



SEED-BORNE DISEASES OF BRINJAL (*Solanum melongena* L.) AND THEIR CONTROL MEASURES: A REVIEW

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Abstract: Brinjal (*Solanum melongena* L.) is an important widely consumed nutritious vegetable crop grown globally. It is native of India or major Asia and cultivated in India for last 4,000 years. It contains several amino acids, alkaloids, pigments, flavanoids and sugars. In ayurveda, it is medicine used for cure of diabetic patients, liver complaints and to control serum cholesterol. Ethano-botanically it is used for cure of fistula, piles, stomach pain and burns. The crop is infected with major diseases caused by fungi, bacteria, virus, mycoplasma and nematode that reduced the quality and market value of crop that directly or indirectly affected the economy of market and crop producers.

Keywords: Brinjal, *Solanum melongena*, Chemical Constitutions, Ethano-Botany, Major Diseases, Biotechnological Approach.

INTRODUCTION

Brinjal (*Solanum melongena* L. fam. Solanaceae) or eggplant or aubergine is an important widely consumed nutritious vegetable crop in India or cultivated commercially throughout the tropical and subtropical region of the world. The name brinjal is popular in India subcontinents and is derived from Arabic and Sanskrit. It is considered a native of India or major Asia where the major domestication of large fruited cultivars occurred. It has been cultivated in India for the last 4,000 years, although it is often thought of as a Mediterranean or mid-Eastern vegetable.

Brinjal is important in the warm areas of Far East, being grown intensively in India, Bangladesh, Pakistan, China and Philippines. It is also popular in Egypt, France, Italy and US. In India, it is popular and principal vegetable crops grown throughout the country except higher altitudes. It is a perennial but grown commercially as an annual crop. The major producing states are West Bengal, Orissa, Bihar, Gujarat, Maharashtra, Karnataka, Uttar Pradesh and Andhra Pradesh. In Rajasthan, it is grown in Alwar, Kota, Jaipur, Sriganganagar and Bharatpur.

The global area under brinjal cultivation has been estimated at 1.85 million h with total production of brinjal fruit of about 32 million MTs (Anonymous, 2005). India accounts for about 8.7 million MTs with an area of 0.53 million h under cultivation. It is also exported in the fresh or frozen form. In 2007-2008, 34 million kg worth of Rs. 19 million was imported mainly to UK, Netherlands, Saudi Arabia and Middle East countries⁴. Rajasthan accounts for about 20339 MTs with an area of 7 h.

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The composition per 100g of edible portion of brinjal constitutes Calories (24.0), Sodium (mg) (3.0), and moisture content (%) (92.7), Copper (mg) (0.12), Carbohydrates (%) (4.0), Potassium (mg) (2.0), Protein (g) (1.4), Sulphur (mg) (44.0), Fat (g) (0.3), Chlorine (mg) (52.0), Fiber (g) (1.3), Vitamin A (I.U.) (124.0), Oxalic acid (mg) (18.0), Folic acid (µg) (34.0), Calcium (mg) (18.0), Thiamine (mg) (0.04), Magnesium (mg) (15.0), Riboflavin (mg) (0.11), Phosphorus (mg) (47.0), B-Carotene (µg) (0.74), Iron (mg) (0.38), Vitamin C (mg) (12.0), Zinc (mg) (0.22) and Amino acid (0.22)¹⁸.

Botanically, it is an herbaceous prickly perennial herb or undershrub; flowers purple, solitary; berries large green or purple, globular or oblong, acrid-sweet in taste. The fruit contains arginin, aspartic acid, solanin, histidine, leucine, methionine, pipercolic acid, phenylalanine, theonone, tryptophane, valine, choline, nicotinic acid, riboflavin, vit- A & C, fructose, glucose, sucrose, anthocynine, lycoxanthin, caffeic acid and chlorogenic acid²⁴.

Taxonomically there are 3 main botanical varieties under the species *Melongena*. The common brinjal, to which large, round or egg shaped fruited forms belong, or grouped under *Solanum melongena* var. *esculentum*. The long, slender types are included under *Solanum melongena* var. *serpentinum* and the dwarf brinjal plants are put under *Solanum melongena* var. *depressum* (Choudhury, 1976). It has been reported that on an average, the oblong-fruited egg plant cultivars are rich in total soluble sugars, whereas the long-fruited cultivars contain a higher content of free reducing sugars, anthocyanin, phenols, glycoalkaloids



(solasodine), dry matter and amide proteins⁶.

