



Original Research Article

***Solanum diphyllum* L.: A New Record for the State of Uttar Pradesh, India with a Special Focus on Leaf Architecture, Morphology Of Bark and Seedling**

Rishi Kumar Sahu, Shiv Narayan Dubey, Ayush Kumar Singh and Ajai Kumar Singh*

Department of Botany, Udai Pratap College (Autonomus), Varanasi-221002, India

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Abstract: Present study highlights the first record of *Solanum diphyllum* L. in the state of Uttar Pradesh, India from Varanasi District. Reported species is a potent source of anticancer molecules. Comprehensive morpho-taxonomic account of the medicinally important species has been provided along with special focus on leaf architecture, morphology of bark and seedling to facilitate easy identification.

Key Words: *Solanum diphyllum*, New Record, Uttar Pradesh, India

Introduction

The Solanaceae contains between 3,000 and 4,000 species in about 90 genera (Knapp *et al.*, 2004). The members of the Solanaceae have a very important relationship with human being as some are noxious weeds, while others are of a great economic importance as a source of food; e.g. *Solanum tuberosum* L. (potato), *Lycopersicon esculentum* Mill. (Tomato), *Nicotiana tabacum* L. (tobacco), and *Capsicum frutescens* L. (chilies), ornamentals (*Cestrum* spp., *Petunia* hybrids and *Solanum* spp.), and as an extremely important drug sources in medicinal pharmacology and drug therapy (e.g. *Belladonna*, *Datura*, *Hyoscyamus* and *Withania*). The Genus *Solanum* L., has a world-wide distribution, and is one of the largest genera of the flowering plants; is considered as the largest and the most diverse genus in the Solanaceae, with 1500-1700 species, and is one of the ten most species-rich genera of flowering plants (Frodin 2004; Mabberley 2008; Hamada 2013).

Solanum L., a subcosmopolitan genus, with 1250 species is distributed mostly in tropical and subtropical regions of the world, especially in Americas (Mabberley, 2008). In India, the genus is represented by 48 species (Reema Kumari, 2004) and by 23 species in its state of Uttar Pradesh (Khanna *et al.*, 1999). *Solanum diphyllum* L. belongs to genus *Solanum* section *Geminata* (G. Don) Walp. (Knapp, 2002). This species is a native plant to Mexico and Central America, and distributed in many places around the world

(Zhang *et al.*, 1994; Hamada *et al.*, 2010). It was reported for the first time for India from West Bengal (Paul & Biswas 1995; Das *et al.*, 1997). Later it was documented from Assam (Nath *et al.*, 2010), from peninsular India (Reema Kumari 2013; Saini 2013) and from Bihar (Halder *et al.*, 2014). Recently, it has been reported as a fast spreading serious perennial weed in India, from Howrah, West Bengal and Pune, Maharashtra (Singh *et al.*, 2014). Methanolic root extract of *S. diphyllum*, afforded an interesting, highly cytotoxic compound, named 3-O-(beta-D-glucopyranosyl) etioline [(25S)-22, 26-epimino-3beta-(beta-D-glucopyranosyloxy) cholesta-5, 22(N)-dien-16alpha-ol]. The compound exhibited high cytotoxic effects against the cervical cancer cell line (El-Sayed *et al.*, 2009). It also showed a promising cytotoxicity against colon (HCT116) and breast (MCF7) carcinoma cell lines, and could be considered as a potent source of anticancer compounds (Hamada *et al.*, 2010; Hamada 2013, Anilkumar *et al.*, 2014).

While working on seedling flora of Eastern Uttar Pradesh, authors have collected the specimens from Varanasi district (25° 10' – 25° 37' N & 82° 11' – 83° 1' E) which turns out to be a new record for the state of Uttar Pradesh, India. The identification and world distribution of the collected *S. diphyllum* specimens were insured through the Missouri Botanical Garden web site, New York Botanical Garden web site, Aluka digital herbarium web site and after going through

***Corresponding Author:**

Dr. Ajai Kumar Singh,

Associate Professor,

Department of Botany,

Udai Pratap College (Autonomus),

Varanasi-221002, INDIA.

related publications (Paul & Biswas 1995; Das et al., 1997; Nath et al., 2010; Reema Kumari 2013; Halder et al., 2014).

Hct. Hypocotyl, Pct. Paracotyledon, L. First leaf.

