

## Bio-rational approach in plant disease management

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Over the last ten years, there has been tremendous shift in plant disease management strategies due to growing concern of people on account of the adverse effect of plant protection chemicals on biodiversity, environmental pollution and health hazards to the human beings. Consequently, emphasis has shifted from use of chemical pesticides to use of environmental friendly non-chemical based plant disease management practices with major emphasis on use of plant products and microbe based pesticides. A large number of plant protection scientists throughout the world are involved in search of effective, cost effective viable tools based on plant origin as well as fungal and bacterial origin which are now a days incorporated in plant disease management strategies.

**Biological control of plant disease:** It is an environmentally sound and effective means of reducing or mitigating pests and pest effects through the use of natural enemies.

**Definition:** Biological control is the reduction of inoculum density or disease producing activity of a pathogen or a parasite in its active or dormant state by one or more organisms accomplished naturally or through manipulation of the environment of host or antagonist by mass introduction of one or more antagonists (Baker and Cook, 1974).

Management through biological means are the involvement of beneficial microorganisms such as fungi and bacteria to attack and manage plant pathogens and as well as the use of plant product for management of the diseases below economic threshold level. These microorganisms play a vital role in the makeup of the soil environment and are part of the normal checks and balances that make up a healthy soil. Bio-fungicide is a naturally based microbial or biochemical product. Bio-pesticides/bio-fungicides can be categorized in the following categories:

**Microbial bio-pesticides:** They have an active ingredient *i.e.* a biological control agent (organism capable of attacking or competing with a pathogen or pest).

**Plant bio-pesticides or plant-incorporated protectants:**

They are defined as pesticidal substances that plants produce from genetic material that has been added to the plant.

Biochemical bio-pesticides contain naturally-occurring substances. Some biochemicals may also be products of fermentation. Biochemicals can directly affect disease-causing organisms or may stimulate systemic acquired resistance.

**Bio dynamics:** It is the use of cow urine and cow dung.

Bio-pesticides generally are narrow-spectrum, have low toxicity, decompose quickly, and thus are considered to have low potential for negative impact on the environment.

**Mechanisms:** There are four different mechanisms by which beneficial or bio-control agents interact with other microorganisms. Most bio-control agents apply only one of these four mechanisms; however, some may employ more than one.

**Direct competition :** In this case, the bio-control agents out-competes the target organisms for nutrients and space. This is typically a fungus or bacteria that grows very fast and overwhelms the harmful organisms. The target organism is suppressed due to lack of food and space.

**Antibiosis :** The bio-control agent produces a chemical compound such as an antibiotic or some type of toxin that kills or has some sort of detrimental effect on the harmful organism. Antibiosis is one of the most effective methods of controlling micro-organisms.

**Predation or parasitism:** In this case of mechanism, the bio-control agent attacks and feeds directly on the target organism, or the agent produces some sort of toxin that kills the target organism and then feeds on the dead harmful micro-organisms.

**Induced resistance of the host plant :** We know that once plant is infected with a pathogen, infection triggers some sort of biochemical reaction in the infected host plant that helps keep it from being infected with further pathogens. The infected plant becomes more "resistant" to other infections. Plants have physiological and biochemical systems that help inhibit infection and spread

of pathogens within tissues of the affected plant. Some bio-control agents are known to trigger these mechanisms, and in the case of induced resistance, host plants are purposely inoculated with this agent in an effort to trigger the resistant response. The micro-organism that triggers the response is usually not a severe pathogen of the host.

**Benefits and constraints:** Even though it appears as if these bio-control agents are the cure-all, there are distinct advantages and disadvantages in using them, when compared to traditional chemical controls.

#### Benefits:

- If bio-fungicides are used properly, they surely helps in reducing the use of chemical-based fungicides. This is good for the environment and is one of the most important reasons to consider their use.

- They helps in reducing the risk of developing pathogen resistance to traditional chemicals. Due to the over use of certain chemical fungicides, some common plant pathogens such as *Pythium* sp. and *Botrytis* sp. have become resistant to fungicides. This is less likely to happen with bio-control agents because the beneficial organism co-evolves along with the target organism and adapts to the changes. Chemical cannot do so.

- In most cases, they are safer to use. Most bio-control agents/botanicals have very low or no toxicity to humans, beneficial micro-organisms, beneficial insects and other mammals. This leads to a tremendous benefit in now a days.

- They tend to be more stable than chemical pesticides if stored properly. These are living organisms and must be stored properly.

- In most cases, they are less phytotoxic. Because they are “natural”. They are less likely to cause toxic effects on the host plant, in spite of that if mistakes are made during the calculation of the dose.

#### Constraints:

- Bio-fungicides agents tend to be more difficult to implement when compared to chemicals. Since most of these products have to be implemented prior to the onset of disease, greater preparation by the user is necessary. In most cases, they have a narrower target range. Most are not broad-spectrum products. Identification of the correct target organism is imperative.

- They may not work as quickly as chemicals. Since their populations need to take more time to become effective. That is why it is necessary to apply them prior to the onset of the disease.

- These products do not eradicate the pathogen or rescue the host from infection.

- They may have a shorter shelf life if not stored properly. Remember, these are living organisms/plant product that don't take well to extreme temperatures.

