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Role of Bio-pesticides in Vegetable Crop Safety

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Vegetables are most important component of a balanced diet and act as a protective food. It is widely accepted that vegetables are important component of a healthy diet, and that their consumption could help prevent a wide range of diseases. Epidemiological data support that protective effect of vegetables against several types of cancers and cardiovascular disease. No field of human endeavour is entirely free of risk. All aspects of our daily life are surrounded by some degree of risk. Even to do nothing can incur a risk. In every case, we have to consider all risks of any activity in the light of all its benefits. This applies equally to the safe and effective pesticide use. For decades, discussions among scientists and the public have focused on the real, predicted, and perceived risks that pesticides pose to people and the environment. In today's agriculture world, the use of chemical pesticides and fertilisers has increased dramatically among farmers. The extensive use of these chemicals has shown to cause damage not only to the environment, but also to the human beings. One of the ways to reduce the detrimental effects of chemical pesticides is to apply more environmentally friendly pesticides. Using bio pesticides is one of the methods to control pests and diseases in many farms. In general, bio pesticides are natural occurring substances that can control pests by non-toxic mechanisms. They are derived from natural materials such as animals, plants, bacteria, and minerals.

Development of biopesticides

In recent years, there has been a very large upsurge of interest in the potential of *Bacillus thuringiensis* (Bt). This has been a result of several factors, such as growing awareness in problems regarding the effects of conventional insecticides, which cause toxic residues in the environment and food, the development of pesticide resistance and decreasing the opportunities for discovering new groups of chemical insecticides. In the last 15 to 20 years, there have been great steps forward in the development of Bt as a pesticide. These include the isolation and selection of new strains that are effective to a wider range of insect pests, such as the Bt *tenebrionis* for control of Coleoptera. The agricultural sector has changed quite significantly over the last 40 years as a result of the use of synthetic chemicals to control

pests on different crops, triggered by the discovery of DDT in 1939. The insecticidal activities of which, were only discovered a few years later. Due to the effect of long-term usage of chemical pesticides and over-dependence on chemical control, modern agriculture has become extremely vulnerable. Undesirable side effects to human health and the environment are a further consequence. In fact, there have been estimated 25 million agricultural workers in developing countries who are being poisoned every year by pesticides.

Bio-Pesticides

Biopesticides are biochemical pesticides that are naturally occurring substances that control pests by nontoxic mechanisms. Biopesticides are living organisms (natural enemies) or their products (phytochemicals, microbial products) or by products (semiochemicals) which can be used for the management of pests that are injurious to plants. Biopesticides have an important role in crop protection, although most commonly in combination with other tools including chemical pesticides as part of Bio-intensive Integrated Pest Management Biopesticides or biological pesticides based on pathogenic microorganisms specific to a target pest offer an ecologically sound and effective solution to pest problems. They pose less threat to the environment and to human health. The most commonly used biopesticides are living organisms, which are pathogenic for the pest of interest. These include biofungicides (Trichoderma), bioherbicides (Phytopthora) and bioinsecticides (*Bacillus thuringiensis*). The potential benefits to agriculture and public health programmes through the use of biopesticides are considerable.

Biopesticides Registered under Insecticides Act, 1968

1. *Bacillus thuringiensis* var. *israelensis*
2. *Bacillus thuringiensis* var. *Kurstaki*
3. *Bacillus thuringiensis* var. *galleriae*
4. *Bacillus sphaericus*
5. *Trichoderma viride*
6. *Trichoderma harzianum*
7. *Pseudomonas fluoresens*
8. Beauveria bassiana
9. NPV of *Helicoverpa armigera*
10. NPV of *Spodoptera litura*
11. Neem based pesticides
12. *Cymbopogan*

Categories of Biopesticides

Biopesticides fall into four major categories:

1. Microbial pesticides
2. Biochemical pesticides
3. Plant-Incorporated-Protectants (PIPs)
4. Semiochemicals

Use of Biopesticides in Vegetables Pests Management

Mostly the vegetables are harvested frequently and the picked vegetables are marketed for human consumption immediately without any analysis for residual effects of the pesticides. However, toxic effects of synthetic pesticides are a real threat to human health. The bio-pesticides are safe and their application not only suppresses the insect pests effectively, but there is no risk of residual effects for the consumers.