***Solanum diphylum* L., Sp. Pl. 184.**

1753; D'Arcy, Ann. Missouri Bot. Gard. 61: 845. 1974; Zhi Y. Zhang et al. in C.Y. Wu & P.H. Raven, Fl. China 17: 317. 1994; T. K. Paul & M. C. Biswas, *Bull. Bot. Surv. India* 37: 137. 1995; M. Das et al., *J. Econ. Taxon. Bot.* 21: 158. 1997; Reema Kumari, *Rheedea* 23(1): 50. 2013; Haldar et al., R. & R.: *J. Bot. Sci.* 3(1): 1-3. 2014. – Type: Herb. Linn. 248.5 (LINN, MH microfiche!) (Vide D'Arcy, l.c.). Fig. 1, Fig. 2. Evergreen shrub, up to 3.0 m high. Young stem green, sparsely hairy and terete.

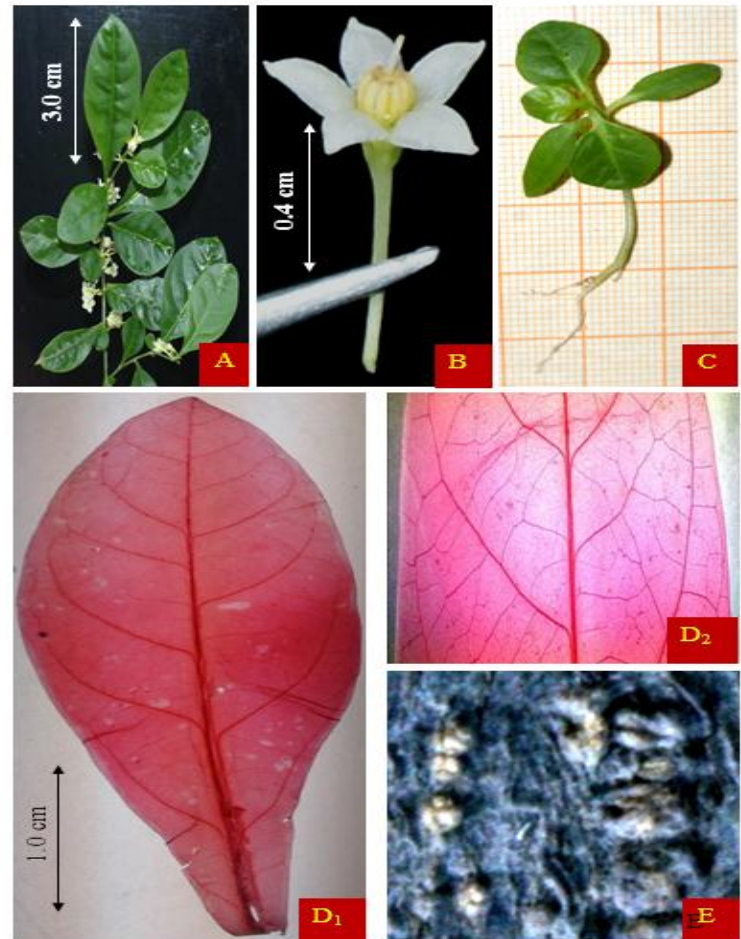


Figure 2: *Solanum diphylum*, A. A twig, B. Single flower, C. Seedling at third leaf stage with paracotyledons, D1. Leaf architecture; D2. Magnified part of the leaf, E. Bark surface (magnified).

Bark silvery grey, lenticulate, shallow fissured, rough, firm and finely sculptured with light green blaze, average thickness 0.4 cm, average flake size 0.2 x 0.1 cm, periderm appear parallel to the cambium (Fig. 2E).

Leaves simple alternate, two at each node from same position, anisophyllous, exstipulate and petiolate. Petiole dark green, sparsely hairy and terete, 0.5 to 0.7 cm long. Bigger leaf blade obovate 1.0-4.0 x 0.7-2.8 cm, mean Length : Width Ratio (L/W) 1.4, base acute, apex obtuse or mucronate, margins entire, both surfaces green, sparsely hairy and glaucous. Smaller leaf blade oval-orbicular 0.5-1.5 x 0.4-2.0 cm, mean L/W 1.2, other features same as bigger leaf (Fig. 1A).

