

Elucidating the morphology and potential of purple datura (*Datura metel*)

Purple-flowered datura (*Datura metel* L.), a member of the family Solanaceae, is renowned for its potent blend of toxicity and therapeutic value. In India, it is commonly known as *dhatura* and holds immense cultural and religious significance as a sacred offering to Lord Shiva. Unlike other datura species, *D. metel* is distinguished by its characteristic purple pigmentation on the stem. The plant produces spectacular purple or white flowers with strong ornamental potential, while its fruits and seeds possess narcotic, anodyne, and antispasmodic properties. This dual nature—both toxic and medicinal—highlights the delicate balance harnessed in traditional healing systems and underscores the scope for further exploration of its therapeutic applications. Moreover, its ability to thrive under harsh and contaminated environments presents promising opportunities for environmental remediation. The striking double- and triple-whorled cultivars, with their bright purple-white blossoms, also make *D. metel* highly suitable for aesthetic landscaping in uncultivated or degraded lands.

PURPLE datura (*Datura metel* L.) is a striking plant, recognized for its large, trumpet-shaped purple flowers, often tinged with white or yellow. The word “Datura” is believed to have originated from Sanskrit, reflecting its deep roots in Indian tradition.

Deeply embedded in cultural and religious practices, datura holds particular significance as a sacred offering to Lord Shiva. While often feared as a poisonous plant due to the presence of tropane alkaloids such as scopolamine and hyoscyamine, it also possesses notable therapeutic potential when used judiciously and after undergoing detoxification protocols like the Shodhan process described in Ayurveda.

In ancient Indian medical literature, datura finds frequent mention. In the Sushruta Samhita, it is referred to as “Kanaka,”

while Tamil texts name it “Unmattam.” The *Charaka Samhita* records its use in *visha chikitsa* (toxicology) and *kushta chikitsa* (management of skin disorders). Acharya Sushruta and Vagbhata classified it under *Alarkavisha*, describing its role in treating dog bites. In the *Harita Samhita*, datura is included in formulations for managing *Vataja Netra Roga* (eye disorders). Several Nighantus (Ayurvedic Materia Medica texts), including the *Dhanvantari*, *Sodhala*, and *Madanapala* Nighantus, classify it under different pharmacological categories such as *Karaveeradi Varga* and *Abhayadi Varga*.

Belonging to the family Solanaceae, the genus *Datura* comprises around 14 species, of which nearly 10 are found in India. Among these, *D. metel*, *D. innoxia*, P. mill, and *D. stramonium* L. are regarded as the most significant for therapeutic applications. These species



Datura metel plant in flowering stage

typically grow in wastelands, roadsides, and garden margins, thriving even in neglected or harsh environments.

Origin and distribution

Datura metel is distributed globally, particularly thriving in warmer climatic zones. Although traditionally believed to be native to Asia, especially India and southwestern China, recent genetic evidence suggests its origin in the Americas, specifically Mexico and the Greater Antilles. The highest diversity of *Datura* species in North America is observed in Mexico and the southern United States. It is believed that species such as *D. innoxia*, *D. metel*, and *D. ferox* reached South America even before the Columbian era.

Despite its New World origin, *D. metel* is thought to have been introduced to the Indian subcontinent as early as the 2nd century CE. Today, it is widely naturalized across tropical and subtropical India, particularly in roadsides, gardens, and wastelands. *Datura innoxia* native to Mexico, is commonly found throughout Latin America, while *D. stramonium*, native to Europe, North America, and parts of Asia, is found in Kashmir Valley, Himachal Pradesh, hills of Uttar Pradesh, and the northern plains of India. In India, most of the cities with tropical and subtropical climates have naturalized presence of various *Datura* species alongside roads, or in barren lands.

