

# CULTIVATION PRACTICES AND PROSPECTS OF RHIZOMATOUS ORNAMENTAL CROPS IN ODISHA

## Abstract

Ornamental rhizomatous crops like Bird of Paradise, Heliconia, Iris, Cannas, Lily of the Valley, and Sympodial orchids are under-exploited exotic flower crops that fetch higher prices both as cut-flower and pharmaceutical inputs. The climatic conditions prevailing in Odisha with warm temperatures, high humidity, and mild winter with enough supply of water are ideal for cultivation of the above rhizomatous crop. As these crops can be used as intercrops and also as fodder, increases the overall income of the farmers. The present chapter discusses about cultivation aspects of different rhizomatous ornamental crops which create awareness among farmers concerning the selection of proper species, multiplication, spacing, nutritional requirement, and crop protection for revenue and employment generation in the state.

**Keywords:** Rhizomatous ornamentals, species, Under-exploited, propagation, cultivation

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Rhizomatous crops are those which are propagated through rhizomes. A rhizome is a modified horizontal stem with nodes and short internodes, that often grows underground, usually forming roots and shoots from its nodes. Heliconia, Bird of paradise, Iris, Lily of the Valley, Sympodial orchids and Cannas are few ornamental rhizomatous crops. Rhizomatous plants are classified based on whether they grow above or below the surface of the ground.

- **Underground Rhizomes:** The most common type of rhizome is an underground stem. Types of plants with underground rhizomes include Ginger, Bamboo, Bermuda grass and hops.
- **Above-Ground Rhizomes:** Less common are rhizomes that grow directly at or slightly above the soil surface. Some types of Irises and Ferns grow from above-ground rhizomes.
- **Multi-Tiered Rhizomes:** The rarest rhizome of all is one that forms multiple layers of growth. The large majority of rhizomes grow roots and shoots from a single layer, but some plant species such as the Giant Horsetail form several rhizome layers.

## I. USE IN LANDSCAPING

1. **Cut Flower:** Alstroemeria with beautiful and long shelf life of cut flower is one of the most important ornamental plants.
2. **Ground Covers:** Pachysandra and Lily of the Valley are pretty ground covers which spread their rhizomes vigorously.
3. **Border Plants, Mass Effect:** Planting large numbers of the same type of rhizomatous plants can create a very dramatic garden border, mass planting, or groundcover, especially in spring when all plants are in flowering.
4. **Potted Plants**

**Focal Point:** In the garden or in a container, a single plant creates an eye-catching spectacle.



**Iris**



**Heliconia**



**Bird of Paradise**



**Canna**



**Lily of the Valley**



**Orchids**

## II. CULTIVATION PRACTISE OF IRIS

*Iris* sp. of Iridaceae family is one of the most intricate and exquisite flower that come in every single colour of the rainbow and their heights range from a few inches tall to up to five feet so they can be planted anywhere in the garden from the back areas to the front borders. Once established, iris care becomes minimal. Iris plants are prolific multipliers, but when their rhizomes become crowded, it can limit iris flower production, necessitating rhizome separation. Irises encompass over 70,000 registered varieties, and these perennial plants grace us with their presence on tall, slender stalks, adorned by fans of emerald-green, spear-like leaves, providing an elegant vertical structure throughout the entire season. These distinctive six-petaled blossoms feature three hanging external petals known as "falls" and three upright inner petals referred to as "standards." The majority of irises bloom in either spring or summer, attracting butterflies and hummingbirds while also serving as excellent cut flowers.

**1. Types of Irises:** Rhizomatous and bulbous are the two primary groupings. Rhizomatous irises are categorized into three groups and are grown from rhizomes.

- **Bearded:** These are the most commonly grown, and their name comes from the noticeable "beard" of colored or white hair that surrounds the outermost petal in the center of each fall. Eg. *Iris germanica*

- **Beardless:** These encompass the Siberian (*Iris sibirica*), Japanese (*Iris ensata*), Pacific Coast, and Louisiana varieties, all characterized by smooth falls. Siberian irises are renowned for their remarkable adaptability, making them an excellent option for low-maintenance mixed borders. Japanese and Louisiana types thrive in wet or moist soil conditions, whereas the Pacific Coast varieties excel in milder climates.
  - **Crested:** These irises do well in full sun or partial shade area in moist humus rich soil.
2. **Soil:** Well-drained soil is ideal for iris growth. Although they like slightly acidic soil with a pH of 6 to 8, they can tolerate quite a bit of imperfect soil.
  3. **Climatic Requirement:** Irises necessitate a minimum of half a day, approximately 6-8 hours, of direct sunlight exposure. In extremely hot climates, some afternoon shade can be advantageous, but, generally speaking, irises thrive best in full sun. For optimal results, plant irises during late summer to early fall, when nighttime temperatures consistently remain between 4 to 10°C or above. This timeframe allows ample opportunity for them to establish themselves before the impending winter. Tall bearded iris varieties are ideally planted closer to fall since they enter dormancy in early to mid-summer. Therefore, whether you receive bare rhizomes or irises in a container earlier in the year, it is advisable to plant them as soon as possible, prioritizing timely placement in the ground over waiting for the ideal moment.
  4. **Propagation:** To propagate irises, divide their rhizomes every 3-5 years, ideally shortly after the blooming period. Cut a 2-3 inch segment from the rhizome and place it in a medium consisting of sand and vermiculite, sand and peat, commercial potting soil, or a similar substrate. Cover the rhizome section with a quarter-inch layer of the medium and ensure it remains adequately moist. To prevent potential fungal issues, it is advisable to treat the rhizome cuttings by immersing them in a solution of water and bleach (10%) for about 10 minutes.

In most cases, new offsets will emerge at the leaf scars. Once these offsets reach a length of 6 inches or more and develop strong roots, they can be carefully separated and transplanted. It is generally best practice to transplant the rhizome cuttings along with the intact offsets, as the new plants will likely derive some nutrients from the original rhizome.

If you notice a decrease in blooming or rhizomes protruding from the soil's surface, these are signs that it's time to dig up and divide the irises. Gently excavate the rhizomes and separate them by hand, although some may require cutting with a knife. Healthy rhizomes will typically have a diameter of approximately 1/2 to 1 inch, along with a well-developed root system and one to two leaf fans. Older or unhealthy rhizomes, such as those that are rotting or hollow, should be discarded. Rinse the roots with water and inspect them for signs of disease or pests, particularly iris borer worms. Trim the leaves to a length of 4 to 6 inches and replant, positioning the rhizome on a ridge with the roots fanned out. Ensure thorough watering for newly planted irises.

5. **Planting:** When dealing with bare-root irises, it's important to plant the rhizome in a horizontal orientation with the top part exposed. In regions characterized by hot summers, position the rhizome just beneath the soil surface. Whether planting individually or in clusters of three, ensure a spacing of 1 to 2 feet, depending on the rhizome's size.

To plant, create a shallow hole measuring 10 inches in diameter and 4 inches in depth. Form a raised ridge of soil down the center of the hole, and then place the rhizome atop this ridge, allowing the roots to extend down both sides. Proceed to fill the hole with soil, gently compacting it, while leaving a portion of the rhizome and foliage exposed above the surface.

- **Irrigation:** Avoid overwatering irises as this can lead to the rhizomes (roots) becoming spoiled due to too much moisture in the soil. Water deeply and consistently, especially during the summer dry period.
- **Fertilization:** The fertilizer requirements for a specific area are determined by its soil type. It is advisable to use a well-balanced fertilizer with an N-P-K ratio of either 10:10:10 or 5:5:5. It's important to avoid fertilizers with high nitrogen content, as this can promote tender growth that is more susceptible to diseases. For optimal results, apply a light fertilizer application in early spring and repeat this process about a month after the irises have finished blooming.

