Digitalis purpurea Linn.

Syn. Digitalis alba Schrank.



Ayurvedic/Unani name	**Hritpatri**
Hindi name	**Tilpushpi**
Trade name	**Tilpushpi, Tilmohar**
Family	**Plantaginaceae**
Parts used	**Leaves**
Threat status	**Not evaluated**

THERAPEUTIC USES:

Digitalis purpurea commonly known as Foxglove is a potent cardiac stimulant widely recognized in modern medicine for its cardiotonic, diuretic, and sedative properties. It is primarily used in the treatment of congestive heart failure, atrial fibrillation, and certain cardiac arrhythmias due to its rich content of cardiac glycosides, particularly digoxin and digitoxin. It has been widely recognized due to its cardiovascular, cytotoxic, anti-diabetic, antioxidant, insecticidal, immunological and cardio protective effects. Traditionally used in treatment of asthma, epilepsy, tuberculosis, constipation, headache, spasm, healing wounds and burns.



MORPHOLOGICAL CHARACTERISTICS

Digitalis purpurea is a herbaceous plant that usually follows a biennial growth pattern, though it may occasionally persist as a short-lived perennial under certain environmental conditions. The mature plant varies from 1 to 2 meters, making it a relatively tall species among herbaceous flora. In its first year, it yields a basal rosette of dark green, hairy, oblong to lanceolate leaves. It has a tall, unbranched, tomentose stem with largely crenate alternating leaves in its second year.

FLORAL BIOLOGY:

The tubular, bell-shaped flowers on its long, hanging terminal racemes are usually purple with maroon patches inside, though there are variations that are pink, white, or carmine red. The zygomorphic, bilabiate blooms have a superior ovary, five sepals, and four stamens (two long, two short). The fruit is described as a capsule with two valves, bearing glandular structures and covered in hairs. This plant is biennial so it grows leaves in the first year and flowers in the second year in the months of May-July followed by fruiting in the months of July-September

DISTRIBUTION

Digitalis purpurea is distributed across Western, South-Western, and West-Central regions of Europe. In India, this species is found between an elevation of 1600-2500 meters above mean sea level in Kashmir, Nilgiri Hills and Darjeeling.

CLIMATE AND SOIL

This plant is very hardy, prefers slightly acidic, well drained and humus-rich moist soil, it can easily survive in droughts. Ideal climatic conditions for growing foxglove are partial shade, cool, mild temperature (20-30°C). It comes up well in hilly slopes at an elevation of 1250 m and above. It requires moderate and evenly distributed precipitation for its optimal growth.

PROPAGATION MATERIAL

Digitalis purpurea is propagated by seeds, by direct sowing in the field or by seedlings transplant from nursery. Vegetative propagation is not the method of choice for reproduction. However, certain vegetative propagation methods like division of roots and stem cuttings can be used in controlled or research settings.





AGRO-TECHNIQUES

Nursery technique

·**Pre-sowing treatment:** The seeds of *Digitalis purpurea* do not require stratification or soaking. Since the seed are light and small in size and are mixed with sand for sowing. The seeds mixed with soil are sown in nursery beds during March-April. Sowing of seeds on moist, well-drained soil is ideal since they require light for germination.

·**Propagule rate:** About 1-1.5 kg seeds are required to raise about 82000 seedlings with 10% mortality allowance, for planting 1 hectare of land.



PLANTING IN THE FIELD

•**Land preparation and fertilizer application:** Field should be well prepared with 2-3 ploughing to loosen the soil. After this a well decomposed farmyard manure at the rate of 20 tons per hectare in two split doses: 2 weeks before sowing and at the time of transplanting is recommended. NPK (nitrogen, phosphorus, potassium) @100 kg, 75 kg, and 50 kg per hectare, respectively, may be applied to the field to achieve optimum growth and high leaf biomass yield in *Digitalis purpurea.*

•**Transplanting and optimum spacing:** Transplanting is done during August – September with spacing of 45cm x 30cm. 74000 plants are required to plant 1 hectare of land.

•**Intercropping system:** This species is primarily grown as a monocrop.

•**Intercultural and maintenance practices:** Weeding must be done every week in the initial stage. Before flowering starts (early spring), removal of any perennial or invasive weeds that may compete with seedlings or young plants is crucial for good establishment. Hand-pulling or cutting weeds below the height of the foxglove plants will help prevent weeds from competing for nutrients, moisture, and space. Avoid heavy soil disturbance near established the crop, as disturbance can promote weed germination and spread. Light and frequent irrigation is necessary since the plant requires moist and well-drained soil but waterlogging must be avoided.

•**Disease and pest control:** *Digitalis purpurea* in Jammu and Kashmir faces common fungal diseases such as Downy mildew (*Peronospora digitalidis*), Damping off (*Fusarium solani*), and Anthracnose (*Colletotrichum* spp), *Mucor mucedo* which thrive in cool and moist conditions typical of the region's climate. Insect pests like aphids and mealy bugs that feed on sap also affect this plant, causing weakening and distortion of leaves. Control measures: Maintenance of proper plant spacing for good air circulation, improving sanitation by removing infected or fallen leaves, avoid overhead irrigation to reduce leaf wetness, and by application of balanced fertilization to strengthen plant resistance is essential. Using of fungicides and insecticides are recommended in severe cases. Fungicide sprays of Carbendazim 50% WP @ 0.1% (1 g/L water), Copper oxychloride 50% WP @ 0.3% (3 g/L water) every 10–15 days in humid/rainy season are recommended and insecticide sprays of Imidacloprid 17.8% SL @ 0.3 ml/L at 15-day intervals or based on pest incidence is advisable.

HARVEST MANAGEMENT:

•**Crop maturity and harvesting:** The plant is harvestable after about 2 years and the leaves are harvested between July and August.

•**Post-harvest management:** The collected leaves are immediately brought to drying centre and dried in vacuum dryer at a temperature between 45-55°C till the moisture is not more than 5% to prevent hydrolysis of cardiac glycosides resulting in loss of its activity.

•**Chemical constituents:** The leaves of *Digitalis purpurea* contained cardiac glycosides, volatile oil, fatty matter, starch, gum and sugars. The cardiac glycosides found were digitoxin, digoxin, ouabain, oleandrin and proscillaridin.

YIELD AND COST OF CULTIVATION:

·**Yield:** 1800-2200 kg/ha (dry weight)
·**Average market price:** Rs 350-500/kg
·**Approximate cost of cultivation:** Rs 100000/ha
·**Approximate returns after 2 years:** Rs 500000-650000
·**Market demand:** 50-70 Matric Tonnes per annum





Dolomiaea costus (Falc.) Kasana and A.K. Pandey

Syn. Saussurea costus (Falc.) Lipsch.
Saussurea lappa C.B. Clarke



Ayurvedic/Unani name	**Kushtha**
Hindi name	**Kuth**
Trade name	**Kuth, Costus, Kushtha**
Family	**Asteraceae**
Parts used	**Roots/Rhizomes**
Threat status	**Critically endangered**

THERAPEUTIC USES:

Kuth is a well-known medicinal plant widely used in traditional system of medicine like Ayurveda, Unani, Siddha and Chinese medicine for treating ailments such as cholera, cold and cough, rheumatism and chronic skin ailments. Kuth roots have been extensively used in traditional medicine system for treating a variety of ailments like asthma, bronchitis and cough as well as gastrointestinal issues like indigestion and ulcers. It has a broad spectrum of biological activities such as anti-microbial, anti-inflammatory, antioxidant, hepatoprotective and anticancer.



MORPHOLOGICAL CHARACTERISTICS

Dolomiaea costus is a robust perennial herb, covered with short, soft hairs with a stem reaching 1-2 meters in height. The plant produces a strong central stem, lyrate leaves and crown of purple florets. The basal leaves are large (0.5 to 1.25 m) membranous, irregularly toothed edges and rough on upper surface. The upper leaves are small and mostly sub-sessile. The roots are 7-15cm in length and 1.5-5cm in width. They are typically fusiform or conical and tapering, often showing central collapse.

