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Short Communication

Recent Developments in Biopesticides as Potential Substitutes to Chemical Pesticides

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Pest is any animal or plant that causes harm to humans and their concerns. Agricultural pests can bring down the yield and nature of harvest. Pesticides have been used as the essential tool to control pests, since the 1960s [1]. Although, chemical pesticides usage has surely contributed to refining agriculture, in terms of both quality and yield, subsequently expanding it. However, imprudent utilization of pesticides without sticking to the standards has presented genuine security dangers to people, other living organic entities, and the environment. But, public mindfulness about the unfriendly impacts of pesticides on food sources and on the environment has expanded lately, and the quest for options, in contrast to broadly utilized synthetic pesticides has become a need [2].

Biopesticides play an important role in managing the agroecosystem and its effect on human health and environment. The new methods of biopesticide activity should be tested thoroughly. However, a huge development and many discoveries are taking place in biopesticide field by academic and industrial investments and these discoveries are thereby amplifying the worldwide market. This comprises the advancement of new ways to deal with new target pests or introducing the novel technologies to improve the effectiveness of previously available products. Although high costs of biopesticides and their discernment of effectiveness are the factors which control the markets and business sector, the essential focus should be on better yield and quality that could be marketed [3-4].

The regular pesticide industry and market have gone through significant changes over ongoing many years. Biopesticides have come up as safe alternative to the chemical pesticides [5]. Biopesticides are derived from plants, animals and microscopic organisms and thus are natural. Thus, biopesticides can be applied as an option in contrast to the utilization of synthetic pesticides as they have been demonstrated to be powerful for pest control. A few components show that biopesticides are incredible options, in contrast to engineered pesticides. In particular, they are exceptionally successful, target-explicit and have fewer natural dangers [6].

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Biopesticides take into consideration a feasible methodology for improving yield which should expand their utilization and ubiquity in the coming years. The fundamental difficulties of new biopesticides in the development and usage is how to showcase or elevate it and how to improve the dependability on biopesticide [2]. This review intends to sum up the new advancements in biopesticides use and explores the future methodologies to improve their commercialization and worldwide reach for successful pest control.

Types of biopesticides

Microbial pesticides

Microbial biopesticides are microorganisms, bacteria, fungi, virus, protozoan, alga, rickettsia, Mycoplasma and nematodes which are pathogenic against the pest of interest. Bacterial biopesticides are the most well-known type of microbial pesticides that work in multiple ways. For the most part, they are utilized as pesticides, however they can also be utilized to control plant pathogenic fungus and bacteria. These are effective against various types of moths, butterflies, beetles, flies, and mosquitoes [7]. Baculoviruses are arthropod-explicit virus that can control lepidopteran pests of vegetable, ornamental plants, cotton, and forests [8]. A few organisms that have been discovered successful in controlling pests are fungi and are commercialized as *Trichoderma*, *Ampelomyces*, *Gliocladium*, *Candida* and *Coniothyrium* [6].

Biochemical pesticides

These include substances which are natural and control pests by non-harmful techniques. These include plant extricates that bait and trap pests or insect pheromones that interfere with mating. These may include plant extractions like corn gluten, garlic oil, and black pepper that are active against plant pests [6].

Plant-incorporated protectants (PIPs)

PIPs, otherwise called Genetically Modified Crops, are biopesticides delivered by plants through the addition or fusion of foreign genetic material into the host genome. Example, utilization of *Bt* protein. PIPs are the product of gene transfer to plant which permits it to create a pest regulatory material [9].

Semiochemicals

These are chemical signals created by one living being, normally insects which could lead to change in behaviour of individual of the same or different species. The most broadly utilized semiochemicals are the insect pheromones, for protecting crops [10].

Recent developments

It is intriguing to perceive the advancement of biopesticides in the worldwide agriculture market. Their prosperity mirrors the altering status of worldwide agricultural business sectors, as well as the effect of consumers. Recent potential biopesticides include betaproteobacteria products. This success recommends that further screening the soil microbiome may bring about extra effective bacterial products [8]. In view of the business interest around there, we expect new energizing microbial items will be approaching. Further, there has been moderately little development in market based on entomopathogenic fungi, however a few strains are as yet sold as mycoinsecticides [6]. Also, right now, in order to satisfy the projected needs of the horticultural industry, baculovirus based products are of interest. But still the requirement of baculoviruses to be produced in vivo, restricts their expense benefits as contrasted to other choices. This may also restrict their application for enormous crops [11]. Another biopesticides which are on development are phytochemicals. When contrasted with engineered pesticides, phytochemical biopesticides are less harmful, less diligent and biodegradable.

