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PROSPECTS IN EXPLORING AND PROMOTING POTENTIAL SOIL ORGANISMS TOWARDS ORGANIC AGRICULTURE AND TO PRESERVE SOIL BIODIVERSITY IN NORTHERN PROVINCE OF SRI LANKA

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ABSTRACT

This paper discusses the potential of soil organisms that can be used to protect agriculture in the Northern Province and to protect the soil biodiversity in future. The findings of researches carried out and on-going researches at the Department of Agricultural Biology at University of Jaffna jointly with Green Farms Pvt. Ltd., an ornamental plants export industry at Marawilla have given hope to minimize and avoid application of inorganic chemicals to grow crops organically. Commercializing bioagents (entomopathogens such as *Nomuraea rileyi, Metarhizium anisopliae, Fusarium incarvatum* and antagonistic fungi, namely *Trichoderma viride and Trichoderma harzianum*), and beneficial soil organisms such as earth worms (*Eisenia fetida*) and making them available at the doorstep will help the farmers to opt for alternate methods to minimize the use of inorganic chemicals. Small scale production of these saprophytic bioagents is possible using waste materials and locally available materials. Research on conversion of organic wastes into vermicompost and vermiwash proved that the combination of both have yielded on par with the application of inorganic chemicals. Further, vermiwash is the cheap and the best nutrient supplement to commercialized foliar nutrient. Extensive awareness programs together with educating farming community will help to protect soil biodiversity. The risk associated with the deterioration of soil biodiversity of this Province can be overcome with the application of beneficial soil microbes and produce a healthy environment for the fauna and flora towards the task of preserving and protecting the biodiversity.

Key works: *Soil organisms, soil biodiversity, entomopathogens, earthworms, bio agents*

INTRODUCTION

Sri Lanka is blessed with an excellent biodiversity, which does not exist in a small island of this nature anywhere else in the world. Such an awesome potential of biodiversity is at the risk of deterioration due to unplanned man-made disasters. In addition, intensive agriculture is an added cause that directly enforces to depend on inorganic fertilizers and pesticides to obtain high yield. The introduction of newly improved input responsive varieties demanded additional intake of readily available nutrients through the commercialized form of inorganic fertilizers. Being an essential component in conventional agriculture, inorganic chemicals are therefore dominated indiscriminately in their application and resulted in additional quantities of nitrate nitrogen dissolved in ground water, declined beneficial microbes in soil, and emergence of unexpected pests and diseases as serious problems in agriculture. Dependence on the artificial fertilizers further influenced the farmers to apply indiscriminately and ended up with polluting the environment. It has been also suspected that the increased incidence of cancer in Jaffna peninsula would have been the result of injudicious application of inorganic toxic chemicals (Jeyakumaran and Mikunthan, 2008).

PRESENT STATUS

At this juncture, it is essential to look for a viable and sustainable alternative to these agrochemicals and to preserve and protect the beneficial microorganisms in the soil to empower the natural system active. Preserving soil biodiversity is essential to provide a conducive soil environment for healthy farming. Understanding the soil biodiversity, especially the soil organisms, helps to minimize the use of inorganic chemicals and to encourage the use of such microbes in the farming by the farming community. Since there are not many commercially readily available soil organisms in the market to enable the farmers to buy and use in their field, research has to be strengthened to provide such accessibilities. Considering the above facts, this paper explains the findings of ongoing research and summarizes the research carried out at Department of Agricultural Biology of University of Jaffna. It also attempts to set a goal for the future line of work to minimize the use of inorganic chemicals and to preserve and protect biodiversity in this region.

MATERIALS AND METHODS

Soil samples were obtained from various places and soil organisms were isolated. Different isolation techniques and trapping methods were employed to isolate the microbes and earthworms. Especially, foliar sampling, serial dilution of soil, soil bait methods using the storage beetle, *Tribolium castaneum* and sampling from litter collected from various places were used to isolate microorganisms.

