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Compatibility of Bio-agents with Chemical Pesticides: An Innovative Approach in Insect-Pest Management

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This article focuses on compatibility of bio-agents with chemical pesticides as a component of the Integrated Pest Management System in Indian agriculture. So far, use of synthetic chemical pesticides had been the widely used approach for reducing the estimated 45% gross crop loss due to pests and diseases, amounting to around Rs. 290 billion per annum. More and more quantities of chemicals are used for agricultural intensification to feed an ever growing population. In fact, the pest induced loss is on the rise despite increasing usage of pesticides. Biopesticides could play a crucial role in IPM strategies although they cover only about 4% of the global pesticide market. Compatibility is the ability to mix different pesticides without physical or chemical interactions which lead to enhance biological efficiency or reduce phytotoxicity. Compatibility of bio-agents with chemical pesticides is very important for effective pest management.

Introduction

In the majority of cropping systems today, emphasis is still placed on single technology aspects such as the use of pesticides, host plant resistance and bio-control, etc., consideration rarely being given to their interaction. However, an important approach that could be taken in integrated pest management (IPM) programs is the use of biological pesticides together with a rational use of chemical pesticides. In fact, when a range of pests is present, or when only one method is not efficient, there may often be economic and environmental advantages in combining two or more control methods. Such methods need to be compatible with each other, as incompatibility can lead to loss in effectiveness, increased toxicity to humans and other non target organisms, the development of pesticide resistance, major product loss, and crop injury. Some information on the selectivity of most pesticides to natural enemies of pests is already known, but data on the compatibility of chemical and specific biopesticides are often limited and are sometimes conflicting. IPM has been

promoted as a combination of techniques without giving due consideration to the compatibility of each component. Biopesticides could play a crucial role in IPM strategies although they cover only about 4 per cent of the global pesticide market. Biopesticides have high compatibility with other pest management techniques such as natural enemies, resistant varieties etc. Integrating biopesticides with pesticides could enhance performance of IPM strategies

What is Compatibility of a Pesticide?

Compatibility is the ability to mix different pesticides without physical or chemical interactions which lead to enhance biological efficiency or reduce phytotoxicity.

Why Compatibility of Bio-insecticides with Pesticides?

After the continued use of an array of chemical pesticides over the decades, many of their limitations have been understood. However, nonselective chemical pesticides can eliminate natural enemies of pests and induce other problems such as secondary pest outbreaks and pest resurgence. Intensive use of most pesticides will often lead to pesticide resistance in target pests. Increasing problems with chemical pesticides have stimulated the search for alternative control measures, such as the use of biological pesticides including viruses, bacteria, fungi, protozoans and nematodes. A common advantage of biological pesticides is that they target a narrow range of pests, and therefore minimize unintended adverse effects on beneficial organisms. Moreover some biological pesticides work better in controlled environments such as greenhouses where consistent results are more likely than in exposed field environments. As the target for biological pesticides is quite narrow, there are still many situations for which they are not available. The use of chemical control agents is still probably the most frequently used and wide spread means of achieving effective and reliable pest reduction.

Importance of Compatibility

Compatibility of bio-agents with chemical pesticides is very important for effective pest management. Enhanced effectiveness can be achieved by joint action of pathogens and chemical pesticides which ultimately reduce the amount of total chemical insecticides used in crop protection. Microbial insecticides in combination with chemicals insecticides not only reduce the use of sole chemical

insecticides to an extent but also increase the effectiveness of pesticides. Besides, both in combination would be economically viable reducing cost and risk by improving B:C ratio. Compatibility of bio-agents with chemical pesticides is very important to reduce the chances of development of resistances to newer chemical insecticides.

Practices to Promote Compatibility of Chemical and Biological Pesticides

1. Use physiologically selective chemical pesticides to support biological pesticides.
2. Evaluate the probable effect of secondary compounds.
3. Reduce dosages of pesticides.
4. Reduce the area of applying chemical pesticide (e.g. treatments in alternate rows).
5. Reduce the contact between chemical and biological pesticides (e.g. applications in strips or inside traps).
6. The application time of pesticides considering the least amount of interference possible if they are not totally compatible.
7. Avoid the periods of greatest susceptibility of organisms composing the biological pesticides.
8. Use and eventually create through biotechnology pesticide-resistant organisms for biological pesticides.

Incompatibility

Incompatibility is the inability of a pesticide to mix with other pesticides without producing undesirable effects.

Effects of Incompatibility

Biological and chemical pesticides can be incompatible as chemical compounds can severely reduce the activity of the live organisms used in biological pesticides, induced mortality, low reproduction rates, reduced infection capacity and changes in host searching behavior.

Type of Incompatibility

Chemical incompatibility: This is mostly affected by temperature, tank pH and length of time that we hold a spray mixture in the tank before use.

