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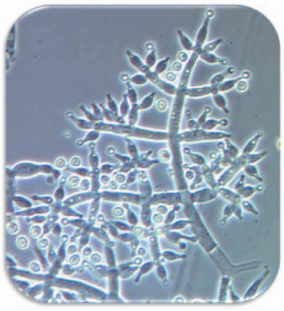
Validation and Up-Scaling of *Tricho*-Products for Soil Borne Disease Management in Vegetable Crops

Due to an increasing awareness regarding human health and conservation of soil and environmental quality, increasing attention is being paid to alternative disease management systems to replace chemical pesticides for producing vegetable crops. Application of composts and manure, various integrated pest management (IPM) tools such as healthy seeds, crop rotation, good cultural practices, use of pheromone traps, hand weeding, hand picking of insects and diseased plants, etc. are being promoted as alternative management options for pest control. These practices help preserve soil quality, promote microbial diversity and abundance and minimize disease incidences. On the other hand, agricultural, industrial and household wastes are increasingly becoming a big problem throughout the country. It has been reported that about 70% household wastes are organics. At present, approximately 0.5-1.0 kg organic waste is produced per family per day, and the total in Bangladesh amounts to 13.0 t/day and 4.9 million t/year. To date, there is no beneficial use of these wastes due to lack of proper initiatives. Water hyacinth, considered a water weed, can be a natural source of fertilizer. Appropriate technology could rapidly convert these solid wastes to useful organic fertilizers. The fungus, *Trichoderma* is a good converter of waste material into useful organic composts. BARI started research on the development and use of *Trichoderma* in 1998. Mixing of a definite concentration of spore suspension of a *Trichoderma harzianum* strain with measured amounts of processed organic materials is a technique of developing the *Trichoderma*-based compost fertilizer named *Tricho*-compost. The composting process produces drainage enriched with *Trichoderma*, known as *Tricho*-leachate which can be collected and reused. These two bio-products were reported to suppress soil borne fungal pathogens (*Sclorotium, Fusarium* and *Rhizoctonia*), root-knot nematode (*Meloidogyne* spp.) and bacteria (*Ralstonia solanacearum*) in artificial inoculated conditions. Relatively low insect and disease infestation has been recorded in vegetables grown under IPM systems, especially with *Trichoderma* based products, compared with non-IPM systems. Brinjal shoot and fruit borer infestation was reported to be reduced by about 20% with Tricho-compost application. *Tricho*-compost reduced seedling mortality caused by *Pythium, Rhizoctonia, Sclerotium* and *Fusarium* spp by 40.92% to 64.45%.



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Therefore, to suppress pathogens and ensure a healthy soil environment, large scale adoption of the *Tricho*-compost technology in vegetable production merits attention. This project was designed to demonstrate the benefits *Tricho*-compost in vegetable production in the country.

A community based participatory approach was used to introduce the *Tricho*-product (TP) technology. A total of twenty farm families from two project sites were involved. Each family grew vegetables on 10 decimal land using TP. A total of 3.24 ha land was utilized in four crop seasons during the project period. Spore suspensions of *T. harzianum* were produced in the BARI HRC laboratory and supplied to the participatory farmers for *Tricho*-compost production at two project sites. The participatory farmers collected waste materials and produced compost using the *Trichoderma* spore suspension under the supervision of trained field assistants of BARI. Vegetables were selected after discussion with farmers, considering disease infestation levels and local market demands. Experiments were conducted for validation of *Tricho*-compost and *Tricho*-leachate production and their use at the farmers' level. *Tricho*-compost was incorporated in soil and *Tricho*-leachate was applied as foliar spray for disease management.

Selection of effective isolate of *Trichoderma harzianum*

An effective isolate of *Trichoderma harzianum* from the plant pathology laboratory of HRC, BARI was purified as the mother culture. The effectiveness of *T. harzianum* was tested against *Sclerotium rolfsii* through the 'Dual Culture Technique'. The percent inhibition of radial growth was calculated using the standard formula as follows:

$$\text{Percent inhibition of radial growth} = \frac{R1 \quad R2}{R1} \times 100$$

where R_1 = radial growth of pathogen in absence of antagonistic agent (control) and R_2 = radial growth of pathogen in presence of antagonistic agent. Radial growth of *S. sclerotiorum* was inhibited by *T. harzianum* on PDA media. The growth reduction was about 73.78% in presence of *T. harzianum* after 120 hours of incubation. However, *T. harzianum* destroyed the whole mycelial growth of *S. sclerotiorum* after 10 days of incubation.

Spore multiplication of *Trichoderma harzianum*

Yeast enriched Richard's solution was used for mass multiplication of the *T. harzianum* spore. Large petri-plates (17 cm diameter) and 250 ml conical flasks were used for *T. harzianum* culture. A total of 68 liter of *T. harzianum* seed spore suspension ($3x10^{12}$ cfu/ml) was produced during May 2013 to May 2016.

Preparation of composting house/device

At each location, 10 compost material loading houses were prepared at 10 selected farmers' homesteads. The building materials, sizes and configurations of these composting houses were similar across the project locations.

Tricho-compost and *Tricho*-leachate production

Kitchen and field vegetable waste materials were collected from nearby houses. Poultry litter was collected from a poultry farm. Molasses (1.5 kg) and *Trichoderma* solution (3×10^7 cfu/ml) were mixed in one bowl of water which acted as the stock solution. The *Tricho*-molasses mixing solution was sprayed on raw materials in the compost houses and mixed vigorously to prepare pastes. About 36 t *Tricho*-compost and 1070 liter *Tricho*-leachate were produced at two project sites.

