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RESEARCH ARTICLE

Low-cost farmer's friendly technology can make the difference: A case study on *Trichoderma* sp.

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ABSTRACT: A case study was conducted to evaluate impact of low cost on-farm production technology for *Trichoderma* spp. being promoted by NIPHM since April 2013. Apart from 575 master trainers, 9130 farmers (including 3500 women) and 262 SHGs from various states of India have been trained. Over 1,50,000 growers got benefitted directly and indirectly. Application and use of *T. harzianum* demonstrated in 1680 ha tobacco fields during 2013-14 to 2015-16 in Andhra Pradesh and Karnataka showed 125 to 375 kg/ha increase in yield through reduced soil borne diseases and increased plant growth even after minimizing 3-4 chemicals pesticide sprays. Out of 1700 farmers, 300 have started production and use of *Trichoderma* sp. (> 10^{15} c.f.u./gm) within the cost Rs. 10-15/- per kg in Kerala and reportedly earned more profit. Technology is being promoted in ten districts of Meghalaya under RKVY project 2013-14 and in 150 villages (16 districts) of Tamil Nadu 2014-15.

Key words: Trichoderma, low cost technology, promotion, case study

The indiscriminate use of chemical pesticides is causing negative impact on human health, environment and agroecosystem. Consequently, the increased awareness and development of biopesticides for management of various crop pests is increasing the biopesticides demand among the farmers. In India so far only 21 biopesticides are registered under the Insecticide Act, 1968 compared to 175 biopesticides registered globally and it represents only 4.2% of the overall pesticide market. The timely availability and potency of available commercial formulations are some of the main constraints in very low acceptability/adoption by farmers at large (Sain and Jeyakumar, 2012a,b).

Since 1930, *Trichoderma* spp. have been reported to be a very good biological control options for soil borne disease management and plant growth however, the adoption rate has been below the chemical pesticides. Consequently, NIPHM is promoting low cost on-farm production of biocontrol agents for farmers themselves as per their requirement since 2013. Thus, the objectives for promotion of the technology were to increase awareness for adoption of quality *Trichoderma* biopesticide, to boost timely availability of low cost quality *Trichoderma* biopesticides to the farmers and to contribute to the sustainable agriculture and safer food production in India. The study was conducted to evaluate the impact of capacity building programmes, the end product of on-farm production technology for *Trichoderma* as well as on-farm produced *Trichoderma* in the various states of India.

METHODOLOGY

The technology: The simplified and low-cost on-farm production methodology for *Trichoderma* spp. being promoted by NIPHM among the farmers through master trainers includes following 13 simple steps sequentially (Satyagopal, et al., 2014):

1.) Take about 200 gm of grains in autoclavable bags [7" (B) × 11" (H)] and add equal amount of tap water.

2.) After filling the bags, keep a 1.5" inches PVC pipe at the top of the cover and tied it with a rubber band.

3.) Close PVC pipe mouth using cotton plug.

4.) Boil the grains in a 10-20 liter pressure cooker with water inside it for a period of 40 minutes.

5.) The grains are cooled at room temperature after sterilization.

6.) Transfer the bags into a wooden inoculation chamber. Spirit lamp/candle should be flamed after closing the inoculation chamber for about 5 to 10 minutes.

7.) Inoculate with 1-2 bits of *Trichoderma* mother culture in each bag inside the chamber with the help of inoculation loop/spatula. Shake the bags properly for mixing the fungal culture all over the grains.

8.) Keep the inoculated bags at the room temperature (25-30° C).

9.) Observe the inoculated bags if there is mycelial growth, do not disturb the inoculated bag. If mycelial growth is not observed, shake the inoculated bag.

10.) Once *Trichoderma* sporulation (green colour) takes place shake the bags every alternate day for about 5 to 7 days in order to spread and allow the *Trichoderma* growth and further sporulation.

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11.) Transfer the grains with fully grown *Trichoderma* mycelia & sporulation into cleaned plastic trays and cover it with blotter/newspaper. Keep these plastic trays for further sporulation and drying for about 3-4 days at room temperature. Mix the transferred *Trichoderma* colonized grains once in every day for upto 3-4 days with the help of spatula for enhancing sporulation and drying.

12.) The *Trichoderma* will be ready for use as soil application or the grounded fine powder for seed treatment and or foliar application.