Nanotechnology has come up with solutions of various issues related to advancement of biopesticides. Encapsulation of biological substances as nanoparticles have proved to be efficient against various pests, along with decreasing toxicity to non-target organisms, environment and human beings [2]. Utilization of nanoparticles has been proved useful in protection of neem oil from degrading rapidly and therefore resulting in extended effect on pests. The active ingredients, in such technology, can be delivered continuously and with minimum harm to environment, as these formulations use biodegradable polymers [12].

However, currently the complete information on factors associated with toxicity and risks due to release of these substances in environment are still lacking. Therefore, future examination should target such methods. As of late, a few new constituents have been accounted in previous reports, as capable biopesticides (Table 1), however more field research is important for evaluating their adequacy on pest problems associated with different cropping systems.

Table 1 Recently registered biopesticides and their target pests

Biopesticide Source	Biopesticide type	Target Pest	Reference
Bacteria	*Bacillus thuringiensis* var. *tenebrionis* strain Xd3 (Btt-Xd3)	Alder leaf beetle (*Agelastica alni*)	[13]
Bacteria	*Burkholderia rinojensis* A396 (heat killed)	Broad spectrum insecticide / acaracide	[14]
Bacteria	*Bacillus thuringiensis* subsp. *Galleriae* SDS 502	Beetles	[14]
Bacteria	*Lactobacillus casei* strain LPT-111	*Xanthomonas fragariae*	[15]
Bacteria	*Bacillus thuringiensis* subsp. *tenebrionis* SA-10	Colorado potato (*L. decemlineata*) and elm leaf (*P. luteola*) beele larva	[14]
Fungus	*Trichoderma harzianum*	Fusarium root rot	[16]
Fungus	*Beauveria bassiana* combination GHA + neem oil	Whitefly, aphids, thrips, scales and other leaf feeding insects	[14]
Fungus	*Talaromyces flavus* SAY-Y-94-01	*Glomerella cingulata* and *Colletotrichum acutatum*	[17]
Virus	Nucleopolyhedrovirus (NPV). *Spodoptera exigua* SeNPV	Beet armyworm, *S. exigua*	[14]
Plant	Stilbenes from grapevine extracts	*S. littoralis*	[18]
Plant	*Clitoria ternatea*	*Helicoverpa* spp.	[19]
Plant alkaloid	oxymatrine	*Spodoptera litura, Helicoverpa armigera, Aphis gossypii*	[20]

Future prospects

Presently the research based on biopesticide is at an initial phase but with the identification of isolates, improvement in formulations and advancement in techniques that lessen expenses and upgrade the product life, the research has been evolving and expanding quickly. Further there is need for the exploration of extra business sectors, as for example, the biopesticides utilized for post-harvest uses are less emphasized [21].

Secondly, there should be check on current registration processes for biopesticides. Current toxicological information prerequisites are obsolete for these items. To decrease costs and speed up the registration cycle for microbial biopesticides, the filing requirements need to be rationalized and the process to patent should also follow legislations. The viability of current approaches to keep up the quality, openness and reasonableness of biopesticides may likewise require survey. Extra research in formulation and production should be directed to help the commercialization of biopesticides. In developing countries, the public-private sector reconciliations can possibly improve the advancement in biopesticide research and industry [22]. Additional help of public-funded projects, business investors and pesticide firms are required too. A significant issue is creating severe administrative systems to keep biopesticides accessible at reasonable costs.

Biopesticides combining health and ecological matters are of new interest and the dependability and efficacy of biopesticides can be improved by the accessible innovation. Improvement in production technology will also result in declining of product costs [5]. Though research and engineering in this technology is aimed and progressing, however, there is still a great deal of challenges that should be addressed and the significant questions related to cost viability and storage stability still persist.

SUMMARY

Pesticides have been continuously used as the essential tool to control pests and have contributed to refining agriculture, but their imprudent utilization has presented genuine security dangers to people and the environment. Biopesticides have come up as safe alternative to the chemical pesticides. This review intends to sum up the new advancements in biopesticides use and explores the future methodologies to improve their commercialization. Recent potential biopesticides include betaproteobacteria products and entomopathogenic fungi and baculovirus based products. Another biopesticides which are on development are phytochemicals. Also, nanotechnology has come up with solutions of various issues related to advancement of biopesticides. But currently the complete information on factors associated with toxicity and risks due to release of these substances in environment are still lacking. Therefore, future examination should target such methods. Presently the research based on biopesticide is at an initial phase but with the identification of isolates, improvement in formulations and advancement in techniques that lessen expenses and upgrade the product life, the research has been evolving and expanding quickly. However, there is still a great deal of challenges that should be addressed and the significant questions related to cost viability and storage stability still persist.

