurring solid of definite chemical

compositions whose atom usually form a regular pattern

Moniliform: Beaded in a row like a garland

Monoculture: It is a system of agriculture in which a single type of crop is

grown in an area

Monoecious: Unisexual, male and female flowers on the same plant

Mucronate : Small projection at the apex (acume)

Mycorrhyzae: It is a fungus that grows in a symbiotic relationship with the

roots of a plant

Nutrient: It is a chemical that an organism need to ingest in order to

survive

Oblong: Longer than broad with narrowing margin towards base

Obpyramidal: Inverted pyramid shaped

Obsolete : Minute or wanting
Obtuse : Blunt top (apex)
Orbicular : Almost circular
Ovate : Egg shaped

Palmate : Hand like structure of a leaf

Peat: A type of soil which is composed of in completely decomposed

plant material that waterlogged and low in oxygen

Pedicel : Stalk of flower
Pedicillate : Stalked flowers

Peduncle : Stalk of inflorescence

Perennial: A plant which continues to grow after it has reproduced, usually

meaning that it lives for several years

Perianth: Vegetative covering of sexual organ in flower, sometime

differentiated into calyx and corolla

Peripinnate: Leaflet in even number

Pesticide : An agent that kills unwanted plants and insects

Petiole: A petiole is a leaf stalk on a compound leaf, the petiole extends

from the stem to the first set of leaflets

Petiolate : Petiolate means having a petiole

Phylloclade : Modified stem

Phyllode : Leaf has enlarged midrib without blades

Pinnate : Compound leaf with leaflets arranged on same rhachis at length

Polyhederal : Many faced, many angled

Prickle: Sharp outgrowth of a plant's epidermis

Procumbent: Creeping on ground then rising up

Pubescent : Carpeting of small soft hair

Rachis : Midrib of a leaf

Radical : Arising from stem base (leaves or branches)

Receptacle: Terminal portion of the flower stock

Reniform : Almost kidney-shaped
Repand : Leaf has a wavy margin

Reticulate : Weaved

Rhizome: Subterranean part between stem and root bearing buds that may

be used as a propagative part

Rhomboid: Quadrihedral with only opposite angles equal

Rosette : A series of whorls of leaves or leaf-like structure produced at

the base of the stem, just above the ground

Rugose : Ridged, rough or wrinkled

Sapling : A small young tree

Sapwood: It is an outer layer of wood in a tree and contains living cells

Sarmentose: Growing among bushes, with long flexuous runners

Scale : Tiny green leaves

Scandent: Weak plants that need support; climbing without any climbing

organ, and so on

Serrate : Margin of leaf cut into saw-shaped structure, pointing upwards

Sessile : Without any stalk

Sinuate : Wavy margins

Spathulate : Service spoon shaped

Spike : Sessile flowers arranged on peduncle

Spikelet : It is a secondary spike found in grasses; it is cluster of two or

more flowers in the inflorescence

Staminode : Barren stamen (infertile anthers)

Stellate : Star-shaped arrangement of short stiff hair (trichomes)

Stipitate : Stalked

Stipule : Paired, appendages found at the base of the leaves

Striate : Marked with vertical lines

Succulent: Thick, soft and juicy

Suffruticose: A herb becoming perennial at base and herbaceous at apices

Syncarpous : Fused carpels
Tap root : Type of root

Terete : Lined

Terminal bud : A bud located at the apex of a stem

Terrestrial : Growing in soil

Tester : Seed coat

Thorn : Modified stem

Tomentose: Dense, soft, layer of hair or cotton easily scraped off

Truncate: Flat topped

Tuber : A swollen, subterranean root containing reserve food material

Turbinate : Tube shaped

Variegated : Spotted with various colour

Veinlet : Small vein

Venation: The arrangement and pattern of veins in a leaf

Villous : Long soft shaggy hair

Vine : A plant that needs support as it grows

Whorl : Arising more than two from one node (leaf or branches)

