



Enumerations on Seed-Borne Diseases of *Datura* (*Datura* spp.) and Their Management

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Abstract

Datura (*Datura* spp.) of family Solanaceae is widely occurring annual or perennial herb used in modern and traditional medicine system. The extracts of *Datura* and allied species has antiepileptic, anti-asthmatic, analgesic, anticancer, anti-inflammatory, anti-rheumatoid, antioxidant, insecticidal or insect repellent, herbicidal, antimicrobial, anti-fungal, anti-bacterial and organophosphate protective effects. *Datura* and allied species are more prone to viral diseases as compare to fungal and bacterial diseases. The plant has therapeutic potential or medicinal values due to presence of alkaloids, saponins, tannin, sterols, flavonoids phenols and glycosides. The plant is attacked by various diseases that reduced the economic and medicinal potential of plant.

Keywords

Datura, seed-borne diseases, pharmacologically, phytochemical, disease management

INTRODUCTION:

Medicinal plants have tremendous potential to develop new drugs for many severe diseases. *Datura* (*Datura* spp.; synonyms: *D. inermis* Juss. ex Jacq., *D. chalybea* W.D.J. Koch and *D. tatula* (L.) Torr.) is an important medicinal plant of family Solanaceae. It has several pharmacological properties as anti-asthmatic, antioxidant, analgesic, antimicrobial, antiepileptic and insecticidal. Various species of *Datura* namely *D. innoxia* Mill., *D. stramonium* L. and *D. metel* L. are used as medicine in crude form and as a source of tropane alkaloids. The seeds of *D. innoxia* and leaves of *D. metel* are used as source of hyoscyne. Due to presence of alkaloid, *D. metel* has antifungal, antibacterial, anticancer, insecticidal, herbicidal, anti-inflammatory, and anti-rheumatoid activity. The alkaloid tropane found in seeds and flowers is used in therapeutic purposes. The plant parts as seeds, leaves and roots used to cure insanity, fever with cerebral complications and skin diseases [1, 2]. Scopolamine (alkaloid) is used as a pre anesthetic in surgery, ophthalmology, and prevention of motion sickness [3, 4]. Mostly the *Datura* species are found

in wild form but *D. stramonium* is cultivated commercially in Europe and South America.

D. stramonium has antinociceptive [5], hypolipidemic [6], antioxidant [7], anti-rheumatoid [8], anti-inflammatory and hypoglycemic properties [9]. It is a wild-growing, hallucinogenic plant causes serious poisoning, severe anti-cholinergic reaction which lead to toxicity in human beings [10-20]. The seed extract has an analgesic (acute and chronic pain) [21], anti-asthmatic, hallucinogenic and euphoric properties [14, 22-23].

Alkaloids hyoscyamine, hyoscyne, atropine, and scopolamine sitosterol and proteins are found in various parts of the plant [20, 24-25]. In *D. stramonium*, hyoscyamine (alkaloid) yielded from the line of flowering [26-28]. Approx. 0.2%-0.45% alkaloid found in leaves and 0.2% of total alkaloid found in seeds [29]. The dried leaves used as an anti-asthmatic, psychotropic, sacred, and antispasmodic [28, 30-34]. It is used to cure asthma, burns, ulcers, sinus infection, headaches, and sores in different formulations [35].

Common names:

It is commonly known as thorn-apple, false castor-oil, jimsonweed, moonflower, purple thorn-apple, thorn-apple in English; gewone stinkblaar in Afrikaans; tatura, nafer, thagher, banj tatura, tatura shaeka, el-shajara el-muskera in Arabic; man tuo luo in Chinese; datura stramoine, herbe des taupes, pomme épineuse in French; Stechapfel in German; indormia, stramonio commune in Italian; Estramónio, figueira-do-diabo in Portuguese; datura manzana, estramonio, tapa, toloache in Spanish and violspikklubba in Swedish [36].