Brinjal fruit (unripe) is primarily consumed as cooked vegetables in various ways and dried shoots are used as fuel in rural areas. It is known to have ayurvedic medicinal properties, good for diabetic patients and recommended as an excellent remedy for those suffering from liver complaints. The fruit contains no endogenous toxins or a significant level of anti-nutritional factors have been found till date and is not capable of causing any disease in human, animals or plants⁴³. In Brazil, eggplant is consumed extensively and believed that infusion of a powdered preparation of the fruit may reduce serum cholesterol. The results suggest that infusion of brinjal has modest and transitory effect which was not different from the obtained with standard and orientation for dyslipidemia patients (diet and physical activities)²⁰. It concluded that water extracts of peduncles used frequently as mouth wash may have benefited effect against periodontal disease¹⁵. Ethano-botanically the plant used for cure of several diseases by using different parts of plants such as fruit stalk used for cure of fistula and piles⁴⁶, mature fruit for stomach pain³⁷ and leaf used for burns⁴⁷.

Review of literature

The crop attacked by major diseases including fungal, bacterial, viral, mycoplasma and nematode.

National status

Fungal Diseases: Brinjal is an important vegetable crop of India in played by many seed-borne diseases^{40, 17, 30, 36, 32, 1, 39}.

Diseases such as leaf spot (*Alternaria melongenae*, *A. tenuissima*, *Cercospora feuilleboisii*, *C. solanacea*, *C. solani*, *C. solani-melongenae*, *Colletotrichum dematium* *C. capsici*, *C. dematium*, *Curvularia lunata*, *Helminthosporium spiciferum*, *Leptosphaerulina australis*, *Phyllosticta hortorum*, *P. macropycnidia* *P. solani*), early blight and leaf spot (*Alternaria solani*), leaf and fruit spot (*Ascochyta lycopersici*) on seeds and decaying fruits (*Aspergillus niger*, *A. parasiticus*), fruit rot (*Chaetomium globosum*, *Chrysosporium pruinatum*, *Cladosporium fulvum*, *Fusarium equiseti*, *Rhizopus nodosus*, *R. stolonifer*, *Trichothecium roseum*), wet rot (*Choanephora cucurbitarum*), black dot of stem and root rot (*Colletotrichum attramentarium*, *Colletotrichum nigrum*), leaf spot and fruit rot (*Corynespora cassicola*, *Epicoccum nigrum*), powdery mildew (*Erysiphe cichoracearum*, *E. polyphaga*, *Leveillula taurica*), dry rot of stored potato tubers and also wilt (*Fusarium lycopersici*), wilt (*Fusarium solani*), charcoal rot (*Macrophomina phaseolina*), leaf blight and stalk rot (*Myrothecium rordium*), wilt and root rot (*Ozonium texanum*), on seeds and seedling of brinjal (*Pellicularia filamentosa*), white rot, foot and root rot of brinjal

(*Pellicularia rolfsii*), soft rot (*Phomopsis vexans*), on seedlings of brinjal (*Phytophthora colocasiae*), blight of leaf (*Phytophthora parasitica*), leaf rust, only accidial stage (*Puccinia penniseti*), damping off (*Pythium aphanidermatum*), on seeds (*Rhizopus nigricans*), rot of stem, root, leaf, petioles, branches and flowering stalks of brinjal (*Sclerotinia sclerotiorum*), warty galls of leaf, petioles and stem (*Synchytrium akshaiberi*), wart disease (*Synchytrium endobioticum*), leaf gall (*Synchytrium melongenae*), wilt (*Verticillium dahliae*) were caused by several pathogens that reduced the market rate and quality of the crop^{32,1,39}.

In another study it found *Helminthosporium halodes*, *Phytophthora* sp., *Cercospora solenigena*, *Alternaria alternata*, *Phomopsis vexans*, *Erysiphe orontii*, *Phoma exigua* var. *exigua*, *Oidiopsis taurica* f.sp. *solanacearum*, *Paracercospora egenula* associated with this plant²⁵.

From the surrounding area of Karnataka 35 species of fungi were identified from 15 seed samples of brinjal²⁹. It has been reported that in Bareilly city (U.P.), the climate is moderate, humid and cloudy that plays an important role in development of fungal diseases on brinjal and five fungal species were encountered viz. *Fusarium solani*, *Helminthosporium spiciferum*, *Choanephora cucurbitarum*, *Curvularia lunata*, *Trichothecium roseum*³⁴.

An antibiotic and hydrogen cyanide producing rhizobacterial strain *Bacillus* SR4 showed a wide range of antifungal activity against many *Fusarium* spp. and brinjal wilt disease pathogen *Rhizoctonia solani*. Seed bacterization with the strain SR4 at 1.2×10^7 Cfu/ml promoted seed germination and plant growth in leguminous (*Phaseolus vulgaris*) and non-leguminous (*S. melongena* L. *Brassica oleracea* var. *capitata*, *B. oleracea* var. *gongyloides* and *Lycopersicon esculentum* Mill.) plants. Root colonization, study confirmed that the introduced bacteria colonized the roots and amounted to 23-25% of total aerobic bacteria, which was confirmed using dual antibiotic (nalidixic acid and streptomycin sulphate) resistant mutant strain¹⁶.

