# Integrated agro and process technology of Rose-scented geranium (*Pelargonium graveolens* L'Her.)

The genus *Pelargonium* encompasses 283 species, among which *Pelargonium graveolens* L'Her. is one of the most commercially significant species for essential oil production. *P. graveolens*, also referred to as rose-scented geranium, is a perennial aromatic bushy shrub (family Geraniaceae) cultivated throughout the world, particularly in China, Algeria, Russia, and India. The primary constituents of the commercial geranium oil are, geraniol, citronellol, isomenthone and linalool. The essential oil is used in pharmaceutical, flavor and cosmetic industries.

## Market potential

The annual demand for Rose-scented geranium essential oil is currently estimated at 600 MT and the market is expected to reach over USD 100 million by 2030, with a CAGR ranging between 4-8%.

## Salient features of CSIR-Technology

- Higher citronellol (45-50%), Geraniol (10-15%)
- Higher essential yield (55-60 kg/ha)
- Essential oil content (0.15-0.18%)
- Bourbon type cultivar

## Contribution of CSIR-IHBT

- Standardized agro and process technologies for mid hill conditions and higher rainfall areas.
- Quality planting material
- Organic and inorganic cultivation practices

# Improvement in Agrotechnology of Aromatic Marigold (*Tagetes minuta*)

*Tagetes minuta* L., commonly known as aromatic marigold, is an aromatic annual herb native to South America has become naturalized in the Himalayan and sub-Himalayan regions of India at elevations of 1000–2500 m. The essential oil extracted from the aerial parts of *T. minuta*, including leaves and flowers, is highly valued for its distinct aroma and beneficial properties. The major components are (*Z*)-*β*-ocimene, dihydrotagetone, (*Z*)&(*E*)tagetone, (*Z*)&(E) tagetenone, (*Z*) & (*E*) ocimenone. The essential oil, in high demand, is extensively utilized in the flavour and perfumery industries, particularly in high-grade perfumes and as a flavouring agent in products like ice creams, candies, liquors, puddings, and gelatins.

## Market potential

The global aromatic marigold essential oil market is experiencing steady growth, valued at approximately USD 203.85 million in 2025 and projected to reach USD 327.34 million by 2032, growing at a CAGR of 7.0%.

## Salient features of CSIR-Technology

- Higher biomass yield potential (150-175 q/ha)
- Higher essential oil content (0.35-40%)
- Higher (Z)-ß-ocimene (> 50%)

## Contribution of CSIR-IHBT

- Improved agronomic practices
- Organic and inorganic cultivation practices for higher biomass yield and essential oil content
- Training on agro and processing technology

# Organic nutrient Management in *Hypericum perforatum* L.

*Hypericum perforatum* L., commonly known as St. John's Wort, is an important medicinal plant widely used in temperate regions. Traditionally, its flowering aerial parts are utilized in herbal medicine to treat mild to moderate depression, anxiety, and inflammatory conditions. *H. perforatum* also exhibits antioxidant, wound-healing, and antiviral effects. The plant's bioactive compounds include hypericin, hyperforin, flavonoids, and tannins, which contribute to its pharmacological activities. In addition to traditional applications, extracts of *H. perforatum* are used in pharmaceutical preparations and nutraceuticals, and as a source for the development of novel therapeutic compounds.

## Market potential

*H. perforatum* extract market is expected to reach between USD 350 million by 2032-2033, growing at a Compound Annual Growth Rate (CAGR) of 6.5% to 6.8%.

