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INTEGRATED DISEASE MANAGEMENT IN SOLANACEOUS VEGETABLES

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Abstract: *The losses due to the attack of insects and diseases to food and fruit crops are enormously large in terms of quantity, quality and monetary value. Solanaceous vegetables are severely attacked by the diseases and pests because solanaceous vegetables have fruits which are pulpy and succulent in nature, thus easily attracted by the pests and insects. Chemical Pesticides has led to many problems, such as pests and pathogens developing resistance, resurgence of once minor pest and pathogens into a major problem, besides environmental and food safety hazards. Integrated pest management (IPM) is smart and intelligent approach, which combines biological, cultural, physical and chemical control strategies in a holistic way for managing the diseases and pests in eco-friendly way without any hazard on human health and environmental resources.*
Keywords: *Disease, Integrated, Solanaceous and Vegetables.*

Introduction: Plants are not absolutely safe in nature because of their susceptibility to various biotic factors like pests and diseases. These biotic factors constitute important constraints for economically feasible cultivation of various crops. The effect of damage and loss due to the attack of insects and pathogens is enormous, and in many cases resulting in complete loss in terms of crop yield. There is a strong historical background to support the fact that insects and diseases caused complete elimination of crops and farmers out of duress had to migrate to other places to escape from the menace of pests and put in renewed effort for cultivation of crop with the idea that such a shifting of place could help them to overcome the problem. The classic examples of insect and diseases attack can be highlighted by giving some examples like Irish famine in Europe due to late blight of potato in 1940s, coffee rust in Sri Lanka towards the end of 19th century, Bengal famine due to brown spot disease of rice crop in 1943, citrus decline in orange plantations, etc. Incidences of Pyrilla and top borer in sugarcane, pink boll worm in cotton, gall midge and brown plant hopper in rice, codling moth in apple and apricot in Ladakh region are some of the examples of diseases and insects invasion. The losses due to the attack of insects and diseases to food and fruit crops are enormously large in terms of quantity, quality and monetary value. Though the disease and pest management schedules and practices are well documented and followed in most of the crops but, quite often the indiscriminate and unscientific use of pesticides has led to many problems, such as pests and pathogens developing resistance, resurgence of once minor pest and pathogens into a major problem, besides environmental and food safety hazards. Integrated pest management has become an alternate and most important of plant pest management practices, as chemical pesticides possess adverse effect on environment and human health. Integrated pest management (IPM), which combines biological, cultural, physical and chemical control strategies in a holistic way is an ideal approach of managing the diseases and pests. Rather than being dependent upon using a single component integrating all the available and feasible are more beneficial, effective and sustainable. IPM refers the dynamic and broad multidisciplinary approach biological, cultural, and other alternatives, including safe and judicious use of pesticides. Its prime and foremost objective is to maintain pest levels below economically damaging levels while minimizing harmful effects of pest management on human health and environmental resources and maximizing the outputs of the produce.

Plants belonging to the group of Solanaceous crops include some of the very important vegetables like tomato, potato, chilli, capsicum, etc. Potato being an exceptional case as it is a tuber crop which has underground growth. Solanaceous crops are severely attacked by the diseases and pests. Commonly solanaceous vegetables have fruits which are pulpy and succulent in nature, thus easily attracted by the pests and insects. Insects directly feed upon these crops or sometimes act as vectors for various pathogens such as viruses.

Major Causal Organisms Associated with Solanaceous Vegetables

i) Fungi: A number of fungal pathogens have been found associated with the diseases of solanaceous vegetable in different parts of the world. *Pythium aphanidermatum* (Edson) Fitz. is a notorious soil borne pathogen causing pre- and post-emergence damping-off of seedlings and root and fruit rots of many crops [1,2]. Seed rot and damping off have been reported to be incited by *P. aphanidermatum, P. adhaerens* Sparrow, *P. acanthircum* Drech., *P. angustatum* Sparrow, *P. irregularae* Buisman, *P. paroecandrum* Drech, *P. rostratum* Butler, *P. splendens* Brawn, *P. vexans* Debary and *P. ultimum* Trow [3]. Reported that *P. aphanidermatum* was most virulent among the *Pythium* species [4]. *Pythium* species have been reported as parasites of various economically important crop plants of solanaceous family, causing seed, seedling or root rots and damping-off diseases [5]. Isolated *P. aphanidermatum* from brinjal fruit left for seed [6], damped off and seedlings rot in chilli fruits and damped off in tomato seedlings. Besides, *P. aphanidermatum, P. ultimum* and *P. arrhenomanes* were commonly found associated with the damping-off disease of different host plants, including vegetables [7].