Plant description:

The plant is glabrous, annual, or sometimes perennial herb [37,38]. The younger parts of plant covered with short curved hairs, which shed as plant became older. It exhales fetid odor arises from the leaves especially when they are bruised. The taproot is large, whitish, fibrous, long thick and frequently branched. The green stem is erect and leafy, branching repeatedly in a forked manner. Leaves are cauline and ramal, exstipulate; alternate to opposite, petiolate, simple, dissected, acute, glabrous, uncosted and reticulate venation. The flowers are ebracteate, ebracteolate, pedicellate, actinomorphic, bisexual, complete, regular, hypogynous and pentamerous except the fourth whorl. Calyx has 5 fused sepals, tubular, sharp-toothed, sepeloid, hairy and persistent. Corolla has 5 gamopetalous petals fused at the base, surface hairy infundibuliform, white or sometimes purple, twisted, inferior, half-opened with six prominent ribs. The blooming of flowers occurs nearly in summer with sweet scented fragrance which attracts night-flying moths. Polyandrous five stamens, epipetalous, filamentous, dithecal, basifixed and introrse are found. The ovary is bicarpellary, syncarpous, posterior obliquely, superior, bilocular with many ovules on swollen placenta with axile placentation. Fruit base has persistent remnant of the calyx which curves sharply downward. A large green colour, walnut-sized and egg-shaped fruit (capsules) covered by numerous sharp spines is developed (hence the name of the plant). The fruit opens apically after maturation with 4 valve-like segments disperses the dark brown seeds. The seeds are large, irregular, and dark-colored with pitted reticulated surface.

Seed-borne microflora:**Fungal diseases:**

The plant is attacked by several fungal, bacterial and viral diseases which affected various parts of plant, their medicinal value and available concentration of bioactive compounds or secondary metabolites [39]. Out of 15 species (*Datura metel*, *D. alba*, *D. stramonium*, *D. fastuosa*, *D. candida* (Pers) Saff., *D.*

ceratocaula Ortega, *D. discolor* Bernh, *D. dolichocarpa* (Lagerh) Saff, *D. ferox* L., *D. inoxia* Mill., *D. anoxia* Mill., *D. kymatocarpa* Barclay, *D. leichhardtii* Benth, *D. reburra* Barclay, *D. wrightii* Regel) of *Datura* found worldwide only 10 species are found in India. *Datura chorantha*, *D. fastuosa*, *D. fastuosa* var. *alba*, *D. innoxia*, *D. metel* and *D. stramonium* L are important species [40, 41]. These are attacked by various diseases reported from various parts of country viz. leaf blight [*Alternaria alternate* (Fr.) Keissler] (Syn. = *A. tenuis* Nees) from Jammu, J&K [42]; leaf spot [*Alternaria crassa* (Sacc.) Rands.] from Calcutta, WB [43]; Maharashtra [44, 45]; Jammu, J&K [46]; Secunderabad, Andhra Pradesh [47], *A. tenuissima* (Kze. ex Pers.) Wiltshire Jammu, J&K [48]; Khumaltar, Nepal, *Ascochyta daturae* Sacc. from Khumaltar, Nepal, *Cercospora daturicola* (Speg.) Vassiljevsky from Kokilamukh, Assam [49]; Kanpur, U.P. [50], *Cercospora jamaicensis* Chupp. from Poona, Maharashtra [51], *Cercospora medicaginis* Ell. & Ev. from Udaipur, Rajasthan [52], *Phyllosticta solani* Ell. & Mart. from Poona, Bombay, Maharashtra [50], *Pseudocercospora daturae* Chiddarwar from Poona, Maharashtra [53], *Colletorichum capsici* (Syd.) Butler & Bisby from Madras, Tamil Nadu [54-57] from Maharashtra [58] and Karnataka [59]; root rot and foot rot [*Corticium solani* (Prill. & Delacr.) Bourd. & Galz.] from Jammu-Tawi, J&K [71]; charcoal rot [*Macrophomina phaseolina* (Tassi.) Goid] from Delhi [60]; powdery mildew (*Oidium cyparissiae* Syd.) from Coimbatore, Tamil Nadu [61], *Oidium* sp. from Hyderabad, Andhra Pradesh [62]; fruit and seedling [*Pythium aphanidermatum* (Edson), Fitzp.]; leaf and stem (*Verticillium dahlia* Kleb.) from Poona, Maharashtra [63]; anthracnose [*Colletorichum capsici* (Syd.) Butler & Bisby] from Madras, Tamil Nadu [54-57] from Maharashtra [58] and Karnataka [59]. Bacterial wilt (*Pseudomonas solanacearum* E.F. Sm.) is very common diseases in India attack severely on the plant [40].