## Salient features of CSIR-Technology

- Higher specialized metabolites, *viz.*, pseudohypericin, hypericin, and hyperforin.
- Higher *Hyperici herba* dry biomass yield (1.5-1.6 t/ha)

## Contribution of CSIR-IHBT

- Organic cultivation practices.
- Quality planting material
- Training in cultivation & processing

# Sugandhbala (*Valeriana jatamansi*): Integrated Nutrient Management

*Valeriana jatamansi* Jones (syn. *Valeriana wallichii* DC), commonly known as Indian valerian in English, Sugandhbala in Hindi, and Tagar in Sanskrit. It naturally occurs on moist slopes in the Himalayas and the Khasi Hills at elevations between 1000 and 3300 m. Traditionally, it has remained an important herb in the Ayurvedic and Unani systems of medicine since ancient times due to the bioactive metabolites and essential oil (EO). Globally, it is widely used to treat a variety of ailments and disorders, viz., insomnia, leprosy, depression, epilepsy, nervous debility, ulcer, hysteria, febrifuge, asthma, nerve diseases, cholera, cancer, Alzheimer's, and Parkinson's. The roots/rhizomes of *V. jatamansi* accumulate EO and valepotriates, which possess sedative properties.

## Market potential

The annual traded volume of Valeriana dry roots/rhizomes is estimated at 1000-2000 MT, with a market price of 300-500 per kilogram.
The price of EO in India is about Rs. 45000-50000 per kilogram.

## Salient features of CSIR-Technology

- Harvesting time for higher biomass is 9 months
- Yield potential of 13.5 t/ha (fresh below-ground biomass)
- Essential oil yield : > 25 L/ha
- Patchouli alcohol: > 60%

## Contribution of CSIR-IHBT

- Developed an Integrated Nutrient Management module
- Standardized harvesting time to reduced crop cycle

# Stevia (*Stevia rebaudiana*): Integrated Nutrient Management

*Stevia rebaudiana* Bertoni is a perennial herb belonging to the Asteraceae family and native to Northeastern Paraguay. It is commonly known as sweet (leaf, herb, and weed), sugar leaf, and honey leaf. Its leaves contain diterpenoid steviol glycosides (SGs). Steviol glycosides are sweet-tasting, non-toxic, and low- or non-caloric. The SGs accumulation in the leaf varies from 4 to 20% among the plants. To date, more than 60 different SG compounds have been quantified and identified in stevia leaves, but most of the SGs are in trace amounts. Nowadays, stevia is profitably cultivated as a commercial and industrial crop across a wide range of agroecological environments in Brazil, Canada, China, Indonesia, India, Japan, Korea, Mexico, Malaysia, Russia, Singapore, and the USA.

## Market potential

The global Stevia market is increasing rapidly, with projected growth from roughly USD 1.47 billion in 2025 to over USD 2.50 billion by 2035.

## Salient features of CSIR-Technology

- Yield potential of 3.0 t/ha (at first harvest)
- 50 % reduction of synthetic sources of NPK
- Steviol glycosides (SGs) are not adversely affected
- Improved soil health

## Contribution of CSIR-IHBT

- Developed an Integrated Nutrient Management module
- Optimized harvesting time for higher Reb-A

# Stevia-Bacopa Intercropping Model

*Stevia rebaudiana* Bertoni is a perennial herb belonging to the Asteraceae family and native to Northeastern Paraguay. It is commonly known as sweet (leaf, herb, and weed), sugar leaf, and honey leaf. Its leaves contain diterpenoid steviol glycosides (SGs). The SGs accumulation in the leaf varies from 4 to 20% among the plants. Nowadays, stevia is profitably cultivated as a commercial and industrial crop across a wide range of agroecological environments India. *Bacopa monnieri* (L.) Wettst. belongs to the family Plantaginaceae and is a perennial plant that grows in wet, marshy areas. *B. monnieri* is widely known as "tonic for the human brain" and is known to act as a brain rejuvenator.