Foliar sampling:

Infected cadavers collected from foliage of different crops such as black gram, green gram, groundnut, chilli, brinjal, tomato, rice, and castor were observed under the stereobinocular microscope for signs of fungal infections. A diseased cadaver, which was having completely developed mycoses naturally, was collected from a paddy field at Murunkan, Northern Province. The fungus was isolated and cultured in PDA. Koch's postulates were applied to confirm the fungal infection.

Serial dilution of soil:

Soil samples were obtained from different cropping systems and were used for serial dilution up to six times. Isolated fungal colonies were plated and pure cultures were maintained. Those fungal species were tested against larvae of different insect pests by applying the fungal suspension topically. Further studies were carried out for those isolated fungi. Through sieving and isolation techniques fungi associated with the roots also recovered.

Soil baits method:

Soil bait method was used to trap entomopathogens from the soil. To trap the entomopathogens larvae of storage beetle, *T. castaneum*, were used. The soil samples obtained from different cropping systems were brought to the laboratory and representative samples were collected in the plastic containers and five from each first and second instar larvae were released into each container. The containers were kept upside down allowing the larvae completely in contact with the soil. After 12 hours the larvae were separated out and kept in a humid chamber with the food to prevent dying of the larvae due to starvation. Infected dead larvae with extruding fungal mycelia were used to isolate the fungal pathogens into Saboraud media plates. Similarly while doing so a nematode was also isolated from the soil using the bait. The nematode was reared in the grub and pupae of the storage beetle, *T.castaneum* and confirmed its pathogenicity through successful infection of the nematode on the insect larvae.

Isolation of earthworm:

While isolating the organisms from the soil, earthworms were also trapped from the litter of the soil. These earthworms were identified using morphological characters and multiplied. The worms were used in different experiments and the results are summarized. Epigeic worms were used to find out the best media from the combination of wastes generated daily at household and to mass rear them.

RESULTS AND DISCUSSION

The organisms recovered using different isolation and trapping techniques were used in many experiments and the results are promising.

From the foliage sampling of chilli and black gram, following fungal pathogens were isolated. *Metarhizium* sp. was isolated from the infected larvae of *Spodoptera litura* damaging black gram (Mikunthan, 1995) and *Fusarium incarvatum* (formerly *Fusarium semitectum*), *Neozygites floridana*, and *Metarhizium anisopliae* were isolated from diseased thrips, *Scirtothrips dorsalis* and *F. incarvatum* were isolated from broad mite, *Polyphagotarsonemus latus* damaging chilli leaves (Mikunthan and Manjunatha, 2005). An entomopathogen, *Nomureae rileyi* was isolated from the infected cadaver of *Helicoverpa armigera* damaging pulses. Though *N.floridana* is reported to be commonly associated with mites, this was the first time it was found to have infected larvae of *S.dorsalis*.

Many isolates of *Fusarium* sp. recovered from the foliage sampling shows its dominance in the soil as a soil borne microorganism. Field experiments showed the potential of *F.incarvatum* against *S. dorsalis* and *P.latus* (Mikunthan and Manjunatha, 2006; Mikunthan and Manjunatha, 2008; Mikunthan and Manjunatha, 2010b), coconut mite, *Aceria guerreronis* (Mikunthan and Manjunatha, 2010a), hadda beetle , *Epilachna vigintioctopunctata* (Thurkathipana and Mikunthan, 2008a), queen palm root borer, *Parapoynx stratiotata* (Arne Sviningen *et al.*, 2008a).

These microorganisms are beneficial to the environment and naturally found in the soil (Thurkathipana and Mikunthan, 2008ba). Exploring the potential of such microorganisms will help to augment them to produce in large scale (Navaneethan and Mikunthan, 2009) and make them available to the farming community at their doorstep. The compatibility of the bioagents with the pesticides was also determined ((Mikunthan and Manjunatha, 2011c). Considering the urgency in substituting the toxic pesticide in farming, such beneficial and potential microbes can be developed further into a potential bioagents to control the pests and diseases in crops (Mikunthan, 2011). Further, the use of such microbial organisms especially *F. incarvatum* exhibited the potential to infect sucking insects and this could lead to the transfer of gene of the fungus into the plants to develop resistance against potential sucking pests, which is a difficult task in using the bioagents especially, *Bt* toxins (Mikunthan, 2009).