FLORAL BIOLOGY:

The flower heads are hard and round covered with purple bracts, measuring approximately 2.4 to 3.9 cm in diameter and are nearly bluish-purple to black in colour. They typically appear in clusters of 2-5 either in leaf axils or at terminal positions. The bracts are ovate-lanceolate, sharply pointed, purple, rigid and glabrous. The receptacle bristles are notably long. The corolla is tubular about 20cm in length and varies from purple blue to black and anthers possess fimbriate tails. The pappus in brown, double and feathery. Fruits are curved, hairy, compressed and cupped. The plant usually flowers from July-August, with fruiting (seed ripening) occurring from August-September.

DISTRIBUTION

This species is endemic to Himalayan region and is particularly found in alpine and sub-alpine zones of Jammu and Kashmir, Himachal Pradesh and Uttarakhand in India between altitudes from 2000-3900 meters.

CLIMATE AND SOIL

The conditions of cold, temperate to sub alpine and alpine at high altitudes are considered ideal conditions for its growth. Sandy loam or alluvial soil, well drained, partial shade are preferable for the crop and thrives well in neutral to slightly acidic soil pH.

PROPAGATION MATERIAL

Dolomiaea costus is mainly propagated by seeds or rhizome cuttings.





AGRO-TECHNIQUES

1.**Nursery technique**:

·**Pre-sowing treatment:** Stratifying (chilling) seeds at low temperatures is highly effective. The best results are achieved with chilling for 50 days, yielding up to 82% germination. Shorter periods (30–40 days) are also beneficial but less effective compared to a full 50-day stratification period. The seeds of *Dolomiaea costus* usually begin germinating within 7–12 days after sowing. The recommended seed rate for the species is 6.5-7.5 kg/ha.

·**Propagation by rhizome cutting.** *Dolomiaea costus* is mainly propagated through rhizome cuttings. Healthy 2–3-year-old stout rootstocks are uprooted during March–April and cut into pieces, each containing a viable terminal bud. The field should be well prepared by thorough ploughing and incorporation of well-decomposed farmyard manure, and the root pieces should be planted horizontally at a depth of 3–7 cm with proper spacing (60 × 60 cm). Since each mother plant provides a limited number of planting pieces, 2–3 multiplication cycles are generally sufficient to raise propagules for one hectare. This method allows farmers to gradually expand cultivation using their own planting material, ensures good field establishment and uniform crop stand, and supports sustainable and productive cultivation of *Dolomiaea costus.*



PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** The land undergoes deep ploughing to loosen the soil and ensure good aeration. Adding of NPK shows good results in growth, root and essential oil yield profile of *Dolomiaea costus*. The doses comprising NPK @ (90:40:20) respectively exhibited increased root yield by 108.9%, and essential oil yield increased by 210.3%. The fertilizer is typically applied partly at transplanting (one-third of N along with full P and K) with the remaining nitrogen is supplied in split doses after transplanting.

·**Transplanting and optimum spacing:** The ideal time for transplantation is generally between April to May in temperate climate at a spacing of 60 x 60 cm apart. 27000 plants are required for 1 hectare of land.

·**Intercropping system:** No formal or widely recognized intercropping system is recommended specifically for *Dolomiaea costus.*

·**Intercultural and maintenance practices:** Regular weeding is essential, especially during the first year, as young plants are easily suppressed by weeds. Frequency: 2–3 weeding in the first growing season, then as needed. Hoeing helps in aeration and loosening of soil for better rhizome growth. The crop requires 5-6 irrigations between May-September. The land is irrigated when seeds are sprouting. Avoid water-logging as it causes root rot.

·**Disease and pest control:** Generally pest-free; fungal rot in poorly drained soils. Application of *Trichoderma spp.* and ensuring proper drainage is helpful to avoid fungal root rot.

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** The crop is usually harvestable in about 2-3 years, when mature roots are developed. However, good yield is obtained from a 3 years old crop. Root is harvested in early September to October or early spring.

·**Post-harvest management:** After harvesting, the rhizomes are dried to preserve their bioactive compounds. Shade drying is preferred for maintaining volatile oil content and medicinal properties. Kept in cool, dry, and well-ventilated place and should be store away from direct sunlight. Rhizomes can be powdered or steam-distilled to obtain costus oil. Powder is packed in airtight containers to preserve aroma and bioactive compounds.

·**Chemical constituents:** *Dolomiaea costus* is rich in costunolide (1.0%), dehydrocostus lactone (0.25-1.4%), palmitic acid (~4.2%), linoleic acid (~4.16%), β-cyclocostunolide (1.7%), alantolactone (~1.63 %), and costic acid, β-cyclocostunolide, isoalantolactone, iso-zaluzanin C, Caryophyllene, saussureamines, beta-sitosterol, chlorogenic acid, guianolides present in trace amount.

YIELD AND COST OF CULTIVATION:

·**Yield:** 2.5-3 t/ha (dry roots)
·**Average market price:** Rs. 300-500/kg
·**Approximate cost of cultivation:** Rs.150,000/ha
·**Approximate returns after 2-3 years:** Rs. 700000-850000/ha
·**Market demand:** 100-200 metric tonnes per annum.





Inula racemosa Hook. F.

Syn. Inula royleana C.B. Clarke.



Ayurvedic/Unani name	**Pushkaramul, Poshkar**
Hindi name	**Pushkarmul, Pohakarmul**
Trade name	**Pushkarmool**
Family	**Asteraceae**
Parts used	**Roots, Rhizomes**
Threat status	**Critically endangered**

THERAPEUTIC USES:

Puskarmool is an aromatic tonic, febrifuge, and expectorant widely used in traditional medicine for its anti-inflammatory, anti-spasmodic, anti-asthmatic, carminative, diuretic, antiseptic and digestive properties along with use in veterinary medicine. The plant is also used in chronic bronchitis, rheumatism, loss of appetite, stomach troubles, spleen and liver disorder.

MORPHOLOGICAL CHARACTERISTICS

The species is a perennial herb growing up to 1.75 m tall with fragrant prominent root and rootstock. Stems are many in number, ascending from the base of the rootstock. Leaves are leathery, rough above and densely hairy below, 25–50 cm long and 10–12 cm broad, and elliptic– lanceolate in shape.

FLORAL BIOLOGY:

Flower heads are solitary, terminal, yellow in colour, clustered in corymbs or panicles, presenting heterogamous florets that can be radiate, disciform, or occasionally discoid, having bisexual florets and occur in terminal racemes. Disc florets are hermaphroditic, characterized by tubular yellow corollas with five lobes. The anthers exhibit caudate morphology, featuring branched sagittate tails with acute or obtuse apical appendices. Flowering occurs from June to September, while fruiting occurs in October-November. Fruits are slender and about 0.5cm long.

DISTRIBUTION

Inula racemosa is endemic to North-West Himalaya and its neighbouring areas. The plant grows in temperate areas of Kashmir, Himachal Pradesh, Uttarakhand from 1800-4200 meters above mean sea level.

CLIMATE AND SOIL

The conditions of temperate and sub-alpine regions are most suited for the cultivation of *Inula racemosa*. Well-drained, clay-loam soils are ideal for the crop and thrives well in slightly acidic to near neutral conditions. It prefers open and sunny locations.



PROPAGATION MATERIAL

Inula racemosa can be propagated by seeds as well as by divisions of rootstock. However, it is preferable to raise seedlings through seeds.





AGRO-TECHNIQUES

Nursery technique:

Pre-sowing treatment: Pre-sowing treatments such as cold stratification, acid scarification, and gibberellic acid (Ga_3) application are effective in breaking seed dormancy, resulting in germination up to 80%. Seeds germinate in 50 days when sown in spring or autumn in a cold frame (November or March) and are transplanted after 2 months after germination.

