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Technologies Ready for Agribusiness

(2019-2020)

P.B. No. 2491, H.A. FARM POST, BELLARY ROAD, HEBBAL, BENGALURU - 560024, KARNATAKA, INDIA

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Preface

From conception to popularization of a pest management strategy, pest management specialists have to work in close concert with both industry and farmers to develop effective, economically viable technologies to combat pests, which can be utilized to the satisfaction of farmers. For a little over three decades, PDBC/NBAII/NBAIR has been working tirelessly on both these fronts to develop ecologically sound biocontrol and biocontrol compatible technologies. These technologies have the potential to suppress several of the pests and diseases of national concern and they can be integrated with other management practices.

Technologies developed at ICAR-NBAIR include protocols for the mass production of macrobials and novel formulations of microbials. Effective delivery systems and storage technologies that retain the long term viability of the bioagents are also a focus of these studies. The major hurdle currently hampering the adoption / commercialization of technologies utilizing macrobials is the non-availability of storage technologies. Particular attention is therefore being paid by ICAR-NBAIR to overcome this impediment.

Amongst the large number of microbial pathogens (fungal, bacterial and viral) in its vast collection, ICAR-NBAIR has identified the most promising isolates to be integrated into pest and disease management modules. Mass production, formulation and storage technologies of these promising isolates are on offer to entrepreneurs for commercialization.

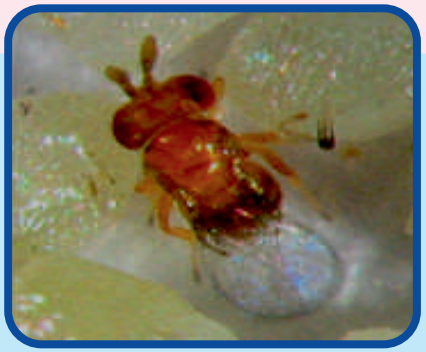
With increasing awareness of the manifold environmental and health hazards of the use of chemical pesticides in agriculture, the need for organic cultivation for the production of chemical free agricultural produce has assumed paramount importance. Pest management in such a situation will progressively become more dependent on biocontrol technologies. ICAR-NBAIR has always been and will continue to be in the vanguard of the national effort to promote organic agriculture by the timely identification of appropriate, efficacious and farmer friendly agents and technologies. Simultaneously this institute will also create awareness on the availability of these environmentally sustainable technologies.

I congratulate Dr T Venkatesan, Principal Scientist and Chairman, ITMU and his team as well as all the technology generators at ICAR-NBAIR for their efforts in generating technologies to ensure green and clean agriculture.

March 2019

Chandish R. Ballal
Director

1 Multiple insecticide tolerant strain egg parasitoid, *Trichogramma chilonis*



Technology Description

Trichogramma chilonis, is an egg parasitoid of lepidopteran pests in many crops. The strains (MITS), is tolerant to multiple insecticides (organo-phosphate, pyrethroids, oxadiazine & spinosyn) with a high resistance factor up to 76.5. The use of strain in 9 states (Punjab, Gujarat, Karnataka, Tamil Nadu, Assam, Arunachal Pradesh, Manipur, Tripura and Uttar Pradesh) indicated substantial reduction in sprays and increase in yield, besides fields were free of pest after use of this strain. The revenue increase to farmers ranged from Rs. 15000-20000 / ha / season because of reduced insecticide application and increase in yield. The large scale validation trials were conducted on tomato, brinjal, chillies and rice during summer, *Kharif* and *Rabi* season of 2011-13.

Background

Agricultural productivity in India is affected largely by insect pests and diseases, which cause losses to the tune of 10-30%. Though there has been increasing awareness in India about the hazards of indiscriminate use of insecticides in agriculture, use of biological agents for pest management has not taken off in a big way due to the susceptibility of bioagents to abiotic and insecticides-induced stresses, though in a totally insecticide free environment, they have been reported to be effective to the tune of 50-60%. Hence, by developing multiple insecticide resistant strain of *T. chilonis* (MITS), which can be released in pest infested crop fields.

Benefits /Utility

No such product is currently available in our country. The existing products are not effective in insecticide affected fields, whereas multiple insecticide tolerant strain of *T. chilonis* parasitize harmful insect's eggs to the tune of about 60% compared to <5% under sprayed condition. However at normal condition, *i.e.*, under unsprayed both behave in similar way.

Scalability

The technology can be extended to any extent.

Business and commercial potential

A total of 27000 cc of *Corcyra* eggs can be obtained from rearing unit based on investment of above investment. Market rate per card is Rs. 50 therefore, revenue of Rs 13.5 lakh will be obtained in first year of operation of the unit. The unit will be in profit after 2nd year of operation and from unit will be in profit of Rs. 13.5 lakh / annum with all cost recovered. No toxicological data or registration is required for its commercialization.

Financial requirement

For coverage of 100 ha of cropped area, initially an investment of Rs. 18.0-20.0 lakh is required. The investment on rearing facility is one time only and all equipments and rearing boxes can be used for 10 years. The recurring cost for a year would be about Rs. 8.4 lakh/annum. A mass rearing unit consisting of rearing boxes, egg laying cages, refrigerator, table UV hood, vacuum unit, etc are required.

Economic analysis

The insecticides tolerant strain of *T. chilonis* is very effective in reducing the number of harmful pests and has great impact on growth of vegetables and commercial crop production and will generate employment.

Target Market/Customer

- Farmers
- Contract farming companies
- Farmer's federations/Groups
- Biocontrol producing companies

Social Impact of the Technology

- Trichogrammatids are safe biological control agents and are specific against insect pests
- It will reduce the cost of production by reducing cost on chemical insecticides.
- Cost-benefit ratio will be improved
- Unemployed youth can start small production units through NABARD support and help farming system and themselves

2 High temperature tolerant strain of egg parasitoid *Trichogramma chilonis*

Technology Description

Trichogramma chilonis, commonly known as mini wasp, is an egg parasitoid of lepidopteran pests. The strain, HTTS, developed at ICAR-NBAIR, is tolerant to high temperature (32-40°C), therefore, can be used efficiently by farmers in high temperature regions. Once emerged, these parasitoids would parasitize eggs of the most of the lepidopteran pests, such as sugarcane borers, cotton bollworms, corn borers, rice stem borer and leaf folder, many others. The parasitoid can be used as a living, "biological insecticide" that strikes only the target pest with no risk to other natural enemies, human health or the environment.

Background

Agricultural productivity in India is affected largely by insect pests and diseases, which cause losses to the tune of 10-30%. Though there has been increasing awareness in India about the hazards of indiscriminate use of insecticides in agriculture, use of bioagents for pest management has not been adopted in a big way due to susceptibility of bioagents to abiotic and insecticide-induced stresses. Though in a totally insecticide free environment, they have been reported to be suppressing the pest to the tune of 50-60%. Recognizing the potential of *Trichogramma* species as biological control agents, entomologists in the early 1900s began to mass rear *Trichogramma* for insect suppression. Today, *Trichogramma* species are the most widely used insect natural enemy in the world, partly because they are easy to mass rear and they attack many important crop insect pests. Nine species of *Trichogramma* are reared in private or government owned insectaries around the world and released annually on an estimated 80 million acres of agricultural crops and forests in 30 countries. *Trichogramma* are released to suppress some 28 different lepidopteran pests attacking maize, rice, sugarcane, cotton, vegetables, fruit trees etc.

Benefits /Utility

High temperature tolerant strain of *T. chilonis* can be used in high temperature affected fields.

Scalability

The technology can be extended to any extent.

Business and commercial potential

- No toxicological data or registration is required for its commercial use.
- Since this strain is high temperature tolerant, these can be used in field alone with farmers practice and go well with IPM.
- These can be used in most of the crops like rice, maize and sugarcane.

Financial requirement

For coverage of 100 ha of cropped area, initially an investment of Rs. 18.0-20.0 lakh is required. The investment on rearing facility is one time only and all equipments and rearing boxes can be used for 10 years. The recurring cost for a year would be about Rs. 8.4 lakh/annum. A mass rearing unit consisting of rearing boxes, egg laying cages, refrigerator, table UV hood, vacuum unit, etc are required.

Market potential

- *Trichogramma* production is a profitable business and there is only less than 0.5-1% cropped area is covered by this bioagent.

Economic analysis

The temperature tolerant strain of *T. chilonis* is very effective in reducing the number of harmful pests and has great impact on growth of vegetables and commercial crop production and will generate employment.

Target Market/Customer

- Farmers
- Contract farming companies
- Farmer's federations/Groups
- Biocontrol agents producing companies

Social Impact of the Technology

- Trichogrammatids are safe biocontrol agents and are specific against insect pests
- Cost-benefit ratio will be improved
- It is green technology
- Unemployed youth can start small production units through NABARD support and help farming system and themselves

3 Pesticide tolerant strain of aphid lion *Chrysoperla zastrowi sillemi*, an important predator of sucking pests

Technology Description

The Common green lacewing, *Chrysoperla zastrowi sillemi* (Neuroptera: Chrysopidae), is an important biological control agent of sucking pests in different agroecosystems. In India, several chemical insecticides are used indiscriminately to control insect pests, which have led to resistance in many insect pests. Therefore, release of insecticide resistant predators would improve their survival in sprayed situations for potential use in augmentative biological control or integrated pest management strategies in many crops. Further, such predators can play an effective role in delaying the development of resistance in pest populations. Keeping the above facts in view, a strain of *Chrysoperla zastrowi sillemi* (PTS-8) having tolerance to different groups of pesticides *viz.*, organophosphate, organochlorine and synthetic pyrethroid has been developed. PTS-8 recorded highest resistant factor (RF) for acephate (277.5), fenvalerate (66.11) and endosulfan (50.36). Biochemical assays revealed that the PTS-8 has got higher detoxifying enzymes activity i.e. >0.04 µM/min/mg protein for esterase and 21.1 µM/min/mg protein for glutathione S-transferase as compared to susceptible population. Biocontrol potential of PTS-8 strain is better than the susceptible strain under pesticide stressed condition. Field studies revealed that the strain was effective against sucking pests in pesticide stressed conditions and are also effective under normal conditions.

Background

Agricultural productivity in India is affected largely by insect pests and diseases, which cause losses to the tune of 10-30%. Though there has been increasing awareness in India about the hazards of indiscriminate use of insecticides in agriculture, use of biological agents for pest management has not taken off in a big way due to the susceptibility of bioagents to abiotic and insecticides-induced stresses. The Common green lacewing, *Chrysoperla zastrowi sillemi* (Neuroptera: Chrysopidae), is an important biological control agent of sucking pests and eggs and neonate larvae of lepidopteran pests in different agroecosystems. It has long been considered as a promising candidate for pest management programs worldwide due to its wide prey range and geographical distribution, voracious larval feeding capacity and commercial availability.

Benefits /Utility

No such pesticide tolerance strains of *C. zastrowi sillemi* is currently available in country. The existing strain of the predators are not effective in insecticide affected fields, whereas pesticide tolerant *Chrysoperla* feed on insect pests under pesticide and high temperature stressed cropping systems. However at normal condition, i.e., under unsprayed situation both behave in similar way.

Scalability

The technology can be extended to any extent

Market potential

Chrysoperla production is a profitable business as there is only less than 1% cropped area is covered by these bioagents.

Economic analysis

Pesticide tolerant strain of *Chrysoperla* is very effective against sucking pests especially aphids, thrips, mealybugs and whiteflies and have great impact on cultivation of cotton, vegetables and other crops which will generate employment.

Financial requirement

Initially an investment of Rs. 20.0 lakh is required for coverage of 100 ha of cropped area. The investment on rearing facility is one time only and all equipments and rearing boxes can be used for 10 years. A mass rearing unit consisting of rearing boxes, egg laying cages, adult rearing cages, oviposition cages, refrigerator, table UV hood and vacuum unit.

Target Market/Customer

- Farmers
- Contract farming companies
- Farmer's federations/Groups
- Biocontrol producing companies

Social Impact of the Technology

- Chrysopid predators are safe biological control agents and are specific against insect pests.
- Cost-benefit ratio will be improved
- Unemployed youth can start small production units through NABARD support and help farming system and themselves.