Wood : A secondary tissue found in seed plants which consists largely

of xylem tissues

Xeric : Dry conditions

Zygomorphic: A symmetrical plain of flowers not divisible into equal halves

Glossary of medical terms

Aborticide : Expels and kills embryo

Abortifacient: A drug that induces foetus expulsion

Abortive : Effecting abortion

Abortion : Expulsion of foetus which is not viable during the first five

months

Abscess: Localized collection of pus in any part of body

Absorbents: Agents which absorb toxins on its surface. Absorbents are

used in diarrhea or vomiting

Acidity : Sign of indigestion-increase in the acid content in stomach

Acrid : Producing irritation or biting and pungent

Adjuvant : An impure ingredient introduced into a preparation

AIDS : (Acquired Immuno Deficiency Syndrome)- A disease caused

by HIV virus, which suppresses an antidote

Alexipharmic : Which neutralizes a poison, acts as an antidote
Alexiteric : Developing resistance against infectious diseases

Alopecia : Baldness, loss of hair, a natural or abnormal condition

Alterative: A drug that alters body condition by improving metabolism;

used against long effect of a medicine

Amenorrhoea : Failure of menstruation
Amoebicide : Kills amoebae (e.g. Ipecac)

Anaemia : Decreased oxygen carrying capacity of blood, decrease

haemoglobin content of blood

Anaesthetics: Drugs that produce temporary loss of sensation

(a) Affects whole system by bringing unconsciousness

(b) Acts on specific parts of system

Analgesic : Pain killer

Anaphrodisiacs: Are agents which allay or diminish or weaken the sexual desire

Anasarca : Generalized oedema Anodyne : A drug used to allay pain

Antacid: To neutralize acidic effect in abdomen

Antalkaline : Agents which neutralize an alkaline state of the system

Anthelmintic : A drug used to expel or destroy intestinal worms

Antiarthritic: A remedy against gout, rheumatism or affections of the joints

Antibiliary/A-biloius: Which are useful in bilious affections

Antibiotics : Agents produced by or derived from living cells of molds,

bacteria or other plants which destroy or inhibit the growth of

microbes (Antibacterial agents) in body

Antibodies : Are specific protective substances produced by the tissue cells

of the host in response to an antigen

Antibronchial: Working against respiratory track infection and Congestion

Anticoagulant : Substance which prevent clotting of blood
Anticonvulsant : Agents which abort or prevent convulsion

Antidiabetic : Medicine preventing or overcoming diabetes by lowering

blood sugar

Antidote : Counteracting the action or effect of poisons

Antidysenteric : Medicine given against dysentery
Antiemetic : A drug used to control vomiting

Antiepileptic : Used to relieve or prevent convulsion in epilepsyAntifertility : A drug that inhibits formation of ova or sperm

Antigalactagogue: That decreases the secretion of milk

Antihistaminic : A drug used for controlling skin irritation and itching caused

due to increase of blood histamine

Antihydrotic : Drug which diminishes perspiration

Anti-inflammatory: A drug used to cure swellings

Antilithics : (Lithontriptrics)- Agents preventing or depositing of renal,

vesicant or biliary calculous medicines used for the relief of

calculous affections

Antimalarial : Prevents or cures malaria
Antineuralgic : Relieves neuralgic pain

Antiparasitic : Destroys parasites infecting the surface of the body

Antiperiodic : A drug that prevents recurrence of a disease

Antiphlogestic : An agent used for reducing or subsiding Inflammations

Antipodagric : Used in gout

Antipruritic : Used to relieve itching

Antipyretic : A drug or a medicine used to lower body temperature in fever

Anti-rheumatic: A drug used against joint pain and swellings

Antirhinitis : Clearing of nasal mucous by subsiding nasal membrane

inflammation

Antiscorbutic : A drug that corrects or cures scurvy

Antiseptic: Prevention of putrefaction or sepsis of wounds and cuts

Antisialagogues: Which decrease or check the secretion of saliva

Antispasmodic: A medicine that releases nervous irritability and reduces spasm

or convulsion

Antisudorific : Anhydrotic

Antisyphilitic : A drug which is effective against syphilis

Antitubercular: Agents used against tuberculosis

Antitussive : A drug controlling cough

Antivirotic : Harmful to viruses; used to treat viral infections

Aperient : Mild laxative/cathartic

Aphrodisiac : Drug increasing the sexual desire and longevity

Aphthae : Small ulcers in the mouth

Appetizer: Increasing digestion and hunger **Aromatic**: An agent that emits sweet smell

