Production Technology of Plumbago: A Practical Guide

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ABSTRACT

Plumbago spp. is an important group of medicinal plants belonging to the family Plumbaginaceae, widely used in traditional systems of medicine such as Ayurveda and Unani. The roots are the primary economic and therapeutic parts, containing key bioactive compounds like plumbagin, sitosterol and pelargonidin, which exhibit diverse pharmacological activities including antimicrobial, anti-inflammatory and cytotoxic effects. Among the major species, *Plumbago rosea, Plumbago zeylanica* and *Plumbago auriculata* are widely recognized for their medicinal and ornamental significance. The plant is used in the treatment of various ailments such as skin diseases, digestive disorders, respiratory conditions, and metabolic imbalances. Cultivation of Plumbago requires warm, humid tropical to subtropical climates with well-drained, organic-rich soils and partial shade. Propagation is commonly carried out through semi-hardwood stem cuttings, followed by proper land preparation, nutrient management, irrigation, and intercultural operations. The crop is ready for harvest within 12–18 months, yielding about 7–10 t/ha under good management practices. Post-harvest curing is essential to reduce plumbagin toxicity. However, the crop is prone to pests like semi-loopers and diseases such as root rot and leaf

spot, which require effective management strategies.

INTRODUCTION

Plumbago spp., commonly known as Plumbago, belongs to the family Plumbaginaceae and represents an important group of medicinal plants widely used in traditional systems of medicine. The root is the principal economic and therapeutic part of the plant and is considered the official drug. It contains major bioactive constituents such as plumbagin and pelargonidin, which contribute to its pharmacological properties. However, due to its potent nature, the root is utilized only after proper curing and purification to ensure safety and efficacy (KAU, 2016). Plumbago plays a significant role in various classical Ayurvedic formulations, including Citrakasavam and Yogarajachurna, where it is valued for its medicinal applications.

Active ingredient present in *Plumbago*

- Plumbagin and Sitosterol- present in roots
- Pelargonidin- present in flowers

Chitrak root is characterized by the presence of plumbagin, a yellow, crystalline and bitter active principle with a melting point of 72 °C. Research indicates that plumbagin possesses significant reproductive pharmacological activities, specifically acting as an anti-implantation, abortifacient, and antiovulatory agent. At the cellular level, it functions as a potent mitotic inhibitor; while it behaves as a spindle poison at lower concentrations, higher doses elicit radiomimetic, nucleotoxic, and cytotoxic effects. Furthermore, the compound exhibits a broad therapeutic spectrum, including documented antibacterial, antifungal, and anticoagulant properties (Joy *et al*., 1998).

Uses:

The therapeutic profile of *Plumbago zeylanica*, traditionally known as Chitrak, encompasses a broad range of clinical applications, including the treatment of leprosy and the remediation of vitiated *kapha* and *vata* doshas. In obstetric medicine, the plant is utilized to manage postpartum hemorrhage, while its systemic benefits extend to acting as a liver cleanser that promotes the healthy metabolism of dietary fats and sugars. These bioactivities are largely attributed to its primary constituent, plumbagin, which demonstrates a distinct dose-dependent pharmacological behavior. At lower concentrations, plumbagin functions as a mitotic inhibitor, specifically acting as a spindle poison; however, at higher concentrations, it exhibits more aggressive radiomimetic, nucleotoxic, and cytotoxic effects. Furthermore, the root extract possesses documented antibacterial, antifungal, and anticoagulant properties, underscoring its multifaceted potential in both traditional and modern medicine (Joy *et al*., 1998).

Major Species of Plumbago

1. *Plumbago. rosea* Linn.

Plumbago rosea Linn. (syn. *Plumbago indica*), commonly known as red chitrak, is believed to have originated along the Coromandel Coast of India. It is widely distributed throughout the country, occurring in moist habitats and also cultivated for its medicinal importance.

The plant possesses a broad therapeutic profile and holds a prominent place in traditional medicine. It is extensively used in the management of skin disorders such as leprosy and leucoderma and is considered effective in balancing vitiated *kapha* and *vata* doshas. In respiratory ailments, it is employed in the treatment of cough and bronchitis by alleviating inflammation of the bronchial mucous membranes. Its gastrointestinal applications include the treatment of indigestion, haemorrhoids, and helminthic infections, along with its role as a liver stimulant in conditions like hepatosplenomegaly. The principal bioactive compound, plumbagin, exhibits dose-dependent pharmacological activity; at lower concentrations, it acts as a mitotic inhibitor and spindle poison, whereas at higher concentrations it demonstrates radiomimetic, nucleotoxic, and cytotoxic effects. Additionally, the root extract shows significant antibacterial, antifungal, and anticoagulant properties, and is used in managing conditions such as toothache, scabies, elephantiasis, anaemia, and amenorrhoea.