13.) From 1 kg sorghum grains approximately 500 gm dried biomass of *Trichoderma* including grains can be produced, which could be utilized directly for soil application for one hectare after mixing in 100 kg of well decomposed compost or Farm Yard Manure (FYM). The dry biomass powder along with 0.5% Carboxy Methyl Cellulose (CMC) can be utilized for seed treatment @ 10 g/kg seed.

Promotional activities: Promotion of a simple low cost on-farm production technique of *Trichoderma* among farmers through organizing awareness programme, 5 to 10 days on - campus and 3 to 5 days off-campus capacity building programmes for extension officials by NIPHM Rajendranagar, Hyderabad since April 2013. The 1 to 3 days farmers training were organized both at NIPHM as well as in the states like Andhra Pradesh, Kerala, Meghalaya, Maharashtra, Rajasthan, Karnataka, Madhya Pradesh, Tamil Nadu, Telangana etc. through master trainers with the backup support from NIPHM. The NGOs master trainers as well as women self-help groups from Kerala, Maharashtra, Karnataka, Chhattisgarh, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Telangana, Tamil Nadu, Rajasthan etc. were also trained in various on-campus and off campus programmes. In addition to organizing the capacity building programmes NIPHM has hoisted videos and information material about the low cost on-farm production technology on-its website. Further, NIPHM and the trained master trainers at Hyderabad have got this technology popularized through short training courses, *Krishi Vasant-2014*, national workshop cum exhibition on "popularization and commercialization of low cost agricultural technologies "from 4-6 February, 2015, exhibitions in other agriculture departmental activities like conferences, workshops, annual fairs, advisory services, news paper, internet you-tube, TV media at Hyderabad and other locations in India (Fig. 1).

The on-farm produced *Trichoderma harzianum* was demonstrated to 2520 tobacco growers in 1680 ha of tobacco fields during 2013-14 to 2015-16 through Tobacco Board with the backup support from NIPHM. This programme emphasized to reduce the indiscriminate use of the chemical pesticides which not only kills the natural enemies and cause environmental pollution but also cause tobacco products quality deterioration both in domestic and international market. The aim of this programme was to extend technical help by NIPHM to Tobacco Board to demonstrate the technologies to reduce chemical pesticides levels in tobacco harvest and for managing the insect pests and diseases through bio-intensive approaches using eco-friendly methods and safe and judicious use of pesticides. NIPHM staff along with Tobacco Board officials created awareness cum training programmes on application, use and profit of *Trichoderma* biopesticides in tobacco crop. The special training cum hands-on-practices programmes were organized to improve skills of the tobacco extension officers, field officers and farmers. The *T. harzianum* produced using on-farm production technology was applied in the 1680 tobacco crop demonstration as seed treatment @ 10gram/ kg seed, nursery treatment @ 1 kg for hectare nursery, and field soil treatment @ 6.25 kg/ hectare with 500kg well decornposed farm yard manure/compost.

NIPHM is also promoting low cost on-farm production of biocontrol agents for farmers through master trainers/Agriculture officials in Kerala through two consequent Post Graduate Diploma in Plant Health Management programmes, and in Tamil Nadu under special training programme (Fig. 2). In these states the on-farm produced *T. harzianum* has been successfully utilized as seed, seedling, cutting, nursery and field soil treatment for management of soil borne diseases in crops like vegetables, legumes, maize, sorghum, wheat, guava, mango, banana, papaya, cotton, tobacco, sugarcane etc.

The training for Agricultural officers/master trainers and farmers in Meghalaya are implemented under

Fig. 1. Promotional material (leaflet, web site, youtube)

Fig. 2. Exposure cum training programmes to officials and master trainers

Fig. 3. Training to master trainers and farmers

RKVY project on "Adoption of Agro-ecosystem Analysis based Biointensive Pest Management Strategies and Promotion of Decentralized Biocontrol Agents and Biopesticides Production Centres through Farmer Self Help Groups in Meghalaya" from 2013-14 and 2014-15 (Fig. 3). Also, the on-farm production technology as well as produced *Trichoderma* was demonstrated to 300 farmers and in 200 hectares crop growing areas in 10 districts under five clusters of Meghalaya. The crops in which the *Trichoderma* application was demonstrated in Meghalaya are paddy, maize, cotton, potato, banana, pineapple, citrus, ginger, arecanut, cashew nut, and rapeseed and mustard.