Vegetables Insect Management: Effect of Neem based pesticides against white fly and jassid was higher than other treatments and Achook and NSKE (3%) were the most effective

in controlling the white fly and jassid. It was found that different Neem products proved to be effective to control jassid under field conditions. Neem based products gave significant control of jassids (*Amrasca devastans*). It is also in agreement with who used Neem oil at 2% and Neem seed water extract at 3% which significantly reduced the population of jassids and white fly. Neem and dhatura controlled the sucking insect pests effectively. The effect of bio-pesticides and their efficacy was to control insect pests of tomato. The bio-pesticides appear to be a promising biological control agent against whiteflies. The use of these products in a context of integrated protection of tomato requires that their efficacy is not altered when applied together.

Vegetable Disease Management: Bio pesticides are used primarily as preventative measures, so they may not perform as quickly as some synthetic chemical pesticides. However, bio pesticides are generally less toxic to the user and are non-target organisms, making them desirable and sustainable tools for disease management. While their use is not overly complicated, the application of some bio pesticides may require a high level of understanding and knowledge of the diseases and pathogens that they are designed to control. As with any disease management program, proper timing and application are essential to ensuring efficacy.

Table- 1: Some successful experimental use of bio-pesticides against various diseases

Bioagent	Pathogen	Host (Crop)
T. harzianum	*Phytophthora capsici, Fusarium oxysporum f. Sp lycopersici*	Tomato
Tricihoderma spp.	*Botrytis cinera*	Tomato
Pseudomonas aeruginosa	*Sclerotinia sclerotiorum*	Tomato
B. subtilis	*Ralstonia solanacearum*	Tomato
T. viride	*Colletotrichum capsici*	Chilli
Xanthomonas spp. Pseudomonas syringae pv. Tomato	Bacterial spot & bacterial speck	Tomatoes and pepper
Streptomyces lydicus WYEC 108	**Soilborne pathogens:** *Pythium spp., Rhizoctonia spp., Phytophthora spp., Fusarium spp., Verticillium spp., Phymatotrichum omnivorum,* and other root decay fungi **Foliar pathogens:** *Podosphaera spp., Botrytis spp., Schlerotinia spp., Monilinia spp., Alternaria spp., Peronospora spp.,* and other foliar fun	Greenhouse, nursery, and turf
Bacillus pumilus QST 2808	Rust, powdery mildew, cercospora, and brown spot	Potatoes
Bacillus subtilis GB03	*Rhizoctonia, Fusarium, Alternaria, Aspergillus,* and others that attack the root systems of plants	peas, and beans
Trichoderma harzianum Rifai strain KRL-AG2	Fusarium, Pythium, and Rhizoctonia	Cucurbit vegetables, leafy vegetables, cole crops and hydroponic crops,

Bacillus subtilis QST 708	anthracnose, and dollar spot	leafy vegetables, and bulbs
Bacillus subtilis strain QST 713	Bacterial spot, powdery mildew, rust, gray mold, leaf blight, scab, and more	Vegetables
Trichoderma virens (formerly *Gliocladium virens*)	Pythium, Rhizoctonia, and root rots	Potato, Cucumber, Lima beans,
Bacillus pumilus QST 2808	Fungal pests such as molds, mildews, blights, and rusts	Lettuce, Broccol, Radish
Trichoderma harzianum Rifai strain KRL-AG2	Fusarium, Pythium, and Rhizoctonia	bulb crops, cucurbits, fruiting vegetables, herbs, spices, leafy vegetables, cole crops, legumes, root crops, small grains, and tuber crops

