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Bio-management of diseases and insect pests in vegetable crops

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Abstract
Pathogens and pests reduce the yield of produce and cause substantial economic losses, and reduce food security at national level. Minimization of losses using chemical pesticides is harmful for plants, soil, and human health. Therefore, different approaches of bio-management provide safe and cheaper protection against soil borne fungal diseases, root knot diseases caused by nematodes and foliar diseases and insect pests of vegetable crops. This review article is aimed to provide meaningful information about bio-management of diseases and insect pests in vegetable crops.

Keywords: bio-management, fungal biocontrol agents, oilseed cake, botanical antagonists, vegetable, pest

1. Introduction
In India, the estimated gross loss in crop production due to pests and diseases is 30-35% (Chakraborty, 2017) [3] or ₹50,000 crore ($500 billion) per annum (Associated Chambers of Commerce and Industry of India, 2014). On the other hand, over use of chemical pesticides on crops causes deleterious effects through accumulations of toxic residue in food chains, spoiling soil fertility and natural biodiversity, and finally resulting in adverse effects on the plants, soil and human health. In view of the above, an alternative to toxic chemical pesticides, bio-management (an eco-friendly, cost effective and easy to handle) of insect pests and diseases evolved and is being used for sustainable agriculture (Annadurai and Palaniappan, 2018, Prakash, 1997, *Haldhar et al.*, 2017, Singh, 2012, http://www.yogickheti.org/) [1, 12, 10, 18]. This article presents a critical review on various aspects of bio-management of diseases and insect pests in vegetable crops under following heads:

1. Management and mass production of fungal biocontrol agents
2. Management of oilseed cake
3. Preparation of botanical antagonists
4. Applications of prepared biopesticides.
5. Mode of Action of Biopesticide
6. Advantages of Bio-management
7. Future Prospects

2. Management and Mass Production of Fungal Biocontrol Agents: Management of fungal biocontrol agents like *Trichoderma viride, T. virens, T. harzianum, Aspergillus niger, A. terreus, Cladosporium oxysporum, Paecilomyces lilacinus, Beauveria bassiana* and *Metarhizium anisopliae*, etc. (known for their fungicidal, insecticidal, nematicidal activities) for the mass production of biocontrol agents are most important step in the bio-management of diseases and pests of vegetable crops. Above biocontrol agents can be isolated from the locality or procure from public institutions (like IARI, etc.) involved in isolation and characterization of biocontrol agents. For mass production of collected biocontrol agents, overnight soaking of starch rich grains of sorghum in water followed by draining out and filling about 100 - 150 gram of the same soaked grains in autoclavable polypropylene bags (packets). The bags packed with grains are sealed with thread and sterilized in pressure for 35-40 minutes. (about 4-5 whistles). After cooling, around 10-15 pre-mycelium colonized grains from already prepared biocontrol agents, transferred in each fresh packet (containing sterilized grains) and packets are sealed quickly. Transfer of pre-mycelium colonized grains in the packets and sealing of packets are done near the flame of the lamp. Inoculated bags were incubated (kept) for 10-12 days at ambient temperature (20-25 °C) for till profuse growth of

biocontrol agents following which they were ready to apply in the fields (Goswami and Pandey, 2004, Goswami *et al.*, 2006, 2007, 2008a, 2008b, 2009, Rathour *et al.*, 2007) [5, 6, 7, 8, 9, 15, 16, 13].

3. Management of Oilseed Cake: Oilseed cake of castor (*Ricinus communis*), neem (*Azadirachta indica*), mahua (*Madhuca Indica*), karang (*Pongamia glabra*), etc. in addition to their fungicidal and nematicidal properties, have also been reported to be ideal medium for the proliferation of fungal biocontrol agents and help in the plant growth due to their rich constituents of NPK. They also make plants more tolerant against plant diseases. Oil seed cake can also be easily extracted through speller by crushing the dried seeds in the village levels or purchase from the local market (Singh *et al.*, 2007) [19]

4. Preparation of Botanical Antagonists: The most important botanical antagonists are kamlesh (*Andrographis paniculata*), aak (*Calotropis gigantea*), datura (*Datura stramonium*), bhangra (*Eclipta alba*), jungli aula (*Phyllanthus niruri*), satyanashi (*Argemone mexicana*), undi (*Calophyllum inophyllum*), etc. (Pandey *et al.*, 2010) [16]. Botanical antagonists are prepared by collection of above plants, drying of collected plants in the shade, powdering of dried plants and packing power in bags (Singh *et al.*, 2007) [19].

5. Applications of Biopesticides: Above prepared biopesticides can be used for the effective bio-management of soil borne fungal diseases, root knot diseases caused by nematodes, foliar diseases caused by fungi and foliar insect pests and diseases (Pandey *et al.*, 2004, 2006) [14, 15]. For the bio-management of diseases and insect pests of vegetable crops, following doses of biopesticide can be used:

5.1 Dose of biopesticide for the treatment of seeds: For the treatment of one kg seeds vegetable with biopesticide, following amounts of bio-constituents are weighted on the electric balance: *Trichoderma* species 8-10g, *Paecilomyces lilacinus* 8-10g, Neem/karanj oil seed cake 50g and botanical antagonists 50g Above weighted amounts of bio-constituents are dissolved in 500 ml water along with sticker, *e. g*., jaggery (50g). Prior to the sowing of seeds in the field, seeds are coated (mixed) with the above prepared solution of biopesticide and dried in shade. Now above seeds can be used for sowing in the field (Pandey *et al.*, 2010) [16].