Business and commercial potential

- No toxicological data or registration is required for its commercial use.
- Since these strains are multiple pesticides and high temperature tolerant, theses can be used field alone with farmers practice and go well with IPM.
- These can be used in most of the crops like cotton, several vegetable and other crops.

4 Novel insecticidal WP formulations of *Heterorhabditis indica* for the biological control of white grubs and other soil insect pests

Technology Description

Entomopathogenic nematodes (EPN) refer to beneficial nematodes that are parasitic to more the 200 species of insects and belong to Steinernematidae and the Heterorhabditidae. The infective juveniles of EPN infect insect hosts by entering via natural body openings, mouth, anus, spiracles or areas of thin cuticle, and in association with mutualistic bacterium cause host mortality within 48 h. The use of EPN has now become an integral part of crop protection. Several EPN species are already available in the market as formulations in the world. Paradoxically in India, several native germplasm of EPN belonging to the species of *Heterorhabditis* and *Steinernema* have been isolated and characterized, which due to lack of effective technologies for evolving commercial formulations with effective levels of nematode concentrations and prolonged shelf-life, are yet gain entry in to the market. Major constraints perceived in utilization of bioagents can be summarized as time-place-quantity-efficacy-biosafety-shelf-life. Large-scale and timely availability of cost-effective viable formulations of biopesticides with long shelf-life is seriously lacking in the country.

Background

The wettable powder formulation of nematodes developed is effective for controlling a variety of insects. This is especially true for the soil insect pests & in particular whitegrubs belonging to scarabaeidae on a number of crops, non-exclusively including arecanut, banana, sugarcane, potato, corn, etc. Novel bio-pesticidal wettable powder formulations comprised of beneficial nematodes, *Heterorhabditis indica* (strain NBAII Hi1) for the control of white grubs and other soil insect pests with improved shelf-life and the method for its preparation.

Benefits /Utility

- These novel wettable powder formulations of *Heterorhabditis indica* (NBAII Hi1) comprising of infective nematode juveniles mixed with a specific proportion of amorphous, wettable silicate mix powder, wherein at least 90% are viable even after eight to twelve months of storage at a temperature of between 25°C and 37°C.
- The method can be scaled up to different capacities depending on the requirements.
- It reduces production and handling costs.
- It has a wide potential for commercial use in the areas of mass production of entomopathogenic nematodes.
- Management of white-grubs/other soil insect pests: An effective solution for the management of white-grubs associated with areca nut, sugarcane, banana, cardamom, groundnut, potato, corn and turf grass.

Scalability

Around 20,000 litres per annum

Business and commercial potential

- Shelf-life: 80-90% viability for 6-8 months at NTP at Bengaluru.
- Methods to use in field: simplified and normal for whitegrub control, no additional agronomic practices.
- Biologically active wettable powder formulations of *H. indica* (NBAII Hi1) and *H. bacteriophora* (NBAII Hb5), on a combination of silicates-mixture of carrier material and defining specific physical properties.
- The semi-synthetic media and protocols that improves/enhances bio-mass production of *G. mellonella* by identifying ideal physical conditions for growth, larval weight and fecundity.

Financial requirement

- Cost of Production: Rs. 80 per Litre (20,000 X 80 = 16 lakh)
- Expected Sales: 20000 L p.a. @ Rs. 350 = 70 lakh
- Net Profit: 54 lakh
- Net Profit Ratio = 77

Target Market/Customer

To be used as chemical pesticide by farmers in pulses and vegetables. The formulation is ecologically safe and non toxic to humans and beneficial insects or organisms. The formulation can be used all over India except in temperate regions.

Social Impact of the Technology

- Entomopathogenic nematodes are exceptionally safe biological control agents. They are specific to insects and are not a threat to the environment unlike chemical insecticide.
- Farmer friendly and easy to apply with conventional equipments.
- Infective juveniles are tolerant to most agrochemicals including herbicides, fungicides and insecticides.
- Shelf life is 8-12 months and exempted from CIB registration and can replace synthetic chemicals.

5 Novel wettable powder formulation of *Pochonia chlamydosporia* as bionematicide for biological control of plant parasitic nematodes

Technology Description

Product is a silicate mix based formulation containing viable, biologically active and resistant chlamydospores of beneficial fungal species *Pochonia chlamydosporia* for the effective management of plant parasitic nematodes. This biocontrol agent is a broad spectrum nematicide with highly effective strain of *P. chlamydosporia* (NBAII PC55). *P. chlamydosporia* as a biological control agent against plant parasitic nematodes is extensive and is now widely accepted natural control agent against root-knot and cyst nematodes in a wide variety of crop rhizospheres and offers immense scope for commercial production and large scale use in field as alternative to chemical control. Chlamydospores are produced using highly productive, simple, demarcated and cost effective technology using solid state fermentation. Formulation developed is contamination free due to sophisticated downstream processing and has the shelf life of 14-18 months. This nematicide can control plant parasitic nematode problems in broad range of crops like tomato, brinjal, capsicum, rice and bhendi.

Background

Novel bio-pesticidal wettable powder formulations comprised of beneficial fungi, *P. chlamydosporia* (strain NBAII PC55) for the control of plant parasitic nematodes with improved shelf-life and the method for its preparation.

Benefits /Utility

- Selection of biologically active isolate (with genetic and morphological distinct identity) which is responsive to media & growth conditions modifications, proven pathogenicity & identified virulence factor
- Production media: definition of semi-synthetic solid media that enhance spore productivity per cycle and production cycles in a given time period
- Post-production partitioning for easy and clear down-stream processing and automation: Down-stream processing including drying of media, spore harvest, spore drying to ideal water activity and water content for spore viability and shelf-life
- Identification of production media factors and post production media factors that enhance spore viability or shelf-life and minimize contamination

- Physical parameters of formulation for better shelf-life with biological activity: identification of ideal silicate mineral mixture for developing the formulation with desired and defined features, homogenization and examination of the formulation developed for desired shelf-life.
- These novel wettable powder formulations of *P. chlamydosporia* (NBAII PC55) comprising of biologically active, resistant spores with a specific proportion of amorphous, wettable silicate mix powder, wherein at least 90% are viable even after 14-15 months of storage at a temperature of between 25°C and 37°C.

Scalability

Around 20,000 liters/annum

Business and commercial potential

- The method can be scaled up to different capacities depending on the requirements.
- It reduces production and handling costs.
- It has a wide potential for commercial use in the areas of mass production of antagonistic fungi.
- Farmer friendly and easy to apply with conventional equipments.
- Chlamydospores are tolerant to most agrochemicals including herbicides, fungicides and insecticides.
- Shelf life is 14-18 months and can replace synthetic chemicals.

Financial requirement

- **Cost of Production**: Rs. 80 per Litre (20,000 X 80 = 16 lakh)
- **Expected Sales:** 20000 L p.a. @ Rs. 350 = 70 lakh
- Net Profit: 54 lakh
- Net Profit Ratio = 77

Target Market/Customer

To be used as chemical pesticide by farmers in pulses and vegetables. The formulation is ecologically safe and non toxic to humans and beneficial insects or organisms. The formulation can be used all over India except in temperate regions.

Social Impact of the Technology

- It has a wide potential for commercial use in the areas of mass production of antagonistic fungi.
- Farmer friendly and easy to apply with conventional equipments.
- The chlamydospores are tolerant to most agrochemicals including herbicides, fungicides and insecticides.

6 Liquid formulation indigenous *Bacillus thuringiensis* isolates against lepidopteran pests

Technology Description

Liquid formulation of *Bacillus thuringiensis* (*Bt*) have mostly replaced wettable powders in the market as they are easier to use and less expensive. Water based flowables are an industrial favourite because of ease of mix and without drying and milling. The Technology for preparation of liquid formulation (water based flowable) of indigenous toxic strains of *Bt* (PDBC-BT1 & NBAII-BTG4) has been designed taking into consideration the medium that supports maximum sporulation and crystal formulation and also a stable water based flowable formulation.

Shelf life

The liquid formulation can be stored for one year at room temperature.

Background

The LC_{50} value with PDBCBT-1 was 0.062 µg/ml against diamond back moth *Plutella xylostella* which is more toxic than the standard HD-1. Against gram pod borer *Helicoverpa armigera* it was 0.64 µg/ml. In pigeon pea lowest pod damage of 4.04% was established as compared to control (33.3%). The toxicity has also been established under AICRP trials and significant increase in yield level of treated crops was observed. Multilocational field trails are carried out at AICRP centres *viz.*, AAU, ANGRAU, MPKV, PAU, TNAU, JNKVV and UAS, Raichur. All the centres have reported effective reduction in pod damage of pigeonpea with PDBC-Bt1 and NBAII-BtG4 sprayed at 2% at pre flowering, post flowering and pod emergence. Highest grain yield of pigeon pea was recorded in application of NBAII-BtG4 sprayed at 2%.

Benefits /Utility

The microbe is a biopesticide with high level of toxicity against *H. armigera, P. xylostella, Chilopartellus, Sesamiainferens, Leucinodes orbonalis* and other Lepidopteran pests affecting pulses, vegetables and oilseeds.

Scalability

The technology can be scaled up to 10-100L based on the equipment and energy availability. The technology can be scaled upto 100L in small scale level. In case of large production sufficient funds, skilled man power and large scale production units are necessary.

Business and commercial potential

Expected annual income = 12 lakh. An initial capital investment of Rs. 40 lakh is required and the cost of production is half of existing technology

Financial requirement

Unit production cost (approx) = Rs 70 to 80/Kg. Predicted per unit selling price of product/services generated by the technology = Rs. 350/Kg. Per unit selling price of product/services generated by existing alternate technology, if any = 700 to 800/Kg.

Target Market/Customer

Industrial producers of biopesticides and farmers growing pulses and vegetables.

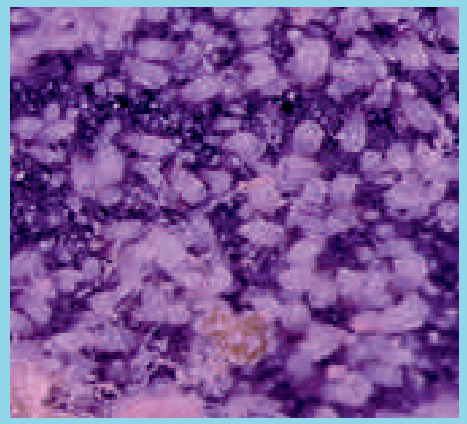
Social Impact of the Technology

The technology is safe to the environment as it can replace harmful chemical pesticides. Suitable for all environments except temperate areas.

Toxicology data

Toxicology data for liquid formulation and technical (culture) *Bacillus thuringiensis* var. *kurstaki* (NBAIR-BTG4) M/s Institute for Industrial Research and Toxicology, New Delhi as per CIBRC guidelines. The data is now available at ICAR-NBAIR, Bengaluru and can be used for CIBRC registration.

7 Closed System for Mass Production of Predatory Mites



Technology Description

In India, small scale production of predatory mites is done on tetranychid mites maintained on bean leaves/mulberry leaves, which are placed on water soaked sponges placed in trays (open system). Another method which is adopted is the large scale production of predatory mites in net houses on spider mite infested bean plants. Here, the method of release generally adopted is the release of leaves with host mites (ie the spider mites) and the predatory mites. The new system developed enables the production of predatory mites on astigmatid mites in closed units. The scale of production is high, while simple infra-structure is required *viz.* room space with racks and items like trays, plastic boxes, cloth covers, vermicultite, yeast, wheat germ and pollen. A simple method of release is also available for the predatory mites produced using this system. The host (astigmatid) mites which may be mixed with the released predatory mites do not harm the plants and they die within a few hours after release due to the absence of its requisite feed.