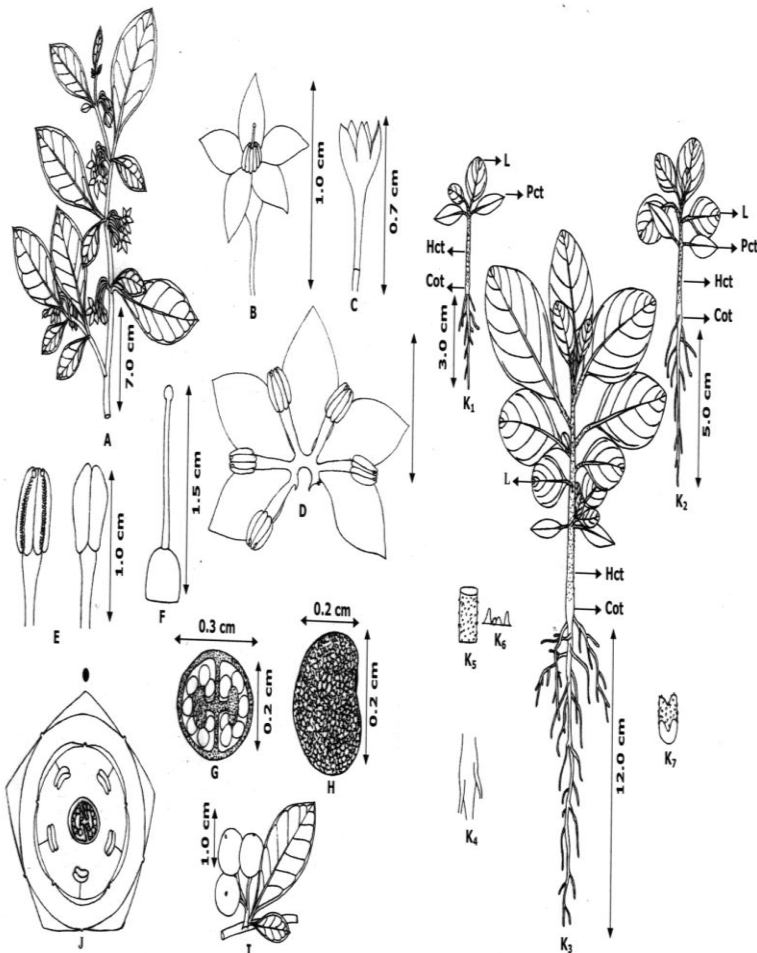


Figure 1: *Solanum diphylum*: A. A twig, B. Single Flower, C. Calyx, D. Corolla (split open), E. Stamen (mature and immature), F. Gynoecium, G. T.S. of Ovary, H. Seed, I. Fruits, J. Floral diagram, K. Seedlings at different leaf stages: K1. Second leaf stage K2. Fifth leaf stage, K3. Tenth leaf stage, K4. Collet, K5. Part of epicotyl, K6. Surface of epicotyl, K7. Part of leaf petiole, Cot. Collet,

Venation brochidodromous (in the sense of Hickey, 1973); unicostate reticulate, single primary vein distinct, reaches to blade apex, moderate, straight and branched into 5-9 secondary veins on each side; Secondary veins divergent, uniformly moderate with primary vein, only lowermost 2-3 more acute diverted, uniformly curved at margins, looping enclosed by secondary arches; Tertiary veins origin right/acute angled from secondary vein, transverse, ramified, randomly reticulated, weakly percurrent and oblique with two secondary veins; higher order venation random, reticulated not distinguished (Fig. 2D).

Inflorescence an axillary racemose fascicles, 6-10 flowered; pedunculate; peduncle, green, sparsely hairy, terete and ca 0.5-0.7 cm long (Fig. 2A).

Flowers bisexual, complete, 0.5-0.8 cm across, actinomorphic, epigynous, ebracteate (Fig. 1B, Fig. 2B),

Calyx valvate, bell shaped, gamosepalous and persistent. Sepals 5, fused at base, ovate, 0.3 x 0.2 cm, mean L/W 1.5, base cuneate, apex acute, margins entire, surface green and sparsely hairy, nerveless (Fig. 1C).

Corolla valvate, gamopetalous, rosaceous. Petals 5, free, elliptical, 0.6 x 0.2 cm, mean L/W 3.0, base cuneate, apex acute, margins entire, white, glabrous and nerveless (Fig. 1D).