Arthritis : Inflammation of joints

Ascaricide : Drug that destroys round worms

Asthma : A disease characterized by wheezing, coughing
Astringent : A drug that contracts the muscular membrane

Atrophy : Wasting, emaciation, loss of tissue

Attenuant : An agent increasing the fluidity or thinness of the blood or

other secretion

Bacteriostatic: Agents which tend to retard the growth of microorganisms

but do not kill them

Balsamic : Medicine of healing or soothing kind

Bechic : Remedies for cough

Biliousness: Term used to describe the giddiness vomiting *etc*.

Bitters: Medicines that stimulate the gastrointestinal tract, without

influencing the general system

Boil : An inflamed pus-filled swelling caused by infection of a hair

follicle

Bronchitis: Inflammation of the mucuous membrane in the bronchial tubes

Bronchodiltaor: A drug that widens the trachea, thus easing Congestion

Cancer: A malignant new growth in any part of the body

Cardiac : Pertaining to the heart

Cardiac Depressant : Reduces frequency or force or both of heart action

Cardiac stimulant: (Cardiotonic)- Stimulates frequency or force of heart action

Caries : Destruction in teeth

Carminative : A drug that releases intestinal gases or flatulence

Cataract : Opacity or clouding of the lens of the eye

Catarrhal : Mucous membrane inflammation with excessive secretion of

mucous

Cathartic : Drastic purgative, totally expelling rectal stool

Caustics : Substances that destroy or disorganize living tissue, by

destroying the vitality of the part on which it is applied

Cephalic : Pertaining to head

Cerebral Depressant: (Sedative)- Decreases functional activity of higher centres of

brain

Chalybeate : Contains iron and is used as a tonic in anaemia

Chicken pox : A contagious diseases resulting in sporadic eruption of papules

Cholagogue : A drug inducing excessive secretion of bile juice
 Choleretic : Drug increases bile secretion or formation by liver