Rhizoctonia solani (teleomorph: *Thanatephorus cucumeris*) is also a very common soil-borne pathogen, with worldwide distribution and a great diversity of host plants including bean, alfalfa, peanut, soybean, cucumber, papaya, eggplant, corn and many more [8]. It is one of the most important causal organisms responsible for damping-off in vegetable crops. Reported *R. solani* as causal organism of crown root rot of capsicum [9], characterized by defoliation and wilting, resulting in the death of the plant. *R. solani* was one of the predominant fungi isolated from roots and stems of infected plants of bell pepper showing symptoms of wilting [10]. Isolated and identified *R. solani* as causal agent of root rot and basal canker in egg plant [11].

Fusarium species are known to cause wilt and damping off in several solanaceous vegetables. Isolated and identified *F. solani, Alternaria alternata, Cocliobolus lunatus, Cladosporium fulvum, Helminthosporium spiciferum* and *Tricothecium roseum* from diseased plants and fruits of aubergines [12]. Observed high incidence of wilt at fruiting stage and identified *F. solani* as the casual agent of wilt [13]. Identify *Fusarium oxysporum* f. sp. *melongenae* as the casual agent of Fusarium wilt on aubergine [14]. Isolated *F. oxysporum* from the discoloured vascular tissue of brinjal [15] and the isolate was tested for pathogenicity and confirmed as *F. oxysporum* f. sp. *melongenae*. Isolate *F. equisetii* from damped-off seedlings of brinjal [16]. Reported that Fusarial wilts in solanaceous crops were caused by *F. oxysporum* f. sp. *lycopersici* (tomato), *F. oxysporum* f. sp. *melongenae* (brinjal), *F. oxysporum* f. sp. *vasinfectum* (pepper), *F. oxysporum* (chilli) and *Fusarium* spp. (potato) [17]. Isolated *F. oxysporum* f. sp. *melongenae* from the brinjal plant roots showing wilt symptoms [18].

ii) Bacteria: The bacterial wilt in solanaceous vegetables known to be caused by *Pseudomonas solanacearum* (Smith), limits the vegetable cultivation in humid, tropical, sub-tropical and warm temperate areas of the world, where the disease represents a major constraint in the production of numerous agricultural crops [19]. The disease has been reported from different parts of the world, in U.S.A, bacterial wilt caused by *P. solanacearum* has been reported to be common on peppers, tomato, potato, eggplant and a number of other cultivated as well as wild plants [20]. In India, [21] reported that chilli could be one of the hosts for the strains of *P. solanacearum,* isolated from eggplants and potato. It has also been reported to attack variety of other crop plants like potato, tomato, brinjal, chilli, castor, groundnut, banana, etc. [22, 23]. Reported *Ralstonia solanacearum* (syn: *Pseudomonas solanacearum*), the causal organism of chilli wilt [24], as the most important constraint in chilli production in Kerala. Have also observed that bacterial wilt was caused by *R. solanacearum* in tomato, chilli, tobacco, banana, brinjal, marigold, jute and ginger in West Bengal (India) [25].

Integrated Disease Management: The four basic requirements for management of plant diseases are clean and healthy seed, clean field or pathogen free soil, prevention of entry of infection of a pathogen in a standing crop and precaution during harvesting and storage of the produce. An ideal schedule for managing a disease is to integrate measures covering these four requirements. Integrated disease management attempts to use all the known suitable techniques of control to maintain a particular pest population at a level below that which causes economically important losses to the crop.

