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Research Article

Microbial Technology in Agriculture

Poonam Choubey*

Krishna Agro Pvt. Ltd., Chhattisgarh, India

ABSTRACT

Food production has been increased as a result of the fast adoption of biotechnological techniques that allow for the quick discovery of new chemicals and microbes, as well as the genetic enhancement of established species. Microorganisms have never been more prevalent in fields such as agriculture and medicine in history, save as well-known villains. Currently, however, different agricultural crops require helpful microbes such as plant growth promoters and controllers for phytopathogens, and many species are utilised as bio-factories for essential pharmaceutical compounds.

Keywords: Phytopathogens; Bio-controlling agents; Sustainable Agriculture, Bio-Products.

INTRODUCTION

Compounds having pesticidal action, primarily herbicidal, insecticidal, and nematicidal, have recently piqued researchers' interest in microorganisms. To manage *Morrenia odorata*, the first commercially licensed mycoherbicide was a suspension of *Phytophthora palmivora* and numerous more plant parasite and phytotoxin-producing microbial species have subsequently been found [1]. *Colletotrichum gloeosporioides* can cause anthracnose symptoms in *Aeschynomene virginica*, a rice and soybean weed, allowing it to be controlled. By totally suppressing blooming and decreasing tuber development, *Puccinia canaliculata* can control yellow nutsedge (*Cyperus esculentus* L) [2].

Bio-herbicides, on the other hand, have not been widely used in agronomic and horticultural crops for weed control since they require a variety of parameters, such as optimum humidity, that reduce their efficacy when compared to conventional herbicides. Biotechnological advancements will most likely reverse this trend and increase the performance of bio-herbicides in the future.

Cry and Cyt, two endotoxin proteins, are now used as insecticides. The soil bacteria *B. thuringiensis* (Bt) produces these endotoxins, which have an entomopathogenic effect on pests found in cabbage, potatoes, and cereals [3]. Several transgenic plants producing Bt protein, eg. Maize, tobacco, and tomato, have been grown across the world because to their efficacy in preventing caterpillars, particularly Lepidoptera, from spreading [4]. Baculovirus may infect caterpillars and eggs of pests like *Spodoptera frugiperda*, decreasing agricultural losses caused by this insect, notably in maize. Furthermore, the development made in the virus's genetic modification has enhanced its efficiency as an insecticide [5]. Several fungi harmful to insects, such as Beauveria, Metarhizium, and Paecilomyces, are also being utilised as control agents. These are most commonly employed to combat leaf caterpillars in greenhouses or other locations with high humidity [6].

Much progress has been made in the research and marketing of bionematicides in recent years [7]. The metabolites known as avermectins produced by the bacteria *Streptomyces avermitilis* are an example of this. These pesticides are model pesticides because they are non-toxic to mammals and active against nematodes at extremely low concentrations. Therefore, *B. firmus* culture filtrates are used against adult nematodes and larvae; majorly *Radopholus similis*, *Meloidogyne incognita*, and *Ditylenchus dipsaci.* This filterate paralyse these nematodes and kill them, which suggest that toxic metabolite synthesis is involved in the control of these pests [8]. When *Myrothecium verrucaria* is cultivated in bioreactors, toxic metabolites are generated, and when these metabolites come into contact with adult nematodes, the metabolites in suspension kill the adults while also preventing egg development and hatching [9]. *Pasteuria sp.* endospores, on the other hand, employ parasitism as a means of control. When these endospores come into touch with nematodes, they germinate, become parasitic, and have a significant impact on host reproduction [10]. The fungus belonging to the genus Trichoderma are the most extensively distributed microorganisms that operate in biological pest management. These fungi are saprophytes, mycoparasite decomposers, and plant symbionts that are often found in soil environments and have a worldwide geographical range [11]. This diversity of lifestyles within the genus explains why *Trichoderma* is the source

***Correspondence to:** Poonam Choubey, Krishna Agro Pvt. Ltd., Chhattisgarh, India, E-mail: Choubeypoonam86@gmail.com

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of numerous strains employed in biological control. Trichoderma spp. parasitise and suppress a wide range of phytopathogenic fungi and exhibit a nematicidal effect on the *Meloidogyne* [12]. This functional feature of *Trichoderma* and other species answer back to the growing need for methods that reduce pesticide side effects such as insect population resistance, soil and water quality decrease, and the formation of residues with negative effects on non-target organisms. Sustainable agriculture, on the other hand, includes not only the management of phytopathogens but also the utilisation of functional microbial features associated to plant growth promotion. Mycorrhizal fungi and rhizobacteria, for example, produce activities that can increase plant fitness by enabling nutrient absorption by the plant. Mycorrhizal fungi and roots complement each other in plant foraging inside nutrient patches [13] and help the plant acquire phosphorus by expressing genes that code for inorganic phosphorus transporters [14]. Plant growth-promoting rhizobacterias (PGPRs), too, stimulate plant development through direct and indirect processes. Direct methods include nitrogen synthesis by strains belonging to the genera *Rhizobium, Allorhizobium, Azorhizobium, Bradyrhizobium, Mesorhizobium, and Sinorhizobium,* as well as root growth stimulation via auxin, cytokinin, and gibberellin production. Antibiosis, development of systemic resistance, and competition for resources and habitats are examples of indirect processes that reduce disease vulnerability [15].

Endophytic bacteria, on the other hand, invade plant tissues without causing disease symptoms, creating a stable long-term relationship with the host plant. Endophytes produce bioactive compounds during the contact, which may improve the plant's fitness. Nitrogen fixation, phytohormone production, biocontrol of phytopathogens through the manufacture of antibiotics or siderophores, competition for nutrients, and the creation of systemic disease resistance may all contribute to endophytic growth promotion [16]. However, the bioprospection and identification of these microbes associated with a wide range of plant species is not only important to obtain the strains of agricultural importance, but also to identify such strains those can produce bio-products having antibiotic ability [17], as well as potential for achieving biotechnologically important chemicals [17].

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