Adaptive trials with Tricho-products

A total of 80 adaptive trials were conducted on disease management for vegetable crops, such as, pointed gourd, bottle gourd, country bean, brinjal, tomato, cauliflower, cabbage and cucumber by using *Tricho*-compost and *Tricho*-leachate with farmers' practice was the control treatment.

Results and Outputs

A total of 73.92 t organic waste materials were collected for preparation of *Tricho*-compost. Participatory farmers learned the production technology of *Tricho*-compost and *Tricho*-leachate through training. The participating farmers produced a total of 36.96 t *Tricho*-compost and 1070 liter *Tricho*-leachate.

The application of *Tricho*-compost and *Tricho*-leachate reduced disease incidence and increased the yield and quality of vegetables. The *Phytophthora* fruit rot of pointed gourd was reduced by 33.71 to 37.78% and its yield increased by 20.74 to 42.44% regardless of location and year. Anthracnose fruit rot of bottle gourd was reduced by 27.37 to 48.67% and its yield increased by 28.22 to 31.86%. *Anthracnose* rot was reduced by 37.65 to 52.81% and fruit yield increased by 29.53 to 33.53% in summer country bean, while in winter country bean, fruit rot was reduced by 66.67- 58.78% and yield increased by 20.05 to 30.42% with *Tricho*-compost and *Tricho*-leachate treatments.

Tricho-compost reduced the need for chemical fertilizers like urea, TSP/DAP and MoP by 18.18-41.67%, 16.67%, 16.67-33.33%, 18.75-33.3%, respectively. Moreover, harmful (parasitic) soil nematodes were reduced and beneficial (bacterivorous and fungivorous) nematode populations increased remarkably due to *Tricho*-product application to soil. After the fourth application, about 63.64 to 70.21% plant parasitic nematodes were decreased and about 88.31 to 89.15% fungivorus and 136.82 to 156.48% bacterivorus nematode populations increased in soil. Similarly, beneficial fungal and bacterial populations were increased by 123.08 to 139.50% and 71.31 to 85.68%, respectively.

Compared with the baseline situation, farmers' average net incomes from brinjal were increased by 344.58% and 175.05% with the application of Tricho-compost and *Tricho*-leachate, respectively. Similar results were obtained for other vegetables. About 3000 copies of leaflets, folders and booklets were prepared and distributed to the stakeholders for technology dissemination. Also, the making and agricultural use of *Tricho*-products were shown on TV for nationwide circulation.

Benefits

Beside disease control, Tricho-compost is a source of organic matter which imparts huge benefits to the soil and crop. These advantages manifest themselves in reduced risks, higher yields and less dependence on inorganic fertilizers.

Farmers learned about the production of Tricho-compost and Tricho-leachate and their use in vegetable production. Farmers are using Tricho-compost to grow vegetables (tomato, brinjal, pointed gourd, country bean, cabbage, cauliflower, cucumber, chili, and potato), fruits (mango, papaya, citrus, etc.) and cereal crops (rice, maize). Use of Tricho-compost and Tricho-leachate reduced the use of chemical fertilizers, and suppressed soil borne disease such as gummosis, bacterial and *Fusarium* wilt, root-knot nematode and foliage infection such as *Phytophthora* fruit rot disease.

Recommendations

Pointed gourd

Tricho-compost @ 2.5 t/ha + foliar application of Tricho-leachate @ 20ml/liter + Bordeaux pest application + poison bait traps + soap water spray package for pointed gourd production was found to be cost effective and high yield producing in the adaptive trials. The package can be used for other cucurbits vegetables, too.

Brinjal

Tricho-compost @ 2.5 to 3.0 t/ha + foliar application of *Tricho*-leachate @ 20ml/liter + use of pheromone traps along with hand picking + clean cultivation may be use as a package for brinjal cultivation. TV and radio advertisement is necessary for awareness development. This package can also be used for other *Solanaceae* vegetables.

Cold crops

Tricho-compost @ 2.5 to 3.0 t/ha + foliar application of *Tricho*-leachate @ 20ml/liter + use of pheromone traps along with hand picking of larva may be used as a package for cold crop cultivation.

Most people are not aware of the benefits of using *Tricho*-compost in increasing healthy plant production, saving money, reducing the use of chemical pesticides and fertilizers and conserving natural resources. The technology is new and needs further facilities development, training and dissemination initiatives to promote this at the national level.

Expected Impacts

Tricho-composting is an environment friendly way of recycling harmful organic wastes for beneficial use in agriculture. It can reduce pollution and provide stable organic matter to improve the physical, chemical, and biological properties of soils enhancing soil quality and crop production. It suppresses plant diseases and pests and promotes higher yields of agricultural crops. *Tricho*-products have great prospects of increasing vegetable production in the country with low production costs and high economic returns for the growers.

This bulletin has been prepared on the basis of technical information available from a completed CGP project of KGF, the details of which are given below:

Project code and title: TF 09 NR: Validation and Up-scaling of Tricho-products for soil borne disease management in vegetable crops; Principal Investigator: Prof. Dr. Md. Shahidul Islam, Sylhet Agricultural University; Project duration: May 2013 to August 2016

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