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Suppressive Soils: A beneficial and natural way to control pathogens

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Abstract

An era of organic agriculture where we have to feed more than 9 billion of the populations by 2050. Also to keep in mind the use of chemicals is very hazardous, hence reducing it by the use of some alternative means. This practice of using suppressive soils as a Biocontrol method is very effective, not more than chemicals, but still there are not many findings and more research have to be conducted for the proper and efficient use of these methods.

Introduction

Soil borne and foliar pathogens are very devastating in nature and usually cause huge damages in the production and productivity during a cropping season. In addition to this, it is also very much difficult to get rid of these pathogens (Corato, 2020). Suppressive soils are a great example of micro biome mediated base for protecting the plants through any external infections naturally especially in the root zones. Suppression of disease was originally defined by Baker and Cook in 1974 as "soils where the pathogen either doesn't establish or doesn't persist, sets up and doesn't do much harm, or sets up and causes illness for a while but then the disease becomes less significant, even if the pathogen might still be present in the soil after that" (Gómez Expósito *et. al.*, 2017). Basically, the number of beneficial microorganisms should be higher than the number of pathogenic microorganisms. It is a great challenge to feed approximately 9 billion of the population by the year 2050. And the plant protection is largely relied on chemicals for the management of the diseases. While looking to the environment it is important to take the seriousness of the hazards caused by these chemicals and switch to some other practices which may not hamper the health as well as the nature (Lahlali *et. al.*, 2022).

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Historical Background of Suppressive Soils

The results revealed by Atkinson in 1892 suggested for the first time the use of suppressive soils can be useful for the suppression of *Fusarium spp.* and other fungus as well. He reported in his work that not each and every bacterium is harmful or pathogenic in nature (Atkinson, 1892). From that time onwards number of pathogens are being reported to be suppressed by some or the other organisms such as*Rhizoctonia solani*, *Fusarium solani*, *Gaeumannomyces graminis var tritici*, *Sclerotinia sclerotiorum*, *Verticillium dahlia*,*Heterodera schachtii*, *Meloidogyne incognita* and many more (Gómez Expósito *et. al.*, 2017).

Some Basic Concepts

The microorganisms which are useful for the management of other pathogens are called as **Biocontrol Agents** or **Biological Control Agents (BCAs)**. Suppressive soils are naturally found, in which the number of beneficial microorganisms is higher than the pathogenic microorganisms, whereas this particular way when used in the biocontrol process for the management it is counted in the Biocontrol or Biological Control or Biorational Method/Approach. In addition to this, one can add BCAs into the soil manually for the better results if the number of BCAs is low in nature.

Types of Suppressiveness

Basically, there are 2 types of suppressiveness;

1. General Suppressiveness: refers to the grouped activity of the microbial colony and is usually related to competition for the available resources. Its efficacy can be enhanced by the use of organic matter.
2. Specific Suppressiveness: refers to the activity of some concerned microbes which may interfere with the specific stage of the pathogen. This type of suppressiveness can be transferred to general suppressiveness by transferring the suppressive soils to conducive soils in minute amount (Gómez Expósito *et. al.*, 2017).

Mechanism of Action

Generally,4 types of effects have been noticed so far;

1. Direct parasitism and this leading death of pathogens.
2. Indirect toxic effects on pathogens by the production of volatile substances.
3. Direct effect can be seen by the production of antibiotics.
4. Competition for food with that of pathogen.

There are mostly cases of direct protection of the plants from the pathogens. Some studies revealed that in most cases when humans have interfered to increase the BCAs that have worked very little because of the existing micro flora already present at that particular place. This adding

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of mixture for the protecting the crops is basically effective in greenhouse or in the laboratory conditions (Agrios, 1997).

Critical Examples Used Successfully in Managing the Pathogens

Some of the BCAs are giving promising results against pathogens. Some of them are *Pseudomonas spp., Bacillus spp., Trichoderma spp.* and *Burkholderia spp.* against *Pythium spp., Agrobacterium radiobacter var radiobacter, Fusarium spp., Erwinia spp., Rhizoctonia solani* and *Phytophthora spp*. (Lahlali *et. al.*, 2022).

Some fungal species which have showed a broad-spectrum action against pathogens are *Aspergillus spp., Phoma spp., Fusarium spp., Beauveria spp.,* and *Penicillium spp.*In addition, some bacteria which have showed broad spectrum are *Pantoea spp., Burkholderia spp., Streptomyces spp., Serratia spp.* and *Paenibacillus spp.* (Lahlali *et. al.*, 2022).

These BCAs show antagonistic properties due to which they are used widely everywhere.

Table.1. Some classic examples of Specific Suppressiveness.

S. No.	Targeted Pathogen	Disease caused	BCA Used
1.	*F. oxysporum*	Fusarium wilt	*Alcaligenes sp., Bacillus sp., Trichoderma sp., Pseudomonas spp., Actinomycetes*
2.	*Gaeumannomyces graminis var. tritici*	Take-All Decline of wheat	*Actinomycetes spp., Trichoderma spp., Bacillus spp.* and *Pseudomonas spp.*
3.	*Cylindrocarpon destructans, Phytophthora cactorum, Pythium spp.* and *Rhizoctonia solani.*	Apple Replant Disease	*Pseudomonas putida* and *Burkholderia cepacia*.

(Weller *et. al.*, 2002)

Advantages of Suppressive Soils

- It reduces the hazards on human, animals, environment and so on.
- As this is the upcoming era of organics it is a very useful method for management.
- Management that is at par with the greatest efficacy.
- Safer method in respect with the use of chemicals. (Chandrashekara *et. al.* 2012)

Disadvantages of Suppressive Soils

- Management is not obtained very quickly as in the case of chemicals.
- It requires skill for the practice.

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- It is sometimes more time-consuming and proper planning has to be done.

(Chandrashekara *et. al.* 2012)

Conclusion

This natural method of using suppressive soils, if practiced on a higher scale, may be an efficient way to reduce the use of chemicals. This practice, when it is practiced by most of the people worldwide, will bring tremendous changes in the health of humans, animals and the environment. There are a number of successful examples set in these papers below which may help everyone. Workers working extension services should give more focus on these types of practices which may help farmers to grow organic produces and also to save their costs from chemicals.

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