To estimate the success of the promotional activities and the technology current case study was conducted by collecting the information about the master trainers and farmers trained at NIPHM, as well as the farmers trained further by the master trainers working under different Agricultural departments, NGOs, Tobacco Board. For studying the impact of *Trichoderma* application on Tobacco crop production the 51 and 40 farmers were interviewed and information was collected from Karnataka and Andhra Pradesh, respectively. In Kerala, Meghalaya the farmers were interviewed individually and in groups.

RESULTS AND DISCUSSION

The success of the capacity building programmes could be visualized with the perusal of number of master trainers and farmers trained for this particular technology in various states by NIPHM and further master trainers in their respective states. A total of 575 government Agriculture Scientist and extension officials, 262 NGOs extension workers & SHGs (Fig. 4) and 8290 farmers (including about 3000 women) were trained. The capacity building programme also includes specials trainings organized for 64 Agricultural officials of Kerala Agricultural Department under PGDPHM, 400

Fig. 4. Women SHGs running units of on-farm production of *Trichoderma*

Fig. 5. Training and demonstration to tobacco growers

Table 1. List of master trainers, SHG members and farmers trained in various states of India by NIPHM

Name of the states	Number of trained participants		
	Master Trainers	SHGs	Farmers
Andhra Pradesh & Telangana	51	15	386
Kerala	32	50	1700
Meghalaya	32	10	150
Maharashtra	15	20	353
Tamil Nadu	400	152	1974
Tobacco Board farmers Andhra Pradesh and Karnataka	30	5	2520
Rajasthan, Chhattisgarh, MP	15	10	195
Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra			1852
	575	262	9130

Agricultural officials from Tamil Nadu Agriculture Department, 108 B.Sc. Ag students from Karnataka, 276 Officials of Maharashtra State Department of Agriculture under CROPSAP project, 1974 farmers in Tamil Nadu and 2520 tobacco growers in Andhra Pradesh and Karnataka (Table 1.). The technology is further being promoted in the Meghalaya state under RKVY project in all the 10 districts and in 150 villages covering 56 Blocks in 16 districts of Tamil Nadu.

Effect of the technology in crop health:

The success of the technology and efforts could be observed in the states like Andhra Pradesh, Karnataka where use of *T. harzianum* was demonstrated in 1680 ha of farmer's fields during 2013-14 to 2015-16 through Tobacco Board. As an outcome of these training and demonstration efforts, a significant reduction in wilt, root rot and black shank was observed (60-85%). Farmers were able to reduce 2-3 chemical pesticide sprays during nursery stage and 2-3 in standing crop. The impact study of 50 farmers from Badakyathanahally (Ramanathpura Auction Platform in Karnataka state) indicated that there were very good germination, no seedling diseases, better root & shoot growth of nursery plants in treated nurseries with no chemical sprays. The biopesticide applied field crops showed very good plant growth and plant height with 21-25 number of leaves per plant compared to the untreated fields (15-20 leaves/plant). The yield was also found to be higher 500-600kg/acre with no chemical pesticides sprays compared to 400-450kg/acre in untreated fields (Fig. 5).

Similarly, the impact study of 41 farmers from Sakkare & Mayeegowdanahally (Kampalapura Auction Platform in Andhra Pradesh state) indicated that there were very good germination, no seedling diseases, better root & shoot growth of nursery plants in treated nurseries with 2 sprays of Ridomil compared to 3 sprays in untreated. The biopesticide applied field crops showed very good plant growth and plant height with 21-25 number of leaves per plant compared to the untreated fields (15-20 leaves/plant). The yield was also found to be higher 750kg/acre with no chemical pesticide sprays compared to 650-700kg/acre in untreated fields with 2 chemical pesticide sprays in main field (Fig. 5).

The tobacco crop growth, vigour and quality were found to be better compared to untreated crop and the tobacco growers were found to be interested and satisfied for adoption of these technologies. Overall, the farmers were able to get more crop yield (125 to 375 kg/ha increase) by reducing the disease problems *viz.* damping-off, basal root rots, black shank, frog-eye leaf spot etc. even after minimizing 3-4 chemicals pesticide sprays in tobacco crop.