## Market potential

Stevia: projected growth from roughly USD 1.47 billion in 2025 to over billion by 2035. Bacopa: market size valued at $435 million in 2024, projected to reach $1.12 billion by 2033

## Salient features of CSIR-Technology

- System yield potential: > 3.0 t/ha (stevia equivalent yield)
- Land equivalent ratio: 1.10
- Steviol glycosides (SGs) are not adversely affected

## Contribution of CSIR-IHBT

- Developed a stevia-bacopa intercropping model
- Optimized planting ratio of stevia and bacopa

# Puskarmool (*Inula racemosa*): agrotechnology

*Inula racemosa* Hook. f., commonly known as Pushkarmool or Mannu, is one of the most important medicinal plant of high altitude region. Traditionally, its powdered roots are utilized in Ayurvedic medicine to treat various ailments, including diabetes, breathlessness, and swelling. Known for its rejuvenating and immunomodulatory properties, *I. racemosa* also exhibits cardioprotective, hypoglycemic, antiapoptotic, antimutagenic and antianginal effects. The root's essential oil is rich in sesquiterpene esters and lactones, such as dihydro-iso-alantolactone, allolantolactone, alantodiene, α-pinene, β- pinene, β- elemene and isoalantodiene. In addition to traditional applications, the root oil is used in pharmaceutical drug synthesis and novel compound development.

## Market potential

The annual demand for pushkarmool is currently estimated at 200 MT with a market price of 350-500 per kilogram.

## Salient features of CSIR-Technology

- Alantolactone (63.65%), Isoalantolactone (34.68%)
- Yield potential of 6.66 tonnes/ha (dry root yield)
- Essential oil content (1.20 %)

## Contribution of CSIR-IHBT

- Standardized agronomic practices
- Technology for essential oil extraction
- Training on agro and processing technology

# Clary sage (*Salvia sclarea*): agrotechnology

Clary sage (*Salvia sclarea* L.) is one of the most important medicinal and aromatic plants cultivated worldwide for essential oil and other perfumery products. Leaves, floral spikes and essential oils are used as flavoring in food and beverages, fragrances, aromatherapy and traditional medicine. Clary sage is also used to treat asthma, stress, depression, fatigue, migraine, nervousness, hemorrhoids, oily skin, spasmodic cough, digestive and menstrual problems. Linalool, linalool acetate, geranyl acetate and sclareol are the major constituent of clary sage oil.

## Market potential

The global market for clary sage oil is currently estimated at USD 708 million at a CAGR of 4.2% and is expected to reach USD 1,184 million by the year 2033.

## Salient features of CSIR-Technology

- Sclareol rich (40%) selection
- Yield potential of 17.26 tonnes/ha (flower spikes)
- Essential oil content (0.232%)

## Contribution of CSIR-IHBT

- Standardized agronomic practices
- Technology for essential oil extraction
- Training on agro and processing technology

# Production of Kala Jeera Seedlings & Tubers

- Seeds show both radicle and epicotyl dormancy
- Due to the dormancy problem, hill farmers have developed little or no interest in its cultivation
- Hill farmers collect Kala Jeera tubers from the wild for cultivation, which is unsustainable.
- There is a need for sustainable production of Kala Jeera seedlings and tubers.

Area under cultivation

| Location | Area (ha) |
|---|---|
| Gurez Valley, Jammu & Kashmir | 225 |
| Shong Village, Kinnaur District, HP | 47 |

- CSIR-IHBT has developed efficient methods for producing healthy young Kala Jeera seedlings (12 wk) and tubers (17-19 wk) under lab conditions
- These technologies can be used to promote large-scale cultivation of Kala Jeera in Himachal Pradesh