Coagulants : Drugs that hasten blood coagulation

Colic : Severe spasmodic and gripping pain in colon region

Convulsants : Agents that cause convulsions

Cordiacs: Pertaining to heart

Corrosive : Drug that destroys organic tissue either by direct chemic

means or by causing inflammation, strong alkali or acid

Debility : Weakness of solid or muscular fibre

Deliriant: Blunt cerebral function so as to disorder or confuse the

mentality

Demulcent : Soothing medicine for digestive function

Dengue fever : An epidemic viral disease having fever and body pain

Dentrifices : Powder or parts used for cleaning the teeth and gums

Deobstruent: Removes obstructions in bowel

Deodorants: Substances which destroy, remove or correct offensive or

disagreeable or foetid odours and emanations

Depilatory : Kills growth or remove hair

Depressants: Diminishes functional activities of any cell, tissue, organ and

system

Depurant: Purifier

Derivativies: Withdraw blood from the seat of disease to some other part of

body, usually to relieve Congestion

Dermatitis: Inflammation of the skin causing discomforts such as eczema

Dessicant : Dries up moist surfaces

Diabetes: A metabolic disorder characterized by excessive elimination

of urine

Diaphoretic : Drug inducing perspiration

Diarrhoea: Gastro-intestinal disease resulting in the increased frequency

or fluidity of stool

Digestants: Aids the process or speed of digestion, often by increasing

the efficiency of break down and absorption of food in the

stomach and intestines

Diptheria : An infectious disease of throat and fauces in which false

membrane form

Discutient: Causes a tumour, exudates or other pathological formation to

disappear, reduces swelling

Diuretic : Increasing urination frequency

Dizziness: A condition of feeling giddy or unsteady

Dropsy: A leakage of the watery part of the blood into any tissues of

the body

Dysentery: Bacterial or protozoal infections in mucous membrane of

intestine, leading to blood or mucous in stool

Dysmenorrhoea: Painful menstrual flow

Dyspepsia : Indigestion with gastric pain

Ecbolics: Increases uterine contraction and aids in or hastens expulsion or

or Oxytoics delivery of child during birth; those which produce abortion or

facilitate parturition

Eczema : Acute non contagious inflammation of the skin

Emetic : Causes or produces vomiting

Emmenagogue: A drug that restores regularity in menstrual cycle

Emollient: Drug that soothes, softens, relaxes and protects the skin

Emulgent : An agent stimulates urinary or bile flow

Epilepsy : An affectation of the nervous system resulting from excessive

or disordered discharge of cerebral neurons

Epistatic: Vesicatory or substance, which applied locally to the skin,

produces a blister, causing redness of the surface

Errhines: Increases nasal secretions or discharge, resulting in sneezing

Escharotic: A powerful caustic, destroying tissue when in contract and

producing eschars (scarce or dry crusts)

Euphoric : Produces an artificial state of happiness
Evacuant : Purgatives laxative, cathartics, aperients

Excitant : Stimulates vital activity in any part of organism

Expectorant: A drug expelling phlegm from trachea

Febrifuge : A drug used to cure fever

Fisture : A linear sore with a narrow base

Flatulance : That presence of an excess of gas in stomach and intestine

Foeticide : Drug that destroys the embryo in vitro Fungistatic : An agent inhibits the growth of fungi

Galactagogue: Increasing and activating mammary gland
 Galactophyge: Decreases secretion and/or flow of milk
 Gangrene: Death of tissues followed by putrefaction

Gastric sedative: Reduces gastric irritation, thus allaying nausea and vomiting;

increases gastric function, thus acting as tonic

Geriatric : Pertaining to old age

Germicide : An agent that kills germs and worms
 Gleet : Chronic discharge from vagina
 Goitre : Enlargement of thyroid glands

Gonorrhoea : Inflammation of the gentio-urinary passage with pain and

discharges

Gout : A purine metabolic disease with raised level of serum uric

acid (blood urea)

Gynaecological: Pertaining to female genital organ

Haematinic/ : Are blood tonics, improves haemoglobin of the blood

Haematics

Haemophilic: Loss of blood coagulation property in which blood continues

to flow on cuts

Haemoptypsies : Spitting of bloodHaemorrhage : Bleeding piles

Haemostatic : Blood coagulant, preventing bleeding

Helminthogogue: Wormifuge

Hemagogue : Destructive to the blood vessels

Hemolytic : Promotes destruction of red blood cells

Hepatic : Pertaining to liver

Hepatitis : Inflammation of the liver

Hepatic stimulant: Increases or stimulates liver function

Herpes: Viral disease with development of vesicles on inflammatory

skin

Hodgkins disease: A disease characterized by progressive enlargement of lymph

glands and spleen

Hydrocholeretic: Increases secretion of relatively thin bile with high water

content

Hydrogogue: Promoting expulsion of water or serum

Hydrophobia: Dread of water contracted from bite of rabid animal

Hyper lipidemia : Reducing fat on joints
 Hypertension : High blood pressure
 HypnicorHypnotic : Agents to induce sleep
 Hypoglycaemic : Lowering blood sugar
 Hypotensive : Lowering blood pressure

Hysteria : Neurotic attack with unusual activities and symptoms

Impotence: Inability to engage in sexual intercourse

Impetigo: A streptococcal skin infection causing crusted erosions

Influenza : Acute infectious febrile disorder, cause by a virus
 Insecticides : Agents kill insects and related microorganisms