Phomopsis blight and fruit rot disease caused by the fungus *Phomopsis vexans* (Sacc. & Syd.) Harter of brinjal is cosmopolitan in most tropical and subtropical area is second only to the bacterial within the extent of damage caused. Although it starts as foliage blight, the most destructive phase of the disease is the fruit rot. In India, the fruit rot phase of the disease causes heavy losses in the field and during transit (yield losses 10 to 20%)^{48,44}. Incidence of Phomopsis of Farmer's eggplant seeds collected from different areas of Bangladesh varied from 0.0 to 7.5% (highest incidence), seed selection had a significant impact on the incidence and use of healthy seed found effective in controlling

damping off, tip over and seedling blight in eggplant. The least (1.25%) incidence and highest germination (86.75%) of *P. vexans* in apparently healthy seed against 6.5% seed infection and 60% seed germination was recorded in farmer's seed. Seed treatment with hot water (56°C for 15 minutes), garlic (*Allium cepa* L.) bulb extract and Allamanda (*Allamanda cathartica* L.) leaf extract, *Trichoderma harzianum* CP, *Trichoderma harzianum* T₂₂ and Bavistin were found promising in controlling seedling disease in the nursery and in increasing the seed germination. Combination of apparently healthy seed (T₂), treated with garlic bulb extract (T₃) and soil treated with *T. harzianum* CP (T₁₁) completely controlled damping off, tipover and seedling blight in the nursery and increased seed germination by 48.33% over control²².

Sclerotinia Blight (*Sclerotinia sclerotiorum*) of eggplant was found a serious disease of brinjal that damage partial or complete wilting of the plant. The plant is also affected with *Sclerotium rolfsii*, *Alternaria* spp., *Phytophthora* spp., *Fusarium solani*, *Pythium* spp., *Rhizoctonia* spp., *Verticillium dahliae* caused several types of symptoms⁴⁴.

The transgenic eggplants containing *E. coli* mannitol-1-phosphate dehydrogenase (mt/D) gene showed increased tolerance to abiotic stresses and increased resistance against three fungal wilts caused by *Fusarium oxysporum*, *Verticillium dahliae* and *Rhizoctonia solani* under both *in vitro* and *in vivo* growth conditions³⁵.

Wilt of brinjal caused by *Fusarium solani* fsp. *melongenae* is tested for controlling *in vitro* efficacy by different plant extracts *Azadirachta indica*, *Artemisia annua*, *Eucalyptus globosa*, *Ocimum sanctum* and *Rheum emodi*. All the plant extracts showed significant reduction in the growth of pathogen²⁶.

From Faisalabad, isolations were made from 25 seed samples of different varieties of eggplant of local market. This seed lots yielded various fungi like *Alternaria alternata*, *Aspergillus flavus*, *Curvularia lunata*, *Fusarium oxysporum* and *Fusarium solani*, ranging from 6.75-13%. Some saprophytic and non-pathogenic species of *Epicoccum*, *Mucor* and *Penicillium* were also isolated, which ranged from 1.29-37.8%. During the component analysis, most of the fungi were located in seed coat and tegmen but not in embryo, the tested fungi reduced the seed germination (30-82%) as compared to the control (85%)²¹. The pathogen was found located in the different component of seed as testa, tegmin and embryo in histopathology.

Bacterial diseases:

Bacterial species reported seed-borne and produced important diseases as soft rot (*Erwinia*

caratovora) and bacterial wilt (*Pseudomonas solanacearum*^{39, 9}).

Bacterial wilt disease established in soil and the characteristic symptoms as wilting of the foliage followed collapse of the entire plant. It was reported that pre-inoculation spray of 1000 ppm of the antibiotics Argimycin-100 chloromphenicol or streptomycin sulphate suppressed the disease but there was no effect if the chemicals were applied after inoculation⁴⁵. It was reported from Gauhati University, to explore the potentiality of various organic formulations of *Pseudomonas fluorescens* (Pf) to manage bacterial wilt (*Ralstonia solanacearum* Yabuuchi et al.) of brinjal under local conditions. Different organic materials and adhesives were used in the formulation of Pf based biopesticides and stored at room temperature (30°C) and 4°C to evolve a suitable substrate carrier adhesive based bioformulation of the basis of comparative longer shelf life of the biocontrol bacteria. Storage condition at 4°C was found more suitable and yield higher viable count of the biocontrol bacteria in all the organic formulations studied. CV Pf formulation and seed + root + soil method of application performed significantly better than others (83.33%) control of bacterial wilt in field experimental. Effective management disease under local conditions signifies its potentiality and scope as a plant growth promoting rhizobacteria (PGPR) when formulated using effective substrate carrier and adhesive 10. Vermicompost and farm yard manure were found to support significantly longer shelf life to biological control the bacteria^{5, 33}.