Physical incompatibilities usually involve the inert ingredients of a formulation. The mixture may become unstable, forming crystals, flakes or sludge that may clog spray equipment.

Mechanism of Synergistic Action

All the synergists appear to work by preventing the detoxification of the insecticides with which they are applied. Most of the synergists are microsomal inhibitors or reduce the activity of microsomal enzyme as a result the rate of detoxification of the insecticides by this enzyme is reduced.

Compatibility of Bio-insecticides

Biological control or the use of natural enemies such as parasitoids, predator and/or beneficial bacteria, fungi, virus, and nematodes is an alternative strategy to manage agriculture crop pests. However, the sole use of biological control may not always be sufficient to control plant-feeding insect or mite populations in agriculture pest. As a result, research within the last 5 to 10 years has investigated the possibility of using so-called "bio rational" or "reduced risk" insecticides in conjunction with biological control agents (natural enemies) to determine if there is compatibility when both management strategies are implemented together. Those insecticides that are classified as bio rational or reduced risk include insect growth regulators, insecticidal soaps and horticultural oil and microbial organisms including beneficial bacteria and fungi and related compounds.

Bacteria: Microbial pesticides based on the soil-borne bacterium *Bacillus thuringiensis* (Bt) are among the most widely used groups of biopesticides. Formulations based on Bt sub sp. *kurstaki* and Bt sub sp. *aizawai* have been found to be effective against several lepidopteran pests either alone or in combination with pesticides, other biopesticides or biocontrol agents on insect pest. Example of *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*) in combination with plant oil *viz*. *B.t.k.* 0.2% + Neem oil 5% and *B.t.k.* 0.2% + Citronella oil 5%.

Virus: Entomopathogenic viruses, especially nucleopolyhedrovirus (NPV) and granulovirus (GV) also are known to be effective against various insect pests. *Helicoverpa armigera* NPV (HaNPV), *Spodoptera litura* NPV (SlNPV) and *S. exigua* NPV (SeNPV) already have been commercialized and are widely used against tomato fruit worm (*Helicoverpa armigera*), common army worm (*Spodoptera litura*) and beet army worm (*S. exigua*), respectively. The higher larval mortality of *H. armigera* was found in chickpea at 72 hrs and 1 week after spraying of endosulfan 0.035 per cent + HaNPV 250 LE/ha. (Bhatt and Patel, 2002). Example of viral based pesticides combination *viz*. NPV + Fenvalerate (0.005%), NPV + Monocrotophos (0.035%), NPV + *B.t.* and HNPV + NSKE (Neem Seed Kernel Extract) 2.5%.

Fungi: Entomopathogenic fungi play a vital role in managing the insect pests in humid tropics, *Beauveria bassiana* and *Metarhizium anisopliae* constitute about 68 per cent of the

entomopathogenic fungi based microbial pesticides (Faria and Wraight, 2007). Temperature and humidity are important factors determining the effectiveness of entomopathogenic fungi. Some example of fungi based pesticides combination *viz*. Deltamethrin + *Beauveria bassiana*, Dimethoate 0.015% + *Beauveria bassiana* and Acetameprite 0.004% + *Beauveria bassiana.*

Nematodes entomopathogens: Parasitism by entomogenous nematodes can have various deleterious effects on their host including sterility, reduced fitness and delayed development and in some cases, rapid mortality. The per cent grub mortality was found relatively higher in combination of nematode and fungus than when applied individually against *H. consanguinea*. A high mortality of grub (96.7 %) was found in treatment of N 2000 IJs (infective juveniles) + F 1X 10^9 spores whereas 86.7 per cent mortality was observed in nematode alone and 20.0 per cent in fungus alone after 11 days of exposure. (Jat and Choudhary, 2006). Some example of nematodes based pesticides combination *viz*. Chlorpyriphos- methyl + *Hetrorhabtis gyeongsan.*

Conclusion

Effectiveness of insect-pests control can be enhanced with combined use of compatible bio-agents with chemical pesticides. Most of bio-agents have indicating their selective use in IPM. Bacterial pathogens are more compatible with pesticides than fungal and viral entomopathogens. These features of microbial agents help us in their exploitation for eco-friendly and less harmful strategies in modern agriculture and also for reducing pesticide load growing on our agro-ecosystem**.**

Future Thrusts

1. More laboratory and field studies on compatibility of microbial agents with newer and emerging pesticides are required in India.
2. Encouragements for production of bioinsecticides and compatible chemicals as combo products, which should be promoted in future.
3. Krishi Vigyan Kendra's and NGO's should also be oriented along with Govt. agencies to give more emphasis on demonstration and timely use of bioinsecticides with compatible chemical pesticides for farmer's awareness and benefits.

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