Insomnia : Sleeplessness

Intoxicant : Excites or stupifies poisons

Irritant : Agent which induces inflammation or irritation

Jaundice : Deposition of bile pigments in body

Lactagogue : Increasing milk secretion

Lactation : Formation and secretion of milk

Laxative : Smoothening rectal wall and loosening the stool

Leprosy : Chronic contagious diseases due to infection with Lepra

bacillus

Leucoderma : A skin condition characterized by defective whitish

pigmentation

Leucorrhoea : White fluid discharge from vagina

Laukaemia : A disease of blood with great increase in numbers of white

blood corpuscles

Lumbago : Muscular pain in the lumbar region

Malaria : Chronic fever caused by protozoa, *Plasmodium*, an acute

infectious epidemic disease

Measles: An acute viral infectious disease with fever and rash

Menorrhagia: Excessive menstrual flow

Menses: The monthly uterine bleeding of women

Migraine : A painful headache often accompanied by giddiness

Mumps : Virus infection which causes acute inflammation of parotid

glands

Myopia : An optical defect of near vision which prevents a clear focus

Narcotics : Tends to paralyze nervous system, producing systemic stupor

and death

Nausea : Causes sensation of sickness of stomach, which may or may

not proceed to emesis

Nervine : An agent that increases nerve strength

Nerualgia : Sudden severe pains radiating along the course of a nerve

Nerve sedative : Allays nervous excitement

Nerve stimulant: Increases nervous excitement and irritability (stimulates the

nerves)

Neuropathy: Diseases related to CNS (central nervous system)

Neurotic : A drug acts on central nervous system

Nutrient(Nutritive): Medicines included in tonic and stimulant
Odontralgics/Odontic: Relieves or reduces severity of toothache

Oedima : Inflammation

Ophthalmic: Pertaining to eye diseases like conjunctivitis

Opiate : Promotes sleep

Opthalmia : Severe inflammation of the conjunctiva of the eye
 Orchitis : Inflammation of testis with hypertrophy and pain
 Orthopedic : Relates to the correction of physical deformities

Ocytocic : A drug increases expulsive power of uterus and aids in

childbirth by stimulation of uterine contractions

Pactoral : Useful in diseases of respiratory tract
Panacea : It claimed to cure all or many diseases

Paralysis: Loss of the power of motion, sensation or function of any

part of the body

Paraplegia : Paralysis, loss of ability to move or feel in the lower part of

body

Parasiticide : Destroys parasites

Parturient: Parturifacient- Aids in child birth by inducing or accelerating

labour

Peptic ulcer: Ulceration in stomach or duodenum due to hyper acidity

Phlegm: Mucous secretion in respiratory track

Phthisis : Pulmonary tuberculosis

Piles : Enlarged or dilated blood vessels or veins in swollen tissues

of the anal canal

Pneumonia: Inflammation of the lungs, resulting the lungs becoming solid

Post-natal : After child birth

Prophylactic: Prevents diseases (Quinine)

Pruritus : Skin itching
Ptalagogue : Silagogue

Pulmonary: Pertaining to lungs

Pulmonary-sedative: A drug which reduces coughing by relieving irritation

Pungent : Agent has a sharp and acrid taste

Purgative: Loosening stool to help exersion, thus curing Constipation

Pustulants: Produces pustules (pus containing lesions) usually for

purposes of counter-irritation

Pyorrhoea : A purulent discharge from gums

Rabies : A fatal virus disease passed on to man by the bite of infected

animal

Refrigerant : Cooling effect

Rejuvinative : Antiageing, prolonging life

Relaxant: Reduces tension or strain of tissue, organ, system

Remittent fever : A fever which has the daily variation of 2°F but never falls to

normal

Renal depressant: Decreases or suspends flow of urine by reducing kidney action

Resolvant : Causing resolution of a tumor or swelling

Respiratory sedative: Respiratory depressant- Decreases force or slows rate of

respiration

Respiratorystimulant: Increases or accelerates force or frequency of respiration

Restorative: Resumptive-Renews strength and vigour

Revulsant/Revulsive: Acts as a derivative or counter-irritant, when applied locally

Rheumatism: A general term used for disease of muscle, joint, bone resulting

in discomfort.