In late winter, consider using a general-purpose fertilizer and work it into the soil around the plants. However, refrain from applying high-nitrogen fertilizers to the surface or mulching excessively with organic matter, as this may increase the risk of rhizome decay. Reblooming irises tend to thrive when given another round of fertilization after their initial bloom has concluded.

- **Cultural Operations:** Keep the iris rhizomes exposed. Unlike bulbs that thrive deep underground, iris rhizomes require some exposure to sunlight and air to prevent rot. If they are buried under soil or crowded by other plants, they may deteriorate. It can be beneficial to apply shallow mulch to irises in the spring. Taller irises may need support to prevent them from falling over. Be attentive to the presence of iris borer drills, which appear as dark vertical lines that may seem water-soaked on the leaves. Remove spent blooms (deadheads). Bearded irises will bloom successively from buds along their stems. After the blooming phase is complete, trim the flower stems down to their base. However, refrain from trimming iris leaves once they have finished blooming, as they continue to carry out photosynthesis for the next year's growth. Trim any browned tips and cut the blooming stalk down to the rhizome to reduce the risk of decay.

After experiencing a hard freeze in the fall, trim the foliage back significantly, removing any spotted or yellowed leaves, and dispose of all debris in the trash. If iris foliage is severely affected by frost, remove and dispose of it to eliminate iris borer eggs. For winter protection, cover the rhizomes with an inch or two of sand and top it with a light layer of evergreen branches. This should be done after the ground has frozen, and the cover should be removed when Forsythias bloom in the following

spring. In late winter, remove the winter mulch and any old foliage to allow for new, fresh growth and to prevent iris borer infestations.

- **Maintenance:** After the flowering period, trim the flowering stalks, but keep the foliage undisturbed to allow it to continue collecting and storing nutrients and energy for the upcoming season. Once the leaves turn yellow in the fall, prune them at ground level. This practice helps minimize the risk of overwintering diseases or pests.
- **Diseases and Pests:** Without effective control measures, irises can suffer significant damage from iris borers and thrips. Additionally, irises may face issues with whiteflies, slugs, snails, aphids, and nematodes, which can be troublesome pests. While deer typically do not pose a threat to irises, they may occasionally nibble on the blossoms of crested varieties, often rejecting and leaving them uneaten. Irises are also susceptible to various diseases, including bacterial leaf blight, rhizome rot, leaf spot, rust, and various viruses.
- **Harvesting:** Iris should be harvested in the '**pencil tip**' stage when a lime of colour projects cut of the sheathing leaves.
- **Post harvest handling:** Pre-cooling is a crucial step to eliminate field heat from the flowers. This is achieved through either forced air cooling or hydro cooling, which rapidly reduces the temperature from 20 °C to 10 °C. It's important to note that irises can withstand a maximum temperature of 0 °C, and their maximum average daily temperature tolerance is 20 °C.

Grading stands as a critical process since it determines the quality of the flowers based on factors like stem length, flower appearance, flower count, stem straightness, color, and freshness. A high-quality stem should exhibit a lengthy, straight, and healthy structure, showcasing vibrant flowers without side shoots, and it should be free from any damage, pests, or diseases.

The postharvest longevity of flowers relies on effective packaging and storage. Proper flower packaging, when combined with pulsing, plays a crucial role in preserving the freshness and quality of flowers for consumers. Additionally, this approach presents the potential advantage of extending the vase life of the flowers.

### III. CULTIVATION PRACTISE OF HELICONIA

Heliconias have a long history of popularity due to their colorful, exotic inflorescences. Originally from South and Central America, these are well-known for being the greatest plants for landscaping and for their potential use as specially cut flowers for floral arrangements. Heliconia, often referred to as lobster claw, wild plantain, or false bird of paradise, is a stunning flower with multicolored bracts that come in a variety of sizes and forms. The bracts include red, pink, orange, yellow, and green. Owing to its striking colors and exotic look, it commands a premium price in the market. Certain heliconia cultivars also sold with their leaves trimmed for use as floral decorations.

1. **Botany:** Heliconia is a perennial flowering herb belonging to the Heliconiaceae family of rhizomatous plants in the Zingiberales order. It is discovered that heliconia are diploid ( $2n=24$  chromosomes), and that triploid ( $2n=3x=36$ ) cultivars are also known to exist. The genus Heliconia contains around 350 varieties and about 89 species. They belong to a class of plants that have an upright, aerial, stem-like tube known as a pseudostem that is made up of overlapping leaf sheaths. Similar to bananas, the plant spreads by way of a fleshy subterranean rhizome. Flowers are often enormous, showy, and come in a variety of shapes and sizes. Their colors can include pink, red, orange, yellow, and other combinations. The terminal inflorescence of heliconia is either erect or pendulous, consisting of two or more boat-shaped bracts that emerge from a central axis. The inflorescence size ranges from 10 to 50 cm, while the stalk length ranges from 0.5 to 3.0 m. Heliconias can grow up to twenty feet tall, depending on the type, and they frequently have a lot of rhizomatous growth. The hummingbird (*Eulampis jugularis*) is the primary pollinator of flowers; additional pollinators include bats and insects (mosquitoes and chysomelids).

## 2. Importance and Uses

- Heliconia is considered an excellent choice as a cut flower due to its vibrant color, unique form, long and straight peduncles, and its remarkable post-harvest longevity.
- In landscaping, Heliconia serves as an ideal plant for various purposes, including creating boundaries, providing privacy screening, preventing soil erosion, and concealing foundations (foundation planting).
- Certain Heliconia varieties, such as *Heliconia psittacorum*, *Heliconia stricta*, *Heliconia angusta*, and the Golden Torch cultivar, find utility as potted plants for interior displays.
- Heliconia leaves have practical uses in thatching and can be employed for food wrapping.
- In the Caribbean and Mexico, Heliconia is frequently utilized as background material in floral decorations. In Brazil, specific varieties of Heliconia roots and seeds are utilized for medicinal purposes.

3. **Types of Heliconia:** Heliconias can be roughly divided into two categories: pendent heliconias, which dangle with bracts pointing down, and erect heliconias, which stand upright with bracts pointing up.

### These Types can further be Divided into four Sub Types like (Smith, 1968)

- **Inflorescence Erect and in One Plane:** *Heliconia aurantiaca*, *H. aureostriata*, *H. bourgaeana*, *H. caribaea*, *H. humilis*, *H. psittacorum* and *H. wagneriana*.
- **Inflorescence Erect Andin more than one Plane:** *Heliconia metallica* and *H. latispatha*.
- **Inflorescence Pendant and in one Plane:** *Heliconia rostrata*, *H. catheta* var. *Catheta*.
- **Inflorescence Pendant and in more than Oneplane:** *Heliconia collinsiana*, *H. collinsiana* Griggs var. *collinsian*.

