

## Bio-pesticide: A eco-friendly approach for plant protection

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Bio-pesticides are of plant origin and include plant products like alkaloids, phenolics, terpenoids and some secondary chemicals. They are biologically active against insects, fungi, nematodes affecting their behavior and physiology. Commonly known insecticides are Pyrethrum, Nicotine, Neem, Margosa, Rotenone etc. *Trichoderma virideae* or *Trichoderma harazianum* or *Pseudomonas fluorescence* formulation @ 4 gm kg<sup>-1</sup> seed either alone or in combination, manage most of the seed borne and soil borne diseases. There is other formulations viz. *Beauveria bassiana*, *Metarizium anisopliae*, *Numeri arileyi*, *Verticillium* sp, which are available in the market and can manage their specific host pest. *Bacillus thurengensis stenebrionis* and *Bacillus thurengensis sandigo* are effective against coleopterans as well as some other insect species. *Bacillus thuringiensis* has been used in the management of diamond back moth on crucifers and vegetables @ 0.5-1.0 kg ha<sup>-1</sup>. Viral biopesticides of baculovirus group viz. granulosis viruses (GV) and nuclearpolyhedrosis viruses provided a great scope in plant protection field. Spray of nuclear polyhedrosis viruses (NPV) of *Helicoverpa armigera* (H) or *Spodoptera litura* (S) @ 250 larval equivalents are very effective tools to manage the *Helicoverpa* sp. or *Spodoptera* sp. respectively.

***Verticillium lecanii*** -As powder (10<sup>7</sup>cfu/gram) 2.5 kg should be dissolved in 500 liter of water for per hectare and should be sprayed. As liquid (10<sup>10</sup>-10<sup>12</sup> cfu ml<sup>-1</sup>) its 1000-1250 ml should be dissolved in 500 liter of water for per hectare and then sprayed for the management of mites and insects like green hopper, leaf miner, thrips, whitefly, brown hopper and other insects.

***Beauveria bassiana***-As powder (1x10<sup>8</sup> cfu gram<sup>-1</sup>) 2.5 kg should be dissolved in 500 liter of water for per hectare and should be sprayed. As liquid (1x10<sup>10</sup>-1x10<sup>12</sup> cfu ml<sup>-1</sup>) its 1000-1250 ml should be dissolved in 500 liter of water for per hectare and then sprayed. For the areas affected by white grubs



mainly for the crop the citrus, mango and coconuts etc. 5 ml of *Beauveria bassiana* per liter water to be applied. *Beauveria bassiana* @ 2 kg should be mixed with 200 liter of water dispensed through the drip or drench system to control the grubs. It can be applied on the crops like banana, soybean, paddy, oilseeds, tomato, chilli, potato, maize, sugarcane, turmeric, citrus crop, onion, garlic, floriculture and horticulture crops.

Pest predators and pathogens has also proved to be effective method of keeping pest problem below ETL. In undative release of *Trichogramma sp.* @ 40,000 to 50,000 eggs ha<sup>-1</sup>, *Chelonus blackburni* @ 15,000 to 20, 000 ha<sup>-1</sup>, *Apanteles sp.*@15,000 to 20,000 ha<sup>-1</sup> and *Chrysoperla sp.*@ 5,000 ha<sup>-1</sup>, after 15 days of sowing and others parasites and predators after 30 days of sowing, can also effectively control pest problem in organic farming.