·**Propagule rate:** About 1 kg seeds are required to raise about 40,000 seedlings. About 74000 plants are required to raise 1 hectare of land.

·**Propagation through Roots:** *Inula racemosa* is propagated through root cuttings using healthy three-year-old rootstocks, which are uprooted during March–April and cut into 20–35 small pieces, each bearing a terminal bud. The field should be well ploughed and thoroughly mixed with well-decomposed farmyard manure before planting. The root pieces are planted horizontally at a depth of 3–7 cm, depending on their size. Although this method results in a high survival rate of up to 98%, cultivation of one hectare at a time using root cuttings requires a large quantity of mature rootstock, making the process labour-intensive and economically burdensome, especially where quality planting material is limited.



PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** The land is ploughed lightly in 2-3 rounds in order to loosen the soil. After this, well decomposed farmyard manure at the rate of 2.5 tonnes/ha is added to the soil.

·**Transplanting and optimum spacing:** Transplantation is recommended during spring season at an optimum spacing of 30 x 45 cm.

·**Intercropping system:** Puskarmool is preferred as a sole crop without intercropping.

·**Intercultural and maintenance practices:** NPK (nitrogen, phosphorus, potassium) @ 200 kg, 150 kg, and 50 kg per hectare, respectively, may be added to the field to achieve high biomass yield. Nitrogen is usually applied in two split doses, one as a basal dose and the other (100 kg/hectare) as top dressing in six to eight weeks after transplantation.

·**Irrigation practices:** Initially, frequent irrigation per week or 10 days is needed. In areas with greater slopes and steeper gradients, a controlled irrigation once in 10 to 14 days is advisable.

·**Weeding:** Regular weeding in the initial stages of crop establishment is necessary. Deep rooted sedges should be removed after irrigating the fields and weeding should be done once in 25 days.

·**Disease and pest control:** No serious incidence of disease or pest has been observed in this crop.

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** The crop is harvested after about one and-a-half years during October–November under temperate conditions. Roots are dug after wetting the soil. In case of seed propagated plants, the first harvest is taken during the third year.

·**Post-harvest management:** The roots are cleaned well and soil particles are removed. The harvested crop should be cut or sliced into small pieces, dried in shade and then stored in airtight containers.

·**Chemical constituents:** Roots of *I. racemosa* contain inulin (10.1%), roylene (3%), alantolactone and two major sesquiterpene lactones eudesmanolides i.e., alantolactone and isoalantolactone. Other active phytochemicals are inunolide (germacranolide), dihydroisoalantolactone, βsitosterol, D-mannitol, dihydroxinunolide, neoalantalactone, inunolide, sesquiterpene lactone, and alantodiene.

YIELD AND COST OF CULTIVATION:

·**Yield:** 2-4 tonnes/ha (dry weight)
·**Average market price dried roots:** Rs. 250-300/kg
·**Approximate cost of cultivation:** Rs. 120,000 per hectare.
·**Approximate returns after 3 years:** Rs. 500000-600000/ ha
·**Market demand:**





Lavandula angustifolia Mill

Syn. Lavandula officinalis Chaix



Ayurvedic/Unani name	**Khuzama**
Hindi name	**Neelgandha**
Trade name	**English Lavender**
Family	**Lamiaceae**
Parts used	**Flowers**
Threat status	**Least concern**

THERAPEUTIC USES:

Lavender oil is recognised for its various pharmacological activities, ranging from its effectiveness in reducing anxiety, stress, and pain through aromatherapy. It improves sleep quality, promotes wound healing, and possesses strong antimicrobial, anti-inflammatory, and antioxidant properties. In addition to these therapeutic benefits, lavender oil is widely used in cosmetics as a natural preservative and soothing ingredient in skin-care products. Lavender oil is also used as a natural insect repellent and is often incorporated into sachets, sprays and candles. Additionally, lavender flowers are used sparingly in culinary dishes, especially in desserts and teas, while their vibrant purple colour and fragrance make them popular in dried floral arrangements and potpourri.



MORPHOLOGICAL CHARACTERISTICS

An evergreen shrub with a much-branched woody stem, the green shoots thickly covered with evergreen, stalk-less, oblong lanceolate, entire, linear 2–6 cm long and 4-6 mm wide leaves, which at first are white-felted, later green.

FLORAL BIOLOGY:

The small, two- lipped flowers are arranged in spike-like terminal panicles often interrupted below. Flowers-in-vertices, emerging from the axil of a rhomboidal bract, individual blooms up to 5 mm long, 1 to 2 mm wide, violet to pale brown in colour, Calyx tubular, ribbed, fine toothed, pubescent, shiny oil glands visible among the hairs, corolla purple grey, tubular, two lipped, posterior lip has two lobes, and anterior lip has three lobes. Flowering occurs from the middle of June to ending July.

DISTRIBUTION

Lavender is a Mediterranean species, where it grows in the wild on the higher hills of Southern France, Italy and Bulgaria. Globally, it is cultivated in several countries due to its significant economic and therapeutic importance. In India, lavender was introduced experimentally in the Kashmir Valley in 1957. It is commercially cultivated in Chenab and Kashmir valley of Jammu and Kashmir, India.

CLIMATE AND SOIL

It is a mediterranean plant and does well in temperate areas having cold winters (snow bound) and moderately warm summers and it doesn't tolerate waterlogging. It is resistant to drought and frost. Light, well drained, dry, calcareous soils slightly alkaline with pH 6.7-7.3 are best suited. It grows very well on sloping lands, thereby checking soil erosion to a great extent.

PROPAGATION MATERIAL

This species is propagated through seeds and stem cuttings. Propagation through seeds is easy, quick and economical but is not preferred due to variation in the progeny compared to mother plants. Vegetative propagation is hence recommended method of mass multiplication to retain the desirable traits.





AGRO-TECHNIQUES

Nursery technique:

·**Pre-sowing treatment:** Stem cuttings treated with 1000ppm IBA for 10 minutes gives 95% rooting.

·**Seeds:** The seeds are sown in nursery-beds during autumn (November-December) at a depth of 1-2 cm. The seeds germinate after 4 weeks in spring (April). The seedlings are pruned periodically to avoid follicle formation and to achieve regular growth of the young plants. 0.5 Kg of seeds are required for 1 hectare of land.

.**Stem cuttings:** Cuttings of size 15-20 cm length are taken from one/two years old branch with apical dominant shoots. The cuttings are planted in the month of November-December or April – June at a distance of 5cmx5cm. The rooted cuttings are transplanted after one year during the month of November-December or April- June.



PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** Land is thoroughly prepared with ploughing and planking, incorporating well-rotted FYM. The crop responds well to inorganic fertilizers; the recommended NPK dose is 100:40:40 kg/ha. Apply 20 kg N, 40 kg P, and 40 kg K as basal in November–December. The remaining 80 kg N is applied in four equal splits during March, June, September, and November. In subsequent years, a 2% foliar spray of nitrogen is recommended in the same months.

·**Transplanting and optimum spacing:** Plantlets with well-developed roots and foliage are transplanted. The plantlets should be treated with 0.1% carbendazim solution before transplanting by root dipping for 15-30 minutes to protect them from soil borne diseases and are planted at a distance of 60 cm x 90 cm both row-row and plant- plant. About 20,500 plants are required to plant one hectare area with 10% mortality allowance.

·**Intercropping system:** Lavender intercropping systems (with crops such as black mustard, chamomile, and various vegetables like tomatoes and beans) can increase yield, improve resource use efficiency, enhance essential oil quality, and support sustainable agro-ecological practices.

·**Intercultural and maintenance practices:** The plantation should be kept weed free. In small/hilly plantation manual weeding is done. Generally, 5-6weedings are required in a year especially during the rainy season. The number of weedings depends upon the infestation intensity. 5-6 hoeings are also necessary in a year to keep the soil loose and aerated. After 2nd year plant puts up enough canopy thereby suppress the weed growth.