#### 4. Species and Cultivars

- ***Heliconia stricta***: It has a lovely inflorescence that looks like lobster claws. The color spectrum of flowers includes red, gold, orange, maroon, and green, either separately or in combination. The inflorescence of these exotic tropical flowers ranges in length from 5 to 12 inches and is not overly weighted, making them perfect for modest presentations. *H. Stricta* cv. Dwarf Jamaican can reach heights of between 0.5 and 1 meter.
- **Cultivars**: Bucky, Dwarf Jamaican, First bird, Royal Tagami.
  - ***Heliconia Rostrata***: It is primarily found in tropical America and is native to Peru. It's called hanging lobster claws most of the time. The most common and traditional heliconias have a stunning pendant inflorescence of alternate, 6–10 cm long, fiery red bracts with cream tips. Inflorescences must be well-developed (with at least two open bracts), clean, well-formed, undamaged, fresh, firm, well-colored, appropriately trimmed, and free of damage from diseases, insects, mechanical tools, or other sources in order to achieve Hawaii Fancy grade requirements. The flowers have a rich crimson color with white to yellow-green tips. Plants bloom all year long.
  - ***Heliconia Psittacorum***: Specie is indigenous to the Guyanan coast. The *H. psittacorum*, also known as Parrot's beak, heliconia is a small, delicate, exotic tropical plant that bears resemblance to the widely recognized Bird of Paradise. Greenish yellow flowers with black specks towards the apex and an abundance of blooms all year round are accompanied by flower heads that give the impression of being hand painted and shimmer with dazzling colors. Although Andromeda was similar but taller with larger bloom heads, the cultivar proved to be quite productive.
- **Cultivars**: Andromeda, Lady Di, Nickeriensis, Golden torch and Sassy.
  - ***Heliconia Latispatha***: It is indigenous to South and Central America. The plant has an erect inflorescence with well-separated boat-shaped bracts that are greenish in color at the tip and orange-yellow at the base.
  - ***Heliconia Bihai***: It's also known as Fire bird or wild plantain. The flowers, which are placed in two ranks on an upright inflorescence, are greenish yellow in color and clustered in the axils of huge stiff boat-shaped, crimson red, flattened bracts with pointy tips.
  - ***Heliconia Indica***: It's a heliconia foliage variety. Although it rarely has stunning foliage, it often has pretty modest flowers.
  - ***Heliconia Acuminate***: It is an upright herb that is native to Brazil, French Guiana, Guyana, Suriname, Venezuela, Colombia, Bolivia, and Peru. It can grow up to 1.6 meters tall. In other areas, it is also planted as a decorative plant.



- ***Heliconia Angusta***: Due to the fact that its red and white inflorescences typically appear around the holiday season, it is commonly known as the Christmas heliconia. The World Conservation Union has designated wild populations that are indigenous to southeast Brazil as fragile, partly because agricultural activities have resulted in the conversion of their dwindling habitats.
  - ***Heliconia Aurantiaca***: It is native to Guatemala and southern Mexico in Central America. The montane woods are its native environment.
  - ***Heliconia Burleana***: It is indigenous to Peru, Colombia, and Ecuador. Tropical or subtropical moist montane forests are its natural habitat.
5. **Soil and Climate**: Heliconias prefer direct sunlight or partial shade, depending on the species. Don't put them where it will be largely shaded. Use organic matter-rich, well-draining soil. Regularly mulch with peat moss to keep the soil moist. In case the potting media or soil gets excessively dry, spider mites could settle down near your plant.
  6. **Propagation**: Although heliconias can be cultivated in a variety of soil types, the ideal soil is thought to be a deep, rich, well-pulverized, well-drained loam. Light is incredibly vital. For example, higher light levels promote healthy plant development, higher yields, and the creation of flowers. Plants grown in lower light intensities grow taller and weeper, which reduces productivity (Broschat and Donselman, 1983). Plants do well in temperatures between 21 and 35 0 c. By raising the minimum air temperature from 15 to 21 0 C, the cultivar's shoot emergence, number of flowering stems/m<sup>2</sup>, stem length, and stem quality are all doubled. Best range for shade regulation: 40–60%.
  7. **Vegetative Propagation**: robust rhizomes with axillary or terminal An average weight of 40 g, or two to three buds, is optimal for rapide establishment. Rhizomes with only one bud will develop slowly. Before planting rhizomes in well-drained soil, they should be dipped in a diluted fungicide solution.
  8. **Tissue Culture**: The first issue was heliconias' delayed seed germination, which takes anything from three months to three years. The development of a tissue culture procedure for heliconia is hardly an alternative because rhizome (the subterranean stem) multiplication is likewise time-consuming.

Heliconia is a challenging species to micropropagate primarily because endogenous contamination occurs frequently. Normal seedlings have been produced by embryo culture methods and used as the first explants.
  9. **Time of Planting**: It is best to establish the plant in January or March in order to receive a prompt response from growth at the start of the monsoon.
  10. **Spacing**: 100 centimeters between each plant and row. Planting rhizomes at a size of 40 by 40 cm will result in a greater number of suckers being produced in two years, hence replanting should be done once every two years.

- 11. Irrigation:** Weekly intervals of watering are recommended during the growing season's dry weather. Water often to keep the soil moist. Since the soil around heliconias should never dry out, the plant can require twice-daily watering if the weather is exceptionally hot or dry. But be careful not to overwater to lessen the likelihood of root rot.
- 12. Manures and Fertilizers:** In two divided doses, 4 kg of FYM/m<sup>2</sup> and 40:20:20 g NPK/m<sup>2</sup> are administered for improved flower development, yield, and quality. Two doses are administered: one at the onset of fresh shoot sprouting and the other 45 days after planting, or when suckering begins.
- 13. After Care:** Timely weeding and pruning of older, burned leaves ought to be routine tasks. Since flowers are monocarpic in nature, it is best to cut off the flower-bearing shoots at ground level to promote the formation of new shoots lateral to the original one.
- 14. Harvesting and Yield:** Flowers can be gathered 6–7 months after planting. Although it blooms all year long, November and December are when the most blossoms are produced. With up to 20 florets per bract and peduncles of at least 70 cm, the flowers are plucked. Early in the day, flower stalks should be trimmed close to the ground. Harvesting occurs when *H. psittacorum* has one, two, or no open bracts. When between half and two thirds of the inflorescences are in bloom, larger heliconia can be chopped (Broschat and Donselman, 1983). Typically, *H. psittacorum* is sent with one to three leaves still attached. Plants can often produce 30–40 stems in their first year and 60–75 stems in their second year of growth in a one square meter space.
- 15. In Packing,** *H. psittacorum* is frequently wrapped in plastic film or open weave netting and put in "metric" bunches of ten. A box of 150 x 50 x 25 centimeters can hold up to 25 such bunches. Large heliconias, such as *H. caribaea*, are packed in groups of 10 to 15, and medium-sized heliconias, such *H. bihai* and *H. stricta*, may be packed in boxes of 20 to 50. To lessen damage from moving during shipment, layers of newspaper and moist or dry shredded newspaper are utilized.
- 16. Pest and Diseases:** There are no serious insect pests and diseases of Heliconia.
  - **Aphids:** It often infests flowers for feeding on the nectar. Spraying of dimethoate at 0.05%
  - **Snail:** It will devour the heliconia's young leaves by scraping, leaving large, uneven holes. Plants are consumed at night by both adults and juveniles. Snail populations can be decreased and snails killed by hand-picking and dropping in a 5% salt solution. Foliage is protected from harm by a spray application of soap nut extract (60g/l) and neem oil (10 ml/l). Heliconia is frequently infested by plant parasitic nematodes, such as root knot nematode, reniform, burrowing nematode, and lesion. Before planting, the soil should be chemically fumigated; only hot water treated or nematode-free rhizomes should be planted.

The most common fungal diseases are Root rot (*Phytophthora*) and Stem rot (*Phythium*). Fungicides like Captaf, Mencozeb, Metalaxyl. Soil Solarization is useful. Excess moisture should be avoided.

- **Leaf Spot:** Removed infected leaves. Foliar application of Mancozeb or Chlorothanil is effective.

