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## *Metarhizium anisopliae*: New Trend Entomopathogenic Fungus for Management of Sucking Pests in Vegetable Crops

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*Metarhizium* species (Metschnikoff) Sorokin (Cordycipitaceae; Hypocreales), an entomopathogenic fungus based products are being developed for the control of insect pests in agricultural system. Demand is ever increasing for organically produced agricultural commodities in India and all round the globe and biological agents have vital role to control the pest damage. In this regard, use of microbial control agents like *Metarhizium anisopliae* in integrated management of insect pests can be considered as best option.

### Introduction

Vegetables are so common in human diet that a meal without a vegetable is supposed to be incomplete in any part of the world. India is the second largest producer of vegetables in the world, next to China, contributing about 10 per cent to the world vegetable production. Though the vegetable requirement is 300g/day/person as recommended by dietician, Indians are able to meet about 1/9$^{th}$ of that requirement only. Vegetables being a rich and cheap source of vitamins and minerals, occupy an important place in the food basket of Indian consumers more popular vegetables like tomato, brinjal, chilli, okra, peas, potatoes, onions and few common cucurbits and leafy vegetables. Unlike other food crops, most of the vegetables are succulent and attract several insect pests. Some pesticides used to control them remain chemically active for a long period and produce hazardous effects on the environment. Biological control of the sucking pest of vegetables using the fungus *Metarhizium anisopliae* (Metschnikoff) Sorokin may provide an alternative to the use of chemical insecticides.

Recently, theoretical and experimental studies have shown the potential of entomopathogenic fungi as next generation agents for the control of sucking pest of vegetable crops, which give priority to maintain the health of the ecosystem thus enabling plant to become resistance to attack by insect pests. However, lack of adequate formulation technologies for most microbial control agents is still a major problem in vegetable crop that has to be harvested at regular interval, it is critical to evaluate safer alternatives like mycopathogens and botanicals which have no toxic residues and hence are best suited for vegetables like okra, brinjal, chilli etc. which is used fresh vegetable for consumption (Anitha, 2007). Entomopathogenic fungi infect their hosts through the cuticle and do not need to be ingested like bacteria, viruses and protozoa. During the process of infection, EPF secrete chitinase to digest insect cuticle. Faria and Wraight (2007) determined that there were 47 different commercially-available *Metarhizium*-based products available around the world. Because of recent

taxonomic changes to the genus *Metarhizium* (Bischoff *et al*. 2009) it is not possible to determine the exact species composition of that list.

Basic functions of formulations are,

- To stabilize the organism during production, distribution and storage.
- To aid handling and application of products, so that it is easily delivered to target site in most appropriate manner.
- To protect the agent from harmful environmental factors at the target site, thereby increasing the persistence.
- To enhance the activity of the organisms at the target site by increasing its activity, reproduction, contact and interaction with target pest (Nagaraja, 2005)

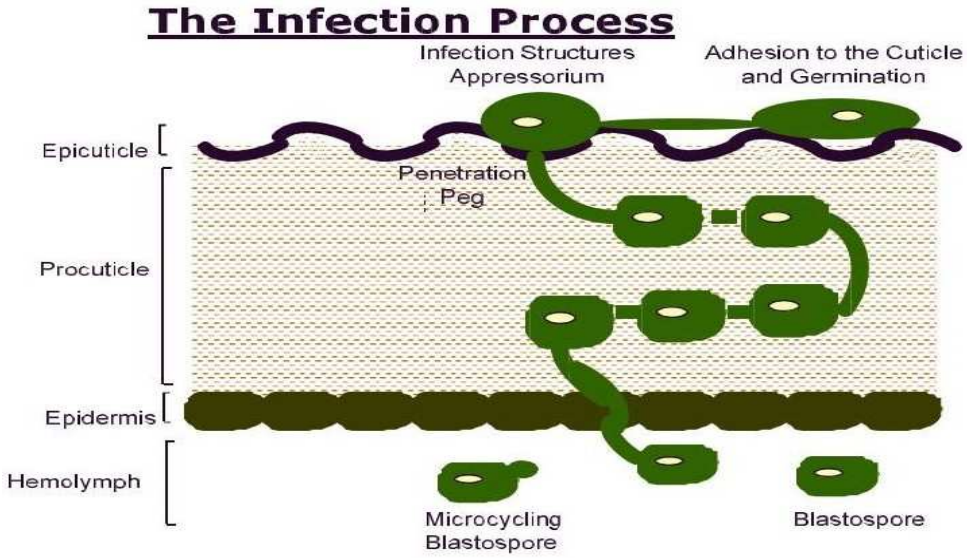
Use of myco- insecticides is most important alternative to manage this pest complex and can reduce the use of broad spectrum pesticides on vegetable crops to enhance natural control by increasing the number of natural enemies.