The soil samples obtained from various cropping systems were serially diluted and the dilutions were plated in PDA medium. By this method two isolates of *Trichoderma* were isolated. The isolates were identified as *T. viride* and *T.harzianum.*

These fungal isolates were tested against many fungal especially, *Sclerotium rolfsii* (Mikunthan, 2008), *Helminthosporium* sp. (Jegathambigai *et al.*, 2008b) and nematode pathogen such as *Meloidogyne incognita* (Jegathambigai *et al.*, 2008a) and the results are promising to develop them as a bio control agent. Since this fungus is well known in its antagonistic ability, they were experimented to grow in the organic wastes and found growing well in scrapings of coconut after extracting milk. These milk squeezed scrapings are commonly kept as a waste and now with this experimentation, the use of scrapings is immensely valuable in developing bioagents formula.

As suggested by Parker *et al.* (1996), instead of *Tenebrio moliter,* the storage beetle *Tribolium castaneum* was used successfully as a bait to trap many isolates of *Fusarium incarvatum* as well as an entomopathogenic nematode this year. The isolated *Fusarium* isolates were cultured and maintained for further studies.

Fusarium isolates were tested for many pests of crops and were found effective against sucking insects like aphid, scales, thrips and even mites. This shows the potential of such beneficial microbes to be used in controlling insect pests in near future. The isolation of an entomopathogenic nematode first time in dry zone has to be given much emphasis as these are available as formulations in other countries for the use of the farming community for the control of insect pests.

From the litter, an epigeic earthworm, *Eisenia foetida* was isolated and reared in organic wastes of plant and animal origin. By using this worm several research works were carried out and the summary is given below. *Eisenia foetida* was very successful to grow in organic waste materials ((Piratheban and Mikunthan, 2006; Arne svinningen *et al.* 2008b) especially, in kitchen waste and to convert the waste into vermicompost, which is the best growing media to the potted plants and even in the field application (Mikunthan and Piratheeban, 2007). The suppressive effect of Neem was also determined against *E. foetida* (Piratheban and Mikunthan, 2006).

Eisenia foetida is a potential earthworm which helps to convert the household organic wastes into vermicompost that can be readily applied to the field. In addition the vermiwash produced from the vermicompost container can also be used as a foliar nutrient and it substitutes the use of artificial foliar nutrient used against queen palm (*Livistona rotundifolia*), which is the main ornamental cut foliage regularly exported to Europe. The combined application of vermicompost and vermiwash also yielded promising results in increasing yield of many crops as well as the colour of cut foliage, *L. rotundifolia* (Arne Svinningen *et al.*, 2008b).

GAPS

Exploration of other potential soil organisms especially, the VAM fungi, other entomopathogens and beneficial microorganisms in diversified agroclimatic zones would help to manage the pests and to reduce the application of pesticides. In addition, exploration and understanding the potential of the microbes to be used as biofertilizer and for compost making also have to be studied further in this region. Developing formulations is essential to bring these organisms into a commercialized products readily available in the markets for the farmers to develop confidence on the biological control. And issues related with the product formulation, storage and effectiveness need to be further studied.

CONCLUSION

The isolation of soil microorganisms especially, the entomopathogenic fungi, antagonistic fungi, a nematode and earthworm, has given emphasis to develop them as commercial products to be made available to the farming community. These soil organisms have the potential to reinstate the lost soil biodiversity due to the application of inorganic chemicals. Further research have to be done to investigate the potential soil organisms in the soils of Northern Province and to make them useful to the farming community is the ultimate task to preserve and protect the soil biodiversity.

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