**17. Post Harvest Handling of Heliconia:** Following pruning, an insecticide dip is applied to the entire inflorescence to eradicate any insects. Growers and exporters employ a variety of techniques. After dipping for five minutes, inflorescences are washed. To get rid of dead flowers and to remove insects, hand washing is required. Before packing, the stalks are kept submerged in water until the inflorescences have dried. According to Paull *et al.* (1991), floral preservatives do not prolong vase life; nevertheless, anti transpirants marginally extend postharvest life (Ka-ipo *et al.*, 1989). While antitranspirants and waxes produce limited response because they don't completely coat the bract surface, the lack of response to preservatives may be linked to inadequate vascular development of the flower stem's base.

**18. Grades and Standards** Inflorescences must be well-developed (with at least two open bracts), clean, well-formed, undamaged, fresh, firm, well-colored, appropriately trimmed, and free of damage from diseases, insects, mechanical tools, or other sources in order to achieve Hawaii Fancy grade requirements. Two percent or less of the heliconias in a lot may have major faults, and no lot may have more than five percent of its heliconias not fulfill the fancy grade requirements. Other than a minimum of 15 cm, stem length is not considered a grading factor (Hawaii Dept. of Agriculture, 1972).

#### IV. CULTIVATION OF BIRD OF PARADISE

Bird of paradise (*Strelitzia reginae*), commonly referred to as the 'crane flower,' is a member of the Strelitziaceae family and originates from South Africa. Its name is derived from the uniquely shaped and vividly colored flower, resembling the crested head of a bird, which lends it an exceptionally captivating presence in landscaping. This evergreen, perennial, herbaceous, rhizomatous ornamental plant thrives in moderate sub-tropical climates. The plant attains a height ranging from 1 to 1.5 meters, featuring large leaves with extended petioles. Its flowers are arranged in a horizontal inflorescence that emerges from a sturdy spathe, and this inflorescence is situated at the apex of a lengthy pedicel. The flower itself comprises three vibrant orange upright sepals and three purplish-blue highly modified petals, each emerging sequentially from the spathe. This low-maintenance plant is easy to cultivate, making it suitable for landscaping. Moreover, it is well-suited for planting alongside water bodies such as ponds, lily pools, water tanks, and swimming pools, as its leaves do not drop into the water. When placed alongside a herbaceous border or in front of a shrubbery, it creates a striking visual effect. Due to the unique shape of its flowers, it can also be grown as a specimen plant.

Bird of Paradise is cultivated for its cut flowers on a commercial scale in various regions, including California, Florida, Hawaii, Israel, and South Africa. In India, it is primarily grown in sub-temperate and sub-tropical areas, such as Himachal Pradesh, Sikkim,

Kalimpong, and Darjeeling in West Bengal, as well as the Nilgiri hills and the Western Ghats, along with Bangalore and its adjacent regions in Karnataka, among others.

Some of the important species of *Strelitzia* are;

- ***Strelitzia Augusta***(syn. ***Strelitzia alba***): Another name for it is White Bird of Paradise. Two spathes make up the inflorescence, from which white flowers emerge in the center. Its leaves are long (60-90 cm) and oblong, and it can grow up to 5 meters tall.
  - ***Strelitzia Caudate***: It is sometimes referred to as the African Desert Banana or Swaziland *Strelitzia*. It has many stems that can grow up to six meters tall and is unbranched. It can be planted in a medium-sized to big garden as the main attraction.
  - ***Strelitzia Juncea***: Because of its absence of leaf blades and reed-like leaves and stems, it is also known as the "leafless Bird of Paradise." It may be clearly distinguished from common Bird of Paradise thanks to its feature. produces orange and blue flowers throughout the winter and early spring, but grows considerably more slowly than others.
  - ***Strelitzia Nicholai***: This is also known as the White Bird of Paradise because it bears big white flowers with accents of dark blue-purple. It is also known as the Giant Bird of Paradise since it can grow into a tree with several stems. It is spherical or heart-shaped at the base and grows to a maximum height of 1.5 cm, with long (2 cm) leaf stalks.
  - ***Strelitzia Reginae***: This perennial forms clumps and grows around one meter wide. The stems can reach a height of ninety centimeters, while the leaf blade and stalk are almost the same length. It blooms most profusely from winter to spring, with gorgeous red, yellow, orange, and purple flowers for most of the year. Var. "Humilis" is a dwarf variety with dense clumps and ovate-oblong leaves, Var. "Glauca" has lovely glaucous foliage and stems, and Var. "Rutilans" has a purple midrib. Mandela's Gold is a cultivar with yellow flowers.
  - ***Strelitzia Kewensis***: This species is a garden hybrid developed from a cross between *Strelitzia augusta* and *Strelitzia reginae*.
1. **Soil:** Bird of paradise plant grows on various soil types but this plant grows well in well-drained, fertile, humus-rich, slightly acidic, loamy soil.
  2. **Light:** Grown in either full sun or semi-shaded light, bird of paradise blooms more when more of the plant is exposed to light. Low light levels can lead to floral abortion, while excessive sunshine exposure—especially in the summer—can scorch foliage.
  3. **Temperature:** Bird of paradise thrives in a semi-cool temperature range of 17-27°C. For early and consistent flowering, it's recommended to maintain nighttime temperatures

between 10-13°C and daytime temperatures between 20-22°C. Temperatures exceeding 27°C tend to stimulate leaf growth while hindering the flowering process.

4. **Propagation:** Common methods of propagation for this plant include seed germination, offset separation, and clump division. Typically, plants grown from seeds require a longer period to establish themselves compared to those propagated vegetatively.
5. **Seed:** Seeds should be planted while they are still in their fresh state. Facilitating the germination process involves soaking the seeds in water and allowing them to sit at room temperature for 3-4 days prior to planting. During sowing, ensure that the potting mixture remains moist and warm. Depending on the soil temperature and the freshness of the seeds, germination typically occurs within 25-30 days. It's important to note that plants grown from seeds may take five to seven years to yield economically viable results.
6. **Separation of Offsets:** Bird of paradise plants readily produce suckers. When these plants become overcrowded in the garden or pot, they tend to yield fewer flowers per plant or may even cease flowering altogether. Consequently, it is advisable to separate the offsets to create new plants.
7. **Division of Clumps:** Mature plants that have been in bloom for a minimum of three years can be divided in the spring, before new growth begins. To do this, carefully lift the plant from the ground or pot and use a sharp knife to separate the underground rhizomes. Ensure that each section contains a fan with its accompanying roots. The newly divided plants can then be replanted in similar locations, at the same depth as their previous placement. After planting, it is important to thoroughly water the newly established plants. Alternatively, you can plant them individually in pots filled with fertile and well-draining soil.
8. **Planting:** In commercial cultivation, it is advisable to plant at a spacing of 60 x 60 cm, resulting in a planting density of 4 plants per square meter. To prepare the planting sites, dig pits measuring 90 x 90 x 90 cm and fill them with a mixture of soil, sand, and farmyard manure in a 1:1:1 ratio. The ideal time for planting is either late spring or early summer.
  - **Irrigation:** In the summer months, it is advisable to water the plants twice a week to maintain soil moisture. In contrast, during the winter season, providing thorough irrigation once every 7-10 days is adequate. It's important to note that because of their rhizomatous nature and fleshy roots, these plants are susceptible to damage from waterlogging. However, it is beneficial to maintain higher soil moisture levels during the flowering season. To mitigate the risk of waterlogging and enhance yield, the incorporation of drip irrigation is recommended.
  - **Fertilization:** To promote the robust growth of Bird of Paradise plants, it is essential to provide them with a fertilizer rich in phosphorus. During the flowering season, it is advisable to apply fertilizers on a monthly basis. For optimal results, apply well-rotted farmyard manure at a rate of 4-5 kg/m<sup>2</sup> and NPK at 20g/m<sup>2</sup> about a month before the

initiation of flower stalks. This approach is conducive to achieving maximum production.

