

Advanced Production Technology of Periwinkle

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Abstract

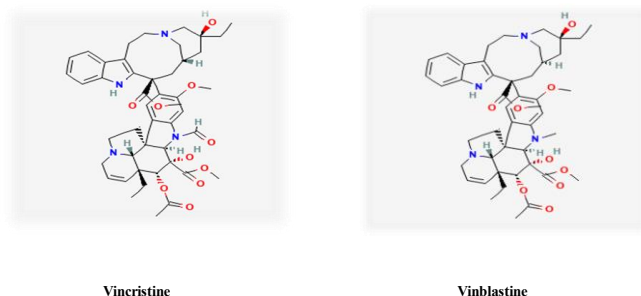
Periwinkle (*Catharanthus roseus* (L.) G. Don is a valuable medicinal plant containing anti-cancer alkaloids like vinblastine and vincristine. Native to the West Indies, it is now cultivated worldwide for its therapeutic compounds. This article covers advanced production methods for periwinkle, including climate needs, field preparation, varieties, nutrients, irrigation, pest management, harvesting, post-harvest handling, quality control, and marketing.

Introduction

Periwinkle (*Catharanthus roseus* (L.) G. Don is a medicinally important plant renowned for its valuable anti-cancer alkaloids like vinblastine and vincristine present in the leaves and roots. Originally native to the West Indies, this plant belonging to the Apocynaceae family is now widely cultivated across tropical and subtropical regions globally to meet the growing pharmaceutical demand for its therapeutic compounds. With increasing applications in cancer treatment, periwinkle cultivation has emerged as a thriving agricultural industry. Implementing advanced production technologies is crucial to ensure optimal growth, yield, and quality of the alkaloid-rich periwinkle crop.

Chemical Constituents and Medicinal Uses

Periwinkle is rich in terpenoid indole alkaloids like vinblastine, vincristine, vindesine, and vinleurosine. The major alkaloids vinblastine and vincristine are potent anti-cancer agents used to treat various cancers like lymphoma, leukemia, breast cancer by disrupting cell division and tumor growth. The plant also contains other bioactive compounds with antioxidant, antimicrobial, and anti-hypertensive properties. The alkaloid composition varies based on the variety, growing conditions, and growth stage, necessitating advanced production techniques for optimal yields and quality.



Vincristine

Vinblastine

Fig 1. Chemical structure of Vincristine and Vinblastine

Soil and Climatic Requirements

Periwinkle can be cultivated in a wide range of soil types, including sandy loam, clay loam, and laterite soils. However, it thrives best in well-drained, fertile soils with a pH range of 6.0 to 7.5. The crop requires a warm and humid tropical climate for optimal growth, with temperatures ranging from 25°C to 30°C. Periwinkle is a tropical plant and cannot tolerate frost or freezing temperatures, which can severely damage or kill the plant.

Soils with good water-holding capacity and adequate drainage are ideal for periwinkle cultivation. Heavy clay soils or waterlogged conditions should be avoided as they can lead to poor growth and root rot. Incorporating well-decomposed organic matter, such as farmyard manure or compost, can improve soil structure, fertility, and water-holding capacity, thereby enhancing plant growth and alkaloid production.

Field Preparation and Planting

Proper field preparation is crucial for successful periwinkle cultivation. The land should be deeply ploughed and harrowed to achieve a fine tilth, ensuring good aeration and water infiltration. Well-decomposed farmyard manure or compost can be incorporated into the soil during land preparation to improve soil fertility and structure.

Periwinkle can be propagated through two methods: seed propagation or vegetative propagation.

For seed propagation, the seeds are sown in well-prepared nursery beds, and the seedlings are transplanted to the main field after 4-6 weeks, when they have developed 4-6 true leaves. Alternatively, vegetative propagation involves planting stem cuttings of about 15-20 cm length directly in the field or in nursery beds. Vegetative propagation ensures uniform growth and true-to-type characteristics of the desired variety.

The planting distance varies depending on the cultivation method and variety. For transplanted seedlings, a spacing of 60 cm x 45 cm or 75 cm x 45 cm is recommended, while for direct-sown crops, a spacing of 45 cm x 30 cm or 60 cm x 30 cm is suitable. Proper spacing ensures adequate air circulation, light penetration, and nutrient uptake, leading to optimal growth and alkaloid production.