Viruses:

The plant is attacked by various viruses like Chilli mosaic virus, Cucumis virus I, Marmor daturae, Potato virus Y, Solanum virus 6, Southern sunnhemp mosaic virus and Leaf curl virus of tomato [63]. The distortion mosaic of *Datura* (*Datura virus 3*, Little leaf virus) reported from South India [39, 40]. Colombian *datura virus* (CDV) found globally with wide host range. It was first identified in *Brugmansia* plants (Solanaceae) from Colombia [64-66]. A seed sample survey was conducted in Rajasthan, India (January to May 2014) to investigate the epidemiology of potyvirus in *Datura* has reduction in leaf size and flower distortion characters [67].

Other viruses that attack on *Datura* are bromovirus (Spring beauty latent and Melandrium yellow fleck bromovirus), bigemini virus (Soybean crinkle leaf bigeminivirus, Bean distortion dwarf bigeminivirus, Abutilon mosaic bigeminivirus, Cassava African mosaic bigeminivirus, Pepper Texas bigeminivirus, Tobacco leaf curl bigeminivirus, Tomato yellow mosaic bigeminivirus, Tomato Australian leaf curl bigeminivirus, Tomato golden mosaic bigeminivirus, Croton yellow vein mosaic bigeminivirus, Euphorbia mosaic bigeminivirus, Serrano golden mosaic bigeminivirus), carlavirus (Nerine latent carlavirus, Pea streak carlavirus), comovirus (Radish mosaic comovirus), cucumovirus (Peanut stunt cucumovirus, Pelargonium line pattern carmovirus), hybrigeminivirus (Tomato pseudocurly top hybrigeminivirus), ilarvirus (Alstroemeria ilarvirus, Tobacco streak ilarvirus, Plum American line pattern ilarvirus), ipomovirus (Sweet potato mild mottle ipomovirus, Sweet potato yellow dwarf ipomovirus), isometric (Kalanchoe isometric virus), luteovirus (Potato leafroll luteovirus, Tobacco necrotic dwarf luteovirus), macluravirus (Narcissus latent macluravirus), necrosisvirus (Guar top necrosis virus, Tulip halo necrosis virus), nucleorhabdovirus (Tomato vein clearing nucleorhabdovirus, Pittosporum vein yellowing nucleorhabdovirus, *Datura* yellow vein nucleorhabdovirus), nanavirus (Milk vetch dwarf nanavirus), nepovirus (Raspberry ringspot nepovirus, Arabis mosaic nepovirus, Arracacha A&B nepovirus, Caraway latent nepovirus, Cassava green mottle nepovirus, Dogwood mosaic nepovirus, Lucerne Australian latent nepovirus, Chicory yellow mottle nepovirus, Tomato black ring nepovirus, Tobacco ringspot nepovirus, Tomato top necrosis nepovirus, Potato black ringspot nepovirus, Potato U nepovirus, Dogwood mosaic nepovirus, Eucharis mottle nepovirus), ourmiavirus (Melon Ourmia ourmiavirus), Potyvirus (Artichoke latent potyvirus, Asparagus 3 potyvirus, Carrot mosaic potyvirus, *Datura* distortion mosaic potyvirus, *Datura* mosaic potyvirus, *Datura* Colombian potyvirus, Brinjal mild mosaic potyvirus, Hungarian mosaic potyvirus, Hippeastrum mosaic potyvirus, Primula mottle potyvirus, Telfairia mosaic potyvirus, Tobacco etch potyvirus, Watermelon mosaic 2 potyvirus, Dioscorea latent potyvirus, Eggplant severe mottle potyvirus, Daphne X potyvirus, Henbane mosaic potyvirus, bigeminivirus Commelina X potyvirus, Melilotus mosaic potyvirus, Potato X potyvirus, Pepper veinal mottle potyvirus, Potato aucuba mosaic potyvirus, Tomato mild mottle potyvirus, White clover mosaic potyvirus, Grapevine chrome mosaic nepovirus), carmovirus (Turnip crinkle carmovirus, Elderberry latent carmovirus),