- **Cultural Operations:** Due to the tall nature of Bird of Paradise flower stalks, they are susceptible to bending or lodging. To maintain their upright position, an appropriate support system is employed. This typically involves the use of galvanized wires or nylon strings secured by iron or bamboo poles. After the flowering season concludes, it is advisable to maintain plant health by removing dried leaves and flower stalks through precise cutting using sharp secateurs.
- **Pest and Diseases:** Bird of paradise plants can be vulnerable to infestations of mealybugs and scale insects. It is essential to conduct routine inspections of the plants to check for the presence of these insects. As a preventive measure, you can apply a diluted solution of soapy water to the plants to deter these insects from infesting them.

For severe insect infestations, apply the recommended dosage rate of Parathion or Malathion insecticide.

Root rot caused by *Fusarium moniliforme*, hot water (45-50°C) treatment of seeds for 30 minutes followed by sterilization of soil by fumigation is effective to control this soil-borne disease.

*Botrytis cinerea* is a major postharvest problem of a bird of paradise flowers. Slime production in flowers that provides a substrate for saprophytic mould growth. Dipping the inflorescence in benomyl or thiabendazole at 200 mg/l were found effective in controlling mould growth.

- **Harvesting and Postharvest Handling:** Flowers should be harvested when the initial floret begins to open. To prolong the storage life of the flowers for up to one month, it is advisable to harvest them while they are in the tight bud stage. Subsequently, immerse them in pulsing solutions that contain 10% sucrose, 250ppm citric acid, and 150ppm hydroxyquinoline citrate (HQC) for a duration of two days at a temperature of 22°C. After harvesting, each Bird of Paradise flower is individually wrapped with either polythene sheet or butter paper. The stems are then packaged in a cardboard box measuring 120 x 30 cm and stored at a temperature of 8°C.
- **Yield:** The annual production of flower spikes per plant is contingent upon factors such as the number of leaves, the age of the plant, and the method of propagation. A robust and well-established clump has the potential to yield between 10 to 15 flowers in a given year.

## V. CULTIVATION OF CANNA

Canna is a widely known perennial flowering plant that thrives widely in wet tropical climates worldwide. Because of its extreme hardiness, growing it is simple and successful. Few perennial plants can match the stunning show of color produced by the blossoms, which come in a multitude of hues and bloom all year long. Although they are more often planted in

public gardens, cannas are often grown in private gardens. Since the flowers don't endure as long as cut flowers, garden plants are sometimes used instead.

The genus *Canna* has about 50 species, native to Tropical America and Asia. The following three species of *Canna* are considered to be the parents of the present cultivated varieties.

- ***Canna Indica (Indian shot)***: Rhizome stout, stem slender green 1 to 1.2 m high. Leaves oblong 45-60 cm long green, flower in simple raceme or in pairs; sepals-short, waxy; petals-pale pink, lanceolate; staminodes 3 red or rose about 5 cm long.
- ***Canna Flaccida***: Stem rather slender, 1.2 to 2 m high. Leaves ovate-lanceolate 20-30 cm long. Flowers few flowered raceme, pale yellow to sulphur; sepals-small; petals-linear-lanceolate, up to 7 cm long; staminodes-3 about 7 cm long.
- ***Canna Lutea***: Stem green 1 to 1.2 meters high. Leaves oblong or broad, lanceolate, 25-40 cm long. Flowers on simple raceme pale yellow; sepals-oblong green white margined; petals-lanceolate pale yellowish white; staminodes pale yellow.

1. **Classification:** In India, hybridization has been the main method used to improve canna. As a result of hybridization and selection, several variants have been created, and these kinds are now frequently planted in gardens. Cannas are categorized as follows based on the size and form of the flowers

- **Alipore Hybrids:** The 45 years of hybridization that went into creating the selections have greatly improved upon the wild kinds from which they are sprung. The blooms' size expanded significantly and they came in a variety of colors.
- **Bouquet:** Flowers on closely branching spikes characterize the optimal form in this class, called "cupid." This cultivar produces miniature plants.
- **Candleabra:** This is obviously divided. The main branches of the flower stalk create up to eight or twelve spikes instead of two or three.
- **Wild and Gladiolus Flower:** These are better hybrids that Vilmorin (1880) raised, and Anne (1850–1851).
- **Dreadnaught:** a significant improvement over standard wild or gladiolus flowered canna in terms of both individual and bunch flowers.
- **Dwarf:** This kind contains variants that are excellent for breeding and never grow taller than 70–80 cm at any time of year.
- **Giant or Orchid flower:** originated in Italy and enjoyed long-term popularity. The silky, huge blooms are reminiscent of the Flag Iris, however they are not very hardy.

- **Miniature:** This little flowering variety is the result of combining *Canna indica* with a dwarf hybrid from a society. Spikes are small and tidy.

### **Cannas can also be Divided into Several Classes according to the Colour of the Flowers**

- Selfs: - without spots or margin, one colour only.
- Spotted: -usually a shade of red on cream or yellow ground or red spots on orange of red ground.
- Striped red on a cream or a yellow ground.
- Margin yellow.
- Margined with a darker shade than the ground colour.
- Flaked red or orange on a paler ground.
- Splashed orange on a deeper ground.

The variety of colors is wide, encompassing yellow, orange, pink, and brilliant crimson red in addition to a delicate white. *Canna* is neither purple nor blue in hue. A few more varieties develop dark red blooms and have dark foliage that are frequently reddish purple. On the other hand, one sort of leaf has yellow stripes.

2. **Propagation** Rhizomes are a popular way for *canna* to spread. By hybridization, seeds are used to raise new types. If the seeds are not treated with hot water or rubbed with sandpaper, they have a hard seed coat and germinate slowly.

Hybridization gives rise to new varieties. They are raised from seeds specifically for this use. New variants are also produced by Bud Sports. The stiff seed coat of the tiny, pea-sized black seeds is covered with rough hair. Without harming the embryo inside the seed, the seeds are scarified by filing, rubbing with sandpaper, or having a tiny piece cut off with a sharp razor blade. This process guarantees improved seed germination. Better germination can occasionally be achieved by soaking seeds in water for the entire night or storing them in cow dung before planting.

3. **Cultivation:** In order to fully benefit from the monsoon and create a robust clump before winter, the rhizomes are gathered in May and then planted. To prepare the soil, dig a hole that is at least 50 cm deep, break up any clods, and add 100 kg of fresh stable manure to a bed that is 10 square meters. The rhizomes are completely submerged, about 3 cm below the soil's surface. For a few days, shade is offered if the weather is hot and dry. Plants are spaced 30–40 cm apart from one another during the planting process. The first flower spikes come six weeks after planting and should also be removed. Promote improved growth. Regular weeding is necessary to keep the bed weed-free. The soil is released and allowed to dry after the rain stops and it has dried completely. In the winter, the bed needs to be dug up and watered at least once a month. Frequent flooding is advised to keep the soil moist. To promote strong flowering in the second flush of flowering, which occurs from April to June, apply leaf mould or cow dung manure to the flowerbeds after the first flush ends in December.



Every year, canna is replanted. Using a forked hoe, the rhizome is raised, thoroughly cleaned, and the top growth is chopped off, leaving around a 15-cm stem. After splitting the clump, only the strongest root is kept for a week or so in a shaded area before being replanted. It's important to remove dry leaves and gather faded blooms from the canna beds to keep them tidy.