Varieties

Several high-yielding and alkaloid-rich varieties of periwinkle have been developed through breeding programs at various research institutions. Some notable varieties include:

1. Prabal: Developed by the Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, India, this variety is known for its high yield and alkaloid content, particularly vincristine.
2. Dhawal: Another variety developed by CIMAP, Lucknow, Dhawal is characterized by its high vinblastine content and good yield potential.
3. Nirmal: Also developed by CIMAP, Lucknow, this variety is appreciated for its high alkaloid content and resistance to various biotic and abiotic stresses.
4. Arka Pahit: Developed by the Indian Institute of Horticultural Research (IIHR), Bengaluru, this variety is known for its high yield and adaptability to different agro-climatic conditions.
5. Arka Nidhi: Another variety from IIHR, Bengaluru, Arka Nidhi is valued for its high alkaloid content and resistance to various diseases.

The selection of the appropriate variety should be based on factors such as local climatic conditions,

soil type, and the specific alkaloid requirements of the intended market or pharmaceutical application.

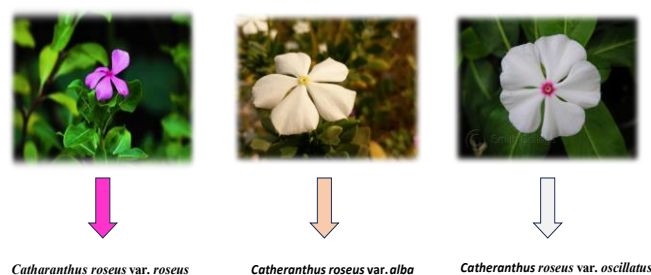


Fig 2. Species of periwinkle

Manures, Fertilizers, and Irrigation

Periwinkle is a heavy feeder and requires adequate nutrient supply for optimal growth and alkaloid production. A recommended dose of fertilizers, including nitrogen, phosphorus, and potassium, should be applied based on soil test results and local recommendations. Typically, a balanced NPK ratio of 120:60:60 kg/ha or 150:75:75 kg/ha is suitable for periwinkle cultivation.

In addition to inorganic fertilizers, organic manures like well-decomposed farmyard manure or vermicompost can be incorporated into the soil to improve soil fertility and structure. These organic amendments not only provide essential nutrients but also enhance soil water-holding capacity, aeration, and microbial activity, leading to better plant growth and alkaloid production.

Periwinkle has moderate water requirements and can be grown under rainfed conditions in areas with adequate and well-distributed rainfall. However, in dry regions or during prolonged dry spells, supplemental irrigation is necessary for optimal growth and yield. Drip or sprinkler irrigation systems are recommended for efficient water use and uniform distribution, minimizing water losses through evaporation and deep percolation.

The frequency and amount of irrigation should be adjusted based on factors such as soil type, climatic conditions, growth stage of the crop, and water availability. Overwatering should be avoided as it can lead to waterlogging, root rot, and other soil-borne diseases, ultimately affecting plant growth and alkaloid production.

Pest and Disease Management

Periwinkle is relatively resistant to pests and diseases compared to other crops. However, some common problems include root-knot nematodes, leaf miners, and fungal diseases like leaf spot and root rot. Implementing integrated pest management (IPM) practices is crucial for effective pest and disease management in periwinkle cultivation.

Root-knot nematodes (*Meloidogyne spp.*) are soil-borne pests that can cause significant damage to periwinkle roots, leading to stunted growth, wilting, and reduced yields. Cultural practices like crop rotation with non-host crops, incorporating organic amendments like neem cake, and using bio-nematicides or nematode-resistant varieties can help manage this pest.

Leaf miners (*Liriomyza spp.*) are insect pests that create tunnels or mines within the leaf tissues, causing discoloration and drying of leaves. Regular monitoring and timely application of neem-based insecticides or release of parasitoids like *Diglyphus isaea* can effectively control leaf miners.

Fungal diseases like leaf spot (caused by *Alternaria spp.*, *Cercospora spp.*, or *Colletotrichum spp.*) and root rot (caused by *Rhizoctonia solani*, *Fusarium spp.*, or *Pythium spp.*) can also affect periwinkle cultivation. Maintaining proper soil drainage, avoiding excessive moisture, and using disease-resistant varieties or biological control agents like *Trichoderma spp.* can help manage these diseases.

Regular field monitoring, crop rotation, maintaining good soil health, and implementing cultural, biological, and chemical control measures (as a last resort) are essential components of an effective IPM strategy for periwinkle cultivation.