Morphologically, *Plumbago indica* is a semi-woody shrub attaining a height of about 1.5–2.0 m, with alternate leaves and a well-developed tuberous root system. The plant bears terminal or axillary raceme inflorescences with characteristic red-coloured flowers. The roots are rich in bioactive compounds such as plumbagin and sitosterol glucoside, contributing to their medicinal value, particularly in the treatment of leucoderma. Clinical observations have indicated that plumbagin-based preparations may be effective against common warts. Furthermore, the root exhibits strong sialogogue activity, stimulating salivary secretion, and also acts as a vesicant when applied externally, causing localized blistering.

2. *Plumbago zeylanica*

Plumbago zeylanica, commonly known as white-flowered leadwort in English, chitraka in Sanskrit and chitrakamuli in Kannada, is widely distributed across peninsular India and is particularly abundant in West Bengal. The species holds considerable importance in traditional systems of medicine such as Ayurveda and Unani. The root is the principal medicinal part and is known for its potent uterine stimulant properties, while both the root and fruits exhibit anti-implantation activity. It is widely used for its appetiser, sudorific, vesicant, diuretic, and caustic properties. Additionally, it functions as an antidiarrheal agent and is employed in the treatment of phlegmatic tumours and pain.

Externally, the root is applied in the management of leprosy, piles, anasarca, influenza, abscesses, aphthae, and chronic skin diseases. The juice is used topically for treating scabies and ulcers, while the leaves are valued for their antirheumatic properties.

The roots of *Plumbago zeylanica* contain important naphthoquinones, among which plumbagin is the major bioactive compound responsible for its pharmacological activities. Other constituents include 3-chloroplumbagin and droserone. These compounds are primarily concentrated in the root bark and exhibit significant antimicrobial and anti-inflammatory properties.

Morphologically, *Plumbago zeylanica* is a branched undershrub characterized by long, tuberous roots and a striate stem. The leaves are simple, alternate, and short-petioled, typically ovate or ovate-oblong with an acute apex and entire or slightly wavy, glabrous margins. The white flowers are arranged in terminal spikes, with a tubular, glandular-hairy calyx. The corolla consists of a slender tube with a five-lobed, rotate limb, and the slender style terminates in five stigmatic branches. The fruit is a membranous capsule enclosed within the persistent calyx.

3. *Plumbago auriculata* Lam.

Plumbago auriculata Lam., commonly known as blue-flowered leadwort and referred to as *Neelakotuveli* in Malayalam, is a widely cultivated ornamental plant grown in gardens across India. Native to the Cape Province of South Africa, the species has become well adapted to Indian agro-climatic conditions and is extensively valued for its ornamental as well

as medicinal significance. It is commonly planted as a hedge or landscape shrub due to its profuse flowering and aesthetic appeal. In traditional systems of medicine, the plant is used as a constituent in various Ayurvedic preparations, although its medicinal importance is comparatively less than that of *Plumbago zeylanica* and *Plumbago rosea*. The roots contain bioactive compounds such as plumbagin, which contribute to its pharmacological properties, including antimicrobial and anti-inflammatory activities. In folk medicine, it is occasionally used for treating skin diseases and minor infections.

Morphologically, *Plumbago auriculata* is a perennial, evergreen subshrub that typically grows to a height of about 1–3 m, often exhibiting a spreading or semi-climbing growth habit. The stems are slender, branched, and somewhat woody at the base. The leaves are simple, alternate, and vary from oblong to oblanceolate or elliptic to obovate in shape, with a smooth surface and entire margins. The inflorescence is arranged in terminal clusters or racemes, bearing attractive sky-blue to violet flowers. The flowers possess a narrow tubular calyx and a five-lobed corolla, along with five stamens, giving them a distinctive appearance. Both flowers and fruits may occur in clusters of up to 12. The fruit is a small capsule enclosed within the persistent calyx.