### Recommended Biological agents:

Crops	Major pests	Eco-friendly management through biological agents
Chickpea/ Pigeon pea/ Pea/Lathyrus /Moong/ Urad	<i>Helicoverpa armigera</i> Hubner (Lepidoptera: Noctuidae)	<ul style="list-style-type: none"> <li>Application of <i>Bacillus thuringiensis</i> Kurstaki 8L @ 1.6 kg ha<sup>-1</sup>. and <i>Bacillus thuringiensis</i> Kurstaki ES @ 1.5 lt ha<sup>-1</sup>, respectively, at early stages of crop infestation (1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> instar larval infestation) with at least 2 applications at 7 days interval.</li> <li>HaNPV 6x10<sup>9</sup> POB/ml @ 250 lt ha<sup>-1</sup>.</li> </ul>
Mustard/ Safflower/	Aphids ( <i>Lipaphis erysimi</i> ).	<ul style="list-style-type: none"> <li><i>Cheilomenes sexmaculata</i> Fabricius 5000 larvae or 500 adults ha<sup>-1</sup>,</li> <li><i>Coccinella septempunctata</i> Linnaeus 5000 larvae or 500 adults ha<sup>-1</sup>,</li> </ul> <p>Two releases; first release to coincide with the appearance of aphids</p>
Sunflower	Aphid ( <i>Lipaphis erysimi</i> ).	<ul style="list-style-type: none"> <li><i>Chrysoperla carnea</i> (Stephens) 10,000 first instar larvae ha<sup>-1</sup>.</li> </ul>
Brinjal	Fruit and shoot borer ( <i>Leucinodes orbonalis</i> )	<ul style="list-style-type: none"> <li><i>Bacillus thuringiensis</i> 500 g ai ha<sup>-1</sup> (10 days interval).</li> <li>3- 4 releases of egg parasite, <i>T. chilonis</i> @1.0 lakh ha<sup>-1</sup></li> </ul>
Cucurbitaceous	<ul style="list-style-type: none"> <li>Fruitfly (<i>Bactrocera cucurbitae</i>)</li> </ul>	<p><b>Poison bait-</b> Mix Ethyl Alcohol-60 ml + Methyl eugenol-40 ml + Malathion/ DDVP (Pesticide)- 20 ml (<i>i.e.</i> in the ratio of 6 :4:2). Use in Mango, Guava, Papaya, Citrus and other fruit crop.</p>



	<ul style="list-style-type: none"> <li>• Aphids (<i>Lipaphis erysimi</i>).</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Cheilomenes sexmaculata</i> Fabricius 5000 larvae or 500 adults ha<sup>-1</sup>,</li> </ul>
Okra	<ul style="list-style-type: none"> <li>• Shoot and fruit borer (<i>Earias vittella</i>)</li> <li>• Fruit borer (<i>H. armigera</i>)</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Trichogramma brassiliensis</i> 2,50,000 parasitized eggs ha<sup>-1</sup> (Inundative release)</li> <li>• 50,000 parasitized eggs ha<sup>-1</sup> (Weekly inoculative release)</li> <li>• <i>Bacillus thuringiensis</i> 500 g ai ha<sup>-1</sup> (10 days interval)</li> </ul>
	<ul style="list-style-type: none"> <li>• Okra aphid</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Chrysoperla zastrowi arabica</i> 50,000 first instar larvae/ha (weekly release)</li> </ul>
Tomato	Fruit borer ( <i>Helicoverpa armigera</i> )	<ul style="list-style-type: none"> <li>• <i>Trichogramma brassiliensis</i> 2,50,000 parasitized eggs ha<sup>-1</sup> (Inundative release)</li> <li>• 50,000 parasitized eggs ha<sup>-1</sup> (Weekly inoculative release)</li> <li>• <i>Bacillus thuringiensis</i> 500 g ai ha<sup>-1</sup> (10 days interval)</li> <li>• HaNPV @ 250 lt ha<sup>-1</sup> (10 days interval)</li> </ul>
Onion	Thrips	<ul style="list-style-type: none"> <li>• <i>Xylocoris</i></li> <li>• <i>Blaptostethus</i></li> </ul>
Potato	Potato tuber moth <i>Phthorimaea operculella</i>	<ul style="list-style-type: none"> <li>• <i>Chelonus blackburnii</i> 50000 adults ha<sup>-1</sup> in the field, Two releases at weekly intervals.</li> <li>• 2 adults per kg of potatoes in godowns.</li> </ul>
Colocasia	Armyworm <i>Spodopteralitura</i> (Fabricius)	<ul style="list-style-type: none"> <li>• <i>Trichogramma spp.</i></li> </ul>
Cabbage	DBM ( <i>Plutella xylostella</i> )	<ul style="list-style-type: none"> <li>• <i>Bacillus thuringiensis</i> 500 g ai ha<sup>-1</sup> (10 days interval).</li> </ul>
	Cabbage aphid	<ul style="list-style-type: none"> <li>• <i>Chrysoperla zastrowi arabica</i> 50,000 first instar larvae/ha (weekly release).</li> </ul>
Weeds	Congress grass weed ( <i>Parthenium hysterophorus L.</i> )	<ul style="list-style-type: none"> <li>• <i>Zygogramma bicolorata</i> Pallister, one adult was found to bring defoliation of a single parthenium plant in 6-8 weeks. Therefore, if releases are to be carried out at this rate, about 0.4. to 0.7 million insects will be required</li> </ul>



		per hectare, as the weed density varies between 40 to 70 plants per square metre. In practice, it is neither possible nor necessary to release so many insects as they are capable of multiplying rapidly. Releases of about 500-1000 beetles can bring about establishment and eventual control.
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**Recommended Bio-pesticide:**