·**Irrigation practices:** The crop is grown as rainfed in the hilly regions of Jammu and Kashmir. The crop needs irrigation immediately after transplanting and needs 1-2 irrigations at 15 days interval till establishment. The crop also needs irrigation during the dry period of summer months.

·**Disease and pest control:**

No significant pest or disease was observed on this species in Kashmir.

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** Lavender yields its first substantial harvest after three years. Flowers are manually harvested at full bloom with stem lengths not exceeding 12 cm, beginning at 50–60% blossom and continuing through peak flowering. Major flowering occurs in June–July (70–80%) and a secondary flush in October (20–30%). Harvesting should be done in early mornings on bright sunny days, avoiding cold, cloudy, or foggy conditions.

·**Post-harvest management:** Harvested lavender flowers should be distilled immediately. Steam distillation is preferred for essential oil extraction, as hydro-distillation may degrade esters. Hydro-steam distillation offers a cost-effective alternative, avoiding direct contact between raw material and boiler. Each batch of 50–100 kg requires 2.5 to 3.5 hours for distillation. Oils should be stored in amber glass bottles or aluminium containers to prevent degradation from light and heat. Spike bunches should be shade-dried in a well-ventilated room. Once dried, flowers detach easily from the stem. Freshly detached flowers may be spread in thin layers for drying. Dried flowers should be packed in breathable materials like muslin or paper for small quantities, and vacuum-sealed or moisture-resistant packaging for bulk storage. Both dried flowers and essential oils must be stored in a cool, dry, and dark environment to preserve quality and extend shelf life

Chemical constituents: Linalool (25.27%) and Linalyl acetate (44.98%) are two major compounds in the essential oil of *Lavandula angustifolia.* Other prominent but less abundant compounds include 1,8- cineole, camphor, α- terpineol, lavandulol, nerol, β-caryophyllene and borneol.

YIELD AND COST OF CULTIVATION:

·**Yield:** 3000-5000 kg/ ha (dry weight)
·**Essential oil yield:** 30-40 kg /hectare
·**Average market price of oil:** Rs. 5000-8000/kg
·**Average market price of dried flowers:** Rs. 500-800/kg
·**Average cost of cultivation:** Rs. 115000/ha
·**Approximate returns after 3 years:** Rs. 4.5 lakh-5.5 lakh/ha
·**Market demand:** 70-80 metric tonnes per annum





Matricaria chamomilla Linn.

Syn. Matricaria recutita L. Rauschert



Ayurvedic/Unani name	**Babunah**
Hindi name	**BabunekaPhal**
Trade name	**Chamomile, Babunah**
Family	**Asteraceae**
Parts used	**Flower**
Threat status	**Least concern**

THERAPEUTIC USES:

Chamomile essential oil is widely used for its anti-inflammatory, antiulcerogenic, antibacterial, antiseptic, antispasmodic, sedative, immunomodulatory and wound-healing properties. It has been used traditionally in several countries to cure a number of diseases, including gastrointestinal disorders, common cold, liver disorders, neuropsychiatric and respiratory problems.

MORPHOLOGICAL CHARACTERISTICS

Matricaria chamomilla is an annual herb that grows 10–80 cm tall with slender, branched, slightly grooved, pale green upright stems. The leaves are long and narrow, alternate, feathery, sparsely arranged with double- or triple-pinnate divisions that look almost like only the veins remain. Flowers are arranged in solitary capitula (flower heads) at the tips of branches and fruits are achenes: small, brown, one-seeded, slightly compressed, ~0.5–1 mm long. The roots are thin and spindle shaped.



FLORAL BIOLOGY:

The pedunculate flower heads ranges from 10 to 30 mm, which is supported by its slender, bi- to tripinnate leaves. The golden yellow tubular florets with 5 teeth are 1.5 to 2.5 mm long, always ending in a glandulous tube. The flowers have 11–27 white ray florets (6–11 mm long) grouped concentrically. The fruit is a yellowish-brown cypsela with 3–5 faint ribs. Flowering generally occurs from May to August, with flowers appearing in flushes over a 3-6week period, often starting in late February in some regions and peaking around March-April in North India. Seeds generally ripen from July to October, shortly after the flowering period ends.

DISTRIBUTION

Chamomile is native to temperate regions of Asia and Europe. Chamomile is distributed across various regions of India, with the main cultivation areas in northern states such as Jammu & Kashmir, Uttar Pradesh, Punjab, Himachal Pradesh, and Uttarakhand between an elevations of 1500-2500meters.

CLIMATE AND SOIL

Matricaria chamomilla prefers well-drained sandy loam to loamy soils with a slightly acidic to neutral pH of 5.6 to 7.5. It thrives in soils that are moderately fertile and rich in organic matter but not overly nitrogenous, as excessive fertility can reduce essential oil content. It can grow at temperatures ranging from 7 °C to 26 °C. The plant can withstand cold weather but grows better in full sun and requires long summer days and high temperatures for optimum essential oil yield.

PROPAGATION MATERIAL

Matricaria chamomilla is propagated by seeds and cuttings but propagation by seeds is more common and preferable.





AGRO-TECHNIQUES

1.**Nursery technique**:
.**Pre-sowing treatment:** Soaking of seeds in water for 8-12 hours prior to sowing showed enhanced germination. Germination typically occurs within 7–14 days.
·**Propagule rate:** 3.5 g/ha of seeds is required for 1 hectare of land for raising about 50,000-55,000 seedlings.

PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** Ploughing of field 2–3 times to achieve a fine tilth, followed by application of well decomposed Farmyard manure (FYM) @ 10 – 15 tons/ ha during the final ploughing is recommended.NPK (Nitrogen, Phosphorus, Potassium) @ 80 kg, 50 kg, 50 kg per hectare, respectively must be added to the field. Application of half of nitrogen and full dose of phosphorus and potassium as basal before sowing and remaining half of nitrogen applied at 30 days after sowing to promote flowering is ideal.
·**Transplanting and optimum spacing:** Sowing of seeds can be done twice a year (March-April and October-November). Transplanting is done after 28-30 days of sowing with 30 cm x 30 cm spacing. 112000 plants are required to raise 1 hectare of land.
·**Intercropping system:** Intercropping combinations include Chamomile with Celery (Apium graveolens), Ajwain (Trachyspermum ammi), Fennel (Foeniculum vulgare), and Sowa (Anethum graveolens) in a 1:1 ratio.
·**Intercultural and maintenance practices:** Weeding is necessary 3-4 times in the crop cycle. First weeding is usually done 15-20 days after germination. Mechanical weed control through hoeing and hand-pulling is effective, especially in smaller plots.
·**Irrigation practices:** Subsequent irrigations should be given at 15–20 day intervals, depending on weather and soil type. Ensure proper drainage, especially in heavy soils, to avoid waterlogging
·**Weeding:** First weeding is usually done 15–20 days after germination. 2–3 manual weedings at 20–25day intervals after sowing is necessary.
·**Disease and pest control:** Powdery mildew is the most common disease faced by Chamomile in nursery. Chamomile yellow virus caused severe crop damage and other reported disease include white rust. For pests, Black bean aphids (Aphis fabae) attack chamomile plants, feeding on sap and weakening the crop.
Control measures: Sprays of Benlate (0.1%) for fungal infections and fosfothion (0.2%) are used to manage aphid infestations.



HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** First harvest is ready in 60–75 days after sowing. Flowers are harvested when they are fully open and white ray florets are horizontal. Harvesting is usually done during dry, sunny mornings after dew has evaporated to ensure quality and reduce microbial growth.
·**Post-harvest management:** Flowers are subjected to steam or hydro distillation to extract chamomile essential oil. Steam distillation produced a higher yield and better quality oil compared to hydro-distillation and helps preserve heat-sensitive constituents like chamazulene, α-bisabolol, bisabolol oxides, which give chamomile oil its medicinal value. It is also more suitable for large-scale commercial extraction.
Chemical constituents: Terepenoids such as α-bisabololand bisabolol oxides (upto 50–70%), chamazulene (1–15%), and β-farnesene (10–15%) and apigenin (flavonoid) (~1%).