Additionally, cannas can be grown in 30-35 cm pots; the compost should be made up of one part garden soil and two parts stable manure. Every six to nine months, the potted plants should be transplanted since the roots becoming pot-bound.

- 4. Pests and Diseases:** Cannas are especially disease-free and resilient plants. Sometimes, especially in the rainy seasons, caterpillars can attack the leaves, and occasionally, beetles will eat the blossoms. Applying insecticides such as rogor, malathion, etc. will deter insects.

**5. Varieties of Cannas and Their Flower Colour**

<b>Name of the Variety</b>	<b>Flower Colour</b>
American Beauty	Handsome orange scarlet flowers.
Apricot	Buff-yellow base overspread with salmon pink.
Aurora Borealis	Canary-yellow with rose pink centre, beautifully rayed.
Carmine king	Bright carmine-red with yellow centre
Cleopatra	Orange terracotta, Light purple leaves
Dorris	Pale salmon-pink Flowers very pretty.
Golden Wedding	Yellow
Louis Cayeux	Large flowers with bright rosy scarlet colour.
Mrs Herbert Hoover	Beautiful flowers with deep watermelon pink colour
Mrs Pierre S. du Pont	Very charming flowers with crinkled edges and light watermelon pink colouration.
Rosamond Coles	Dark reddish-orange with deep orange yellow border.
Rosea gigantean	Very large flowers with soft rose to carmine-pink colour.
Statue of Liberty	Plants with bronze coloured leaves and blazing flame-red flowers.
Susquehana	Dwarf plants with rose-pink flowers.
The President	Beautiful large flowers with rich growing scarlet colour.
Yellow King Humbert	Bi-coloured flowers. Bright yellow petals marked with crimson dots.

**VI. CULTIVATION OF LILY OF THE VALLEY**

*Convallaria majalis* Belonging to the Asparagaceae family, this plant originated in Europe and is commonly recognized by names such as May bells, Our Lady's tears, and Mary's tears. It is characterized as an herbaceous perennial with underground stems known as rhizomes. During the summer, new shoots, referred to as "Pips," emerge at the ends of stolons, usually in an upright and dormant state. These Pips develop into new shoots during the spring season. The plant typically reaches a height of 15-30 cm and features one or two leaves. Its inflorescence is in the form of a raceme, bearing five to fifteen sweet-scented

flowers. These flowers have six white tepals (occasionally pink), fused at the base to create a bell-like shape. The plant's fruit is a small, orange-red berry. It's important to note that these plants are self-incompatible, and colonies consisting of a single clone do not produce seeds.

### 1. Important Cultivars of Lily of the Valley are as follows

- *Convallaria majalis* 'Rosea' bears rosy pink flowers.
- *C. majalis* 'Fortin's Giant' has larger flowers than the typical lily of the valley.
- *C. majalis* 'Flore Pleno' is valued for its double flowers.
- *C. majalis* 'Hardwick Hall' has a yellow outline to its leaves.
- *C. majalis* 'Albostriata' has white streaks throughout the leaves.

2. **Soil and Climate:** Prefers silty or sandy soils that are acidic to moderately alkaline with plenty of humus. It performs well under partial shade and warm summers are required. It can grow on mountains of elevation upto 1500 m .This plant thrives in regions characterized by relatively cool summers, and it tends to experience foliage decline in hot summers. However, it typically recovers when cooler weather returns. Under ideal conditions, Lily of the Valley has the potential to spread aggressively.

### 3. Uses

- Widely grown in gardens for its scented flowers
- Used as ground-cover in shady locations.
- Used as a pot plant.
- Used as a food plant by the larvae of some moth and butterfly (Lepidoptera) species.
- Essential oil from the flowers is used in perfumes.
- Extracts from the roots and flowers have anti-bacterial properties.
- Leaves provide green dye in summer and yellow die in autumn.
- Used in weddings as a Bridal bouquet and other celebrations.
- Used in folk medicine against gout and dumb palsey.
- It was the National flower of Yugoslavia and Finland.
- It signifies the return of happiness in the language of flowers.

4. **Toxicity:** Every component of the plant possesses potential toxicity, including the alluring red berries. Ingesting any part of the plant, including these berries, can result in symptoms such as abdominal pain, nausea, vomiting, and irregular heart rhythms. The presence of cardenolides in the plant can lead to disruptions in cardiac conduction.

5. **Propagation:** Lily of the valley reproduces by spreading the rhizomes. The rhizomes with the growth buds are planted 6 inches apart at about ½ inch depth.

Growing Lily of the Valley from seeds is not a common practice, as it is a more intricate and time-consuming method compared to propagation through root division, which is simpler. When opting to grow Lily of the Valley from seeds, it involves specific steps. The seeds should be sown at the end of winter or early in spring, typically in seed flats or small pots. After sowing, they should be covered with a layer of compost and then fine gravel. Place the seed flats or pots in a shaded area and maintain consistent moisture.

The germination and sprouting of seeds can take anywhere from two months to a full year. Once the seedlings have emerged, they can be transplanted into individual pots and nurtured for an additional two years. Following this period, they are ready for transplantation into the garden, which can be done during either the spring or fall seasons.

6. **Potting and Repotting Lily of the Valley:** Lily of the Valley can be conveniently cultivated in well-draining pots or containers filled with standard potting soil. Potted plants can be relocated to a sheltered area for overwintering. Alternatively, it's feasible to maintain them as permanent houseplants; however, it's essential to transfer them to a cool environment for a few weeks each winter to ensure they undergo the required dormant phase. This annual dormancy regimen will enable the plants to bloom indoors for approximately four weeks each year.
7. **Overwintering:** Garden plants do not necessitate protection from cold during the winter months. However, the autumn season presents an opportune moment to apply a top dressing of compost, which fulfills all the essential annual feeding requirements.
8. **Blooming Period:** Lily of the Valley typically undergoes a flowering phase lasting approximately four weeks, spanning from mid-spring to early summer. In established colonies, the vigor of flowering tends to diminish as the clumps become denser and more crowded. To encourage improved flowering, it is advisable to excavate and divide the root clumps, subsequently replanting them with appropriate spacing.
9. **Common Pests & Plant Diseases:** In the case of Lily of the Valley, pest infestations are generally not a severe concern. These pests primarily comprise aphids and spider mites, and they can be addressed by utilizing horticultural oil or, alternatively, by allowing natural predators to manage them.

Common diseases encountered include stem rot, different types of fungal leaf spots, and anthracnose, all of which are typically not of significant concern. To manage these issues, it is recommended to eliminate and dispose of affected plant parts, making sure not to compost them, as this can potentially facilitate the transmission of spores.

10. **Harvesting and Post Harvest Handling:** The optimal stage for harvesting fresh cut flowers is when approximately half of the florets have opened. This harvesting typically occurs in the late months of September and October, once the leaves have withered. To facilitate this process, a small and delicate harvester is employed to cut through the tangled mass of fibrous roots, typically located 20cm beneath the surface. Subsequently, the remaining steps in the process are carried out manually. The soil residue is shaken off, and the intricate network of fibrous roots is untangled into manageable clumps. These clumps are then transferred to a sorting table, where the pips are segregated into one-year-olds, containing only leaves for replanting, and two-year-olds, which include flowers destined for sale.