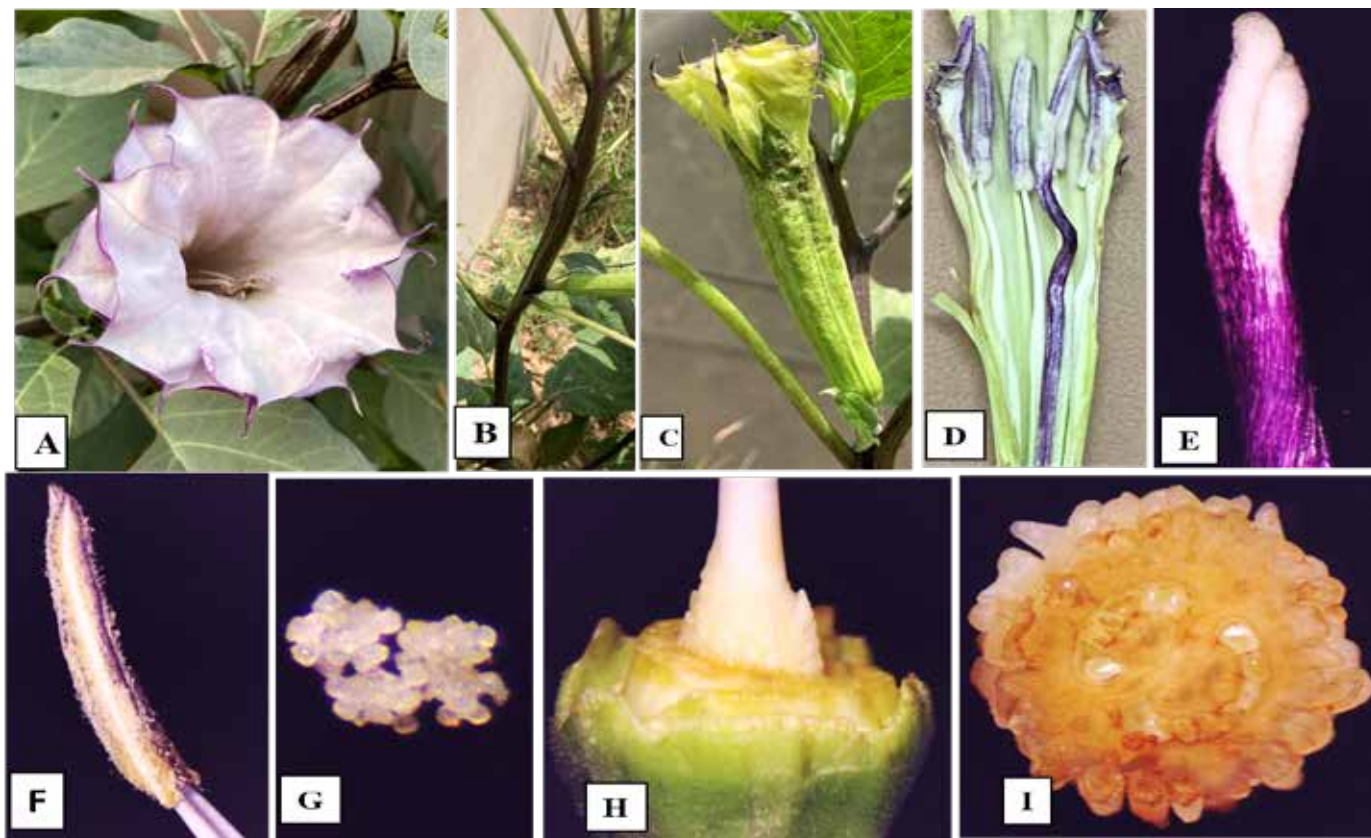
Botanical description

Datura metel is a robust, herbaceous annual or perennial that typically grows up to 1.5 m in height. It exhibits an erect and branching growth habit. The stems are often purplish,

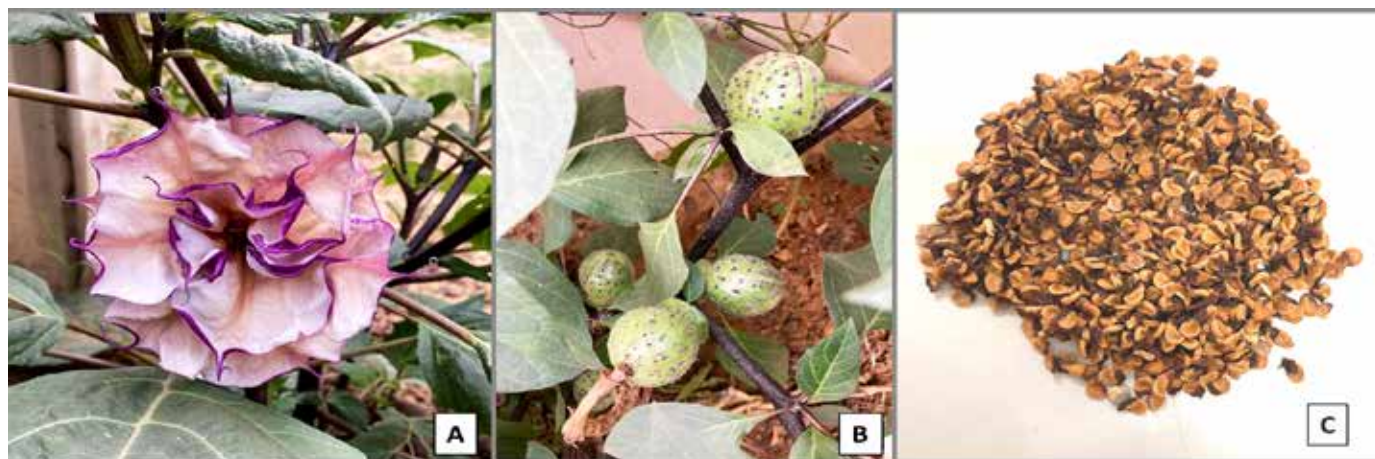
distinguishing it from closely related species. Leaves are arranged alternately, broadly ovate, dark green, and shallowly lobed. They are petiolate with sinuate or dentate margins, ranging from 10–20 cm in length and 5–18 cm in width. Young leaves are glabrous or softly pubescent. The species is characterized by large, fragrant, trumpet-shaped flowers that are solitary and borne in the axils of leaves or at branch forks. The corolla varies in colour—ranging from white and yellow to pale or deep purple—and may be single or multi-whorled. The calyx is tubular and elongates as the flower matures, while the corolla is funnellform or salver-shaped with five stamens and a bilocular ovary. Each ovary chamber is partially divided, creating an incomplete four-locular structure. The fruit is a capsular, egg-shaped structure approximately 4–5 cm in diameter. It is covered with short, blunt spines and exhibits irregular dehiscence through four valves. The capsule is enclosed within the persistent calyx and dries upon maturity. Seeds are numerous, laterally compressed, with a curved embryo—typical of the genus. Cytologically, *D. metel* generally possess $2n = 24$ or 48 chromosomes.