LITERATURE CITED

1. Fernandez-Cornejo J, Nehring RF, Osteen C, Wechsler S, Martin A, Vialou A. 2014. Pesticide use in US agriculture: 21 selected crops, 1960-2008. USDA-ERS Economic Information Bulletin. 124.
2. Damalas CA, Koutroubas SD. 2018. Current status and recent developments in biopesticide use. *Agriculture* 8(1): 13.
3. Abdelfattah A, Malacrinò A, Wisniewski M, Cacciola SO, Schena L. 2018. Metabarcoding: A powerful tool to investigate microbial communities and shape future plant protection strategies. *Biol. Control* 120: 1-10.
4. Malacrinò A, Campolo O, Medina RF, Palmeri V. 2018. Instar- and host-associated differentiation of bacterial communities in the Mediterranean fruit fly *Ceratitis capitata*. *PLoS One* 13: e0194131.
5. Samada LH, Tambunan USF. 2020. Biopesticides as promising alternatives to chemical pesticides: A review of their current and future status. *OnLine Jr. Biol. Science* 20(2): 66-76.
6. Thakur N, Kaur S, Tomar P, Thakur S, Yadav AN. 2020. Microbial biopesticides: current status and advancement for sustainable agriculture and environment. *In*: New and Future Developments in Microbial Biotechnology and Bioengineering. Elsevier. pp 243-282.
7. Kachhawa D. 2017. Microorganisms as a biopesticides. *Jr. Entomological and Zoological Studies* 5(3): 468-473.
8. Ruiu L. 2018. Microbial biopesticides in agroecosystems. *Agronomy* 8(11): 235.
9. Liu X, Cao A, Yan D, Ouyang C, Wang Q, Li Y. 2021. Overview of mechanisms and uses of biopesticides. *Int. Jr. Pest Management* 67(1): 65-72.
10. Verma DK, Guzmán KNR, Mohapatra B, Talukdar D, Chávez-González ML, Kumar V, Srivastava S, Singh V, Yulianto R, Malar SE, Ahmad A. 2021. Recent Trends in Plant-and Microbe-Based Biopesticide for Sustainable Crop Production and Environmental Security. *In*: Recent Developments in Microbial Technologies. Springer. Singapore. pp 1-37.
11. Walia S, Saha S, Tripathi V, Sharma KK. 2017. Phytochemical biopesticides: some recent developments. *Phytochemical Review* 16(5): 989-1007.
12. Durán N, Marcato PD. 2013. Nanobiotechnology perspectives. Role of nanotechnology in the food industry: A review. *Int. Jr. Food Sci. Technology* 48(6): 1127-1134.
13. Eski A, Demir l, Sezen K, Demirbag Z. 2017. A new biopesticide from a local Bacillus thuringiensis var. tenebrionis (Xd3) against alder leaf beetle (Coleoptera: Chrysomelidae). *World Jr. Microb. Biot*. 33: 95.
14. Arthurs S, Dara SK. 2019. Microbial biopesticides for invertebrate pests and their markets in the United States. *Jr. Invertebr. Pathology* 165: 13-21.
15. Dubois C, Arsenault-Labrecque G, Pickford J. 2016. Evaluation of a new biopesticide against angular leaf spot in a commercial operation system. *In*: *VIII International Strawberry Symposium* 1156: 757-764.
16. Kirk WW, Schafer RS. 2014. Efficacy of new active ingredient formulations and new biopesticides for managing Fusarium root rot disease of gladiolus hybrids. *In*: XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014) 1105: 55-60.
17. Ishikawa S. 2013. Integrated disease management of strawberry anthracnose and development of a new biopesticide. *Jr. Gen. Plant Pathology* 79: 441-443.
18. Pavela R, Waffo-Teguo P, Biais B, Richard T, Mérillon JM. 2017. *Vitis vinifera* canes, a source of stilbenoids against *Spodoptera littoralis* larvae. *Jr. Pest Sciences* 90(3): 961-970.
19. Mensah R, Moore C, Watts N, Deseo MA, Glennie P, Pitt A. 2014. Discovery and development of a new semiochemical biopesticide for cotton pest management: assessment of extract effects on the cotton pest *Helicoverpa* spp. *Entomol. Exp. Appl.* 152(1): 1-15.
20. Rao PVM, Kumari A. 2016. Effect of oxymatrine 0.5% EC on predators and parasites of important pests on certain vegetable crops cultivated in Ranga Reddy District (Telangana). *Pestology* 40: 15-18.
21. Ivase TJP, Nyakuma BB, Ogenyi BU, Balogun AD, Hassan MN. 2017. Current status, challenges, and prospects of biopesticide utilization in Nigeria. *Acta Univ. Sapientiae, Agric. Environ.* 9(1): 95-106.
22. Kumar KK, Sridhar J, Murali-Baskaran RK, Senthil-Nathan S, Kaushal P, Dara SK, Arthurs S. 2019. Microbial biopesticides for insect pest management in India: Current status and future prospects. *Jr. Invertebr. Pathology* 165: 74-81.