5.2 Dose of biopesticide for the treatment of soil: For the treatment of one hectare soil with biopesticide, following amounts of bio-constituents are weighted the on the electric balance: *Trichoderma* species 2 kg *Paecilomyces lilacinus* 2kg Neem/karanj oilseed cack 200kg and botanical antagonists 20kg Above weighted amounts of oil seed cake and botanical antagonists are mixed together and broadcast in the field. Field is irrigated with water for the fast decomposition oil seed cake and botanical antagonists. After 10 days, above fungal biocontrol agents along with farm yard manure (FYM) to be applied at the time of sowing of seeds/ transplanting in the furrow as soil treatment (Goswami and Pandey, 2004, Goswami *et al.*, 2006, Singh, 2007, Pandey *et al.*, 2010, Rathour *et al*., 2007) [5, 6, 19, 16, 13].

5.3 Dose for root dip treatment of seedlings: For the treatment of roots of seedlings with biopesticide, following amounts of bio-constituents are weight on the electric balance: *Trichoderma* species 8-10g, *Paecilomyces lilacinus* 8-10g, Neem/karanj oilseed cack 50g and botanical antagonists 50g above weighted amounts of bio-constituents are dissolved in one liter water along with sticker, *e.g.*, jaggery (50g). Prior to transplanting of seedlings in the field, roots of seedlings are dipped for 30 minutes in the above prepared solution biopesticide.

5.4 Doses of biopesticide for the field and foliar broadcasting: For one hectare foliar broadcasting of biopesticide, following amounts of bio-constituents are weighted on the electric balance: *Trichoderma* species 2 kg, *Beauveria bassiana* 2 kg, Oilseed cake 10 kg and Farm yard manure 25 kg Above weighted amounts of bio-constituents are mixed with 25 kg farm yard manure (FYM) and broadcast in one hectare field. For foliar application through dusting, the above weighted amounts of bio-components to be mixed and after 10 days of seed germination/seedlings transplanting, 4 times broadcasting/dusting to be done at 10 days intervals (Pandey *et al.*, 2010) [16].

5.5 Doses of biopesticide for field and foliar spray: For one hectare field/foliar spray of biopesticide, following amounts of of bio-constituents are weighted on the electric balance: *Trichoderma* species 2 kg, *Beauveria bassiana* 2 kg and Oilseed cake 10 kg above weighted amounts of bio-constituents are dissolved in 500 liter of fresh water and sprayed in one hectare field. For foliar spray, the above prepared solution biopesticide started spray after 10 days of seed germination/seedlings transplanting; Four sprays can be done at 10 days intervals Goswami, *et al*., 2007, 2009) [7]

6. Mode of Action of Biopesticide

The combined application fungal biocontrol agents, *Trichoderma viride* and *Paecilomyces lilacinus*, is targeted for the management of soil borne wilt and root rot causing fungi by the former while the latter being nematophagous would manage root knot nematode. Both botanical antagonists, kateli/satyanashi (*Argemone mexicana),* aak (*Calotropis procera),* jungli aula (*Phyllanthus niruri*) and oilseed cake in addition to their plant growth enhancing properties, are also reported to be fungicidal, nematicidal and insect repellent. Spraying of fungal biocontrol agent, *Beauveria* bassiana (an insect parasite) and neem oil seed cake help in the management of pests through parasitizing and also repelling by fungal biocontrol and neem oil seed cake, respectively. This management of pests being also vectors of viruses results in minimizing the incidence of viral diseases (Goswami and Pandey, 2004, Singh *et al.*, 2007) [5, 19].

7. Advantages of Bio-management

The interest in bio-management of diseases and pests of vegetable crops is based on the disadvantages associated with chemical pesticides, some of which are as follows: (i) extensive pollution of the environment, (ii) serious health hazard due to the presence of their residues in the food, fiber and fodder, and (iii) increasing cases of insects developing resistance, *e. g., Helicoverpa* (*Heliothis*) has become resistant to most of the insecticides (Baphna, 1997, Dixit, 1997, Singh, 2012) [2, 4, 18]. In view of above, bio-management of diseases and insect pests provide following advantages over chemical pesticides:

1. They protect vegetable crops from nursery to till harvest,

against diseases, pests and root knot nematodes infecting a wide range of vegetable crops.
2. They protect vegetable crops from disease complexes caused by root knot nematodes and some pathogenic fungi, the former pre-disposing the crops for the fungal attack.
3. As we know that all the components used for preparing biopesticide are eco-friendly (natural products) and they are safe for use by farmers with zero risk.
4. They don't have any adverse effect on the environment.
5. They are much cheaper than chemical pesticides.
6. It results in disease free plants much healthier and thus adds to the yield of the crop.
7. They do not affect the quality of crop produce. Therefore, the produce of crops is safe for consumers.
8. Bio-management of pests and diseases in vegetable crops will reduce the dependency of farmers on costly chemical pesticides.
9. Most of the bio-constituents can be managed at the home or procure from the local market.

8. Future Prospects

Day by day increasing health awareness among the people certainly enhances the demand for healthy food in the coming years. In this direction, food produced by using less inorganic fertilizers and chemical pesticides will play an important role in ensuring the good health of the people. In coming years, bio-management of diseases and insect pests in vegetable crops will certainly play a key role in minimizing the losses of produce due to diseases and insect pests.

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