Comparative morphology of related species

Datura stramonium typically has shorter, more branched and spreading stems that lack purplish pigmentation. Its leaves are generally parted or deeply lobed. Flowers are solitary, axillary, purplish on the outside, and whitish inside. The mature fruit is erect and armed with long spines (up to 5 mm in length). *Datura innoxia* plants are distinctively hairy. The whole plant is covered with grey hairs. Flowers are large and white. The leaves are ovate and pubescent. The plant is considered more spreading in growth habit.



Datura metel. A) Fully open flower with purple white corolla; B) Stem with purple pigmentation; C) Flower bud showing purple pigmentation on calyx; D) Epipetalous stamen and pistil; E) Bifid stigma with bright purple style; F) Anther; G) Pollen grains; H) Ovary; I) TS of ovary



Datura metel. A) Fully open flower having double layered corolla; B) Young fruits with purple tubercles; C) Extracted seeds from mature fruits

Morphological characterisation of purple flowered *datura* germplasm

Although *Datura metel* is an introduced species, it is now widely distributed across India. The white-flowered types, which may belong to *Datura metel* or *Datura innoxia*, are the most common, while the purple-flowered variety is comparatively rare in the country.

In 2021, a germplasm of purple-flowered *Datura* was collected from the Alwar district of Rajasthan. The seeds were germinated in plug trays and later transplanted into field beds at ICAR-NBPGR, New Delhi. The collected germplasm was characterized, multiplied, and deposited in the National Genebank for long-term conservation and future utilization. This accession has been allotted the Indigenous Collection number IC0651765.

The plant was characterized based on its morphological traits. It is a herbaceous perennial, growing up to 1.5 m in height, with an erect and branching growth habit. Almost all plant parts, including the stem, petiole, flower, and fruit, displayed distinct purple pigmentation; even the stamens and pistil showed purple coloration.

The corolla was purple-white, funnel-shaped, and double-whorled, giving the flowers a striking appearance. The fruits bore small tubercles, in contrast to the larger spines seen in other *Datura* species. The androecium comprised five polyandrous, epipetalous stamens, while the gynoecium was bicarpellary and syncarpous, with a superior ovary exhibiting axile placentation.

Although *Datura stramonium* also produces purple-shaded flowers, stem pigmentation is a distinguishing

Morphological description of *Datura metel* (IC0651765)

Trait	Description
Plant type	Perennial herbaceous
Plant height	1.2-1.5 m
Leaf shape	Broadly ovate
Leaf type	Simple: alternate, shallowly lobed, and broadly ovate
Leaf length	16-20 cm
Leaf width	10-12 cm
Leaf colour	Dark green
Leaf pubescence	Glabrous
Stem colour	Purple
Stem pubescence	Glabrous
Flower colour	Purple white
Flower type	Solitary, double layered, hermaphrodite
Flower shape	Trumpet-shaped
Fruit shape	Egg shaped
Fruit colour	Green when young, brown when mature
Fruit spines	Small tubercles
Fruit diameter	4.0-4.5 cm
Seed colour	Golden brown

feature unique to *D. metel*. Another important differentiating trait lies in the orientation and morphology of the mature fruits: *D. metel* bears drooping capsules with short tubercles, whereas *D. stramonium* produces erect capsules with long, pronounced spines.