Simultaneous use of bio and chemical fertilizer

Even though bio-fertilizer is superior to chemical fertilizer in terms of sustainable agriculture, it's immediately its complete replacement in place of chemical fertilizer is not possible. A modality of balanced path that involves combined use of chemical and bio-fertilizer can be evolved. It was observed that the application of PSB, *Bacillus megatherium* var. *phosphaticum*, increased the PSB population in the rhizosphere and P availability in the soil. It also enhanced sugarcane growth, its yield and quality. When used in conjunction with P fertilizers, PSB reduced the required P dosage by 25%. In addition, 50% of costly superphosphate could be replaced by a cheap rock phosphate, when applied in combination with PSB. The effects of a combined treatment of multifunctional bio fertilizer plus 50% chemical fertilizer on lettuce yield. From his results it is observed that there was a 25% increase of lettuce yield for the treatment of ½ chemical fertilizer plus bio fertilizer compared to that of the chemical fertilizer treatment, indicating that at least 50% of chemical fertilizer can be saved as multifunctional bio fertilizer was used along with chemical fertilizer. Again an employment of multifunctional bio fertilizer on rhizosphere microbial activity and the growth of water celery in a field showed that the dry weight of water celery in the treatment with 50% organic compound fertilizer with multifunctional bio fertilizer was increased by 34% compared to the treatment with 100% organic compound fertilizer.

Role of Government in Bio-Fertilizer Promotion

Government of India has been implementing the scheme for the promotion of bio fertilizers since 7th Five Year Plan. Under this scheme, one national centre and six regional centres have been established. The main functions of these centres include the promotion of bio-fertilizer through training, demonstration and supply of 10 efficient cultures for production of bio-fertilizers. The promotion of bio-fertilizer also needs extensive extension work to convince the farmers about the need of bio-fertilizer use for increase in productivity. Seminars on bio-fertilizers and micronutrients are regularly being organized by Government of India which are attended by executives of fertilizer industries, agriculture research and extension specialists, academicians, administrators, policy makers and farmers. Marketing of bio-fertilizer is a very difficult task as they are not primary inputs like seed and fertilizer. Again, the farmers' acceptance to bio-fertilizer use has been far from satisfactory. This is the main reason why effective demand has not been created so far. Even if in few cases there is the demand of bio fertilizer but it's limited to few varieties like Rhizobium, Azotobacter, and Phosphorus Solubilizing Micro-organism. As observed from still there is significant amount

of unused capacity of bio fertilizer production. Besides farmers awareness there are also some other technical constraints of the promotion of bio fertilizer in India. Like: Marketing constraints, because of its short self-life, lack of proper storage, consumer illiteracy, low awareness amongst consumers, inadequate guidelines to consumers, inadequate production/promotion effort. A National Bio fertilizer Development Centre was established at Ghaziabad as a subordinate office of the Department of Agriculture and Cooperation with six regional centres. The purpose of the scheme covered organization of training courses for extension workers and field demonstrations and providing quality control services. Production and distribution of different bio fertilizers were also undertaken but subsequently discontinued as the centres redefined their role towards R&D and HRD related activities.

Advantages of Bio pesticides

1. Reduce over dependence on chemical fertilizers and pesticides that has created problems in agriculture.
2. Farming with bio-fertilizer involves natural pesticides, resulting in -no reduction to nutrient value of vegetable.
3. Nutritional quality significantly higher in the grown bio-fertilizer produced product [66].
4. Bio-fertilizer works as vegetative and yield growth promoters.
5. It is beneficial always in terms of soil fertility, ecological health etc.
6. Bio pesticides are usually inherently less harmful/toxic and cause less environmental load or pollutions.
7. Designed to only one specific pest or, in some cases, a few target pests as opposed to chemical that have a broad spectrum activity.
8. Cost of developing bio pesticides is significantly lower than those of synthetic chemical pesticides.
9. Their nature of control is preventive not curative and their effects on flower is less.

Disadvantages of Bio pesticides

1. Specificity is high which may require an exact identification of the target pest/ pathogen.
2. Because of their slow speed of action, bio pesticides are often unsuitable if a pest outbreak is an immediate and becomes a threat to crops.
3. Bio pesticides are not suited for a standalone treatment rather they have to be with a compatible method for high efficacy.
4. Living organisms evolve and increase their resistance to biological, chemical, physical and any other form of control .

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