Harvesting and Post-Harvest Handling

Periwinkle is a perennial crop, and the leaves and roots can be harvested multiple times a year. The optimal time for harvesting is when the plant has reached the flowering stage, as this is when the alkaloid content is highest. However, it is essential to follow the recommended harvesting intervals to ensure sustainable yields and maintain the plant's vigor.

The leaves and roots are typically harvested separately. Leaf harvesting is done by hand, carefully plucking or cutting the mature leaves from the plant, leaving behind the younger leaves and growing tips. Root harvesting is more labor-intensive and involves uprooting the entire plant, separating the roots, and replanting the shoot portions for subsequent harvests.

After harvesting, the plant material must be handled with care to preserve the alkaloid content and quality. The leaves and roots are typically dried in the shade or using mechanical driers to reduce the moisture content to around 10%. Proper drying is crucial to prevent fungal growth and deterioration of the alkaloids.

Once dried, the plant material is graded based on quality parameters like color, aroma, and size. The graded material is then packed in airtight containers or polybags to prevent moisture absorption and deterioration. Proper storage conditions, such as cool and dry environments, are essential to maintain the quality and potency of the alkaloids for an extended period.

Irrigation Management

Proper irrigation management is crucial for optimal growth, yield, and alkaloid production in periwinkle cultivation. The crop requires frequent, light irrigations during the establishment phase and after each harvest to promote new growth and sustain alkaloid production.

Drip or sprinkler irrigation systems are preferred for efficient water use and uniform distribution. These systems minimize water losses through evaporation and deep percolation, ensuring that the water reaches the root zone effectively.

The amount and frequency of irrigation should be carefully determined based on factors such as soil type, climatic conditions, growth stage of the crop, and water availability. Overwatering should be avoided as it can lead to waterlogging, root rot, and other soil-borne diseases, ultimately affecting plant growth and alkaloid production.

Advanced irrigation scheduling techniques, such as soil moisture sensors or evapotranspiration-based methods, can be employed to optimize water

use efficiency and ensure that the crop receives the right amount of water at the right time.

Quality Control and Standardization

To ensure the quality and consistency of the alkaloids produced, it is essential to follow good agricultural practices (GAP) and good manufacturing practices (GMP) throughout the cultivation, harvesting, and post-harvest handling processes. Standardization of production processes, including seed or planting material selection, cultural practices, and post-harvest handling, is crucial for maintaining product quality and meeting industry standards.

Quality control measures, such as regular monitoring of alkaloid content, moisture levels, and contaminants, should be implemented throughout the production chain. Advanced analytical techniques like high-performance liquid chromatography (HPLC) or mass spectrometry can be employed to accurately quantify the alkaloid content and ensure consistent quality.

Certification programs, such as organic certification or good agricultural practices (GAP) certification, can also help in ensuring product quality and access to premium markets. These certifications not only attest to the quality and safety of the produce but also provide assurance to consumers and pharmaceutical companies about the responsible and sustainable production practices employed.

Value Addition and Marketing

The dried leaves and roots of periwinkle can be further processed to extract the valuable alkaloids, such as vinblastine and vincristine, for use in pharmaceutical products. The extraction process involves various steps, including solvent extraction, purification, and isolation of the desired alkaloids. Advanced extraction techniques, such as supercritical fluid extraction or ultrasound-assisted extraction, can improve the efficiency and yield of the alkaloid extraction process.

The extracted alkaloids can be formulated into different dosage forms, such as injections, tablets, or capsules, for cancer treatment. Collaboration with pharmaceutical companies and research institutions can facilitate the development of novel formulations

and drug delivery systems for improved efficacy and patient compliance.

Apart from the extraction of alkaloids for pharmaceutical applications, periwinkle can also be processed into various value-added products, such as herbal teas, tinctures, and cosmetic preparations. These value-added products can diversify the product range and increase the economic returns for growers and processors.

Effective marketing strategies, including branding, attractive packaging, and exploring new market opportunities, are essential for maximizing the returns from periwinkle cultivation. Collaboration with export promotion agencies, participation in trade fairs and exhibitions, and leveraging e-commerce platforms can facilitate access to domestic and international markets for periwinkle products.

Conclusion

Advanced production techniques, including proper soil and climatic conditions, field preparation, varietal selection, nutrient management, irrigation strategies, integrated pest and disease management, harvesting protocols, and post-harvest handling procedures, are crucial for achieving high yields and maintaining the quality of periwinkle alkaloids. Quality control, standardization, value addition, and effective marketing strategies are also essential for enhancing the economic returns from periwinkle cultivation and meeting the growing demand for its valuable medicinal compounds.

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