Background

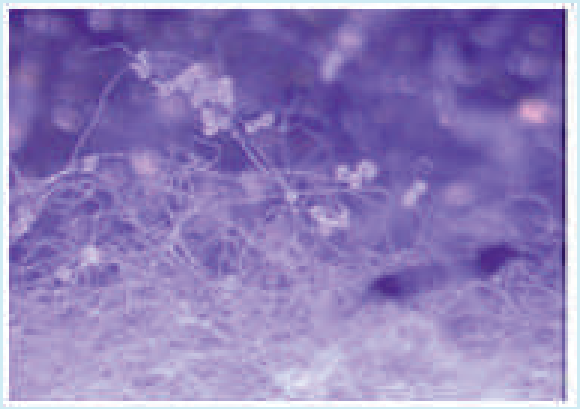
In India, phytophagous mites are a major problem on vegetables grown in polyhouses. Predatory mites belonging to the genera *viz. Amblyseius* and *Neoseiulus* are known to be potential bio-agents of phytophagous mites. Predatory mites are generally produced on a small scale on tetranychid mites maintained on bean leaves/mulberry leaves, which are placed on water soaked sponges placed in trays (open system). The second method which is generally adopted is the large scale production of predatory mites in nethouses on spider mite-infested bean plants. Here, the method of release adopted is to place the leaves with host mites (i.e. the spider mites) and the predatory mites on infested plants. Considering the above, an urgent need to was felt develop simple and cost-effective technologies for mass rearing predatory mites.

Benefits /Utility

- Simple technology for large scale production
- minimum infra-structure required
- can be adopted even by polyhouse growers and farmers
- easy to release
- no specific skills required for production or release
- not reared on phytophagous mites, hence prevents release of phytophagous mites on the crop plants
- does not require growing of potted bean plants infested with tetranychid mites in net houses

Scalability

The technology is amenable to up scaling the continuous production of predatory mites.



Business and commercial potential

The technology would be useful for polyhouse growers & commercial insectaries. Tetranychid mites are a major problem in several polyhouse crops and though it is known that predatory mites are potential bio-agents, they are not available in required quality and quantity. The existing production methodologies in our country enable only the small scale production of the predatory mites either in open trays or net-houses. The closed system for production of predatory mites would be in demand by commercial insectaries and polyhouse growers.

Financial requirement

The investment required is one room space for production to hold ten racks. The other items required are - trays, plastic boxes, cloth covers, vermicultite, yeast, wheat germ and pollen, besides nucleus cultures of host and predatory mites. As the initial investment is minimal and as predatory mites are in great demand, especially by polyhouse growers, a significant return and profit can be expected.

Target Market/Customer

Polyhouse growers, commercial insectaries and Biocontrol agents producing industries.

Social impact of the technology

The technology, if adopted by polyhouse growers, can lead to adoption of a non-chemical pest management strategy, leading to availability of pesticide residue free produce from polyhouses. Using the technology, growers themselves can produce predatory mites and utilise them, thus increasing their awareness regarding bio-control and improving their confidence to adopt this technology for pest management.

8 A dispenser for monitoring of eucalyptus gall wasp, *Leptocybe invasa*

Technology Description

Eucalyptus gall wasp, *Leptocybe invasa* is known as an important pest on the coppices and nurseries of eucalyptus. The present technology can easily capture the wasps through the volatiles. The volatiles were identified from the susceptible eucalyptus clones.

Background

- *Eucalyptus* spp. occupies around 8.0 million ha in India, mainly due to its use in paper manufacturing. Eucalyptus gall wasp, *Leptocybe invasa* was reported in Karnataka in 2001 and subsequently reported from a few pockets in Tamil Nadu and Karnataka. The pest has created havoc in forest nurseries and young plantations.
- The insect form galls on leaf midrib, and stems of seedlings as well as coppice shoots resulting in stunted growth. Galls also weaken the plants when their abundance is more.
- There is great variation in the susceptibility of *Eucalyptus* clones to *L. invasa*. Some clones are highly susceptible.
- There was a search for an attractant which will make it possible for the early detection of *Leptocybe* to program our release of biological control agents. This technology has important volatiles identified from the susceptible eucalyptus clones.

Benefits /Utility

The lures will help in the monitoring of population of *Leptocybe* in various regions of the country where the incidence is likely to occur. Besides, the lures can also be used for mass trapping.

Scalability

The technology can be extended to any scale.

Business and commercial potential

The lures can be manufactured and used in all the eucalyptus nurseries and forest plantations for monitoring and mass trapping. Great scope for export potential of the lures in all the countries where the threat of *Leptocybe* looms over. The technology can be well integrated with biological control practices for effective management of *L. invasa*.

Social impact of the technology

Through the application for monitoring and mass trapping the pest can be effectively managed.

Financial requirement

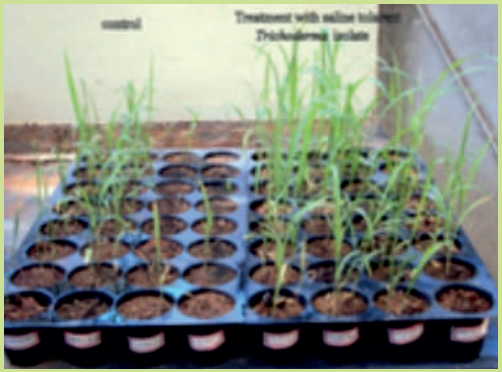
Cost of each lure is Rs 3.00

Target Market/Customer

All the commercial producers of pheromones/lures

9 Bioformulation of salinity tolerant isolate of *Trichoderma harzianum* for biological management of plant diseases

Technology Description



It is a bioformulation of a fungal antagonist *Trichoderma harzianum* which has the salinity tolerance (upto 2 M NaCl). It has good biocontrol potential against soil borne pathogens that has been verified by pot and field experiments with groundnut and sorghum. There is no salinity tolerant formulation of *Trichoderma* available in the market. Besides having salinity tolerance it induces tolerance in plants and protects against salinity. Pot culture experiments showed tolerance to salinity upto 2 M NaCl and potential to control soil borne pathogens of groundnut and sorghum. The isolate used not only has salinity tolerance but has potential to protect plants from salinity when applied as seed treatment or soil application. Field trials at Junagardh (5 locations) and Udupi (4 locations) clearly showed the efficiency of the formulation in controlling the soil borne pathogens in groundnut. Toxicological data required for complete registration has been developed. This can be obtained along with the cultures at the time of transfer of technology. The isolate can be maintained as dry spores in silica gel without losing the viability and other traits. The isolate can be maintained at high NaCl amended medium and *Trichoderma* production is a growing business and there is only >2-3% cropped area are covered by bioagents. In seed treatment and soil application a huge demand for the quality agents are required and the business will be very durable.

Background

Trichoderma isolates collected from groundnut and sorghum ecosystem were screened for saline tolerance at 500mM, 1M and 2M NaCl concentration. The identity of these stress tolerant isolates was confirmed using oligonucleotide barcode and identified *Trichoderma* isolates have been submitted to Genbank and accession number is obtained. Among them, Th NBAII HAR16B (*Trichoderma harzianum*) was found to be an efficient saline tolerant isolate. The bioformulation is filed for patent (2273/CHE/2011 Dt. 04/07/2011). The efficacy has been field tested for soil borne diseases of groundnut.

Benefits /Utility

This bio-formulation of salinity tolerant isolates of *Trichoderma* with biocontrol potential is applicable to the crops grown in sodic soil, and it not only helps in disease control but also induces the salinity tolerance to crop plants with increased seed germination and growth. These *Trichoderma* isolates are tolerant to 2M concentration of NaCl and have good bio-control potential. Besides

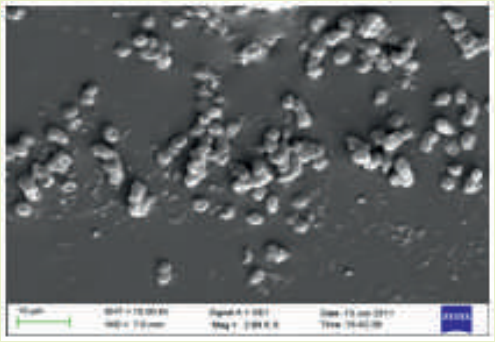
their tolerance to the salinity, they can protect the plants from salinity (4800 ppm concentration of NaCl in soil) as evident from increased germination of seeds. Conventional liquid fermentation derived talc formulation as well as solid state derived talc formulations and invert-emulsion formulation from solid state derived conidia were tested for their bio-efficacy and the bio-control potential of these bio-formulations has been confirmed against *Macrophomina phaseolina* infection on sorghum. The bio-formulations of these isolates will be very useful in chemical free management of plant pathogens under saline and sodic soil conditions.

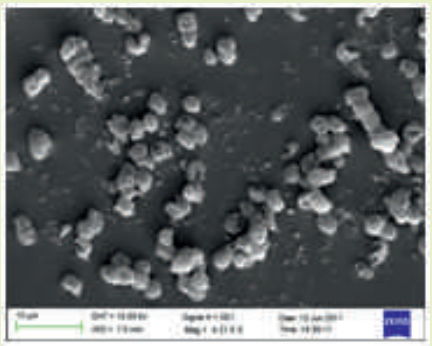
Scalability

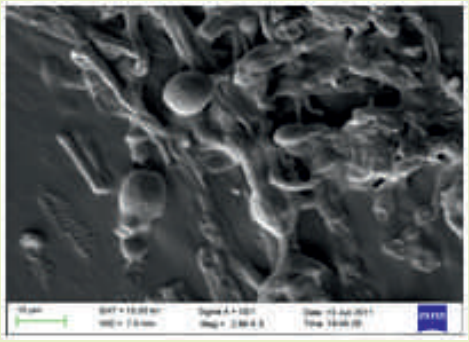
As there is great demand for the bioagents the production can be scaled up based on the capacity of fermentation units procured.

Business and commercial potential

There is great demand for the quality bioagents. Our country has met only less than 3% area covered with bioagents for plant disease management. *Trichoderma* seed treatment is a proven technology for managing soil borne diseases. There is huge demand.







Financial requirement

(for 50 batches in a year, each with 200 kg using 100L fermentor)

- Total Capital Investment (excluding Land and licensing fees) : Rs25 lakh
- Break of capital investment
  Equipment – Rs. 18 lakh
  - License fee, Registration cost – Rs. 5 lakh
  - Miscellaneous – Rs. 2 lakh
- Variable cost (per year/unit): Rs2.5 lakh
- Break of variable cost
  - Chemicals and talc – Rs. 0.25 lakh
  - Packing material – Rs. 0.10 lakh
  - Electricity and rent – Rs. 0.35 lakh
  - Man power – Rs. 1.80 lakh
- Expected sale/unit: Rs (can take selling price of a similar product):

No. of units to be sold for monthly break even on variable cost

Target Market/Customer

All types of farmers, seed producers, farmers in protected cultivation, plantation crops

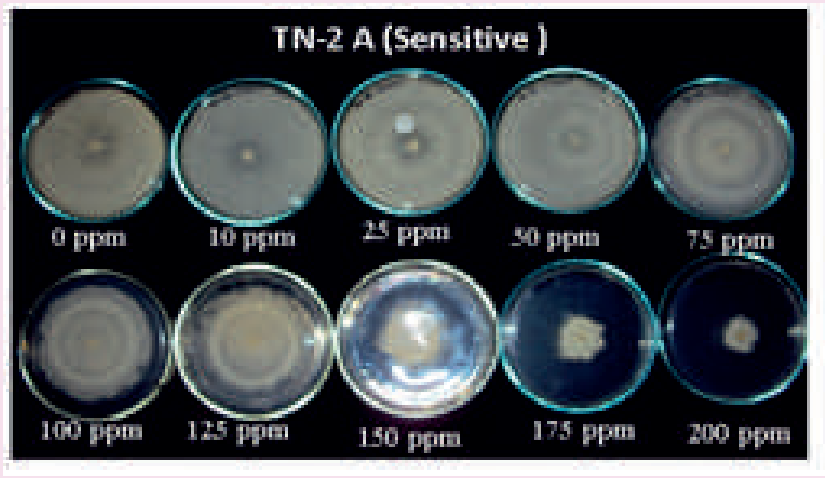
Social impact of the technology

Unit production cost (maximum): Rs.100 per kg

Predicted per unit selling price of product/services generated by the technology: Rs. 175 to Rs.200 per Kg

10 Bioformulation of carbendazim tolerant *Trichoderma harzianum* for biological management of plant diseases

Technology Description



- It is a bioformulation of a fungal antagonist *Trichoderma harzianum*
- The formulation has the carbendazim tolerant isolate of *T. harzianum*
- The carbendazim tolerance is upto 500 ppm
- It has good biocontrol potential against soil borne pathogens that has been verified by pot and field experiments with groundnut and sorghum
- There is no carbendazim tolerant formulation of *Trichoderma* available in the market
- Besides carbendazim tolerance, it is tolerant to Carboxin, Oxycarboxin and Imidacloprid which are commonly used seed treatment chemicals.