## Kala Jeera seedlings

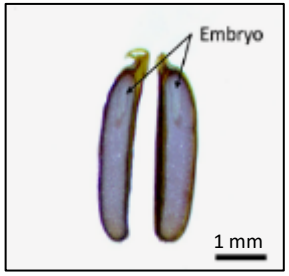


**Fig. 1**. Dissected Kala Jeera seed.

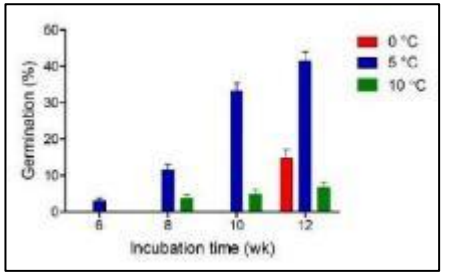


**Fig. 2**. Seed germination at 0, 5 and 10 °C. Higher seed germination was observed at 5 °C.

**Fig. 3**. Kala Jeera seedlings

## Kala Jeera tubers

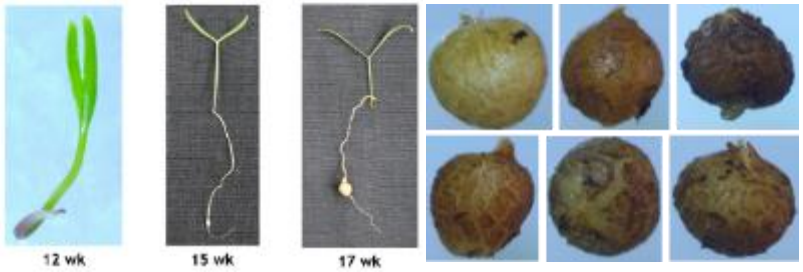


**Fig. 4**. Kala Jeera seedling growth and tuber formation.

**Target beneficiaries**: Hill farmers, Start-ups, Tissue Culture companies

# Agrotechnology of Gypsophila (Baby's Breath): A Filler Ornamental Crop

## Challenge/ Need:

Gypsophila is an indispensable filler flower in the global floriculture trade. Its delicate white blooms enhance the aesthetic value of bouquets, floral arrangements, wedding decor and event styling. It has high consumer demand in both fresh and dried flower markets because of its long vase life, light weight and elegant appearance. It's a perennial plant with life cycle of three years yielding 2-3 flushes per year thus giving higher economic returns.

## Market Value:

The global market size of Gypsopila is USD 250-300 million and in India it is USD 30-50 million (2024-25)

## Salient Features:

Agrotechnology package integrating optimized nutrient, irrigation, and intercultural practices for consistent multi-flush production.

## CSIR-IHBT Provides:

Training and skill development programs on agrotechnology
Consultancy to cultivate Gypsophila in protected cultivation

**Potential Beneficiaries:** Farmers, SHGs

# Agrotechnology of Limonium (Statice): A Filler Ornamental Crop

## Challenge/ Need:

Limonium is a key filler flower valued for its vibrant colours, excellent vase life, and suitability for both fresh and dried floral arrangements. It is widely used in bouquets, wedding décor, and event styling, with steady demand in domestic and export markets. As a perennial crop producing multiple flushes over 2–3 years, it offers high economic potential. However, productivity and quality are often limited by sensitivity to soil salinity, climate stress, and inadequate postharvest handling. There is a strong need to optimize cultivation and postharvest practices to ensure uniform, export-quality spikes and reduce losses.

## Market Value:

The global market size of Limonium is USD 180-250 million and in India it is USD 13-22 million (2024-25)

## Salient Features:

Agrotechnology package integrating optimized nutrient, irrigation, and stress-management practices for consistent multi-flush production.

## CSIR-IHBT Provides:

Training and skill development programs on agrotechnology
Consultancy to cultivate Limonium in protected cultivation

**Potential Beneficiaries:** Farmers, SHGs

# New Variety of Clary sage (CSIR-IHBT-SS-07)

The selection 'CSIR-IHBT-SS-07' of Clary sage (*Salvia sclarea*) derived from heterogeneous base population of clary sage made through half-sib progeny selection approach.

- **CSIR-IHBT-SS-07 has significantly higher yield (418.73 g/plant) than overall mean at all tested locations in Himachal Pradesh.**

Certificate
Plant Germplasm Registration

It is certified that germplasm CSIR-IHBT-SS-07 of Sage/Chia (INGR25098) developed by

*Sanatsujat Singh, Satbeer Singh, Ramesh Chauhan, Dinesh Kumar, RK Sharma and Ashok Kumar*

*CSIR-Institute of Himalayan Bioresource Technology, Palampur, Himachal Pradesh*

has been registered by Plant Germplasm Registration Committee of Indian Council of Agricultural Research on December 26, 2025.