Reported that damping-off of vegetables (*Pythium* spp., *Fusarium* spp., *Rhizoctonia solani* and *Phytophthora* spp.) [26] was controlled by sowing hot water treated seed (52ºC for 30 min) in 2 per cent formalin treated soil. Reported that integration of metalaxyl with *Trichoderma harzianum* had an additive effect on *Pythium* disease control in sugar beet [27]. Metalaxyl (0.01 %) provided only 62 per cent control but addition of 3.5 g/m of *T. harzianum* inoculum which was ineffective alone increased disease control up to 92.5 per cent along with metalaxyl. While higher amount of *T. harzianum* inoculum (10.5 g/m) in combination with either 0.01 or 0.05 per cent metalaxyl resulted in 100 per cent control of damping-off (*Pythium* spp.) disease of sugar beet. Reported that integration of soil solarization and seed treatment with Apron, *T. harzianum* and *Pseudomonas fluorescens* effectively reduced the population of damping off pathogens (*Pythium* spp., *Fusarium* spp., *Rhizoctonia solani* and *Sclerotium rolfsii*) in vegetable crops [28]. Used farm yard manure (10 t/ha), poultry manure (1.4 t/ha), mushroom spent compost (10 g/L of water), carbendazim (0.2 per cent) and copper oxychloride (0.3 per cent) against *Ralstonia solanacearum* and *Fusarium oxysporum* f. sp. *Melongenae* [29]. They stated that mushroom spent compost + paddy straw, *Trichoderma viride* and copper oxychloride effectively reduced the incidence of brinjal wilt.

Reported that pre-sowing seed treatment with *Pseudomonas fluorescens* + carboxin resulted in 62 per cent wilt control in lentil (*F. oxysporum* f. sp. *lentis*) in pots while seed treatment with carbendazim + thiram and *Gliocladium virens* + *P. fluorescens* + carboxin were effective in controlling 48.8 and 44.2 per cent lentil wilt, respectively, in field [30]. Evaluated the efficacy of chemicals (salicylic acid, Bactrimycin and Plastomycin) [31], soil amendments (bleaching powder + lime + oil cakes and neem cake) and biocontrol agents (*P. fluorescens* MPf-1 and MPf-2, and *Trichoderma* sp.) against *R. solanacearum* causing wilt in tomato, and found that reduction in wilt incidence was highest with MPf-2 treatment followed by soil amended with bleaching powder + lime + oil cakes.

Used neem cake, muriate of potash, Blitox-50, Bavistin 0.1 per cent, marigold leaf extract 5 per cent, garlic bulb extract 5 per cent and neem leaf extract 5 per cent alone and in combination treatments against wilt complex fungi (*R. solani, F. oxysporum, Sclerotium rolfsii* and *Macrophomina phaseolina*) in lentil and inferred that application of neem cake (250 kg/ha), neem leaf extract (5%) and seed treatment with Bavistin (1 g/kg seed) followed by drenching Blitox-50 (0.03%) reduced the incidence of wilt complex [32]. Integrated different management practices including fumigation, biocontrol agents and seed treatment with fungicides against *Pythium aphanidermatum* causing damping-off in tomato [33] and observed that nursery bed treatment with formalin, basamid and their combination with seed treatment (captaf 0.3%) provided 100 per cent control of the disease, whereas, nursery bed treatment with carbendazim granules and *Trichoderma viride* was slightly less effective (4% disease incidence).

Reported that damping-off (*Fusarium* and *Pythium*) of egg plant was lowest when soil was drenched with formaldehyde (5 %) combined with seed treatment with thiram @ 3 g/kg seed and drenching of copper oxychloride @ 0.3 per cent after seedling emergence [16]. Observed that soil disinfection with lime one month before seedling transplantation and the use of *Pseudomonas fluorescens* as biocontrol agent effectively minimized the bacterial wilt in tomato caused by *Ralstonia solanacearum* [34]. Reported effectiveness of soil solarization in combination with *P. fluorescens* and *Trichoderma harzianum* against *Pythium* spp. causing damping-off in tomato [35].

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