Efficiency

Pot culture experiments showed tolerance to carbendazim upto 500ppm and potential to control soil borne pathogens of groundnut and sorghum. The isolate used not only has salinity tolerance but has potential to protect plants from salinity when applied as seed treatment or soil application. Field trials at Junagardh (5 locations) and Udupi (4 locations) clearly showed the efficiency of the formulation in controlling the soil borne pathogens in groundnut.

Feasibility

Toxicological data required for complete registration of carbendazim and salinity tolerant isolates of *T. harzianum* has been developed. This can be obtained along with the cultures at the time of transfer of technology

Durability

The isolate can be maintained as dry spores in silica gel without losing the viability and other traits. The isolate can be maintained at carbendazim amended medium and *Trichoderma* production is a growing business and there is only less than 2-3% cropped area are covered by bioagents. In seed treatment and soil application a huge demand for the quality agents are required and the business will be very durable.

Background

Bio-formulation of carbendazim tolerant *T. harzianum* isolate (NBAII-GJ16B) has biocontrol efficiency against major plant pathogens besides tolerance to fungicide - carbendazim (500 ppm). Bio-formulation of *T. harzianum* with carbendazim tolerance is new to the market. Besides carbendazim, it is tolerant to commonly used seed treatment chemicals like Carboxin, Oxycarboxin and Imidacloprid. This formulation will certainly help in decreasing accumulation of synthetic fungicide in the environment and residues in plants. The isolates used in this formulation have good biocontrol potential besides fungicide resistance thus help in control of plant pathogens.

Benefits /Utility

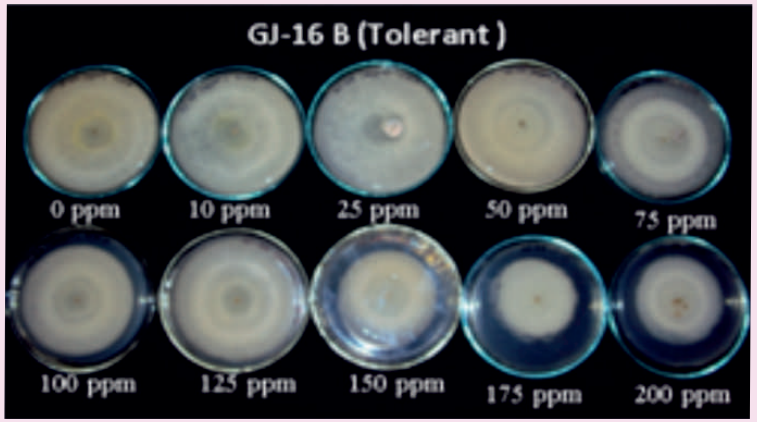
This bio-formulation of carbendazim tolerant isolate of *T. harzianum* with biocontrol potential applicable to different crops. Combined effectiveness of carbendazim tolerant *Trichoderma* along with carbendazim will be effective against different plant pathogens. The impact of this technology (bio-formulation) will help in control of plant diseases and also helps in plant germination and growth. The isolates of *T. harzianum, T. asperellum* or other species used in these bio-formulations are tolerant to carbendazim up to 200 ppm. Liquid fermentation derived talc formulation and solid state derived talc formulations were tested for their bio-efficacy and the bio-control potential of these bio-formulations has been confirmed against soil borne diseases of groundnut caused by *Macrophomina phaseolina*, *Sclerotium rolfsii* and *Aspergillus* spp. infection on sorghum. The bio-formulations of these carbendazim tolerant isolates will be very useful in chemical free management of plant pathogens.

Scalability

As there is great demand for the bioagents the production can be scaled up based on the capacity of fermentation units procured.

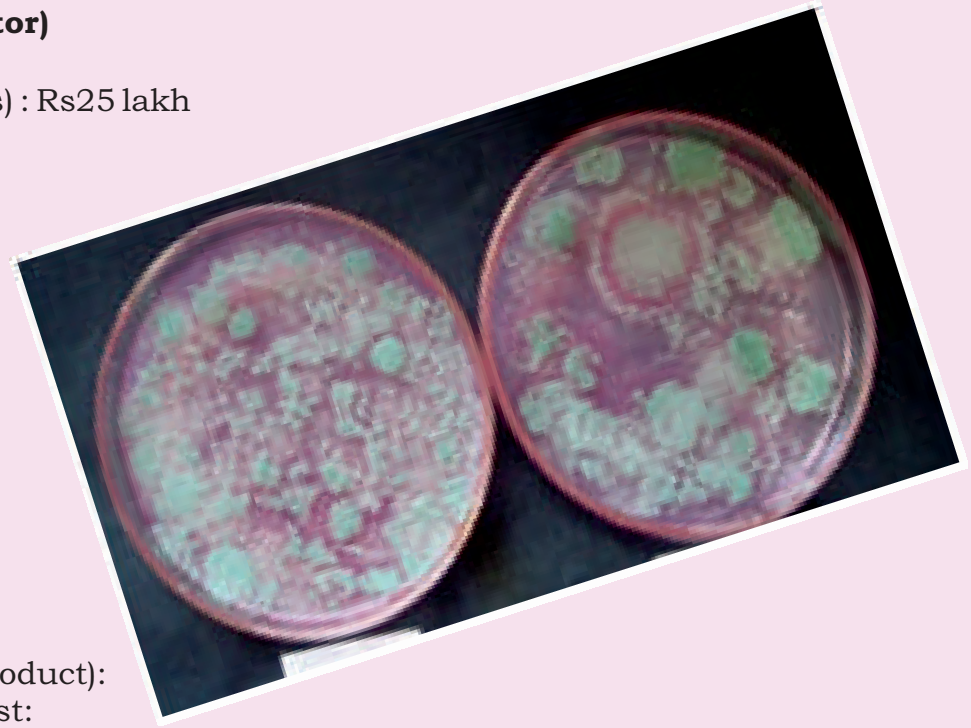
Business and commercial potential

There is great demand for the quality bioagents. Our country has met only less than 3% area covered with bioagents for plant disease management. *Trichoderma* seed treatment is a proven technology for managing soil borne diseases and there is huge demand.



Financial requirements

(for 50 batches in a year, each with 200 kg using 100L fermentor)



- Total Capital Investment (excluding Land and licensing fees) : Rs25 lakh
- Break of capital investment
  - Equipment – Rs. 18 lakh
  - License fee, Registration cost – Rs. 5 lakh
  - Miscellaneous – Rs. 2 lakh
- Variable cost (per year/unit): Rs 2.5 lakh
- Break of variable cost
  - Chemicals and talc – Rs. 0.25 lakh
  - Packing material – Rs. 0.10 lakh
  - Electricity and rent – Rs. 0.35 lakh
  - Man power – Rs. 1.80 lakh
- Expected sale/unit: Rs (can take selling price of a similar product):
- No. of units to be sold for monthly break even on variable cost:

Selling price per kg	Income*(Rs. In lakhs) with 50 batches in a year each with 200 kg
Rs. 150	15 lakh
Rs. 175	17.5 lakh
Rs. 200	20 lakh

Target Market/Customer

All types of farmers, seed producers, farmers in protected cultivation, plantation crops

Social impact of the technology

Unit production cost (maximum): Rs.100 per kg

Predicted per unit selling price of product/services generated by the technology: Rs. 175 to Rs. 200 per Kg.

11 Powder based formulation of *Pseudomonas fluorescens*, a DAPG producing abiotic stress tolerant isolate for rain fed and stressed agricultural soils

Technology Description

The bioformulation is developed with an efficient abiotic stress tolerant agent. The bacterium survived in high temperature (50°C), salinity (1.5M NaCl) and drought tolerance (up to -10.28 Mpa). The isolate produced plant growth promoting enzymes like phosphatases, proteases, chitinase, cellulase and ACC deaminase. They produced secondary metabolites like HCN which is involved in disease management. The isolate effectively inhibited *Sclerotium rolfsii, Rhizoctonia solani* and *Fusarium oxysporum.* They produced proline which stabilized plant growth under stressed condition. Additionally it also proved its excellent rhizosphere competence by establishing well in soils (log 8.7 cfu/gm). They proved to be an effective plant growth promoter under saline and water limiting conditions.

Background

Presence of fluorescent pseudomonads is ubiquitous and some reports are available on their occurrence in stressed environment like saline, sodic and semi arid soils. Hence we undertook a research under NAIP project "Effect of abiotic stresses on the natural enemies of crop pests: *Trichogramma*, *Chrysoperla*, *Trichoderma* and *Pseudomonas*, and mechanism of tolerance to these stresses" to study the diversity of fluorescent pseudomonads that occurs in such soils and also to see their level of tolerance to high temperature, salinity and drought. We also wanted to ascertain their biochemical / antibiotic producing properties so as to ascertain whether they could be useful in plant protection under stressful conditions. *Pseudomonas fluorescens* (NBAII PFDWD) was originally isolated by us from ground nut rhizosphere of North India.

Benefits /Utility

P. fluorescens is a well known PGPR. *Pseudomonas fluorescens* (NBAII PFDWD) is proved to be a plant growth promoter additionally having abiotic stress tolerance. They also produce DAPG which makes it effective against major plant fungal pathogens.The formulations of this isolate can be used in disease management of pulses, rice, legumes and vegetables grown in rain fed and stressed soils.

Scalability

The technology is scalable. The current scale of operation in 5L and this can be scaled up to 10-100L based on the equipment and energy availability. The technology can be scaled up to 100L in small scale level. In case of large production sufficient funds, skilled man power and large scale production units are necessary.

Business and Commercial potential

Viable unit – Rs. 25 to 40 lakh

Production capacity – 9000 kgs per annum

Selling price = Rs. 400.00 per kg

Production cost per kg = 150.0 per kg

Revenue per annum = 36.00 lakh

Profit = Rs. 22,50000/-

Financial requirement	
Scientist	24,00,000
Technical (1 SRF + 1 Semiskilled)	16,00000
Chemicals	3,00000
TOTAL	41,60000 (10% = 41,6000)

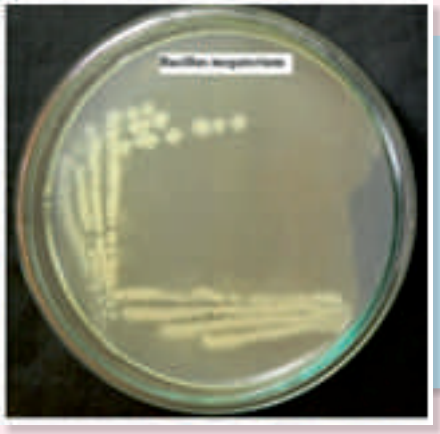
Target Market/Customer

Biocontrol and Biopesticide industries, Farmers, State Agriculture departments, KVK's

Social impact of the technology

The technology development needs large production units and man power. Hence, the proposal will generate employment and economic profits.

12 Wettable Powder based formulation of *Bacillus megaterium* for the growth and management of Bacterial wilt disease of brinjal and tomato



Technology Description

The bacterium *Bacillus megaterium* was formulated in talc powder and the shelf life of the formulation was 8 months. The powder based formulation of *B. megaterium* (strain NBAII 63) (10^8cfu of bacteria g^{-1}) was found to be a promising and an effective antagonist against bacterial wilt caused by *Ralstonia solanacearum* in tomato and brinjal. It is also an efficient phosphate solubilising organism. The dosage and methods of application of the formulation against bacterial wilt disease have been standardized.

Background

Bacterial wilt disease caused by *Ralstonia solanacearum* is one of the most devastating diseases of solanaceous vegetable crops and it is difficult to control with chemicals and cultural practices. Resistant sources are also not available. Biological control can play an important role in the management of bacterial wilt in the field level. *Bacillus megaterium* (NBAII 63) induced the growth and reduced the bacterial wilt incidence in the field level. The antagonist induced systemic resistance against the wilt disease through the activity of phenolic enzymes such as peroxidase and polyphenol oxidase and phenols. The bacterium induced growth and yield of brinjal and tomato plants due to its better root colonization and phosphate solubilization ability.

Benefits /Utility

- The bacterial wilt disease incidence of tomato and brinjal could be reduced to maximum extent.
- The growth and yield of the plants will be enhanced due to the phosphate solubilization ability of the organism.
- The technology may play a major part in the organic production of tomato and brinjal.
- The farmer can reduce the cost by 25% for bacterial disease management by adopting this technology.