In Kerala, 300 farmers have started production and use of *Trichoderma* sp. (> 10^{10} c.f.u. per gram) in about Rs. 10-15/- per kg. Farmers in Kerala and Meghalaya, Tamil Nadu using bio-intensive strategy including application of on-farm produced *Trichoderma* have reportedly earned more profit and were able to reduce serious soil borne disease caused by *Pythium*,

Fig. 6. Farmers showing the Trichoderma multiplied by their own

Fig. 7. *Trichoderma* treated gerbera, soybean and ginger crops at Meghalaya

Fig. 8. *Trichoderma* used and demonstrated in kitchen & school garden, medical area and net housed

Phytophthora and *Fusarium* in various crops like coconut, arecanut, banana, pepper, vegetables etc. Additionally, farmers were able to grow healthy vegetable nurseries for themselves and other farmers using on-farm produced *Trichoderma* enriched compost material. The demonstration were organized by Kerala Agricultural Officer the master trainers in several *panchayatas* including Vattiyoorkvu, Chal, Azhikode (Kannur District), Kadakampally, Porathissery, Eruvessy, Kadakampally, Kazhakuttam, Pallichal (Trivandrum District), Nediyiruppu (Malappuram District), Talakulathur (Kozhikode Dist), Pattamb, Vadakkenchery, Anakkara (Palakkad Dist), Rajakumari (Idukki Dist.), Nagalassery (Palakkad Dist.), Kodur, Puramattom, Nediyiruppu (Malappuram Dist.), Pallichal (Trivandrum Dist.), Methala Kodungallur, Annamanada & Kuzhur, Methala Kodungallur (Thrisuur District) (Fig. 6).

The technology is further being promoted in 10 districts of Meghalaya state under RKVY project (Fig.7) and in 150 villages covering 56 Blocks in 16 districts of Tamil Nadu. About 10 SHGs have started producing *Trichoderma* in Meghalaya and about 300 members of SHGs are satisfied with product in terms of crop disease & health management.

The salient points in terms of success of technology and the efforts for its promotion observed under the study are:

- **Increased awareness about healthy food production through production and use of *Trichoderma* biopesticide:** 8290 farmers, 575 master trainers, and 244 NGOs/ SGHs members got benefitted through the training programmes within a span of 18 months. Product is being utilized and demonstrated in nurseries, field crops, poly houses, home-, school-, hospital-, church garden areas (Fig. 8).

- **Increased adoption of *Trichoderma* in various agriculture and horticultural crops:** vegetable vegetables, legumes, maize, sorghum, wheat, guava, mango, banana, papaya, cotton, tobacco, sugarcane and pepper, banana, coconut especially in Kerala and paddy, maize, cotton, potato, banana, pineapple, citrus, ginger, arecanut, cashew nut, and rapeseed and mustard in Meghalaya.

- **Contributing to sustainable agriculture:** The success of technology and efforts could be observed in the states like Andhra Pradesh, Karnataka where use of *T. harzianum* was demonstrated in 1680 ha of farmer's fields. Farmers were able to get more crop yield (125 to 375 kg/ha increase) by reduced disease problems even after minimizing 3-4 chemicals pesticide sprays in tobacco crop. Farmers were able to manage soil borne disease in vegetables, cereals, fruits and ornamental crops.

- **Enhancing timely availability of low-cost, quality *Trichoderma* biopesticide:** More than 1000 farmers have started production and use of *Trichoderma* sp. @ about Rs. 10-15/- per kg. Farmers using bio-intensive strategy have reportedly got better quality yields and earned more profit.

- **Technology adopted for organic farming:** The organic farming and the production and use of biopesticides including *Trichoderma* is being promoted at grass root level in Kerala by Agricultural Extension officials since 2014. The area under organic farming in Kerala state which was 15020 ha in 2013 is increasing and the Government is aiming to declare Kerala as fully organic state in 2016.

- **Technology is being further popularized and adopted** in Meghalaya, Kerala, Tamil Nadu through ATMA, RKVY projects & horizontal expansion through several agricultural conferences, fairs, exhibitions, *Krishi Vasant-2014*, News Papers, TV, internet YouTube, telephone, pamphlets etc (Fig. 9). Over 1.5 lakh growers got benefitted directly and indirectly.

Fig. 9. Capacity building programmes and technology coverage in news papers and media

The adoption of better technologies are affected with the cost, labour, production method, source of availability of the material required either for production or for application and the efficiency of promotion of activities through trainers. Lack of these requirements can affect the adoption of any good technology. Thus, the study indicates that a low-cost farmer's friendly technology can make the difference in adoption rate if the proper promotional activities are done actively and jointly with the master trainers and farmers so as to reach the quality product in time to the farmers.

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