satellivirus (Tobacco mosaic satellivirus), sequivirus (Parsnip yellow fleck sequivirus), fabavirus (Broad bean wilt fabavirus, Lamium mild mottle fabavirus), cytorhabdovirus (Broccoli necrotic yellows cytorhabdo virus), dianthovirus (Carnation ringspot dianthovirus), carlavirus (Cassia mild mosaic carlavirus), caulimovirus (Cauliflower mosaic caulimovirus), tobamovirus (Pepper mild mottle tobamovirus), comovirus (Cowpea mosaic comovirus), carmovirus (Cucumber soil-borne carmovirus), tombusvirus (Cymbidium ringspot tombusvirus), tymovirus (Dulcamara mottle tymovirus), ourmiavirus (Epirus cherry ourmiavirus), tombusvirus (Eggplant mottled crinkle tombusvirus), cytorhabdovirus (Ivy vein clearing cytorhabdovirus, Lettuce necrotic yellows cytorhabdovirus), sobemovirus (Solanum nodiflorum mottle sobemovirus, Sowbane mosaic sobemovirus), Tymovirus (Poinsettia mosaic tymovirus, Potato Andean latent tymovirus Scrophularia mottle tymovirus, Abelia latent tymovirus, Belladonna mottle tymovirus), tombusvirus (Pelargonium leaf curl tombusvirus, Pepper Moroccan tombusvirus, Sunn-hemp mosaic tobamovirus, Tobacco mosaic tobamovirus, Pea early browning tobavirus, Neckar River tombusvirus, Maracuja mosaic tobamovirus, Rose tobamovirus, Ullucus mild mottle tobamovirus, Frangipani mosaic tobamovirus), tymovirus (Kennedya yellow mosaic tymovirus, Ononis yellow mosaic tymovirus, Physalis mosaic tymovirus), trichovirus (Potato T trichovirus), tospovirus (Tomato spotted wilt tospovirus, Peanut yellow spot tospovirus) and umbravirus (Tobacco mottle umbravirus) [68].

Bacterial disease:

The bacterium, *Xanthomonas campestris* pv. *musacearum* attack on *Datura* and banana. Bacterial wilt (BBW) is caused by *Xcm* and affect banana in Uganda (since 2001) [69, 70] with an incidence of 70-80% in many other plants. In Ethiopia, the disease appeared and produced symptoms on hot pepper, tobacco, sesame, cabbage, wheat, barley, *Datura stramonium*, banana relatives (*Musa zebrine* and *Musa ornata*) and Canna-lily (in Uganda).

Some important fungal disease of *Datura* is-

Leaf blight: The disease is caused by *Alternaria alternata* (Fr) keissler. In an experimental and commercial plantations *Datura innoxia* was found suffer from this disease [39, 68, 71]. Initially water soaked dull coloured circular spots appeared on the leaves surface. As the disease progress these spots coalesced became necrotic light brown with concentric rings; and finally, the infected tissue died. The branched, septate, and dark brown hyphae bear conidiophores with conidia in chains can be

observed. The branches of infected leaves are curled show defoliation or sometimes wilting. In diseased plant the older leaves were found more susceptible than younger [68, 72]. Although there was no control measure reported for the disease but spray of dithiocarbamates (eg. Dithane Z-78 or Dithane M-45) were found beneficial.

Leaf blight and Fruit-rot:

The disease is caused by *Alternaria crassa* (Sacc) Rands. Leaf blight and pod blight were reported on *D. metel* from Israel [73] and on *D. stramonium* in Lucknow, India [74]. *Datura metel* and *D. stramonium* growing in the experimental plots were found affected. The infection was initially observed on leaves with small necrotic spots. From these spots singly or in groups, straight or flexuous, septate and pale brown conidiophores arise that bear's ovoid, ellipsoid or sub spheroid conidia in chain [71]. The fungus produces a phytotoxic metabolite (*in vitro*) which on isolation identified as tenuazonic acid [74]. This toxin induced typical chlorosis, yellowing and necrosis in *D. stramonium* leaves [71, 75-76] by reducing the chlorophyll and protein contents [77]. Disinfection with thiram suspension found effective to control the pathogen. The organo-mercurial dust seed treated did not give efficient control of the pathogen [73, 84].