Bio-pesticide	Eco-friendly management against major insect / disease
<i>Trichoderma viride / harzianum</i> <i>Pseudomonas florescence</i> Alone or in combination	<ul style="list-style-type: none"> <li>• Seed treatment for seed born disease @10 gm kg<sup>-1</sup></li> <li>• Soil treatment for soil born disease @ 5 kg qt<sup>-1</sup> of FYM ha<sup>-1</sup></li> </ul>
<i>Trichoderma viride / harzianum</i>	<ul style="list-style-type: none"> <li>• Soil borne pathogens i.e. wilt, dry root rot, collar rot etc of chickpea, vegetables, oilseeds and fruit crops @ 5 lt ha<sup>-1</sup></li> <li>• Blast disease in rice @ 5 lt ha<sup>-1</sup></li> <li>• Sheath blight, brown spot and sheath rot of rice @ 5 lt ha<sup>-1</sup></li> </ul>
<i>Pseudomonas florescence</i>	<ul style="list-style-type: none"> <li>• Soil borne pathogens i.e. wilt, dry root rot, collar rot etc of chickpea, vegetables, oilseeds and fruit crops @ 5 lt ha<sup>-1</sup></li> <li>• Sheath blight and sheath rot of rice @ 5 lt ha<sup>-1</sup></li> </ul>
<i>Bacillus subtilis</i>	<ul style="list-style-type: none"> <li>• Soil borne pathogens i.e. wilt, dry root rot, collar rot etc of chickpea, vegetables, oilseeds and fruit crops @ 5 lt ha<sup>-1</sup></li> <li>• Early and late blight in tomato, rice blast in rice, foliar blight in beans/soybean @ 5 lt ha<sup>-1</sup></li> </ul>
<i>Metarhizium anisopliae</i>	<ul style="list-style-type: none"> <li>• Brown plant hopper in rice @ 5 lt ha<sup>-1</sup></li> <li>• Early shoot and top shoot borer @ 5 lt ha<sup>-1</sup></li> <li>• Sugarcane pyrilla @ 5 lt ha<sup>-1</sup></li> <li>• Groundnut cut worm @ 5 lt ha<sup>-1</sup></li> <li>• Rhinoceros beetle @ 5 lt ha<sup>-1</sup></li> <li>• Diamond back moth of cabbage, Lepidoptera caterpillars and other sucking insects (white flies, aphids, thrips) of crops @ 5 lt ha<sup>-1</sup></li> </ul>



<i>Beauveria bassiana</i>	<ul style="list-style-type: none"><li>• Stem borer and leaf folder in rice @ 5 lt ha<sup>-1</sup></li><li>• White grub of groundnut @ 5 lt ha<sup>-1</sup></li><li>• Diamond back moth of cabbage, Lepidoptera caterpillars of crops @ 5 lt ha<sup>-1</sup></li></ul>
<i>Bacillus Thuringiensis</i>	<ul style="list-style-type: none"><li>• Diamond back moth of cabbage @ 5 lt ha<sup>-1</sup></li><li>• Leaf eating caterpillars (soybean, groundnut, chickpea, vegetables spodoptera sp.) @ 5 lt ha<sup>-1</sup></li><li>• Beetles of different crops @ 5 lt ha<sup>-1</sup></li></ul>
<i>Lecanicelium lecanii</i>	<ul style="list-style-type: none"><li>• White flies, aphids, thrips in vegetables and fruits, scale insects, mealy bug, and other sucking insects @ 5 lt ha<sup>-1</sup></li></ul>
<i>Paceliomyces lilacinus</i>	<ul style="list-style-type: none"><li>• Nematodes in vegetables, white flies, aphids, thrips in different crops @ 5 lt ha<sup>-1</sup></li></ul>