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CONTROL OF PLANT DISEASE BY BIOLOGICAL AGENTS

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Introduction

Plant disease known to mankind date back to 520BC (Amos 4:9 and Haggai 2:17). In 1670 with Antonie van leeuwenhoek made history by first observing microorganism. Later in 1743 Needham observed nematodes in wheat seeds as parasites. This became an important milestone in study of plant pathology. In 1853 DeBary studied life cycle of Phytophthora infestants in potato. Millardet in 1885 used fungicide to control disease in grape vine, which opens the path to control plant diseases using chemicals. Introduction of thiram by Tisdale and Williams in 1934, later systemic fungicides oxathins (1966) and benamidazole (1966-1988) and their continuous usage made fungi gain resistance towards them (Kommedahl T, 2000). There is continuous search and need for antimicrobial compounds to control plant diseases. This review details how biological control agents help to control plant pathogens by targeting bacteria, fungi, nematode and virus affecting plant (Abdulkhair, W.M. and Alghuthaymi, M.A., 2016). Biological control agents explored well in constrict manner by Pal, K.K. and Gardener, B.M., 2006. i. ecology of microbes with plants, ii. Application of strain on plant. iii. Discovery of such strain and its mechanism of action on plant pathogen, iv. Application in agriculture field.

Over view

Mycoparasite

- Adams, P.B., 1990 elaborate mycoparasite as control, totally eight species tested only two (Sclerotinasclerotivorum and Teratospermaoligocladum) found to control Sclerotina minor scletrotia in the field. The other six were not able to grow and named as passive mycoparasite. They concluded as non-economical method but effective against plant pathogenic fungi.
- Falk S.P., et al., 1995 found mycoparasite Ampelomycesquisqualis exhibit partial control on powdry mildew of grapevine.
- Hill, S., et al. 2018. Fluorescent Pseudomonas sp. Inhibit soil born fungal plant pathogen. They found phenazine-1-carboxylate and 2, 4-diacetylphloroglucinol metabolite as biocontrol agent.
- In the same year Jaber, L.R. and Ownley, B.H., 2018 studied that entamoparasite hinder the growth of plant pathogen playing dual role.

Phage therapy

Phage refer to virus which depends on bacteria for their multiplication. It stops the growth of bacteria or even destroys it. This finds new application in agriculture, plant pathogen (bacteria) as host to phage so it controls plant disease.

- Jones J.B., et al., 2007 in their article suggest bacteriophages used as integrated pest management to control bacterial disease in plants with continuous check for resistance.
- Balogh B et al., 2010 discussed about virus infecting plant pathogenic bacteria which can be other choice to control plant diseases. They stated that commercially phage available to control certain diseases but persistence of phage and host resistance must be considered while using to manage the disease.
- Gill J.J and Hyman P., 2010 work on phage isolation, preparation for therapy with various methods and techniques. In 1940s phage therapy lost it value because lack of proper techniques at that time. They detailed alternate techniques for the same.
- Jones J.B., et al., 2012 discussed about the factors affecting bacteriophages. Sun light or Ultra Violet light inactivate the bacteriophage on the plant. They questioning the persistence of bacteriophage, time to apply on plants and formulations which protect phage.

Endophytes

Endophytes reside inside the plant, it can be bacteria, fungi etc. These will not impose any threat to the plant.

- Ellis J.G., 2017 reviewed about Rhizobium rhizogenus K84 isolated from infected plant and used to treat crown gall in stone fruit.
- Bhatt P., 2020 discussed how endophytes effectively manage plant diseases without harming the plant. Endophytes compete with plant pathogen for nutrients or place or increase plant resistance or antibiosis.
- Singh M., et al., 2020 discussed in detail about how endophytes protect plants and enhance growth of plant it resides.

Plant growth promoting rhizobacteria (PGPR):

Microorganism associate with root of a plant which support the growth of the plant.

- Kumudini, B.S., et al., 2017, plant rhizosphere free living organisms help and interact with plants. Bacillus and pseudomonas are such PGPR import systematic resistance in plants.

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- Liu, K., et al., 2018 worked with PGPR of Bacillus altitudinis, strains of B. velezensis shows broad spectrum of control against Xanthomonas axonopodis pv. vesicatoria and Pseudomonas syringae pv. Tomato is also a fungal pathogen. Based on their results they suggest combination of two strains gave better result compared to single species.
- Singh H., et al., 2017 discussed how PGPR support the growth of plant, micro ecosystem around root, inhibition of plant pathogen and soil health.
- Kannojia P., et al., 2019 suggest PGPR as an alternate to manage plant disease as they indirectly or directly increase growth of plant, increase resistance and also secretion of metabolites inhibiting plant pathogen.

Competition based disease control

Competition between any two populations competes for nutrition or place. One will outgrow the other counterpart; plant pathogens compete with other microorganism not affecting plant growth. Pathogen suppressed by counterpart known as competition-based disease control.

- Kinkel, L.L. and Lindow, S.E., 2019. Worked on Pseudomonas syringae to study competition-based plant disease control. Success of control achieved when the resources within pathogen population.

Microbiome

Microorganism present in particular place or environment.

- Montesinos, E., 2007 expressed their view on antimicrobial peptides secreted by microorganisms control plant pathogen. These compounds used to produce synthetic compounds commercially or recombination of these genes into plants help to create resistant varieties.
- Mazzola, M. and Freilich, S., 2017 discussed about microbiome as plant disease control agent. It may by natural or synthetic microbiome and its role can be analysed by omics tools. This will help to create synthetic microbiome, their established based on the endemic substrate selection.
- Mota, M.S.,et al., 2017 worked on the selection of biological agent to control plant pathogen from rhizobacteria and phyllo sphere organisms and they compared it.

Advantage and Disadvantages of biological control

- Cook R.J. et al., 1996 analysed merits and demerits of biological control measures of plant disease in their article. They raised concern of using microorganism as control agent against pathogen may impose i. threat to non-targeted species. ii. May supress helpful organism. iii. May affect the ecosystem. iv. Cause allergies in human and animals.
- Emmert, E.A. and Handelsman, J., 1999. They supported gram positive bacteria as a very good source of biological control agents. Their spore forming nature make them an efficient agent. They mentioned Bacillus cereus UW85 control oomycete fungi. It interacts with plant and rhizobacteria around root.

Result and discussion

Microorganisms associated with plant or free living helps the plant by not only providing nutrients but also induce plant resistance, competing with plant pathogen for nutrients, place, overcome adverse effects of physical and chemical condition. Endophytes, PGPR association with plants are called mutualism, here plants and microorganism are benefitted. Competition based plant disease control exhibiting microorganism with plant pathogen called competitors. Phage and mycoparasite with their plant pathogen called parasitism. AlabouvetteC.,et al., 2006 suggest antagonistic microorganisms as biological control fails in field as they are applied like pesticides. Whatever the association is all kind of activity finally protects the plant from its pathogen. Apart from protection as a biocontrol agent, should not impose any threat to environment and ecosystem. Still lot of work has to be done to identify biocontrol agent and its application on the field. Before registering, it is must to clear certain criteria as being biological agent to control plant pathogen before applying it in field. It must be economic, easy to handle may widen the opportunity for formers to opt this method. Still lot more to explore microorganisms as biological agent to control plant diseases.

Future prospects

Pesticides cause water, land and air pollution. There is always a need to control plant disease in order to produce good quality and quantity products. Biological control agents may provide a solution to it. But there is not much work done on them so it opens a path to aspiring researchers in microbiology.

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