YIELD AND COST OF CULTIVATION:

·**Yield:** 1000-15000 kg/ha (dry weight)
·**Average cost of cultivation:** Rs. 200-300kg
·**Approximate market price:** Rs. 80000/ha
·**Approximate returns after 2-3 years:** Rs. 150000-200000/ha





Picrorhiza kurroa ex Royle Benth.

Syn. Picrorhiza lindleyana Wettst. and *Veronica lindleyana* Wall.



Ayurvedic/Unani name	**Kutki**
Hindi name	**Kutki, Katuka.**
Trade name	**Kutki**
Family	**Plantaginaceae**
Parts used	**Root/ Rhizomes**
Threat status	**Endangered**

THERAPEUTIC USES:

Picrorhiza kurroa is known for its numerous therapeutic virtues, traditionally, it has been used to treat a wide range of ailments, including asthma, arthritis, diabetes, diarrhoea, fever, gastrointestinal disorders, jaundice, urinary and respiratory problems. This species is best known for its hepatoprotective immunomodulatory, anti-inflammatory, antimicrobial, anticancer, antiasthmatic, and antidiabetic properties.



MORPHOLOGICAL CHARACTERISTICS

Picrorhiza kurroa is smaller in height upto (5-10 cm) and width of (0.5-1.2 cm) with stolons that are elongated, sturdy, and creeping type and are covered with withered leaf bases. The stem of this plant is small, weak, creeping, slightly hairy, leafy, and erect at the flowering end. Leaves are sharply serrate, almost radical, spathulate, and base narrowed with winged sheathing petiole. Rhizomes are cylindrical, irregularly curved, 2.5-12 cm long, 4-10 mm thick, tubular, little curved externally greyish brown in colour, jointed, and zigzag with jointed nodes. Roots are greyish brown, erect, 5-10 cm long, 0.3-1.0 mm wide having scales at distant interludes or the roots of this plant always feature transverse cracks and longitudinal wrinkles. The rhizomes and roots have a bitter taste but have a pleasant odour.

FLORAL BIOLOGY:

Flowers are very small and white or pale blue-purple coloured with dense terminal spikes. Depending upon the altitude, the flowering period varies from June to August. Seeds develop in the month of September and fruiting starts in October and November. Fruits are an ovoid capsule around 12 mm long being narrow at top, each plant contains 5–14 capsules, with each having 32-65 seeds.

DISTRIBUTION

This species is endemic to the Himalayas stretching from Kashmir to Sikkim, at an elevations between 3,000 and 5,000 meters. In India, it is found in the States of Jammu and Kashmir, Ladakh, Himachal Pradesh Uttarakhand, Sikkim and Arunachal Pradesh.

CLIMATE AND SOIL

The plant grows well in cool and moist climate. Sandy clay textured soil is the best for its growth. It requires porous soil layers, which facilitate the horizontal spreading of the rhizomes underneath, producing aerial sprouts from the nodes, and prefers a pH of 5.5 to 7.0. The plant prefers sufficiently moist and shaded locations but suffers heavy mortality during prolonged and intense rains.

PROPAGATION MATERIAL

It is propagated through rhizomes. The planting stock can initially be raised through seedlings. By cultivating seedlings at lower elevations in the winter and transplanting them at higher altitudes in the spring, the harvesting period can be shortened by few months. Propagation through stolon cuttings is also recommended for multiplication as well as for higher production within a short period of time.





AGRO-TECHNIQUES

Nursery technique

·**Pre-sowing treatment:** Nursery is raised in polybags, trays or mother beds during October–November by using rhizomes/stolons. Planting propagules must have two to three intact nodes for better establishment in the field. For better rooting, cuttings should be dipped in the solution of IBA or IAA for 4 hours. To maximize rooting percentage, the soil surface is covered with moss.

·**Propagule rate:** 1–1.5 kg seeds are required for raising saplings for 1 hectare of land

·**Propagation by cutting:** If beds are not ready or for off season plantation, cuttings can be kept in trenches with water dip treatment for 48 hours. Top segment is more suitable than middle or lower segment with 90% rooting after two to three weeks of plantation.



PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** The land should be tilled and made friable and porous by repeated ploughing in order to facilitate horizontal spreading of rhizomes, which produce aerial sprouts from the nodes. Field is left open for a week for solarisation. Forest leaf litter or well decomposed FYM (Farm Yard Manure) is mixed with the soil @ 6 tones/hectare at least 15 days before transplantation.

·**Plant transplanting and ideal spacing:** 112,000 plants are needed for transplantation, which is carried out at 30 cm × 30 cm interval.

·**Intercropping system:** Kutki grows well when interplanted with *Foeniculum vulgare, Solanum tuberosum* and *Digitalis purpurea* because these plants provide a favourable microclimate for greater growth by retaining moisture for longer periods and shade for Kutki.

·**Irrigation practices:** The field should be irrigated on alternate days during summer, while in winter irrigation is required only occasionally as per the need. Both seedlings and stolon cuttings need watering every 24 hours during the early developmental stage. In case of heavy rains, the plots should be drained by digging channels across the fields.

·**Weeding:** Manual weeding must be done place frequently at an interval of five to seven days during the first growing season. At later stages, weeding along with hoeing at an interval of one month is recommended.

·**Disease and pest control:** Plant is susceptible to powdery mildew at lower altitudes during early growth period (March–May), which can be controlled by spraying Topsin-M (thiophinate methyl 0.1%) about 15–20 days after initiation, followed by another spray after15 days. Leaf blight was also observed in *P. kurroa.* Symptoms observed were small, circular, brown necrotic spots on the abaxial and adaxial sides of the leaves. Lesions gradually increased in size and coalesced irregularly, resulting in withering, extensive drying, and shedding. The disease can be effectively managed by spraying Mancozeb (0.25%) or Carbendazim (0.1%) soon after the appearance of initial symptoms, followed by a second spray at 15-day intervals. Severely infected leaves should be removed and destroyed to reduce the spread.

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** This crop has a life cycle of three years. After the completion of flowering, the fruiting starts in August and continues up to September. The plant needs one year for complete maturity of the seed. The roots and rhizomes are manually harvested in September when the shoots or the aerial parts begin to wither and dry. Plants raised through stolon cuttings mature almost a year earlier than those raised from the seedlings. However, to get higher active contents, plants must be collected before flowering occurs.

·**Post-harvest management:** The roots and rhizomes should be dried in shade, and after proper drying, the material should be packed in polythene-lined jute bags to ensure protection from moisture.

·**Chemical constituents:** Roots of *P. kurroa* contain a mixture of two major C9- iridoid glycosides, i.e., Picroside I 1.90 % upto 5.18 % (6-O- trans cinnamoylcatalpol) and "Kutkoside" 2.18 % (10-O-vanilloylcatalpol) in the ratio of 1:2. Kutkin, kutkoside, picroside, II, III, IV, V, pikuroside, mussaenosidic acid, bartsioside and boschnaloside, cucurbitacins, apocynin, drosin, veronicoside, pikuroside, cucurbitacins, 4-hydroxy-3-methoxy acetophenone and phenolic compounds and some still unidentified substances.

YIELD AND COST OF CULTIVATION:

·**Yield:** 900-1100kg/ha (dry weight)
·**Average market price:** Rs. 700-800/kg
·**Approximate cost of cultivation:** Rs. 140000/ha
·**Approximate returns after 3 years:** Rs. 600000-700000/ha





Salvia rosmarinus Spenn.

Syn. Rosmarinus officinalis Linn.