**Appearance**

The disease caused by the fungus is called green muscardine disease because of the green color of its spores. When these mitotic (asexual) spores (properly called conidia) of the fungus come into contact with the body of an insect host, they germinate and the hyphae that emerge penetrate the cuticle Infections of arthropods by *Metarhizium* species are easily recognized a few days after death. Initially, one only sees fungal hyphae that appear white, but, as conidia form and mature they often take on a characteristic olive green color. However, depending on the species and strain of *Metarhizium,* spores can range in color from white to yellow to brown and green (Tanada and Kaya 1993).

**Mode of Action**

The fungus proliferates throughout the insect's body and hyphal growth continues until the insect is filled with mycelia. When the internal contents have been consumed, the fungus breaks through the cuticle and sporulates, which makes the insect appear "fuzzy." *M. anisopliae* can release spores (conidia) under low humidity conditions (<50%).




(Source: Web image)

**Application Methods**

Commercially available in formulations that can be applied using conventional spray equipment. Foliar Spray (For Sucking pests): The product should be sprayed on the growing plants using aerial spray equipment.

**Frequency of Application**

Applications should be repeated at least once in a week for four weeks. For greenhouse pest problems, applications in every 10-15 days are recommended up to fruiting stage. All applications should be based on monitoring of pest populations.

**Dosage**

Foliar spray: 2.5 kg / hectare in 500 litres of water i.e., 5 gm per litre of water. The spray volume depends on the crop canopy.

**Mass Culture**

The successful mass culture of *M. anisopliae* and development of methods of mass-producing infective spores has led to the commercial development of this fungus as a microbial insecticide. *M. anisopliae* is grown on a large scale in semi-solid fermentation-- similar to that used in the production of *Bacillus thuringiensis*--and the spores can then be formulated as a dust. The fungal spores can also be grown on sterilized rice in plastic bags for small-scale production. *M. anisopliae* is sensitive to temperature extremes; spore viability decreases as storage temperatures increase and virulence decreases at low temperatures

Germination on complex media induced conidia of the entomopathogen *Metarhizium anisopliae* to produce infection structures (appressoria and penetration hyphae) when the germ tube contacted a hard surface. The morphology of the infection structures and their rate of formation are very similar to those observed on cuticle. Differentiation frequencies were greater (more than 70% as compared with less than 40%) on hydrophobic surfaces [Teflon, polyvinyl chloride, polystyrene, polypropylene, polyester (Gel Bond), aluminum foil] than on hydrophilic surfaces (agarose-coated polyester and cellophane). Differentiation frequencies were similar on both positively and negatively charged surfaces.

*Metarhizium anisopliae*'s mode of action makes it excellent tools for management application to a broad range of insect targets, foliar as well as soil dwelling insects. This is compatible with pollinators, predators, and parasitoids as well as with some foliar fungicides: Fluazinam, Metalaxyl, Captan, Chlorothalonil, Flupicolide, etc.

**Major sucking pest of vegetable crops and compatible natural enemies to *Metarhizium anisopliae***

| Common name | Scientific name | Order/ Family | Compatible with beneficial species | Crops |
|---|---|---|---|---|
| Jassid | *E. fabae* (Harris) | Hemiptera Cicadellidae | *Ambliseius degenerans* | Solaneceous crops |
| Whitefly | *B. aurentifolia* | Hemiptera Aleurodidae | *Eretmocerus mundus , E. Eremicus Encarcia formosa* | Cucurbitaceous crops |
| White fly | *Bemisia tabaci* (Gennadius) | Hemiptera Aleyrodidae | | Solanaceous crops |
| Onion thrips | *Thrips tabaci* Lind | Thysanoptera Thripidae | *Orius laevigatous* | Onion, Garlik |
| Chilli thrips | *Scirtothrips dorsalis* (Hood) | Thysanoptera Thripidae | | Chilli, Sweet Paper |
| Cotton Aphid | *Aphis gossypii* (Glover) | Hemiptera Aphididae | *Aphidius colemani A. ervi* | Solanaceous, malvaceous |
| Jassid | *Amrasca bigutella bigutella* (Ishida) | Hemiptera Cicadellidae | | Solanaceous, malvaceous |
| Yellow Mites | *Polyphagotarsonemus. Latus* (Banks) | Acari Tarsonemidae | *Ambliseius cucumeris Ambliseius californicus* | Chilli, Sweet Paper Eggplant |
| Red Spider mite | *Tetranychus neocaledonicus* | Acarina Tetranychidae | | Eggplant |
| Other | | | *Chrysopa sp. Adalia sp. Coccinella sp.* | |

## Conclusion

Bio-pesticide still represents a very small portion of plant protection, however their role has been considered significant. Because fungi penetrate the insect body, they can infect sucking insects such as aphids and whiteflies that are not susceptible to bacteria and viruses. Biological pest management is ecofriendly and important key for sustainable vegetable production. The fungal mycelia start feeding on the body fluid of insects and results in disease and death of the insect pests.

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