

**MYCORRHIZA AS A BIOCONTROL AGENT AND  
BIOFERTILIZER**

by

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Centre for Rural Development and Technology

Submitted

in fulfillment of the requirement of the degree of Doctor of Philosophy

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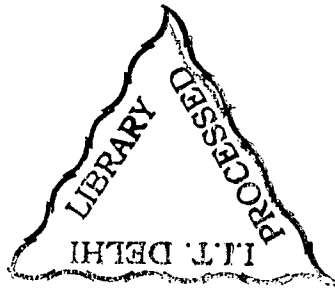


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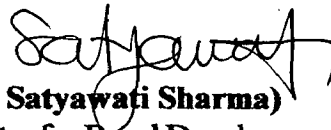
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**dedicated to  
my  
mummy and pitaji**

## **CERTIFICATE**

This is to certify that the thesis entitled “Mycorrhiza as a biocontrol agent and Biofertilizer”, submitted by Ms. Anuja Sharma has been prepared under my guidance in conformity with the rules and regulations of Indian Institute of Technology, Delhi, India. The research report and results presented in this thesis have not been submitted for any degree or diploma in any other University or Institute.



**(Dr. Satyawati Sharma)**

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Anuja  
(Anuja Sharma)

## **ABSTRACT**

*The use of synthetic chemicals as nutrients and plant protection chemicals has become essential for crop production in present era. However, their use is now being seriously questioned as they pose a substantial risk to the environment due to toxicity to non-target organisms. The usage of these synthetic chemicals is presently challenging the sustainability of agriculture itself. Present day concern regarding the long-term productivity and sustainability of agro-ecosystems is leading scientists to consider a shift from conventional, chemical based agriculture to low-input ecofriendly sustainable agriculture. Practices that minimize the rate of soil degradation, improve soil fertility, increase crop yields and raise farm income are key to sustaining agricultural productivity. Thus, there is need to develop effective, economical and safe pesticides, which must be pest specific, non-toxic to humans and beneficial organisms, biodegradable, not prone to insect resistance and pest resurgence and, last but not least, cheap. Efforts should be made in such a way so as to maximize the total benefits and minimize the harmful side effects arising from chemical inputs, which can be achieved through a coordination of all known chemical, biological and cultural control methods—an integrated pest and nutrient management.*

*Mycorrhiza possesses the potential for sustainable agricultural practices. It is one of those microbial tools available, which modifies the plant in such a way, which would make it less susceptible to pathogens attack. Also, the mycorrhizal technology offers a biological means of assuring plant protection and production at low cost with less input of chemical pesticides and fertilizers. The functional attributes of AM fungi assign them a priority in microbial biotechnology.*

*Plants can provide the wherewithal in the form of specific biodegradable alternative to synthetic organic insecticides. Nearly 2000 species of plants are known to have pesticidal properties. Various plant extracts have been reported to possess*

*insecticidal, ovicidal, attractant/repellent, antifeedant, insect growth regulatory and/or chemosterilant properties. Identification, development and deployment of plant products of sufficient potency against various pests have become important research endeavours in context of preservation of ecosystem quality.*

*Keeping the above in view, the present study was focussed on testing the viability of the integrated approach i.e. combining the potential of arbuscular mycorrhizal fungi with selected botanicals, cakes, bioinoculants and chemical pesticides. The major objectives were;*

- To study the efficacy of AM fungi alone and in combination with other additives for nematode (*Meloidogyne incognita*) control in tomato (*Lycopersicon esculentum* var. Pusa Ruby) and chilli (*Capsicum frutescens* var. Pusa Jwala).*
- To study the efficacy of AM fungi alone and in combination with other additives for termite control in mulberry (*Morus alba* var. Sujan Puri) and chilli (*Capsicum frutescens* var. Pusa Jwala).*
- To study the residual effects of chemical pesticides used in same crops and soil.*
- To increase the biomass yield of selected plant crops namely tomato, chilli and mulberry with the use of AM fungi and additives.*
- To reduce the requirement of phosphorous in mulberry in alkali soils by enhancing the synergy of AM fungi exploiting some additives.*

*The thesis entitled “Mycorrhiza as a biocontrol agent and biofertilizer”, organized in 5 chapters, starting with a brief introduction on the background of the study presents literature review on relevant aspects and focuses attention on arbuscular mycorrhizal fungi. Initially screening of best host plant for mycorrhiza culturing was done. Then, *Ricinus communis* being identified as the best host plant was selected for AM culturing and inocula production. The effect of different inocula namely soil, root and soil–root and nutrient solutions (Hoagland and two different*

concentrations of sugar solutions) on the mycorrhizal culturing was studied. Initially laboratory level studies for the identification and quantification of the selected botanicals for chosen pests (nematodes and termites) were conducted. Thereafter, field level studies were performed with tomato and chilli for the nematode control and mulberry and chilli for termite control in Micromodel (an experimental field site at I.I.T., Delhi). The combined effect of AM fungi with the selected botanicals viz, *Azadirachta indica*, *Carica papaya*, *Lantana camara*, *Ocimum sanctum*, *Pongamia glabra*, *Ricinus communis* and *Tagetes patula*; oil cakes viz, *A. indica*, *Brassica campestris* and *R. communis*; and bioinoculants viz, *Azotobacter chroococcum*, *Azospirillum brasilense*, *Ganoderma* and earthworms (*Eisenia fetida*) with vermicompost was studied. The comparative study with chemical pesticides was also done. The data with respect to plant growth parameters, mycorrhizal response and nematode infection were collected. The plants and pre and post experimental soil samples were analyzed for carbon, nitrogen, phosphorus and potassium. Pesticide residue analysis was also done in both the plant and soil samples. In order to study the fertilizer potential of mycorrhiza in alkaline soils, two sets of experiments were performed with a selected plant, mulberry. All the data were statistically analyzed and discussed.

*R. communis* was found to be the best host plant for mycorrhiza culturing. The soil+ root based inoculum was proved to be the best amongst the three inocula used and the Hoagland nutrient solution found to be more effective than sugar solutions in enhancing the growth of arbuscular mycorrhizal fungi. However, sugar solution also showed better effect on the AM culturing than control. In the laboratory level study, the efficacy of botanical *O. sanctum* was followed by *T. patula*, *C. papaya*, *A. indica* and *R. communis* in delaying and controlling the hatching of *M. incognita*. In the case of termites the effect of plant extracts was observed in the order of; *P. glabra*, *C. papaya*, *L. camara*, *T. patula*, *R. communis* and *A. indica*.

*In the field level experiments the additives were found to have synergistic effect with mycorrhiza. They promoted mycorrhizal colonization, reduced the nematode infection to certain extent, influenced nutrient uptake of plants and improved plant growth and biomass yield. Mycorrhizal fungi also proved an efficient tool for the curtailing chemical fertilizer use (25%) in alkaline soils. The combined use of 75% of recommended dose of P and AMF along with botanicals further enhanced mulberry growth.*

*These findings open up the interesting possibilities for ecofriendly management of insect pests. Incorporation of mycorrhizal fungi as bioinoculant to supply essential nutrients to cultivated crops especially in low fertile areas may substantially improve the production potential of nutritionally deficient soils and help in conserving the costly fertilizer reserves. The present findings suggest that intrinsic high and possibly synergistic activity of mycorrhizal fungi with environmentally acceptable additives may be used to enhance overall biomass production and soil fertility on sustainable basis.*

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