Ayurvedic/Unani name	**Rujamari**
Hindi name	**Rusmari**
Trade name	**Rosemary**
Family	**Lamiaceae**
Parts used	**Leaves and Flowers**
Threat status	**Not Evaluated**

THERAPEUTIC USES:

Salvia rosmarinus, commonly known as rosemary, is widely used in both traditional and modern medicine, particularly for the management of diabetes and hypertension. It has long been valued as a natural remedy for a variety of health conditions and is recognized for its broad therapeutic relevance. Rosemary exhibits numerous pharmacological properties, including antifungal, antiviral, and antibacterial effects, along with anti-inflammatory and antioxidant activity. It is also known for its antitumor, antithrombotic, antinociceptive, antidepressant, and anti-ulcer potential, highlighting its importance as a medicinal plant.



MORPHOLOGICAL CHARACTERISTICS

Rosemary is an evergreen, woody, perennial plant with fragrant, green grey needle like leaves. It has indistinctly quadrangular stem, finely grey pubescent. Leaves are 2-4 cm long and 2-4 mm broad, opposite, sessile, linear, tufted on the branches, leathery, glossy in appearance. Inflorescences are small cluster in nature situated towards the ends of branches. The branches are 28-30 cm in length.

FLORAL BIOLOGY:

Flowers of rosemary are opposite, soft to medium blue or lavender-blue, in colour, but some varieties have white or pinkish flower coloration. The sepal is bell-shaped, with two lips. The crown is faintly blue, with two lips; the upper lip is deeply bilobed, and the lower lip is broad, middle and has 2 thin lateral lobes. Flowers are hermaphrodite and are pollinated by bees. The flowering phase begins by the end of July and lasts for 28-30 days.

DISTRIBUTION

Rosemary originated from the Mediterranean region, and is cultivated in Europe. It grows in many parts of the world such as Algeria, China, Middle East, Morocco, Russia, Romania, Serbia, Tunisia, Turkey, and India.





CLIMATE AND SOIL

The rosemary plant prefers a hot climate and slightly alkaline, light dry soil, very heavy soil is not suitable. The plants become smaller but are more fragrant when grown on chalky soils. Soil with pH 5.5 to 7 with good drainage facilities is suitable for rosemary.

PROPAGATION MATERIAL

Propagation of rosemary can be done by seed and cuttings. For cultivation and commercial purposes, vegetative propagation is preferred because seed germination is slow.

AGRO-TECHNIQUES

Nursery technique

·**Propagation by cutting:** 15-20 cm long cutting is directly planted into the soil. Rooting starts after 3-4 weeks.

·**Propagation by seed:** Can be propagated from seeds, but it is generally slow and lower germination rates compared to cuttings.

·**Propagule rate:** 20500 cuttings required for 1 hectare of land with 10% mortality allowance.

PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** Apply FYM at 15-20 t/ha and 20:40:40 kg NPK per/ha for medium- fertile soil.

·**Transplanting and optimum spacing:** After 3 months, well-established seedlings are transplanted in the main field. The seedlings are planted in the field at an optimum spacing of 60x90 cm.

·**Intercropping system:** Rosemary is successfully intercropped with sweet pepper, which in turn significantly reduces the population density of major pest species.

·**Interculture and maintenance practices:** Mulching with organic materials such as straw, dry leaves, or farmyard manure helps in conserving soil moisture and suppress weed growth.

·**Irrigation practices:** It is irrigated twice a week during establishment and once in a week after being established.

·**Weeding:** The first weeding should occur approximately within one month after transplanting. Generally2- 5 weeding per year are necessary to maintain the crop health.

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** Harvesting commence at the time of 50% blooming and continues till 75-90 % inflorescence emergence. Annually 2-3 harvests are taken after 3 years of growth of rosemary.

·**Post-harvest management:** After harvesting, rosemary is handled with care to preserve its essential oil content and aromatic quality. The harvested shoots are best dried under shade in a well-ventilated area at moderate temperatures (30–40 °C).

·**Chemical constituents:** The major constituents of *S. rosmarinus* oil identified are α-pinene (16.33%), 1, 8-cineole (14.33%), camphor (22.01%), camphene (9.28%), β-pinene (5.97%), β-phellandrene (5.19%), bornyl acetate (4.59%), myrcene (4.31%), borneol (3.35%), β-caryophyllene (2.88%), verbenone (1.39%), linalool (1.16%), terpinen-4-ol (1.11%), α-terpineol (1.02%) and γ-terpinene (1.04%%).

YIELD AND COST OF CULTIVATION:

·**Yield:** 2500-3000 kg/ha (dry weight)

·**Oil yield:** 8-12 litres/ha/annum

·**Average market price:** Rs. 200-300/kg of dried leaves.

·**Approximate cost of cultivation:** Rs. 130000/ha

·**Approximate returns after 3 years:** Rs. 500000-600000/ha

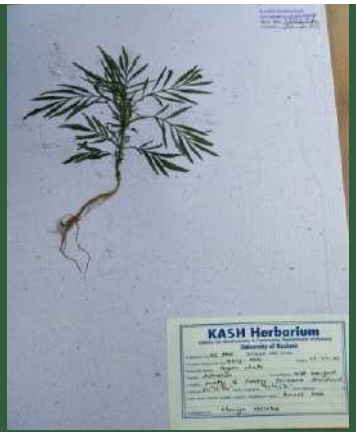






Tagetes minuta Linn.

Syn. Tagetes glandulifera Schrank



Ayurvedic/Unani name	**Not used**
Hindi name	**JangliGainda**
Trade name	**Tagetes, Wild marigold**
Family	**Asteraceae**
Parts used	**Flowers, Leaves**
Threat status	**Least concern**

THERAPEUTIC USES:

Tagetes minuta L. is widely recognized for its medicinal and industrial applications. The essential oil (EO) is used as an insecticide, nematicide, and for its antimicrobial, acaricidal and allelopathic activities. Traditionally, this plant is used for treating diverse ailments, including digestive issues, respiratory problems, and skin conditions. Its oil is used as flavouring agent in various products such as alcoholic beverages, mayonnaise, cola, candy, margarine, puddings, frozen-dairy desserts, vegetable oil, condiments, gelatines, and baked foods.



MORPHOLOGICAL CHARACTERISTICS

The herb is erect, annual, hermaphrodite, and has compound leaves with narrow, serrated leaflets. Its green stem can reach a height of 1-2 meters. The leaves are opposite, pinnately compound, stalked, 7–15 cm long, and pinnately dissected into 4–6 pairs of pinnae. They are also slightly glossy green. The leaves have coarsely serrated margins and a lanceolate form. The taproots are often small and encircled by fibrous lateral roots that form mycorrhizal connections.

FLORAL BIOLOGY:

The floral biology of *Tagetes minuta* is characterized by its unique eleven-stage developmental cycle and a highly efficient often cross-pollinated breeding system. Each flower head (capitulum) is heterogamous, containing approximately 3–5 female ray florets with tiny cream-colored ligules and 3–15 bisexual disk florets. The species exhibits protandry, where pollen production begins early (stage 2) and peaks in viability by stage 6, well before the bilobed stigma matures and protrudes at stage 7. While pollination is primarily entomophilous, heavily reliant on bee activity, the plant's structure also suggests anemophilous (wind) potential. Successful fertilization results in the formation of dark, linear achenes equipped with a scaly pappus for dispersal.

DISTRIBUTION

Tagetes minuta L. is a native of South America, which includes Argentina, Chile, Bolivia, Peru, and Paraguay. In India, it grows naturally between 1000 and 2500 meters above sea level in the Western Himalaya. The primary growing locations where it occurs in its native habitat are the hills of Uttar Pradesh, Himachal Pradesh, and Jammu & Kashmir. In Jammu & Kashmir, *Tagetes minuta* is predominantly distributed at elevations between 1,250–2,500 m.