Scalability

It is amenable to multiply in large scale.

Business and commercial potential

Being a very good growth promoting and antagonistic organism it attracts lot of vegetable growers and entrepreneurs across the country. Since the bacteria are spore formers the shelf life of the product is longer. The product will have high demand because vegetables are grown all over the country throughout the year. The product is highly essential for the vegetable nurseries to produce quality and disease free seedlings.

Financial requirement

Any industry or entrepreneur can produce the product without much cost and sophisticated equipments. The expected return will be 25% of the sales after taking into account all the cost of production.

Target Market/Customer

There are huge numbers of tomato and brinjal vegetable nurseries in the country. The product and the technology could be sold to these nurseries for the production of quality, Robust and bacterial wilt disease free seedlings.

There are lot of entrepreneurs/ industries producing and supplying the antagonistic and growth promoting microorganisms in India at reasonable price. The product could be commercialised to them at a competitive price.There is a good scope to transfer the technology to the state government biocontrol laboratories at a competitive price.

Social impact of the technology

The cost of production for raising crops will be very low due to adaptation of the technology. The standard of living and health of marginal and small farmers will be improved due to adaptation of this technology. The fertility status of the soil will be maintained due to the application of the product.

13 A plant volatile based attractant for enhanced attraction of fruit fly

Technology Description

Scientists worldwide have been looking for a most robust attractant than methyl eugenol. In this context, the present technology has a cocktail of volatiles identified from some host plants which attracted almost 3 times more than the methyl eugenol. The attractant efficiency has been proved in the field trials.

Background

Mango is a major crop in India with high export potential. Among the several pests infesting mango, fruit flies are considered as important. The oriental fruit fly, *Bactrocera dorsalis* is a direct pest on mango. The fruit loss in mango was estimated to be around 16%. Fruit flies such as *B. dorsalis* and *B. caryeae* are generally attracted to the methy eugenol. Methyl eugneol has been successfully used for the management of *B. dorsalis* through male annihilation technique. The *B. dorsalis* and other species of *Bactrocera* are attracted to the methyl eugenol. Efforts were made to improve the catches through the volatile mixtures and for sustained release for a longer period. This will ultimately reduce the number of traps per unit area. With this idea is the present technology was developed.

Benefits /Utility

In the present technology higher number of *Bactrocera* was caught than methyl eugenol and can be used for catching fruit flies in mango, guava and other fruit crops.

Scalability

The technology can be extended scalable depending on the infrastructure available.

Business and commercial potential

The lures will have more attraction than the methyl eugenol.

The lures have longer duration of field efficacy than the methyl eugenol

The number of females caught was comparatively more than the methyl eugenol alone.

Financial requirement

Cost of each lure is Rs 32. However, the total cost in the field could be reduced with the reduction in the number of traps per unit area and less frequency in changing the lures.

Target Market/Customer

All the commercial producers of pheromones/lures

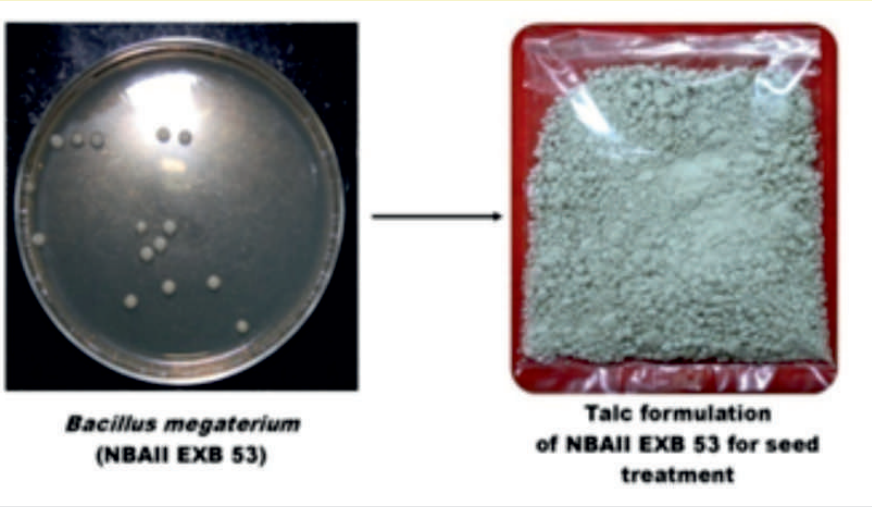
Social impact of the technology

The technology will reduce the number of traps needed per unit area and also with sustained release, the lures can be effective in field for longer period and thus need of change of lures for farmers is minimised. The technology can be an effective tool in the male annihilation technique and could farm a good practice in organic farming. The technology could form a part in the integrated pest management.

14 Promising plant growth promoting strain of *Bacillus megaterium* for vegetable crops

Technology Description

A new plant growth promoting strain of *Bacillus megaterium* (NBAII EXB53) which can promote growth in different chilli varieties, *Capsicum*, tomato, egg plant, cauliflower and cabbage has been identified at ICAR-NBAIR. Seed treatment with talc based formulation of *B. megaterium* (NBAII EXB53) @ 10g/kg seeds significantly increased vigour index (20-245%) of different vegetable crops under nursery conditions. Furthermore, *B. megaterium* (NBAII EXB53) has higher plant root colonization ability, produce plant growth promoting hormone, indole-3-acetic acid (IAA) and phosphate solubilisation ability. The strain can be mass produced using molasses urea medium and talc formulation can be made as per Central Insecticide Board (CIB) standards.



Background

Various strains of *Bacillus* species act as beneficial bacteria by promoting plant growth through direct action or by providing protection from various plant diseases. Among the different species of *Bacillus* genus, *B. megaterium* is one of the plant growth promoting bacterium found associated with many types of plants and also found in diverse natural habitats. *B. megaterium* is a gram-positive, spore forming aerobic bacterium which can promote direct plant growth through extensive root colonization and production of certain plant growth regulators

Benefits /Utility

The technology will be helpful for raising healthy and robust seedlings (planting material) in nurseries and also for direct seeded vegetable crops. Increased seed germination, root and shoot length, fresh/dry weight with overall increase in seedling vigour can be obtained by seed treatment with *B. megaterium* (NBAII EXB-53). The present technology is eco-friendly strategy of obtaining healthy and robust vegetable seedlings which can also reduce the use of fungicides for vegetable seed treatment.

Scalability

The current scale of operation is 10L and this can be scaled up to 100L or more using industrial fermentor systems. Large scale production requires skilled man power.

Business and commercial potential

The technology can be commercialized in vegetable growing areas of India.

Financial requirement

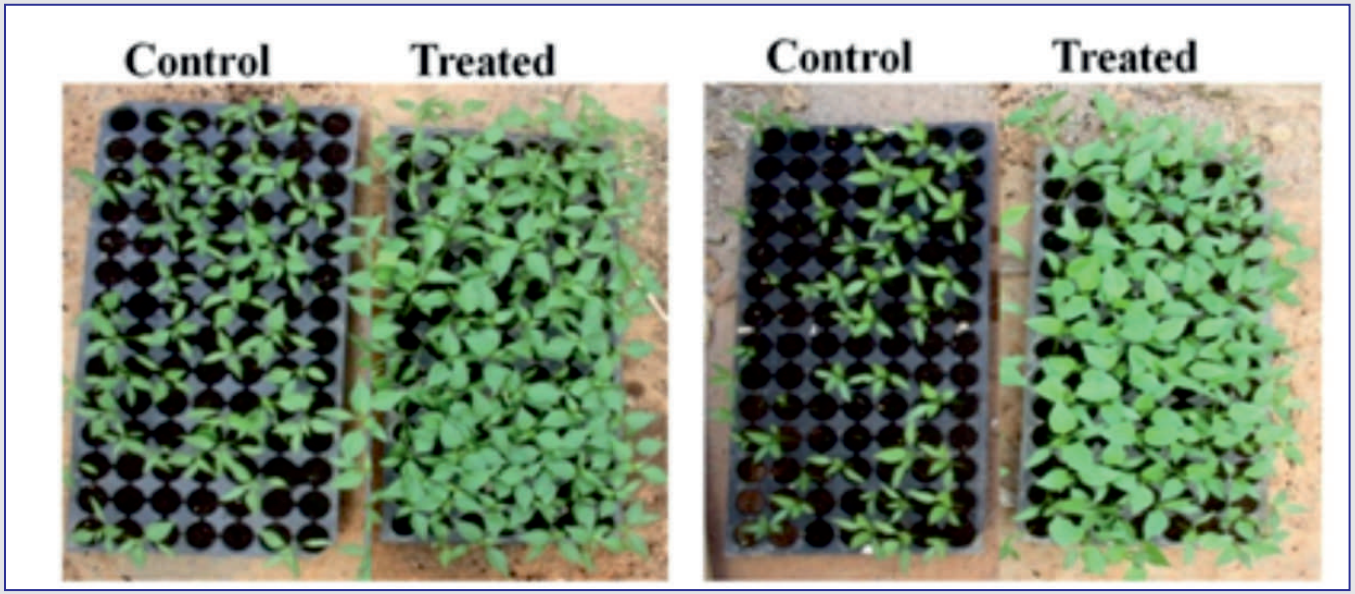
The approximate cost of the product is Rs. 50-60/kg.

Target Market/Customer

For commercial biocontrol agent producers for targeting vegetable nurseries and farmers

Social impact of the technology

The present technology is an eco-friendly strategy of obtaining healthy and robust vegetable seedlings which can reduce the usage of chemical fungicides for vegetable seed treatment and thereby minimize the risks associated fungicides on environment and non-target organisms including human beings.



15 A simple technique of rearing brinjal shoot and fruit borer, *Lucinodes orbonalis*

Technology Description

A simple process of rearing *L. orbonalis* on potato tubers has been standardised. To initiate settling and sustained feeding, the tubers are being pre-treated with a combination of phagostimulants. The growth and development for all the stages of the insect was found better as compared to rearing on the brinjal fruits. Due to fruit rotting and frequent transfer of larvae to fresh brinjal fruits, the larval mortality and successful pupation rate were severely affected when reared on brinjal. It is considered as an enabling technology with minimum facility and high recovery of healthy larvae.

Background

Brinjal fruit and shoot borer, *Leucinodes orbonalis* Guenee is the key pest of brinjal in India and many other south East Asian Countries, inflicting sizeable damage. As a result of its feeding inside fruit, the fruits become unmarketable and yield losses up to 90 percent in case of unprotected cultivation. Rearing of *L. orbonalis* on brinjal fruits is tedious and fruit rotting is the major problem. The present invention simplified the rearing.

Benefits / Utility

Large scale screening brinjal germpalsm and toxicity screening of insecticidal molecules require large number of laboratory reared *L. orbonalis* larvae. The present technology offers the solution for large scale rearing of *L. orbonalis* larvae in a simplified manner.

Scalability

With one kg of pre treated potato tubers up to 246 healthy larvae could be obtained.

Business and commercial potential

Large scale rearing of *L. orbonalis* larvae could be undertaken by private companies / Scientists / students working on germplasm screening and testing of insecticide molecules

Economic analysis

Parameters	Potato tuber (One change)	Brinjal fruit (4-5 changes)
Total number of neonate larvae released per big sized potato tuber / brinjal with tender shoot	50	50
Number of late second instar larvae recovered from a batch	34 - 41	11 - 17
Number of larvae entering pupation in a batch	31 - 39	7 - 16

Possible recovery of second instar larvae from a kilogram of potato tubers	**204 - 246**
Rate per kg potato	**Rs 25/-**

Target Market / Customer

Private companies / Scientists / students

Social impact of the technology

Easy rearing of *L. orbonalis* larvae for large scale screening purpose.

16 Protocol for designing lure for impregnating parapheromone 4[4-acetoxy) phenyl-butanone to attract male flies of *Bactrocera* spp attacking cucurbit crops for mass trapping and monitoring its population thereof.

An alchohl free formulation for trapping more melon fly, *Bactrocera cucurbitae*

A *Bactrocera cucurbitae* infested bittergourd fruit

Technology Description

This technology uses alcohol free formulations for trapping melon fly which reduces the need for the alcohol. Further at the installation stage, there is no need for the insecticides and hence the produce can be organic.