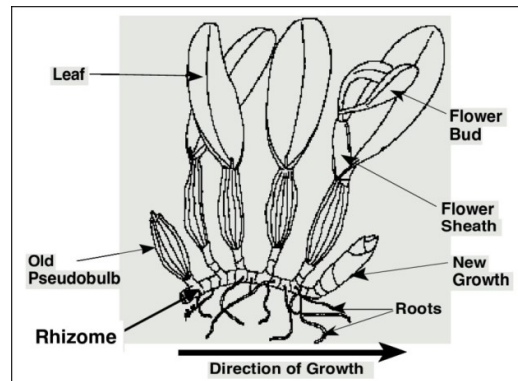
Storage temperature and approximate storage life and vase life for fresh cut flowers of Lily of the Valley are  $-0.5^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  ( $31-32^{\circ}\text{F}$ ), 2 -3 weeks and 4 -11 days respectively.

## VII. CULTIVATION OF SYMPODIAL ORCHIDS

These are monocotyledons belonging to family Orchidaceae and are perennial herbs. Sympodial orchids include Cattleya, Cymbidium, Dendrobium, Oncidium, Laelia etc.

Sympodial orchids represent one of the two primary growth habits observed in orchids. These orchids grow horizontally within their pots, with older growth typically positioned along one side of their path. These plants feature a rhizome at their base, often oriented horizontally, from which a succession of growths extends upward. As the rhizome, which serves as the stem at the plant's base, grows horizontally, it curves upward and transforms into a small plant. This new growth includes leaves, and it may also develop a pseudobulb and flower stems. Following blooming, as the plant resumes its growth, an axillary bud located at the base of the previous growth will initiate the growth of another segment of the rhizome, repeating the process. The older growth will not bloom again, although in certain types of orchids, blooming can persist for many years. Eventually, the older growth will shed its leaves, and in orchids featuring pseudobulbs, it is referred to as a "back bulb." After additional years, it will eventually senesce and die off.

Each fresh growth, specifically the apical bud within it, is referred to as a "lead." Certain plants will possess only a single lead, generating a sequence of growths aligned along a linear pattern. In contrast, some plants may experience branching of the rhizome into multiple new leads if multiple axillary buds sprout at the base of a growth. If this branching process recurs, the plant will eventually expand into a sizable clump. During the division of orchids, it is possible to cut the rhizome into sections, each containing 3-4 growths, preferably with at least one of the plant's leads within each segment.



Temperature stands as the pivotal factor influencing the flowering of orchids. Orchids with sympodial growth habits are classified into cool, intermediate, and warm-growing categories based on their temperature requirements. Cool-growing orchids, exemplified by cymbidiums, thrive when exposed to daytime temperatures ranging from 60°F to 70°F and nighttime temperatures below 50°F. Intermediate-growing orchids flourish in conditions with daytime temperatures between 65°F and 75°F and nighttime temperatures in the 55°F to 60°F range. Examples of intermediate orchids include specific types of cattleyas, oncidiums, and dendrobiums. Conversely, warm-growing orchids thrive when daytime temperatures range from 70°F to 90°F and nighttime temperatures fall between 65°F and 75°F. This category encompasses various dendrobium species.

Light requirements vary among orchid species. Dendrobiums thrive in conditions ranging from full sun to light shade, while Cattleyas prefer a shadier environment. However, it's essential to note that all orchids benefit from partial shade, and they are typically susceptible to damage when exposed to direct, intense sunlight.

The majority of orchids do not rely on soil for growth. Many are cultivated using osmunda fiber, which is derived from the roots of a fern found in the Pacific and Australia. Alternatively, fresh pine bark, peat, perlite, and vermiculite are employed in various combinations. Some orchids can even flourish in a mixture of pebbles and bark. Orchids exhibit a greater tolerance for windy and airy conditions compared to excessively moist surroundings.

Orchids have a relatively slow growth rate and typically necessitate repotting every two years, following the flowering period and during the emergence of new growth in the spring through the fall.

- 1. Repotting Cattleya and Other Sympodial Orchids:** Cattleya and other sympodial orchids like Laelia, Dendrobium, and Oncidium should undergo repotting when the rhizome of the plant extends beyond the pot's edge or when the potting medium significantly decomposes, leading to poor drainage. Orchids tend to thrive when they are somewhat snug within their pots, accommodating only a few years' worth of growth, which promotes optimal flowering and development. It is crucial to refrain from repotting orchids that are currently in bloom, regardless of any apparent need. Instead, it is advisable to wait until they have completed their flowering phase and new growth becomes visible before undertaking the repotting process.
- 2. Potting Medium Recipe:** Various materials are frequently employed, including tree fern fiber, sphagnum moss, fine-grade fir bark (at approximately 1/4 inch in size), and commercial peat moss mixes. Particularly, the peat moss mixes have proven to be advantageous when used with seedling flats. Commercial mixes, in general, tend to be free of pests. It's also advisable to select brands that incorporate a wetting agent within the mix. This inclusion facilitates enhanced water absorption by the peat moss.
- 3. Selecting a Suitable Pot:** Container size plays a crucial role because most orchids tend to flower more successfully when they are kept moderately pot-bound. For sympodial orchids, it is advisable to select a container that accommodates the plant just adequately. If the pot is too large, it can lead to root rot due to excessive moisture retention within the medium.

Plastic pots, being lightweight and cost-effective, retain moisture for more extended periods. On the other hand, clay pots tend to facilitate quicker drying of the potting medium. Nevertheless, clay pots are preferred for two specific reasons: firstly, they provide the necessary weight to anchor bulky orchids with substantial top growth, preventing them from toppling over, and secondly, their porous nature allows for faster drying, aiding in the prevention of root rot by enhancing air circulation within the root zone.

If it becomes necessary to reuse a pot, soak it for 1 to 2 hours in a solution of hot soapy water containing chlorine bleach (with a ratio of 1 part bleach to 9 parts water). Afterward, scrub it thoroughly, rinse it well, and allow it to dry. In the case of clay pots, the drying period should extend for at least 2 days to ensure complete outgassing of chlorine, which can be detrimental to the roots.

4. **Remove the Plant from the Pot:** Orchids that require repotting exhibit root growth solely from the part of the plant that will continue to grow and produce flowers. As a result, they need to be carefully removed from the pot while keeping their root system intact.
5. **Break the Pot if Necessary:** When dealing with a clay pot, gently break it using a hammer, ensuring the hammer head is positioned alongside the living roots but not directly on them. For plastic pots, if required, carefully cut the pot away from the roots. Subsequently, delicately slide the pot fragments out from under the roots. This procedure should be repeated until all the roots are completely detached from the pot. It's essential to exercise caution to prevent any damage to the root tips, as these serve as the growth points for the roots.
6. **Remove and Discard all the Old Potting Medium:** Effort should be made to eliminate the old potting medium by gently shaking the plant and extracting any fragments of bark, all the while ensuring that no harm comes to any living plant tissue. Additionally, it's possible to wash out remnants of the old potting medium using lukewarm water. It's important to emphasize that the old potting medium should not be reused.
7. **Identifying the Youngest Pseudobulbs:** Signs of youthful portions of the plant that are poised to grow and flower include the presence of swollen buds or the emergence of new shoots from the base of existing pseudobulbs, well-developed green pseudobulbs, and the presence of robust, white roots.



Green pseudobulb New shoot & white healthy roots below it

8. **Separate Sections with Living Pseudobulbs:** Gently separate the rhizomes by hand, ensuring that each section retains a minimum of three young pseudobulbs (equivalent to three sets of stems with leaves). It's important to note that any section with fewer than three pseudobulbs is unlikely to thrive.