Leaf spot: It is caused by species of *Alternaria* like *Alternaria tenuissima* (Fr) Wiltshire, *A. alternata* and *A. crassa*. The disease appears as small water soaked circular spots on leaves which coalesce become enlarge turned yellow to light brown finally infected tissue died with necrosis. The spots are dark brown, round to oval or irregular which coalescing [68]. Sample regarding leaf spot disease of *Datura metel* collected in Korea in 2013 infected with small circular to oval or irregular dark brown spots with concentric rings were observed. The morphological examinations, pathogenicity tests and the rDNA sequences (ITS1 and ITS4), G3PDH and RNA polymerase II, RPB2, gene sequence) revealed *Alternaria tenuissima* as causal agent. It was first report on *D. metel* caused by *A. tenuissima* in Korea as well as worldwide [78]. The leaf spot disease was also reported on *D. metel* from USA caused by *A. crassa* and *A. solani* [79]. The wilting of the entire branch occurs when 2-3 leaves of a single branch are affected; later on, the leaves showed defoliation followed by death. The normal fruits and seeds were not produced by infected plants. Older leaves are more susceptible than younger ones. *Datura stramonium*, *D. metel* and *D. innoxia* showed severe defoliation after attack of pathogen resulting causes considerable economic loss [48]. The simple conidiophores produce 5-10 or more conidia in chain

of gold-brown and closely obscurely to conspicuously punctulate [68, 71]. Spraying 2-3 times copper oxychloride (3 g/b or mancozeb) or 2.5 g/l or any other thiocarbamates were found effective to control of the disease [68].

Anthraco-nose: It is severe disease caused by species of *Colletotrichum* on *Datura* that affected crop worldwide. In a study severe anthracnose symptom was recorded on the leaves of 5 angiosperms (*Datura metel*, *Gossypium hirsutum*, *Abelmoschus esculentus*, *Cucurbita maxima* and *Vigna sinensis*) in 2010 and total 9 fungal species of 4 genera of deuteromycetes and a sterile fungus listed found to be associated with the infected leaves. *Aspergillus flivaus* Link, *A. fumigatus* Fresenius, *A. nidulans* (Eidam) G. Winter, *A. niger* van Tiegh, *Cercospora* sp., *Colletotrichum capsici* (Syd.) Butler & Bisby, *Colletotrichum dematium* (Pers.) Grove, *C. gloeosporioides* (Penz.) Penz. and Sacc., *Curvularia clavata* Jain, and a sterile fungus were found associated [80]. Three fungal species (*Colletotrichum* sp., *Pseudocercospora* sp. and *Trichoderma* sp.) were found to be associated with anthracnose symptom of *Datura metel* and *Vigna catjang* in Bangladesh [68, 81].

Carpospora leaf spot: The disease is caused by *Carpospora jamaicensis*, *C. daturicola* characterized by oval to irregular, scattered spot which often coalescing [82]. Initially the disease produced spots as huffy brown in color which becomes alive or brown on account of numerous fructifications. The disease can be control effectively by 3-4 spraying with dithane M-45 (2.5 g/litre) @ 10 days interval or bavistin (1.5 g/l) or duter or cercobin (2.5 g/l) @ 15 days interval or to check spread of disease in the field [68].

Charcoal rot: The disease is caused by *Macrophomina phaseolina* of division ascomycota. The disease appears as black sunken cankers bodies just below the cotyledonary node at the time of emergence. The pycnidia and sclerotia of pin head sized are found all over the bark inside the pith, below the epidermis and within the xylem vessels [68, 71]. These lesions later may be extended up to the stem and leaf petioles or up to the growing point. On disease severity, leaf yellowing, stunting, withering of lower leaves observed. Infected plant produces unfilled or immature seeds or there is no fruit setting. Furrow application of PCNP or thiram @ 8 kg/ha at the planting time gives significant relief against the charcoal rot [83].

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