Rickets: A vitamin-D deficiency disease of bones of children, marked

by faulty ossification

Ringworm : A contagious disease produced by fungi that affects skin, hair

or nails

Rubifacient: Producing counter effect on external application

Scabies : A contagious disease of skin caused by the mite Sarcoptes scabi

Sciatica : Neuralgic pain along the course of sciatic nerve

Sclerosis: Hardening of soft tissue resulting from overgrowth of fibrous

tissues

Scrofula: Tubercular cervical adenitis, with or without ulceration

Scurvy: A vitamin-C deficiency disease, causing extreme weakness

and spongy gums

Sedative : Central nervous system depressant in which a person is made

calm or asleep

Sialagogue : Increases salivation by stimulating secretion and flow of saliva

Simple Purgative: Causes active purgation without inflammation or depression

Small pox : An eruptive contagious disease marked by chills, high fever,

and headache

Somnifacient: Hypnotic; which produces sleep without delirium

Soporific : Drug that induces sleep

Sorbefacient: Produces or aids or promotes or facilitates absorption of

exudates

Spasmodic : Pertaining to spasms

Specific : Has direct curative or prophylactic influence on certain

individual diseases

Sprain : To wrench or tear a ligament or muscle of a joint without

dislocating joint or fracture of the bones

Sternutatory: Errhine; which causes sneezing

Stimulant: Increases or augments normal functional activity or specific

portions of body; as intestinal, cardiac and respiratory

Stomachic : A drug used for improving digestion

Styptic : Blood purifier

Sudorific/Diaphoretic: Induces profuse sweating

Synergist : Aids the action of another drug in one way or another
 Syphilis : A venereal disease caused by Treponema pallidum

Taeniacide: Drug that kills tapeworms

Tatanus: An infectious disease caused by the *Bacillus clostridium tetani*

Thermogenic: Producing heat offer metabolism

Thrombosis: A blockage preventing the flow of blood in the body caused

by clot

Tonic: Improves or increase general bodily tone and vitality;

restoring strength and energy

Tonsilitis : Inflammation of the tonsils

Tranquilizer: A drug used to calm a person and reduce mental activity

Tuberculosis: An infectious disease caused by the *Tuberculi bacillus*

Tumor : An abnormal swelling of the body

Tympanitis: Swelling in tympanum

Typhoid: Infectious disease caused by bacteria, it causes fever and

intestinal disorders

Ulcer : Any open sore other than a wound

Urticaria : Nettle rashes on skin

Uterine sedative: Reduces hypermotility of uterus, hence prevents or tends to

prevent miscarriage

Vaso-constrictor: Medicine that causes diminution or constriction of lumen of

small blood vessels

Vaso-dilators: Produces dilatation of the peripheral vessels, and the

arterioles, lowers the blood pressure, and thus relieves the heart, increase circulation and equalize blood pressure; used

to relieve internal congestion

Venereal : Sexual diseases

Vermicide : Agent the kills intestinal worms

Vermifuge : Expelling or destroying intestinal worms

Vertigo : Dizziness, a feeling of spinning

Vesicant: Irritates skin sufficiently to cause watery blisters or vesicles

to form

Vulnerary : A healing agent for wounds

Whooping cough: Cough with a peculiar whooping sound

Zomotherapy: Involves treatment of disease by administration of raw meat

diet, muscle plasma, meat juice etc.

DICINALA

Traceability of raw materials to their source is one of the biggest quality concerns impacting herbal products. This coupled with the need for reducing pressure on wild sources of medicinal plants, has prompted the need for cultivation of medicinal plants outside wild habitats. The first step for this to become a reality on a big scale, is to develop and disseminate suitable agricultural practices for each species which currently is a big gap.

The present publication is an attempt to bridge this gap as it lays down agro-techniques for 32 important species. The work is a result of painstaking efforts of scientists from various R&D institutions and universities who have dedicated their time and effort towards standardizing these techniques.

It is hoped that farmers, students, teachers, R&D institutions and the general public will find this publication useful.



National Medicinal Plants Board

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