9. **Discard Old Sections:** Dispose of any portions of the plant that are devoid of healthy roots and do not exhibit robust, budding growth or emerging shoots. Additionally, eliminate healthy sections that possess less than three well-established pseudobulbs.
10. **Keep only the Young Healthy Sections:** Keep sections with 3 or more healthy pseudobulbs.
11. **Remove Dead Roots and Shoots:** Utilizing a fresh razor blade or sharp pruning shears, excise all deceased tissue from the roots. If uncertain about the vitality of a particular root, cautiously apply gentle pressure to it. Dead roots will appear hollow when compressed or have a wiry appearance, whereas live tissue will remain solid. In the event that an entire root is confirmed to be deceased, it should be entirely removed.
12. **Remove Dried Leaf Sheaths:** With your hands, carefully remove the papery, tan, or brown sheaths that encase the pseudobulbs, taking care not to harm the pseudobulbs themselves. This process of peeling away the dead tissue serves to enhance the plant's aesthetic and eliminates hiding spots for insects. It's important to note that this task can be performed at any time, not solely during the repotting process.
13. **Apply Cinnamon to all Cuts and Abrasions (optional):** Many orchid growers have found that cinnamon has anti-bacterial and anti-fungal properties which reduces the chance of rots developing at the cuts.
14. **Prepare the Pot:** Cover the bottom of the pot with a thin layer of the premixed potting medium.
15. **Position the Rhizomes in the Pot:** Arrange the most mature section of each clump along the pot's side, allowing the new growth to spread inward and progress across the pot as it develops. Ensure that the new buds are situated slightly above the level of the potting medium. Each cluster of stems can be either potted individually in appropriately sized containers or combined together in a single pot. Consolidating the clumps in a shared pot promotes the generation of additional new pseudobulbs, leading to a more impressive floral presentation during the blooming period.
16. **Fill with Potting Medium:** Gently introduce or press the potting mixture into the voids surrounding the roots, ensuring that no air pockets remain. Proceed until the potting medium's level is slightly below the rhizomes, while still leaving the new buds exposed.
17. **Staking:** This step involves using a stake, string, or thin twine, along with scissors. It's advisable to use green string or twine, as it blends in more effectively with the green foliage. To provide stability to the plant, insert a stake into the pot's side, positioning it opposite the new growth. Attach the string or twine to the stake and proceed to wrap it around the tops of the pseudobulbs, specifically where the leaves emerge. Securely tie it off at the stake and trim any excess twine. It's important not to fasten the plant too tightly.
18. **Install Rhizome Clips:** Metal rhizome clips serve to provide additional support to the plant as new roots develop. Place a clip lengthwise on top of the potting medium in the vacant areas between pseudobulbs. Ensure that the clip's end rests on the pot's rim, and

then secure it by gently hammering it down onto the pot's rim. If necessary, repeat this process in another section of the pot. Depending on the pot's size, you may require two clips, although a smaller plant typically only needs one clip for stability.

**19. Firm the Potting Mix:** Once the rhizome clips are firmly in place, position the handle end of a screwdriver against an area of the potting medium that is devoid of plants. Gently tap the other end of the screwdriver with a hammer. This step is essential to remove any air pockets within the potting medium and enhance the plant's stability. If there are any depressions on the surface of the potting medium, fill them with additional potting medium and tamp it down using the screwdriver and hammer.

**20. Water:** Following repotting, it's crucial to provide the plant with a thorough watering. It's advisable to use tepid water at room temperature, particularly for tropical plants. If the tap water isn't overly cold, it can also be used. An effective method is to immerse the entire plant, including the pot, in a bucket of tepid water for about an hour. It's important to avoid cold water as it can harm the roots. Similarly, ice can lead to damage to the roots and stems, potentially causing root rot and eventual plant demise, much like the effect of early spring frost on tender outdoor plants. Additionally, when watering, ensure thorough saturation of the entire potting medium, allowing it to drain completely. Any excess water in the drip pan should be discarded.

## 21. Pests and Diseases

- **Slugs and Snails:** Slugs and snails chew round holes in the young plant parts and also attack root tips. Placing slug pellets in the pots and on ground and application of Metaldehyde 6% @ 0.7 g/ sq.m.
- **Mites:** They suck the sap from underside of the leaves and cause slight deformation and silvery discolouration of the leaves. They can be controlled by spraying fresh water and spraying Karathane (0.5ml/lit) or Kelthane (1ml/lit).
- **Caterpillar:** It attacks occasionally on young leaves and flowers. Spraying with Lannate (1g/lit) or Metasystox (1ml/lit) can control them.
- **Aphids or Scale Insect:** Aphids can be recognized by the presence of whitish deposits on the plants, while brown scales manifest as oval lumps both on the surface and beneath the leaves. These insects secrete a sticky substance that, over time, attracts black molds, resulting in a blackened appearance on the affected plants.

To manage and control aphids and scale insects, several measures can be taken. These include raking the area around the plants, applying Thimet (2g per pot) to the soil, and utilizing Dimethoate (2ml per liter) through spray applications.

- **Sciaridae (Fungal gnats):** Larvae attack the root. They are controlled by hanging of yellow sticky pads and spraying with Decis @ 0.5ml/lit or Lannate @ 1.5g/lit.



- **Spider mites and thrips** also attack orchids which cause purple spots on leaves and scraping of the leaves respectively.
- **Damping off** The issue of damping off is persistent. When seedlings start to exhibit symptoms like browning and excessive moisture, it's essential to take action. Isolate the affected composts from the healthy ones and apply a thorough fungicide treatment to address the problem.
- **Root Problems:** This condition typically arises when there are significant fluctuations in nutrient and water levels, as well as fluctuations in substrate temperature. Overwatering and inadequate drainage can also lead to root necrosis. When the roots are unable to supply sufficient water and nutrients to the plants, the edges of the leaves become weaker and lose their vibrant color. Preventing fluctuations in nutrient and water quality is essential to address root-related issues.

**22. Harvesting and Yield:** The spikes should be collected when all the flowers are fully open. A standard spike should have no fewer than 8 flowers. Dendrobium orchids should be harvested when they are at the 75% bloom stage. For Cattleya orchids, flowers should be collected 3-5 days after they split. During the first harvest, the plant will yield only one spike, but this number gradually increases to three in subsequent harvests.

**23. Post Harvest Management:** After harvesting stems are kept in bucket containing water and stored under a temperature between 7 to 10°C. The vase life varies between 5 days to 6 weeks depending on climate and variety. The flowers are packed in single used boxes that have dimensions of 100x15x11.5cm. Depending on the number of flowers per stem, 25 to 30 stems are packed per box.

## VIII. CONCLUSION

Odisha is a state with a lot of potential for growing and selling flowers. Since agriculture employs 76% of Odisha's entire population, floriculture offers the state's citizens plenty of employment opportunities in addition to benefits to farming. The state has a tropical climate with warm temperatures, high humidity, moderate to heavy precipitation, and brief, mild winters. Combined with a enough supply of water is ideal for flower plantations, and its popularity is growing daily to satisfy both the state's business owners' and the nation's domestic need. Most flowers grown in Odisha are roses, marigolds, tuberose, jasmine, lotus, champa, kewda, etc. However, businesses in the floriculture industry are drawn to the steady transition away from traditional flower plantations and toward the production of cut flowers and underutilized flowers for export for landscaping. Underexploited exotic flower crops mostly include rhizomatous flower crops like Iris, Canna, Lily of The Valley, Heliconia and some Sympodial orchids, which fetches higher price as cut flower, pharmaceutical input; vegetative parts can be used as fodder which is having high nutritional content. Besides, taking these as sole crop, the farmer can use it as intercrop in commercial fruit orchards which aids in overall income from the crop. For example, Heliconia can be taken up as intercrop in coconut orchard. The above discussion emphasizes on cultivation aspects of rhizomatous ornamental crops which can create awareness among the farmers for smooth

cultivation of them and promotion of floriculture as a revenue earning and employment device of the state.

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