A trap containing the formulation

Background

Melon flies are serious pests in cucurbits, and most importantly export oriented crops like gherkins. The adults lay the eggs on the developing fruits and emerging larvae seriously feed and finally make the produce unmarketable. Besides, *B. cucurbitae* is a quarantine pest, not tolerated in importing countires. The technology tries to develop an organic formulation with more attraction without the need for the alcohol or insecticide

Benefits /Utility

Better management of melon flies without the use of insecticides. Twenty traps per acre are recommended for the effective management of this pest.

Scalability

The technology can be extended to any scales.

Business and Commercial Potential

The formulation is being marketed now.

17 Controlled release dispenser for delivery of semiochemicals

Technology Description

The technology relates to a process for preparing composition for housing the composition, a method of sustained release of semiochemicals, a method of pest management and a method of pest management in crops. The sustained release of behaviour modifying chemicals (Semiochemicals) from substrate aids in causing behavioural response insect pests to orient to the source. This attract and kill strategy aids in pest management without polluting the environment. This technology was jointly developed by ICAR - NBAIR and JNCASR.

Background

Recently the pest control systems depend on chemo-ecological approach that involves semiochemicals which are signalling molecules within or between the species. Pheromones are chemical substances secreted or excreted by insects that can be sensed by other members of the species in the vicinity, triggering a social response depending on the nature of the pheromone being released. Pheromone dispensers currently available in variety of designs (Polymer membrane, cardboard blocks, rubber septa and capillary tubes), are a bottleneck along the way to a sustainable pheromone-based strategy in integrated pest management (IPM). Hence, there is a need to develop controlled release dispensers.

Benefits and utility

The disadvantage with currently available dispenser (Polymer membrane, cardboard blocks, rubber septa and capillary tubes), is the higher release rate of pheromone that fluctuates with weather conditions. This is mainly due to the poor holding capacity of the matrix used for loading pheromones. Nanoporous materials are a novel carrier/ dispenser for the volatile signaling molecules. The expected advantages of the nanoporous materials are highly controlled spatiotemporal release rates of pheromones / kairomones with improved climatic stability.

Scalability

Its suited as a small scale industry and by Self Help Groups. Production can cover 10000 ha.

Business and commercial potential

Lure made of polymembrane have increased release rates and warrant frequent replacement. This adds to cost of lure and the labor required in replacement. In the present invention the dispenser has lower load of semiochemicals than commercial lures and in terms of efficacy in trapping of insect's it is effective or at par with the existing commercial lures. Decreased load of semiochemical helps to scale down the cost involved in crop health management.

The present technology that has extended release rate coupled with lower load of lure in case of tomato pinworm, *Tuta absoluta* and date palm weevil, *Rhychoporous ferrugineus* and coconut rhinoceros beetle, *Oryctes rhinoceros*. In India, the polymer membrane or polypropylene tube dispensers loaded with rhinoceros beetle and red palm weevil pheromone dominate the market. The product from our invention will have an edge over the existing dispensers as they aid to scale down the cost involved due to extended field efficacy of the lure and the lower load of pheromone use

Social Impact of the Technology

Use of pheromone minimizes the need for pesticides use that causes health hazard to producers and end-users. Pheromone can be used in tandem with bioagents and their use does not harm the pollinators and nontarget organisms that provide ecosystem service.

Financial requirement

In order to cover 100 ha a capital investment of Rs. 500000 is needed. The capital equipment's are one-time purchase and the consumables can be sourced from India.

Target Market/Customer

Farmers | Small Scale industries | Self help groups

18 Mass production of *Trichogramma chilonis* & *Trichogramma embryophagum* using Eri silkworm eggs

Technology Description

Egg parasitoids *Trichogramma chilonis* and *T. embryophagum* can be mass produced on eggs of Eri silkworm (Esw) *Samia cynthia* (generally known as Sacred or Aesthetic silk moth). The field performance of *T. chilonis* Esw strain was evaluated against borer pests of rice and sugarcane in Andhra Pradesh, Karnataka and Tamil Nadu and pest reduction was significantly higher in the Tc – Esw strain released fields in comparison to control fields. Good field parasitism was also recorded. Farmers have recorded significant reduction in pesticide applications and realised monetary benefit varying from Rs. 15000 - 25000/- / ha / season. *Trichogramma embryophagum* (Esw strain) released against Leaf web worm *Acria* sp. infesting oil palm trees in Andhra Pradesh and against codling moth *Cydia pomonella* infesting apple orchards of Kargil recorded significant reduction in pest incidence. Percent reduction over control varied from 11.5 to 30.4 and sentinel average parasitism varied from 15.2 to 22.4% in treated apple orchards.

Background

In India, the rice moth *Corcyra cephalonica* is utilized as a laboratory host insect for mass production of trichogrammatids. Other host insects like *Sitotroga cerealella*, *Ephestia kuehniella* and *Helicoverpa armigera* have also been utilized for rearing *Trichogramma* in different insectaries. Several steps are involved in the production system for the host insects mentioned above, which include moth collection, egg collection, egg sterilization and larval rearing. Some of the steps are manual and some mechanized. The number of parasitoids which emerge from the above host eggs when parasitized range between one and four per egg and the size of the parasitoid is recorded to be inversely proportional to the number of the adults emerging from each egg. It is generally reported that the larger, healthy adults have superior biological attributes and perform better in the laboratory and in the field. A method has been devised for production of *T. chilonis* and *T. embryophagum* using the eggs of Eri silkworm (Esw).

Benefits / Utility

Higher yield of *Trichogramma* adults can be obtained from each parasitized egg of Esw (an average of 29.2 adults per each parasitized egg) in comparison to *Corcyra*. Adults which emerge from these parasitized eggs are robust with superior biological attributes -higher female progeny production (97.4%), highly fecund, higher parasitism & adult emergence (100%); higher longevity (8 days) and better searching ability. This technology is also amenable to on-farm production.

Business and commercial potential

Tricho cards of Tc – Esw / Te – Esw can be produced to cover a release area of 136.3 ha @ 50000 adults / ha / release & 8 releases / crop season. A total of 8000 cards can be produced in one year and production cost of each tricho card of *T. chilonis* & *T. embryophagum* using Esw eggs is Rs. 30/-. Selling price can be fixed at Rs. 50/- per card. Rs. 4.0 lakhs can be obtained from the unit in the 1st year on the initial investment and this can be the operational cost for the 2nd and successive years. The unit will be earning Rs. 4.0 lakhs in the 2nd year, which will be the profit for the unit. Additional income can be generated by selling the shelled cocoons of the host insect – Eri silkworm.

Financial requirement

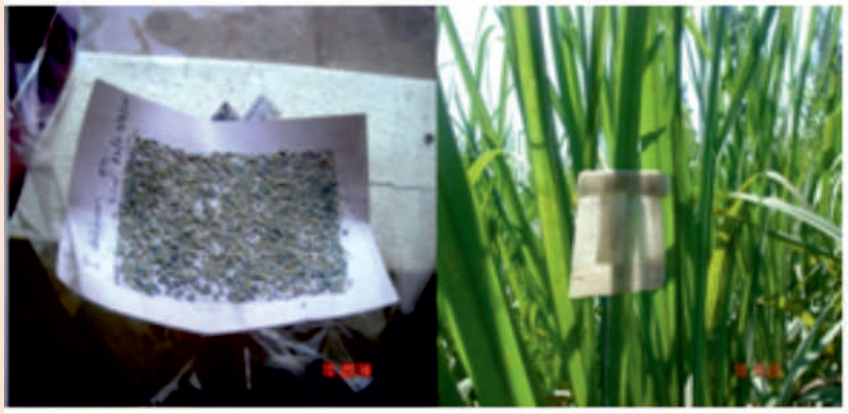
An initial investment of Rs. 5.0 to 10.0 lakhs is required to produce Tricho cards on Esw to cover 100 ha cropped area. It would be a onetime investment i.e. provision of land for growing castor and creating rearing facility. Recurring expenditure of about Rs. 50000/- per annum is required. Other infra-structure required include: a) adult moth ovipositional cages fabricated with iron rods measuring 40cm Length x 40cm Width x 45cm Height, with four legs measuring 6 cm each and covered with nylon mesh with an opening (with a zip) on one side for releasing moths, b) larvae rearing cages / trays, c) refrigerator, d) table, e) chair, f) steel racks etc. and these items have a life of approximately 10 years.

Scalability

The technology is scalable by utilizing a larger space, increasing the manpower and the initial inputs with close and careful monitoring to maintain hygiene and following the precise protocol developed.

Economic analysis

Tc – Esw & Te Esw can effectively control the pest, reduce the application of insecticides, ensure environment safety, generate employment, ensure low and affordable production cost and can be easily adopted by farmers. The business potential and economic analysis with respect to production and supply and effect on pest management are clearly defined in the above sub-sections.



Target Market / Customer

- Farmers
- Self help groups
- Contract farming groups
- Biocontrol producers

Social impact of the technology

Trichogrammtids are safe and promising biological control agents for the eco-friendly pest management practices. This technology will ensure that the farming community is not exposed to the toxic effects of pesticides and also the availability of pesticide residue – free produce for the common man.

19 A Herbal based Repellant for Termites on woody trees - REPTER

Technology Description

Termites are serious pests on shadow trees supporting the pepper vines in coffee/tea plantations and also stored wooden logs. This formulation effectively repels the termites and thus totally wards off infestation by termites.

Background Formulation treated tree after 6 months of treatment

Termites attack the wooden trees, especially the trees supporting pepper vines during the winter and pre-monsoon period. When the infestation becomes very serious, coupled with abiotic factors like less rainfall, the infested tree dies, which takes another 15-20 years to find a replacement for the shadow trees. Termite management is an important component in the maintenance of wood trees. Though insecticides can be used for the management of termites, environmental safe is a major concern. To address this issue, the present botanical based repellent was developed.

Benefits /Utility

The formulation is totally plant based with appropriate stickers and dispersable materials which allow the formulation to stick to the trees. Once applied, the termites are consistently repelled. The infested trees are free from reinfestation for a period of 6 moths. This allows the tree to rejuvenate and grow. The formulation is totally plant based and thus totally organic

Scalability

The technology can be extended to any scales.

Business and commercial potential

The formulation is greatly in demand and two firms have already purchased the technology. The formulation is being marketed now.

Social Impact of the Technology

The termite infestation can be greatly reduced through the use of this formulation.. This formulation can also be applied stored wooden logs. However this formulation is not recommended for termite infestation in field crops.

Termite infested tree

Formulation treated tree after 6 months of treatment

20 A. Herbal swabber for the management of white stem borer *Xylotrechus quadripes* in Coffee (organic)

B. Booster for boosting plant health in coffee (not for certified organic coffee)

Herbal based formulation for the management of coffee stem borer in 'arabica' coffee

Technology Description

Coffee stem borer, *Xylotrechus quadripes*, selectively attack the Arabica coffee. The present technology acts as an ovipositional repellent for *X. quadripes*. When applied during the premonsoon and post monsoon season (coinciding with flight period where the adults oviposit maximum eggs) the adults can be easily managed. This is recommended as a prophylactic and curative method.

Background

Adults of *Xylotrechus quadripes* are active cerambycid beetles. They emerge during the sunny period, during premonsoon (April-May) and post monsoon (October –November) from their pupal period and mate and lay the eggs on the trunk of the Arabica coffee plants. Larvae which emerge from the eggs tunnel into the trunk and start feeding the xylem portion damaging the conductivity of water and nutrition. Ultimately the infested tree is killed. However one major problem is that infestation can not be identified like other borer infestation, as there is no frass or ooze.

The present technology was found to drastically reduce the oviposition there by reducing the damage. However, four consecutive application is suggested in the same plot for effective results.

Benefits /Utility

The formulation is plant based and hence totally organic. An inorganic micro nutrient spray is also recommended where organic farming is not practiced along with this formulation which increased the yield of coffee beans by 10-15%.

Scalability

The technology can be extended to any scales.

Business and commercial potential

The formulation is greatly in demand and two firms have already purchased the technology. The formulation is being marketed now.

Social Impact of the Technology

The technology is being adopted by coffee growers in Chikmagalur and Kodagu districts effectively.