Androecium pentandrous, antisepalous, exerted. Stamens 5, equal, epipetalous, introrse; filaments connate at base, light green, glabrous, 0.1-0.2 cm long, flat; anthers dithecous, oblong, saggitate, light yellow, basifixed, 0.2-0.9 cm long, anthesis poricidal initially, later longitudinal (Fig. 1E).

Gynoecium bicarpellary, syncarpous; ovary superior, globose, light green, glabrous, 0.1-0.3 cm long, bilocular, placentation axile with oblique and swollen placenta, ovules many; style terminal, light green, glabrous, terete, 0.7-1.0 cm long; stigma capitate, light yellow (Fig. 1F, Fig. 1G, Fig. J).

Fruit berry, in fascicle of 3-7, globose, glabrous, green when young, yellow/golden-red at maturity, 0.6-1.0 x 0.6-1.0 x 0.5-0.8

cm, slightly constricted in the middle (Fig. 1I).

Seeds many in one fruit, reniform/discoid, 0.15 x 0.20 cm, mean L/W 0.75, margins entire and thickened, surface reticulate, light yellow to golden, hilum distinct (Fig. 1H).

Seedlings (Fig. 1K₁, Fig. 1K₂, Fig. 1K₃, Fig. 1K₄, Fig. 1K₅, Fig. 1K₆, Fig. 1K₇, Fig. 2C) Macaranga type (in the sense of Vogel, 1980). Primary root non fibrous, tap root, much branched, equally developed as shoot, glabrous, milky white, terete in cross section, 1.5 cm long at paracotyledon stage and 2.0 cm, 3.0 cm, 3.8 cm, 5.0 cm and 6.7 cm long at 1st, 2nd, 3rd, 4th and at 5th leaf stages respectively; secondary roots same as primary root. Collet distinct, white, glabrous and slightly swollen. Hypocotyl green, scabrous, terete in cross section, 2.0 cm long at paracotyledon stage and 2.5 cm long at 1st, 2nd, 3rd, 4th and at 5th leaf stages. Paracotyledons two, opposite, phanerocotylar, anisocotylar; blade size variable; foliaceous, long persistent, exstipulate and petiolate. Petiole green, scabrous, convexo-concave in cross section, 0.6 cm long. Blade lanceolate, 1.4 x 0.5 and 1.6 x 0.6 cm, mean L/W 2.8, base cuneate, apex apiculate, margins entire, both surfaces green and glabrous. Venation hyphodromous (in the sense of Hickey, 1973); unicostate reticulate, single primary vein distinct, reaches to blade apex. Epicotyl green, scabrous, terete in cross section, 0.3 cm, 0.5 cm, 0.9 cm, 1.2 cm and 1.4 cm long at 1st, 2nd, 3rd, 4th and at 5th leaf stages respectively. Internodes (at 5th leaf stage): First one 0.6 cm long, later internodes elongating. First leaf alternate, simple, exstipulate and petiolate. Petiole green, scabrous, convexo-concave in cross section, 0.5 cm long. Blade sub-orbicular, 1.0 x 1.0 cm, mean L/W 1.0, base attenuate, apex obtuse, margins entire, both surfaces green and glabrous. Venation craspedodromous (in the sense of Hickey, 1973); unicostate reticulate; single primary vein distinct, reaches to blade apex, 6 secondary veins distinct, 3 on each side of primary vein, alternate and free at margins. Second and third leaves same as 1st leaf. Fourth and subsequent leaf blades obovate-oblongate, other features same as 1st leaf.

Floral Formula: $\oplus \left(\overset{\curvearrowright}{\text{K}}^{(5)} \overset{\curvearrowright}{\text{C}}^{(5)} \text{A}_5 \underline{\text{G}}^{(2)} \right)$
Flowering & Fruiting: May – July.

Distribution: Native to Mexico and Central America. Bhutan, Costa Rica, El Salvador, Europe, Guatemala, Handuros, India [Assam, Bihar, Karnataka, Maharastra, Tamil Nadu and West Bengal], Mexico, Nicaragua, Nepal, N. Africa, Pakistan and W. Asia.

Common Name: Amatillo, Twinleaf nightshade, Two-leaf nightshade, Tomatilo (Mexico), Huang guo long kui (China)

Exsiccatae: Udai Pratap College (Autonomous) Campus, River Banks of River Varuna, Varanasi 15.07.2014, AKS 764; AKS 733.

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Conflict of interest: None Declared