- In most cases, bio-fungicides are more expensive to use. This includes both time and money. They may be a bit more expensive to purchase initially, and they take more time to initiate, if used properly.

- They may not be compatible with the use of other chemical fungicides and bactericides.

**Table A : Biocontrol agents for the management of plant pathogens**

Biocontrol agent	Pathogen/disease
<i>Ampelomyces quisqualis</i>	Powdery mildew fungi
<i>Darlucal filum, Verticillium lecanii</i>	Rust fungi
<i>Pichia gulliermondii</i>	<i>Botrytis, Penicillium</i>
<b>Biocontrol agent</b>	<b>Nematode</b>
<i>Pasteuria penetrans</i> (Bacteria)	Juvenile parasite of root knot nematode
<i>Paecilomyces lilacinus</i> (Fungus)	Egg parasite of <i>Meloidogyne incognita</i>

**Important fungal biocontrol agents:** Most of the species of *Trichoderma*, viz., *T. harzianum*, *T. viride*, *T. virens* (*Gliocladium virens*) are used as bio-control agents against soil borne diseases, such as, root rots, seedling rots, collar rots, damping off and wilts caused by the species of *Pythium*, *Fusarium*, *Rhizoctonia*, *Macrophomina*, *Sclerotium*, *Verticillium*, etc.

**Commercial Formulations of biocontrol agents available:**

**Important fungal biocontrol agents:** *T. viride* (Ecofit, Bioderma, Monitor, Funginil, Trichogourd, Defense SF, Tricho-X, Biogourd etc., in India), *G. virens* (GlioGard in USA), *T. harzianum* (F-Stop in USA), *T. polysporum* (BINABT) and *Aspergillus niger* (Kalisena)

**Important bacterial biocontrol agents:** *Pseudomonas fluorescens*: Dagger-G against damping off of cotton seedlings in USA, *Bacillus subtilis* : Kodiak against damping off and soft rot in USA, *Agrobacterium radiobacter* :K-84: Gallex or Galltrol against crown gall of stone fruits caused by *Agrobacterium tumefaciens*.

Plant which part/product has been proven as fungicides/insecticides in the management of the diseases (Table 1).

Standard procedures for the preparation and application of the plant extracts:

- Select plant parts that are free from diseases.
- When storing the plant parts for future usage, make sure that they are properly dried and are stored in an airy container (never use plastic container), away from

**Table 1 :**

Neem ( <i>Azadiricta indica</i> )	Leaf, kernel, seed, cake	Azadaractin/lemonoids
Garlic ( <i>Allium sativum</i> )	Leaves	Amino acids/allenin
Ginger ( <i>Zingiber officinale</i> )	Rhizome	Scented oils
Stink weed/ Dhatthura ( <i>Datura stramonium</i> )	Leaves/Seeds	Alkaloids/Hayacine
Tulasi ( <i>Ocimum basilicum</i> )	Leaves	Scented oils/yuginals
Karanj ( <i>Pongamia pinneta</i> )	Fruits	Karangin/glabrin
Castor ( <i>Ricinus communis</i> )	Seeds	Ricinolic acid
Marigold ( <i>Calendula officinalis</i> )	Flowers	Alkaloids
Bael Tree ( <i>Aegal marmalus</i> )	Leaves	Beta-citosterol
Turmeric ( <i>Curcuma domestica</i> )	Rhizome	Curcumin/Alkaloids

direct sunlight and moisture. Make sure that they are free from molds before using them.

- Use utensils for the extract preparation that are not use for food preparation and for drinking and cooking water containers. Clean properly all the utensils every time after using them.

- Avoiding direct contact with the crude extract while in the process of the preparation and during the application.

- Harvest all the mature and ripe fruits before plant extract application.

- Always test the plant extract formulation on a few infested plants first before going into large scale spraying. When adding soap as an emulsifier, use a potash-based one.

- Wear protective clothing while applying the extract.

- Wash hands after handling the plant extract.

#### **Strategies to promote bio-fungicides/ botanicals/ Bio dynamics:**

In the current crop production scenario, bio-fungicides/ botanicals/ is of utmost importance, but its potential is yet to be fully exploited primarily because the research in this area is still confined and very little attention has been paid to producing the commercial formulations of bio agents/

botanicals/bio dynamics. Moreover, whatsoever has been commercially produced has not been used professionally by the farmers due to the lack of knowledge regarding its use. So commercialization could be promoted by popularization of biocontrol agents/ botanicals/ bio dynamics among the growers and industrial linkages among the agencies.

**Popularization of biocontrol agents/botanicals/ Bio dynamics:** It may be done by motivating the growers through its 1) Publicity, 2) Field demonstrations, 3) Farmers days, 4) Bio village adoption and 5) Conducting periodical trainings for commercial producers and farmers for further improvement of the products.

**Industrial linkages:** It may be done through:

- Technical support should be made available to entrepreneurs on quality control and registration.

- Regular monitoring is essential to maintain the quality.

- Constant research support should be extended to standardize the dosage, storage, and delivery systems. Positive policy support from government to use more of biocontrol agents/botanicals/ bio dynamics in crop protection.

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