Climate and Soil

The cultivation of Plumbago requires a warm, humid tropical to subtropical climate and thrives best in deep, well-drained soils. In its natural habitat, the plant prefers moist soil rich in organic matter and grows well under partially shaded conditions. Open and excessively sunny environments are generally unfavourable, as the crop performs better in protected situations. It can be cultivated either as a sole crop or as an intercrop, particularly with coconut.

Propagation

Propagation is carried out using single, double or three-node semi-hardwood stem cuttings. For raising planting material, cuttings of 10–

15 cm length with at least three nodes are collected from mother plants during March or April. Alternatively, shoots obtained from an existing crop at the end of the first year can also be used. These cuttings are planted in nursery beds of convenient length and about 1 m width for proper rooting.

Land Preparation

The field is ploughed two to three times to obtain a fine tilth. Ridges approximately 30 cm in height are then formed at a spacing of 50 cm. Two- to three-month-old rooted cuttings are transplanted during June or July at a spacing of about 15 cm on these ridges (KAU, 2016).

Manures and Fertilizers

Nutrient management plays an important role in crop growth and yield. Well-decomposed cattle manure or compost is applied at the rate of 10 t ha^{-1} as a basal dose. Fertilizers are applied in the form of N, P_2O_5, and K_2O at 50:50:50 kg/ha, while for Plumbago zeylanica, a recommendation of 30:30:30 kg/ha is also followed. The full dose of phosphorus (P_2O_5) is applied as a basal application, whereas nitrogen and potassium are given in two split doses at 2 and 4 months after planting (MAP) (KAU,2016).

Irrigation

Irrigation is not required during the rainy season. However, during dry periods, irrigation is provided four to five times, typically in November, January, March, April, and May. Flat or flood irrigation with about 2 cm of water per irrigation is sufficient for optimal crop growth.

Intercultural Operations

Intercultural practices include regular weeding, which should be carried out two or three times depending on weed growth. Earthing up is done twice along with the topdressing of fertilizers. For the management of nematodes such as *Meloidogyne incognita* and *Radopholus similis* associated with Chethikoduveli, application of *Pseudomonas fluorescens* at 10 g per plant at the time of transplanting rooted cuttings is recommended.

Harvesting

The crop becomes ready for harvest approximately 12 to 18 months after planting. The root tubers are carefully dug out and thoroughly cleaned by washing in water before marketing. Since the roots contain plumbagin, which can cause a severe burning sensation upon contact with the skin, it is essential to wear gloves during handling.

Yield

Under good management practices, Plumbago yields about 7–10 t/ha.

Post-Harvest Operations

Post-harvest processing involves cutting the harvested roots into pieces of about 10 cm length and curing them to reduce excess plumbagin content. This is done by immersing the root pieces in a 3–4% lime solution for 2 to 3 hours, during which the solution turns pink. After each immersion, the roots are washed in clean water, and the process is repeated until the lime water remains clear, indicating adequate removal of plumbagin. The treated roots are then dried and stored.

Diseases and Pests

The crop is susceptible to pests such as semi-looper larvae and Bihar hairy caterpillars,

which cause heavy defoliation and damage to buds and young shoots during the active growth period. These pests can be effectively managed by spraying malathion at the rate of 2 ml per litre of water, applied twice at an interval of 15 days when infestation appears. In addition, the crop is also affected by important diseases such as root rot and leaf spot, which lead to wilting, root decay, and the development of brown or black spots on leaves, ultimately reducing plant vigour and yield. Proper drainage, field sanitation and appropriate fungicidal measures can help in managing these diseases effectively.

CONCLUSION

Plumbago spp. represents a valuable group of medicinal plants with significant therapeutic, economic, and ornamental importance. The presence of potent bioactive compounds such as plumbagin, sitosterol, and pelargonidin contributes to its wide range of pharmacological properties, including antimicrobial, anti-inflammatory, and cytotoxic activities. Major species *like Plumbago rosea, Plumbago zeylanica* and *Plumbago auriculata* play an important role in traditional systems of medicine for the treatment of various ailments. Successful cultivation depends on suitable climatic conditions, proper propagation techniques, balanced nutrient management and effective intercultural practices. Despite its high medicinal value, careful handling and post-harvest curing are essential to reduce toxicity and ensure safe usage. Furthermore, timely management of pests and diseases is crucial for maintaining yield and quality. Overall, Plumbago cultivation offers promising opportunities for sustainable medicinal plant production and supports the growing demand for herbal medicines.

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