CLIMATE AND SOIL

Tagetes minuta can be cultivated in a wide range of soil types, including heavy clay, sandy, loamy, and porous soils, though it performs best in well-drained conditions. It requires at least 50 cm of rainfall distributed evenly throughout the growing season. Temperature ranges from 30-35 C is ideal. It is highly sensitive to frost.

PROPAGATION MATERIAL

Tagetes minuta L. is propagated by seeds. The plant can be multiplied by direct seeding or transplanting.





AGRO-TECHNIQUES

Nursery technique

·**Pre-sowing treatment:** Pre-sowing treatments such soaking seeds in distilled water at 25°C for 24 hours significantly improves germination.

·**Propagule rate:** For direct sowing, seeds are sown in the field during March–April and lightly covered with soil; about 1.5-2kg of seeds is sufficient for one ha of land.



PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** The field should be prepared with four ploughings and two plankings to achieve fine tilth. All plant residues must be removed to prevent pest and disease carryover. The land should then be levelled and divided into beds for efficient irrigation and field operations. During land preparation, 5–6 t/ha of well-decomposed FYM should be mixed into the soil to improve its structure, moisture-holding capacity, and beneficial microbial activity. For enhancing oil yield, a fertilizer dose of 120:60:60 kg/ha of nitrogen (N), phosphorus (P), and potassium (K) is recommended.

·**Transplanting and optimum spacing:** Although this method is slightly more expensive than direct sowing, but this approach ensures a more reliable and uniform crop yield. Seeds are sown in the nursery during ending March-1st week of April and it starts germinating within 10 days. Once the seedlings are large enough to handle (10-12 cm), they are transplanted into the field. The transplanting is usually done in May at a spacing of 45 × 30 cm (74000 plants per ha) for optimal growth.

·**Intercropping system:** Itis usually grown as a monocrop due to its competitive, allelopathic character. Intercropping with maize has shown compatible results in experimental systems but is not a routine practice.

·**Intercultural and maintenance practices:** During the initial 3–4 weeks, slow crop growth necessitates timely weeding to prevent nutrient competition. The first weeding is done one month after planting, followed by a second after 20–25 days; 2–3 sessions are required per season. Pinching at 50 cm height encourages branching and biomass. Well-prepared soils aid weed suppression, while poorly prepared soils demand thorough weeding to safeguard yield and oil quality.

·**Irrigation practices:** Maintaining adequate soil moisture is critical during germination and initial vegetative growth, while waterlogging must be strictly avoided through proper drainage management. The crop requires daily irrigation for 3-4 days after transplantation to ensure successful establishment, particularly in the absence of rainfall. Under dry weather conditions, 3-4 supplemental irrigations may be necessary during the early growth phase.

Disease and pest control: The crop showed no major insect-pest or disease issues in both mid-hill and high-hill zones. It is generally considered hardy, requiring minimal plant protection under normal field conditions

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** The above ground parts are harvested in the month of Oct-Nov after 4 months of transplantation, at the height two feet above ground level, leaving behind the lower stem without foliage.

·**Post-harvest management:** The fresh flowers and leaves are immediately subjected to hydro-distillation. Hydro Steam distillation is the preferred method for extracting essential oil. To retain oil quality, distillation should be carried out immediately after harvest or within one to two days.

The oil should be stored in cool and dry places away from direct sunlight. For small quantities, airtight glass bottles are suitable, whereas for bulk storage, containers fabricated from aluminium, galvanized iron (GI), or stainless steel are preferred. To minimize moisture-induced deterioration during storage, containers should be filled to full capacity, and anhydrous sodium sulphate should be incorporated @ 2 g per litre of oil.

Chemical constituents: The essential oil of *Tagetes minuta* L. contains main compounds such as cis-β-ocimene (56.34%), tagetenone (%), dihydrotagetone (28.07%), cis-tagetone (14.46%), and limonene (6.96%), along with other constituents like sabinene(0.24%), α-pinene oxide(0.33%), 3,4-dimethyl-2,4,6-octatriene, trans-tagetone, isopiperitenone, β-caryophyllene, elixene, spathulenol (3.13%), and caryophyllene oxide(0.14%).

YIELD AND COST OF CULTIVATION:

·**Yield:** 14-25 tonnes/ha (fresh weight)

·**Essential oil yield:** 30-60 kg/ha

·**Average market price of oil:** Rs. 4000-8000/Kg

·**Approximate cost of cultivation:** Rs. 80000/ha

·**Approximate returns after 4-6 months:** Rs.150000-300000/ha

·**Market demand:**





Thymus linearis Benth.

Syn. Thymus himalayicus Ronniger



Ayurvedic/Unani name	**Jangliajwain**
Hindi name	**Jangliajwain**
Trade name	**Himalayan thyme**
Family	**Lamiaceae**
Parts used	**Leaf and Flower**
Threat status	**Least concern**

THERAPEUTIC USES:

Thyme possesses an array of beneficial properties, including antiseptic, antibacterial, medicinal, astringent, anthelmintic, carminative and disinfecting qualities. Widely utilized as a culinary herb, it finds application in distilleries, cuisine, and perfumery. Thyme oils and extracts are widely used in pharmaceutical and cosmetic industry. It is used for flavouring chocolates, toothpastes, mouthwashes, cough medicines and preservation of several food products.

MORPHOLOGICAL CHARACTERISTICS

The plant features a tall stem with a sterile leaf rosette at its apex and a sturdy woody base. Characterized by an oval shape, the leaves are 4-6 mm in length and 2-4 mm in width, rounded at the top and tapering at the base. They exhibit a glabrous texture on both sides, adorned with long trichomes, a prominent central vein, and inconspicuous lateral veins near the base along the edge.

FLORAL BIOLOGY:

The 4-5 cm tall inflorescences are arranged in a row, enveloped in a uniform coating of trichomes. At the tip of the stem, flowers form spherical verticillaster. Flowering starts from April-September. The flowers are hermaphrodite and form whorls, that are often arranged in spikes, heads, racemes, or cymes.

DISTRIBUTION

Himalayan Thyme is found at an altitude of 1500-4300m on rocky slope in the Himalayas, extending its distribution to N.E. Afghanistan, N.W. Pakistan, Nepal, and Tajikistan.

CLIMATE AND SOIL

Welldrained, light loamy or calcareous soil with pH 6–7 is suitable for thyme. It prefers sunny, temperate climate. The wild thyme is known to thrive in meadows, open sandy heaths, and dry, stony terrain.

PROPAGATION MATERIAL

Thyme can be propagated through seeds and vegetatively. The optimal time of propagation is during spring. Sowing seeds in well-drained soil under full sun, with temperatures between 15-20°C (59-68°F), ensures successful germination and growth.







AGRO-TECHNIQUES

Nursery technique

·**Propagation through Seeds:** Seeds are sown in April in well prepared nursery beds. The germination occurs in 2–3 weeks and are transplanted once they are 5-6cm in height.

. **Seed rate:** 0.5 - 1 kg of seeds are required for 1 hectare of land.

·**Vegetative Propagation:** Healthy, non-flowering stems that are about 4-6 inches long are used.

.Pre-sowing treatment: Treatment of 200 ppm IBA + soil: sand:FYM (1:1:1) gives 91.9% rooting.

PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** 2–3 deep ploughings, followed by levelling is required to make the soil loose and well-aerated. FYM @ 50 t/ha is considered best for thyme.

·**Transplanting and optimum spacing:** Transplanting is done in weed free field with good drainage. Approximately 55,000 cuttings will be required for planting one hectare at an optimum spacing of 45cm x 45cm with 10% mortality allowance.

·**Intercultural and maintenance practices:** Mulching with organic materials such as dry leaves or farmyard manure helps in conserving soil moisture.

·**Irrigation practices:** Frequent irrigation is required during initial dry period for 1-1.5 months.

·**Weeding:** Regular weeding is required during early stages of establishment, to minimize competition for nutrients, moisture, and light.