21 Absorption and delivery of molecules using Nanoporous materials

Fallarmy Worm trap

Technology Description

The technology relates to a method of developing a platform for sustained delivery of semiochemicals, a method of pest management in crops. The sustained release of semiochemicals aids in attracting the insect pests to the source. This is clean technology in pest management without polluting the environment. This technology was jointly developed by ICAR - NBAIR and JNCASR.

Background

Pheromones secreted or excreted by insects are sensed by their conspecifics and are used for habitat and mate finding. Pheromone dispensers for fall armyworm, *S. frugiperda* are currently available in Polymer membrane and rubber septa. They have a bottleneck as they have short filed efficacy that warrants frequent replacement. Hence, there is a need to develop controlled release dispensers.

Benefits and utility

Dispenser made of polymer membrane and rubber septa have higher release rate of pheromone that fluctuates with weather conditions. This is due to the poor holding capacity of the matrix used for loading pheromones. Nanoporous materials have an advantage as they have highly controlled spatiotemporal release rates of pheromones with improved climatic stability.

Scalability

Its suited as a large/small scale industry and by Self Help Groups. Production can cover 100000 ha.

Trapped adults

Business and commercial potential

Pheromone lures of fall armyworm loaded in polymer or rubber septa have high release rates and warrant frequent replacement. This adds to cost of lure and the labor required in replacement. In the present invention the dispenser has lower load of semiochemicals than commercial lures and in terms of efficacy in trapping of insect's it is effective or at par with the existing commercial lures. Decreased load of semiochemical helps to scale down the cost involved in crop health management.

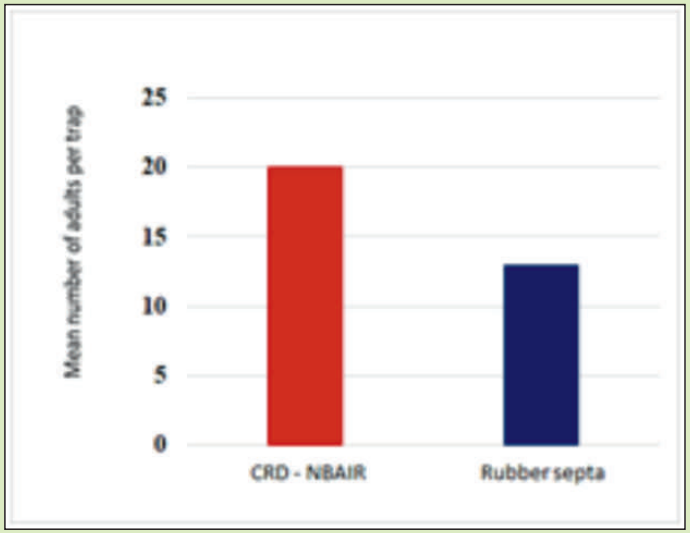
The present technology that has extended release rate coupled with lower load of lure in case of Fall army worm. In India, the polymer membrane or polypropylene tube dispensers loaded fall armyworm pheromone dominate the market. The product from our invention will have an edge over the existing dispensers as they aid to scale down the cost involved due to extended field efficacy of the lure.

Social Impact of the Technology

Use of pheromone minimizes the need for pesticides use that causes health hazard to producers and end-users. Pheromone can be used in tandem with bioagents and their use does not harm the pollinators and nontarget organisms that provide ecosystem service.

Financial requirement

In order to cover 100 ha a capital investment of Rs. 500000 is needed. The capital equipment's are one-time purchase and the consumables can be sourced from India vendors.



Efficacy of nanoporous FAW lure

Target Market/Customer

* Farmers
* Small Scale industries
* Self help groups

22 Shatpada Dorsa-Delta an efficient trap for the mango fruit fly

a) Dorsa-Delta, an efficient trap for mango fruit fly

Technology Description

A synergized volatile combination was impregnated in a delta trap. This showed very good attraction because of the interaction of olfactory and visual cues. This is very effective trap in male annihilation techniques

Background

Mango fruit fly, *Bactrocera dorsalis* cause serious damage to the mango furits and also a notorious quarantine pest, The adults visit the immature mango fruits and lays eggs. The larvae on hatching start feeding on the pulp of mango causing serious damage to fruit reducing its market value.

The present technology at a rate of 5 per acre along with the bisexual attractant greatly reduced the damage by *B. dosalis.*

Benefits /Utility

The formulation is plant based and hence totally organic. No insecticides are used for killing the pest. When used in yellow trap, the catches were significant due to synergistic combination of olfactory and visual cues. Besides, the traps also catch good numbers of mangohoppers additionally

Scalability

The technology can be extended to any scales.

Business and commercial potential

The formulation is being marketed now.

b) A bisexual attractant for *Bactrocera dorsalis* in delta trap

Technology Description

Unlike the methyl eugenol, the dispenser attracts both the sexes of *B. dorsalis*, there by increasing the effectiveness of the traps.

Benefits /Utility

Since the females are also trapped, the establishment of next generation is greatly reduced. In combination with methyl eugenol traps, the management of mango fruitfly is very easy without insecticides or with minimal insecticides.

Background

Methyl eugenol is an effective parapheromone used for the management of *B. dorsalis*. However only males are attracted to the methyl eugenol traps. In the present trap both the sexes of *B. dorsalis* have been captured which makes the management of this pest on mango easy.

Scalability

The technology can be extended to any scales.

Business and commercial potential

The formulation is being marketed now.

23 Rearing techniques for multiplication of housefly, *Musca domestica* pupal parasitoids

Adult Housefly

Nasonia vitripennis

Spalangia cameronensis

Emergence hole on fly pupae

Technology description

A pteromalid *Spalangia cameronensis* and *Nasonia vitripennis* are pupal parasitoid that are effective against the sarcophagids and muscids. Although promising bioagents have been identified, implementing the program involving the use of bioagents is second only to chemical insecticides because of the difficulty faced in mass production of the parasitoids. A mass rearing technique of housefly parasitoid, *S. cameronensis* on the pupa of housefly, Musca domestica has been developed.

Background

The house fly, *Musca domestica* (L.), is a significant public health pest for humans and domestic animals. They are mechanical carriers of over 100 human and animal intestinal diseases and are responsible for protozoan, bacterial, helminthic, and viral infections. They are a serious pest in animal rearing facilities, where they transmit disease, cause annoyance to people working and staying close to animal or poultry sheds. Synthetic insecticides are widely used to control *M. domestica*. They have become less acceptable due to their persistence in the environment, toxicity to non-target organisms and resistance development to several established insecticides. Therefore, an alternative approach using the bioagents for vector control that environmentally safe demands for search for bioagents that can keep the fly population at low.

Benefits and utility

Farmers involved in animal husbandry and poultry rely on use of insecticides for the control of housefly. In poultry sector over Rs. 200000 is spent per annum for maintaining sheds housing one lakh birds. These flies are managed using the chemical pesticides. In majority of the cases the pesticides are used indiscriminately, and this has led to development of resistance. This situation warrants increased level of pesticides to be used over a period to control the flies. Increase the load of pesticides in animal sheds and poultry only adds to exposure of pesticide residues that are harmful to nontargets and the consumers.

The parasitoids of housefly *viz.*, *S. cameronensis and N. vitripennis* are effective in parasitizing the housefly pupae. This bioagent fits perfectly in the housefly IPM umbrella. Innundative release of the pupal parasitoid will help to bring down the population of houseflies and thereby decrease the dependence on the pesticides. These parasitoids can be reared easily utilizing the locally available materials making this technology suited for local conditions.

Scalability

Its suited as a small scale industry. It can be taken up by Self Help Groups and unemployed youth in rural and urban areas.

Business and commercial potential

As the farmers in poultry sheds and Animal sheds spend over two lakhs on insecticides use of the parasitoids manage the houseflies is a clean and green technology. Innundative release of the parasitoids will scale down the fly populations. The technology can be used in poultry, animal husbandry and waste management sector.

Target Market/Customer

*** Farmers** *** Farming companies** *** Self help groups** *** Bioagents mass multiplying companies**

Social Impact of the Technology

S. cameronensis and N. vitripennis are safe biological control agents and are specific against insect pests. Use of the bioagents will help to scale down the population of flies by scaling down the use of pesticides.

Financial requirement

An investment of Rs. 100000 is required to produce over twenty lakh parasitoids. Insect rearing cages and plastic containers are the capital required.

24 Waste to wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes

Technology Description

The black soldier fly (BSF), *Hermetia illucens* (L.) (Stratiomyidae: Diptera) is mainly a tropical insect that is useful in converting solid organic waste into manure thereby reducing the quantity of the waste. The BSF pre-pupae are also used as valuable nutrient additive in poultry feed and fish meal. In this current technology rearing method and structure for rearing BSF larvae were standardised and developed.

Background

India produces around 3000 million tons of organic waste annually. Utilization of this waste material for productivity process is important for both economic and environmental reasons (Mehta and Chorawala, 2014). Farm and kitchen waste is a source of foul odour its slow degradation leading to environmental pollution. Farm waste has enormous nutrient wealth to be recycled for its effective utilisation. Composting is a process that safeguards and conditions diversity of decomposing ecosystem with the help of micro and macroorganisms. Bioconversion of organic solid waste into compost by earthworms or microbes normally takes several weeks to months. The present technology employing the larvae of Black Soldier Fly (BSF) for the above purpose is a simple bioconversion process that effects a 70-85% reduction in the weight and volume of food waste within a matter of few days. This process does not require energy, electricity and chemicals. It is totally self-contained and does not produce methane or any other greenhouse gases. The process does not require introduction of any foreign or exotic material. The BSF larvae feed voraciously on the organic solid waste and convert it into manure in three days, achieving a dry mass volume waste reduction. The larvae are the primary output of the solid waste conversion and the weight of the prepupae for meal could be around 20kg / 100 kg solid waste conversion.

Benefits /Utility

* ***Biomass conversion*:** Biomass reduction of 50-95% are been reported with this technology involving various types of organic wastes.
* ***Odour reduction*:** Black soldier fly larvae are voracious feeders, and process waste very quickly, restraining bacterial growth and significantly reducing the bad odours. Also, larvae aerate and dries the manure, reducing odours.
* ***Housefly and other fly control and reduction of pathogenic bacteria*:** Being competitors for housefly larvae they significantly control housefly and other fly populations. Larvae suppress the population of pathogenic bacteria.
* ***BSF is neither pest nor vector* :** Both larvae and adults are neither pests nor vectors of pathogens. Adult flies do not have functional mouth parts and do not feed, whereas larvae feed on decaying matter only.
* ***Rearing structure:***
* Structure designed is compact, economical, easier to fabricate and maintain and can be utilized for rearing of black solider fly throughout the year irrespective of seasons and geographical locations.

* Easier harvesting of pupae, collection of egg masses, leachate separation from biomass
* Structure conserves moisture for degradation of substrates compared to other reported open structures, and avoids entry of rodents and other pests.

Scalability

The structure for rearing BSF is scalable to the commercial level for processing large volumes of organic wastes with minor alterations/ modifications in rearing structure as per convenience according to need. The process and methodology of rearing BSFL remains the same.

Business and Commercial Potential

The current technology has business potential as the technology has advantages of up to 90% reduction of bulky organic wastes generated in urban and rural areas yielding matured compost which can be utilized for diverse crops nutrition and establishment of nurseries. Also the technology yields larvae as primary output of the solid waste conversion and the weight of the prepupae for meal could be around 20kg / 100 kg solid waste conversion, which can be used as valuable nutrient additive in poultry feed and fish meal

Financial Requirement

Establishment of polyhouses for BSF breeding and to house fabricated rearing structures involves financial requirement depending on need and the volume of output desired by the entrepreneur or stakeholder. Approximately Rs. 50,000/- for two size net-houses (10 x10 ft^2)

Economic Analysis

The technology is viable and adopted in foreign countries and is very effective in reducing the organic wastes biomass, generating useful byproducts and will generate employment. Technology evaluated with designed structure has net overall benefit: cost ratio of 1.173 and net composting benefit: cost ratio of 0.94.