Member-Secretary
PGRC

Chairman, PGRC
DDG (CS) ICAR

**Morphological characters of 'CSIR-IHBT-SS-07' in western Himalayan region**

| Characters | 'CSIR-IHBT-SS-07' | Over all Mean |
|---|---|---|
| Basal Leaf length (cm) | 23.01 | 13.67 |
| Plant height (cm) | 143.54 | 94.17 |
| Number of branches | 37.92 | 22.78 |
| Inflorescence Length (cm) | 61.09 | 44.00 |
| Fresh Inflorescence weight (g/plant) | 418.73 | 243.81 |

**Field view of vegetative growth of 'SS-07'**

# New Variety of Inula (CSIR-IHBT-IR-09)

The selection 'CSIR-IHBT-IR-O9' of Inula (*Inula racemosa*) made through a single plant selection approach from the base population "*IR-B*".

- **CSIR-IHBT-IR-O9 has significantly higher root biomass (553.39 g) and essential oil content (3393.21 mg /Kg) than overall mean in Himachal Pradesh.**

Certificate
Plant Germplasm Registration

It is certified that germplasm CSIR-IHBT-IR-09 of Inula (INGR25094) developed by

*Sanatsujat Singh, Satbeer Singh, Ramesh, Dinesh Kumar, RK Sharma and Ashok Kumar*
*CSIR-Institute of Himalayan Bioresource Technology, Palampur, Himachal Pradesh*

has been registered by Plant Germplasm Registration Committee of Indian Council of Agricultural Research on December 26, 2025.

Member-Secretary
PGRC

Chairman, PGRC
DDG (CS) ICAR

**Morphological characters of 'CSIR-IHBT-IR-09' in western Himalayan region**

| Characters | 'CSIR-IHBT-IR-09' | Over all Mean |
|---|---|---|
| Basal Leaf length (cm) | 74.88 | 66.17 |
| Plant height (cm) | 160.17 | 154.55 |
| Number of branches | 4.21 | 2.70 |
| Root biomass (g/plant) | 553.39 | 392.28 |
| Essential oil (g/Kg) | 3.39 | 1.76 |


Plant growth **(A)** at vegetative and **(B)** reproductive stage.

# New Variety of Geranium (CSIR-IHBT-PG-05)

The mutant 'CSIR-IHBT-PG-O5' of Inula (*Inula racemosa*) made through chemical mutagenesis followed by clonal selection.

Certificate
Plant Germplasm Registration

It is certified that germplasm CSIR-IHBT-PG-05 of Rose geranium (INGR25097) developed by

*Sanatsajat Singh, Satbeer Singh, Ramesh, Dinesh Kumar, RK Sharma and Ashok Kumar*
*CSIR-Institute of Himalayan Bioresource Technology, Palampur, Himachal Pradesh*

has been registered by Plant Germplasm Registration Committee of Indian Council of Agricultural Research on December 26, 2025.

Member-Secretary
PGRC

Chairman, PGRC
DDG (CS) ICAR

- **CSIR-IHBT-PG-O5 has highest biomass (1195.08 g/plant) and essential oil content (0.20%) than overall mean in Himachal Pradesh.**

**Morphological characters of 'CSIR-IHBT-PG-05' in western Himalayan region**

| Characters | 'CSIR-IHBT-PG-05' | Over all Mean |
|---|---|---|
| Number of Leaves | 88.13 | 79.88 |
| Plant height (cm) | 81.37 | 79.27 |
| Number of branches | 65.88 | 56.48 |
| Biomass yield (g/plant) | 1195.08 | 862.04 |
| Essential oil (g/kg) | 2.00 | 1.30 |

Field view of PG-05 at Palampur during flowering