·**Disease and pest management:** The plant is not damaged by any serious pest, but wilt disease is a major problem in this crop

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** The crop is harvested after 2 years to obtained the best yield. Harvesting starts from 3rd week of May to 2nd week of July, which yields maximum essential oil content.

·**Post-harvest management:** After harvesting, the aerial parts (leaves and flowers) are carefully handled to preserve the quality and yield of essential oil. The harvested material is dried in a well-ventilated and shaded area. Direct exposure to strong sunlight is avoided.

·**Chemical constituents:** Major components present in oils of thyme includes thymol (53.8–67.3%), terpinene (4.9–17.6%), p-cymene (4.0–5.5%), thymyl acetate (1.7–5.2%), bisabolene (3.2–5.1%), thymol methyl ether (2.8–3.6%), terpinene (0.7–2.6%), and (E)-caryophyllene (1.9–2.3%).

YIELD AND COST OF CULTIVATION:

·**Yield:** 3000-4300 kg /ha (dry weight)
·**Essential oil yield:** 50-60kg/ha
·**Average Market price:** Rs. 250-400/kg
·**Approximate cost of cultivation:** Rs. 110000/ha
·**Approximate returns after 2 years:** Rs. 600000-700000/ha
·







Valeriana jatamansi Jones.

Syn. Valeriana wallichii DC.



Ayurvedic/Unani name	**Tagar**
Hindi name	**Mushkbala**
Trade name	**Mushkbala, Tagar**
Family	**Valerianaceae**
Parts used	**Root/Rhizomes**
Threat status	**Endangered**

THERAPEUTIC USES:

Valeriana jatamansi is widely known for its insect repelling and antihelmethic properties. It possesses sedative, neurotoxic, cytotoxic, antidepressant, antipyretic, diuretic, antioxidant, and antimicrobial properties. Rhizomes and roots of tagar are used as hepatic and nervine tonic. It is used in epilepsy, hysteria, hypochondriasis, nervous unrest, skin diseases, ulcers, convulsions, jaundice, cardiac debility, dry cough, asthma and seminal weakness.



MORPHOLOGICAL CHARACTERISTICS

Valeriana jatamansi is an aromatic herb which grows up to 50 cm tall. Rootstock is thick, with 6–10 cm long fibrous roots knotted by uneven circular ridges. The plant has several stems, 15–45 cm long. Leaves are of two types, radical and cauline. Radical leaves are cordate–ovate, 2.5–8 cm, toothed or sinuate, long stalked, while cauline leaves are few, small, entire or lobulate.

FLORAL BIOLOGY:

Flowers are white or tinged, pink in colour and occur in flat-topped corymbose clusters on erect, nearly leafless peduncles. Flowers are unisexual. Corolla is funnel-shaped with five lobes. Fruits are crowned with a persistent pappus-like calyx. Flowering and fruiting occur in March–April. Seeds ripen in April–May.

DISTRIBUTION

The species is native to the Himalayan regions of India, Nepal and South-Western China. It is distributed abundantly in India from Kashmir to Assam. It is found at an elevation of 3000 meters a.s.l.

CLIMATE AND SOIL

The plant prefers a temperate climate and grows well in moist loamy soils having partial shades of trees like Deodar and oak. It can grow over a wide range of soils with pH 5-6. However, it thrives best in humus-rich, heavy loam soils, with adequate moisture and good drainage. The roots of the plant are sensitive to rotting.

PROPAGATION MATERIAL

Valeriana jatamansi is propagated by seeds, cuttings and rhizome divisions. Seeds are short-lived and loses viability quickly, therefore propagation through rhizome division is the most common method, as it ensures true-to-type plants and better survival.





AGRO-TECHNIQUES

Nursery technique

·**Propagation through seeds:** Seeds are sown during March-April in raised beds under partial shade conditions. As the seeds are small so they are sown on the surface of nursery beds and covered with thin layer of soil mixture (approx. 1cm). The seedlings are ready for transplanting after 3-4 months. About 2.5-3kg of seed is required to get the planting stock for propagating 1 ha area of land.

.Propagation through rhizome and apical shoots: *Valeriana jatamansi* can be propagated through both rhizome splitting and apical shoot–based methods; however, the efficiency of multiplication differs markedly between the two. Propagation through rhizome splits is relatively slow, producing about 17 plants per mother plant after three years of growth, whereas apical shoot propagation allows rapid multiplication, yielding an average of 22 apical shoots per plant within the first year. Starting with only 10 elite mother plants, nearly 80,000 rooted propagules can be produced in three multiplication cycles using apical shoots, which is sufficient for 1 ha at the recommended spacing of 30 × 45 cm for maximizing underground biomass. Raised plants through apical shoots show negligible mortality and ensure large-scale production of quality planting material, genetic uniformity, and consistent essential oil composition similar to the mother plant. In contrast, if one hectare is cultivated at a time using rhizomes, the large quantity of rhizomes required as planting material substantially increases the initial input cost, making rhizome-based cultivation economically burdensome compared to apical shoot propagation.



PLANTING IN THE FIELD

·**Land preparation and fertilizer application:** 2-3 rounds of ploughing is done to achieve a fine tilth. Prior to ploughing, FYM @ 10 tonnes/ha is recommended to enhance soil fertility and structure.

·**Transplanting and optimum spacing:** Rooted propagules are transplanted into field during June –July. Seedlings of height 8-10cm are selected for transplantation to ensure proper establishment.

·**Intercultural and maintenance:** Leaf mulching is employed for moisture conservation, temperature control and weed suppression and protection.

·**Irrigation practices:** Moderate amount of water is required for the optimal growth. Irrigation is necessary during the establishment phase (First 1-2 months post-planting).

·**Weeding:** Manual weeding is essential every 20-25 days during initial stages of field establishment.

HARVEST MANAGEMENT:

·**Crop maturity and harvesting:** The crop reaches physiological maturity after one year of planting. But for optimal harvesting, it is harvested after two years of cultivation period.

·**Post-harvesting:** The underground plant material (rhizomes and roots) is dried without overheating. The maximum preservation of the valepotriates is achieved when dried within the range of about 35–40°C. Dried rhizomes and roots are best stored in gunny bags/ bamboo baskets.

.Chemical constituents: Like most medicinal plants, its roots and rhizome are rich in medicinally important components, i.e., valepotriates. The underground part of this plant are exploited for the commercial production of Valerian. It also includes other bioactive constituents such as α -Pinene,3-methyl valeric acid, β -Pinene, p-cymene, Bornyl acetate, α-copaene, β-elemene, γ-Patchoulene etc.

YIELD AND COST OF CULTIVATION:

·**Yield:** 1700-2300kg/ha (dry weight)
·**Average market price of dried roots:** Rs 400-500/ kg
·**Approximate cost of cultivation:** Rs. 135,000/ha
·**Approximate returns after 2 years:** Rs. 650000-800000/ha
·**Market demand:** 1000-2000 metric tonnes per annum





Centre of Excellence on Herbal Technology
Division of Forest Products and Utilisation Faculty of Forestry (Benhama-Ganderbal) J&K Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir (SKUAST-K)

For Further Details Contact

Dr. P. A. Sofi

(Prof. & Head, Division of Forest Products and Utilization, FOF, SKUAST-K)

E: parvezsofi1@gmail.com

Dr. Peerzada Ishtiyak Ahmad

(Principal Investigator, Centre Of Excellence on Herbal Technology, FOF, SKUAST-K)

E: drishtiyak@skuastkashmir.ac.in








3rd Best State Agriculture University

7th Rank in Agriculture & Allied Sectors Category by National Institutional Ranking Framework-2025

36th Rank among all State Public Universities by National Institutional Ranking Framework-2025

75th Rank in University Category by National Institutional Ranking Framework-2025

94th Rank in Overall Category by National Institutional Ranking Framework-2025