Target Market/Customer

* Poultry sector/ Fish Farming Sectors/ Farmers
* Contract farming companies/ Farmer's federations/Groups
* Municipalities / Panchayats

Social Impact of the Technology

Black Soldier Flies are safe biological means for bioconversion of organic waste and helpin reduction of organic waste biomass,associated filthy and foul smells and yielding a good degraded organic matter suitable as compost. Also larvae can be used as valuable nutrient additive in poultry feed and fish meal. Thus, organic wastes are recycled effectively reducing organic wastes and converted to useful compost and larvae.

25 Novel Device for Field Release of Parasitoids

Technology Description

Black-headed caterpillar, *Opisina arenosella* Walker (Lepidoptera: Cryptophasidae) are the major pests of coconut palm causing severe and frequent outbreaks in Myanmar and Bangladesh. Also, the pest is most common in coconut growing areas such as Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Tamil Nadu, and West Bengal, especially it is commonly occurs throughout the year in coastal and backwater tracts. Biological control of the pests using natural enemies, specifically *Goniozus nephantidis* (Hymenoptera: Bethylidae) is the dominant parasitoid which feeds on *O. arenosella*. However the adult *G. nephantidis* can be easily produced on *Corcyra cephalonica* larvae, the effective field release is most important. To either establish parasitoids in new locations, or augment established populations, classical and augmentative biological control programmes typically culture parasitoids in the laboratory, then release them in the field either by releasing the adults of *G. nephantidis* on the crown of the coconut trees or releasing the adults on the trunk of each tree (Venkatesan *et al.*, 2003). However, it is labour intensive methods i.e. at least it will take 2 to 3 minutes to release parasitoids/tree and would take 6 hrs to 9.5 hrs to complete one ha area/person. Hence, the newly invented parasitoid release device makes the release of the parasitoids quicker, easier and in more economic aspects too.

Background

Opisina arenosella is an outbreak pest and it assumes severe proportions on the coastal and backwater tracts, also occasionally observed in the interior areas near river and paddy fields. On the west coast of India, the pest occurs throughout the year with high population from February to May. Among different natural enemies attacking the black headed caterpillar, *G. nephantidis* is the dominant parasitoid and is responsible for the reduction of *O. arenosella*, which is being widely used in the biological control programme against the coconut leaf-eating caterpillar. However, there are no suitable methods available for the field release of parasitoids against *O. arenosella*. Keeping the above in view, a novel device was developed for the field release of the parasitoids against *O. arenosella*.

Benefits /Utility

It was practically impossible to release the parasitoids in large areas, such as coconut plantations, which sometimes cover up to thousands of hectares. Manual release will take 6.0 to 9.5 hours/hectare (2-3 min/palm) also warrants huge manpower. The novel and simple device will reduce the time and cost towards the manpower. Therefore, release of parasitoids in thousands of hectares can be covered in a short time and the precision of the release of parasitoids could be easily matched with the target pest stage (3rd to 7th instar larvae).

This technique can avoid stinging from the parasitoids as the mature cocoons (soon to emerge) are kept inside the device. The newly emerged adults will come out of the device through the insect emergence holes and climb up the trunk to the crown of the coconut palm. So, this device avoids the need for the farmer to handle the adult parasitoids which sting badly during release.

The device is semi-permanent and easy to fix on the trunk of the tree. During off season, the device can be removed and stored.

Scalability

For coverage of 100 ha of plantations, Rs.2.5-3.0 lakh is required. The investment on rearing facility is a one time investment can be utilized for more than a decade and the device manufacturing cost may range from Rs.10-15/piece also it can be reused. The parasitoid can be easily mass produced on *C. cephalonica* larvae which yields 8-12 parasitoids/larva and the cocoons (2 days old) could be stored for 10 days at 15 °C. Fecundity of the parasitoid is 60-70/female. All the materials are locally available and cost effective (Rs. 15/piece) and costs Rs. 2655/ha. The basic infrastructure facility with incubator and other operational expenditures is applicable.

Business and commercial potential

The technology leads to generation of employment and easy to manufacture even by women farmers/ NGOs/ unemployed youths/self help groups.

Financials

The economic design of a device enables a single device can be produced using locally available materials and a single device can be produced at the cost Rs.15 approximately.

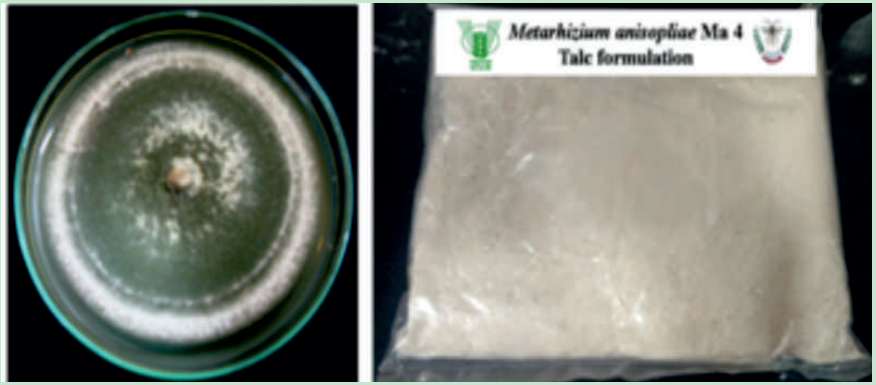
Target Market/Customer

Coconut farms and large plantations

Social Impact of the Technology

The technology could be very useful for farmers especially women and could reduce the pesticide usage on the coconut gardens and conserve the parasitoids. The technology would be helpful to generate employment for the farmers, unemployed youths and women farmers.

26 *Metarhizium anisopliae* ICAR-NBAIR Ma 4 for management of white grubs in sugarcane



1. Technology Description:

Metarhizium anisopliae ICAR-NBAIR Ma 4 strain has been identified as a promising microbial biocontrol agents for management of white grubs in sugarcane based on multilocational field testing at AICRP biocontrol centres. Talc based formulation of *Metarhizium anisopliae* NBAIR Ma4 was developed and soil application method and dose was standardized for effective management of the white grubs in sugarcane. Results of field trails indicated 70-90% reduction in the plant damage caused by the white grubs and increased yield by 40-50%. The complete data of the technology for CIBRC Registration is ready including toxicological data.

2. Background : (5-6 lines)

Holotrichia spp. are polyphagous pests causing severe damage to several crops, particularly in sugarcane crop in India. *Metarhizium anisopliae* has been extensively used for management of root grubs in various crops in several countries. ICAR-NBAIR-Ma4 strain was found highly effective against white grubs in sugarcane and its efficacy was on par with chemical insecticide in the field trials.

3. Benefits /Utility

Microbial biocontrol technology using *Metarhizium anisopliae* NBAIR-Ma4 for managements of white grubs is ecologically safe and do not have any deleterious effects on non-target organisms, other living organisms in the environment, unlike the chemical inseticides which are highly hazardous and pollutes soil, water and environment. Apart from this, the technology is as effective as chemical insecticide application and cheaper than chemical insecticides.

4. Scalability

It can be scaled up to large quantities using large-scale fermentors of 500-1000 litres capacity depending on the need.

5. Business and commercial potential

This technology has a wide scope of commercialization and there is a high demand for biocontrol agents for management of root grubs. At present, very small quantities of microbial BCAs are produced in the country against very high demand. There is scope for label expansion of this technology for management of root grubs in other crops.

6. Financial requirement

The cost of production of this product may around 100/- per kg and it can be sold at 200-250/kg. An investment of 15-20 lakhs for equipments, other infrastructure etc. is required to produce 100 tonnes/ annum.

7. Target Market/Customer

Sugar cane is extensively grown in India and root grubs is a serious pest of this crop and some time total loss of the crop is reported due to white grubs in several areas. This technology will be highly useful to sugarcane growers in the country especially for sugarcane growers in Andhra Pradesh, Karnataka, Maharastra, Uttar Pradesh etc.

8. Social Impact of the Technology

The present technology is an ecofriendly strategy of obtaining healthy and robust crop which can reduce the usage of chemical insecticides for root grub infested crops and thereby minimize the risks associated with insecticides on environment and non-target organisms including human beings.

9. Toxicology data

Toxicology data for primary culture and wettable powder formulation of Metarhizium anisopliae ICAR-NBAIR Ma 4 has been generated as per CIBRC guidelines.

27 Long-term storage of *Trichogramma chilonis* (Ishii) (Hymenoptera: Trichogrammatidae)

Technology description:

Trichogramma chilonis is widely used as a biocontrol agent against lepidopteran pests in India and other countries due to its broad host acceptability and high survival capacity. The fact that Tricho-cards are not amenable to long term storage is a major obstacle in commercialization of the Trichogramma technology. Developing a long-term storage technology for Trichogramma chilonis through can lead to more commercial units taking up the production of Tricho-cards. For long term storage of Tricho-cards, simple infrastructure is required viz. cooling incubators (with temperature, light and humidity adjustments). The technology provides a means to stockpile the parasitoids for timely large-scale field releases against target pests.

Background

Previous reports on successful diapause induction in *Trichogramma embryophagum* Hartig and *Trichogramma cordubensis* Vargas and Cabello were from the temperate regions of the globe. No reports are available on either natural occurrence or induction of diapause in *Trichogramma chilonis*. This technology clearly indicates that Indian species of Trichogramma do contain the genetic makeup to undergo diapause at their pre-pupal stage. The present technology focuses on the right combination of factors that could successfully initiate, maintain, and terminate diapause in strains of *T. chilonis* and maintenance of the biological attributes of the emerging adults to ensure their efficacy as a biocontrol agent.

Benefits

- Simple technology for long term storage of *Trichogramma chilonis* strains, *T. embryophagum* and *T. Cordubensis.*
- Minimum infrastructure required
- Can facilitate commercial insectaries to plan production and storage of Tricho-cards for large-scale field releases.

Benefits

- Simple technology for long term storage of *Trichogramma chilonis* strains, *T. embryophagum* and *T. cordubensis*.
- Minimum infrastructure required
- Can facilitate commercial insectaries to plan production and storage of Tricho-cards for large-scale field releases.

Business and commercial potential

Trichogrammatids are widely used as biocontrol agents for managing lepidopteran pests, especially in paddy and sugarcane ecosystems. Long term storage of Tricho-cards is a great challenge.

Through this technology, Tricho-cards (*T. chilonis*) could be stored for 95 days and around 60 – 70% adult emergence can be obtained from the stored cards. This technology would enable commercial insectaries to stockpile the cards for timely large scale field releases.

Target market/customer

Commercial insectaries, State Bio-control labs.

Social impact of the technology

Long term storage of tricho-cards can help in stock-piling the cards and using them for timely field releases covering large areas. The use of Tricho-cards to tackle the egg stage of lepidopteran pests can reduce chemical insecticide load on crops, thus it is an ecofriendly technology.

Note

ICAR-NBAIR – INDUSTRY INTERFACE MEET

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26th June 2019

A venture to promote Biocontrol technologies, pheromones & Agribusiness

ICAR-National Bureau of Agricultural Insect Resources

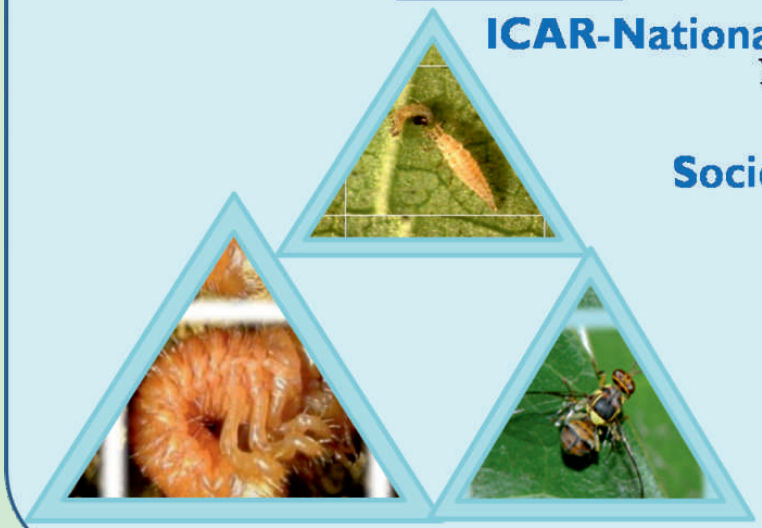
Yelahanka Campus, Bengaluru -560 064

In Association with

Society for Biocontrol Advancement

Bengaluru -560 024

SOCIETY FOR BIOCONTROL ADVANCEMENT
SBA



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