USES AND POTENTIAL OF *DATURA METEL*

Religious significance

In Hindu mythology, *Datura metel* holds profound spiritual significance, particularly in its association with Lord Shiva. Its flowers and fruits are regarded as sacred and are routinely offered during temple rituals, especially on the occasion of *Mahashivratri*. The offering of datura is symbolic, representing the renunciation of negative traits such as bitterness, pride, and toxicity.

In places like the *Kashi Vishwanath* temple in Varanasi, entire marketplaces are dedicated exclusively to the trade of datura fruits for ritual purposes. Historical evidence also highlights its deep-rooted presence in Indian culture. During the Chola dynasty (9th–13th century CE) in southern India, datura flowers became an integral part of Shiva's divine iconography—particularly seen adorning the headgear of Nataraja bronze sculptures. Interestingly, these depictions bear a striking resemblance to modern cultivated varieties, especially those with double- or triple-layered corollas.

Traditional medicinal uses

All parts of the *Datura metel* plant—including flowers, seeds, leaves, and roots—are valued in traditional medicine. The plant is rich in tropane alkaloids, with scopolamine being the most prominent, known for its potent psychotropic properties. Historical records, such as the Chinese *Compendium of Materia Medica*, document its early use as an anaesthetic. In addition, the presence of withanolides throughout the plant contributes to a wide range of therapeutic effects.

Traditionally, *D. metel* has been employed in the management of various ailments, including epilepsy, skin disorders, hysteria, febrile catarrh, insanity, cardiac conditions, and diarrhea. In complementary and alternative medicine, it has been used to treat asthma, relieve pain during bone setting, and serve as an anaesthetic in minor surgical procedures effects largely attributed to its hallucinogenic and anticholinergic properties. In Ayurveda, *D. metel* is classified under the "*Upavisha Varga*" (secondary toxic plants). Consequently, it is administered only after undergoing detoxification (*Shodhana*), ensuring its safe incorporation into medicinal formulations.

Applications in commercial medicine

Datura metel is an active ingredient in several ayurvedic and homeopathic medicines. One such Ayurvedic formulation, *Kanakasava*, addresses respiratory issues such as asthma and chronic coughing. It combines *Datura* with other herbs like *Adhatoda vasica*, *Woodfordia fruticosa*, and *Vitis vinifera*. In Unani medicine, the preparation *Habb-e-Zeequn Nafas* (HZN), incorporating *D. metel*, is used for asthma treatment. Furthermore, in homeopathy, Dr

Willmar Schwabe's *Datura Metel Mother Tincture* is used for respiratory conditions, skin ailments, rheumatic pain, and fever, providing both internal and topical relief.

Agricultural and environmental potential

Apart from its medicinal and cultural significance, *Datura metel* has great potential as ornamental and environmental remediation. The plant's vivid, ornamental blooms—particularly in double and triple-flowered cultivars—make it suitable for aesthetic landscaping in uncultivated or degraded lands. Moreover, its hardiness enables it to thrive in contaminated soils, where it can assist in phytoremediation of heavy metals like cobalt (Co) and nickel (Ni). Studies have highlighted its bio-pesticidal properties, showing efficacy against pests such as red ants, grasshoppers, and *Helicoverpa armigera* larvae. It has been identified as a phytomonitor species capable of indicating metal content in soils.

Toxicity and precautions

In datura, the therapeutic window between beneficial and toxic doses is narrow, warranting extreme caution in its use and handling. Its leaves and seeds, rich in alkaloids like daturine and potassium nitrate compounds, can be fatal if consumed raw or without proper detoxification. Any use of the plant for therapeutic purposes should strictly follow professional supervision and Ayurvedic purification protocols (*Shodhana*). Children, pets, and vulnerable individuals should be kept away from the plant due to the risk of accidental poisoning. To ensure controlled production and prevent illicit use, cultivation of datura for medicinal purposes is often subject to government licensing and strict regulations in India. Farmers or manufacturers typically need specific permits to grow and process datura for medicinal extraction.

Future prospects

Datura is known to be a good source of scopolamine, hyoscyamine, and anisodamine. World Health Organization (WHO) considers scopolamine to be one of the most important medicines needed in a basic health system. Thus, datura offers the pharmaceutical industry a potential source of raw products. Various reports suggest that datura help in remediation of heavy metals from industrially contaminated areas. Due to its ability to thrive under harsh climate, datura might be promoted as an ornamental in degraded or wasteland and even under polluted areas. Researchers should step forward to characterize and evaluate the diversity available in the country to identify the best genotypes for medicinal, herbicidal, pesticidal, ornamental and environmental uses. Efforts should be taken for collection and conservation of germplasm for its sustainable utilization.

For further interaction, please write to:

¹ICAR-National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi 110 012, India; ²ICAR-Indian Agricultural Research Institute, Pusa, New Delhi 110 012, India; *Correspondence e-mail: ruchi_105@rediffmail.com