Viral diseases:

Alfalfa mosaic virus, virus diseases of *S. jasminoides*, Mosaic of potato, *Solanum* virus, Tobacco mosaic virus, Brinjal crinkle mosaic virus and Brinjal mild mosaic virus causes the important viral diseases. In India, several viruses have been reported on brinjal but details of their particle properties, structure and composition are not available. The symptoms range from mild mosaic to severe mosaic molting, etching and necrosis^{41, 49}.

It has described a mosaic of eggplant caused by a strain of cucumber mosaic virus (CMV)⁴². Khurana (1970)²⁸, Vyanjane and Mali (1984)⁴⁹ have also reported a non-aphid-borne mosaic virus of brinjal. It has a wide host range in Solanaceae, Leguminosae, Cucurbitaceae, Amaranthaceae, Chenopodiaceae and Compositae.

Mycoplasma diseases:

Little leaf of brinjal was reported from India 1938 and probably occurs only in India and Sri Lanka. Joshi and Bose (1983)²⁷ reported over 90% loss in fruit production. Early infection result in reduced root

length and fresh and dry root weight more than in late infections¹³.

Nematode diseases:

Root knot (*Meloidogyne incognita*) and Reniform nematode (*Rotylenchulus reniformis*) effected severely the plant. The root-knot disease caused by *Meloidogyne javanica* and *M. incognita* reported losses in brinjal up to 30-60%¹⁴.

International status

Ismel (2010)²³ isolated, identified and detected some fungal species from two regions Sulaimania and Germian / Iraq from the seed samples of tomato and brinjal namely *Aspergillus clavatus*, *A. flavus*, *A. niger*, *Cladosporium sp.*, *Penicillium digitatum*, *Pythium sp.*, *Rhizoctonia sp.*, *Rhizopus arrhizus*, *R. stolonifer* and *Sclerotinia sp.* The highest percentage of repletion was 0.77 for *A. niger* whole the lowest percentage was 0.05 of *Fusarium oxysporum*.

Egg plant plantlets infected with *Vesicular arbuscular mycorrhizal* (VAM) fungus (*Glomus etunicatum* and *Gigaspora margarita*) were transplanted to a field contaminated with *Verticillium dahliae* to investigate the disease foliar found that VAM fungus infected plants yielded more fruits than did the non-inoculated plants the incidence of fruit malformation caused by *Verticillium wilt* were similar especially in *Glomus etunicatum* infected plants³¹.

Balogun and Fawehinmi (2007)⁸ reported that egg plant cv. golden beauty obtained Ibadon (Nigeria) in green house experiments aimed to evaluate the interacting effect of infection of cucumber mosaic virus at different ages of direct studied. In Iraq, a new vines eggplant eggplant blister mottled lines (EBMV) was isolated (character as poly virus). This study was conducted to evaluate the effect of 3 product vit-org nutrients, 2-nitromethyl phenol and Thuja extract, on multiplication of EBMV³⁸.

The antifungal activity of brinjal leaf extract with petroleum ether, chloroform, methanol and water as evaluated against three human pathogenic dermatophytes namely *Trichophyton mentagrophytes*, *T. rubrum* and *T. tonsurans* and two opportunistic fungi *Candida albicans* and *Trichosporon beigeli*. The activity of different solvent extract against the test pathogens was as follow: Chloroform extract > Petroleum ether extract > Methanol extract for *T. mentagrophytes*, *T. rubrum* and *T. tonsurans*. The intensity of control of pathogens was like Chloroform extract > Methanol extract > Petroleum ether extract for controlling *C. albicans* and *T. beigeli*¹².

Accessions of *S. torvum* SW, a wild relative of eggplant, were collected in Java Island, Indonesia, and

assessed for morphology, fertility, levels of resistance against both *Ralstonia solanacearum* and *Fusarium oxysporum* f. sp. *melongenae*¹⁹.

Future prospects and biotechnological approach:

Fruits of brinjal commonly consumed as vegetable across the globe. Brinjal is generally propagated by seed that is slow and labour intensive method. To meet the growing demand of crop or its large scale cultivation plant tissue culture techniques offer an opportunity for rapid clonal propagation of desired crop. Assessment of genetic polymorphism using modern biotechnological tools such as molecular markers are the vital part of plant breeding because its utilization helps the plant breeder to develop new varieties.

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