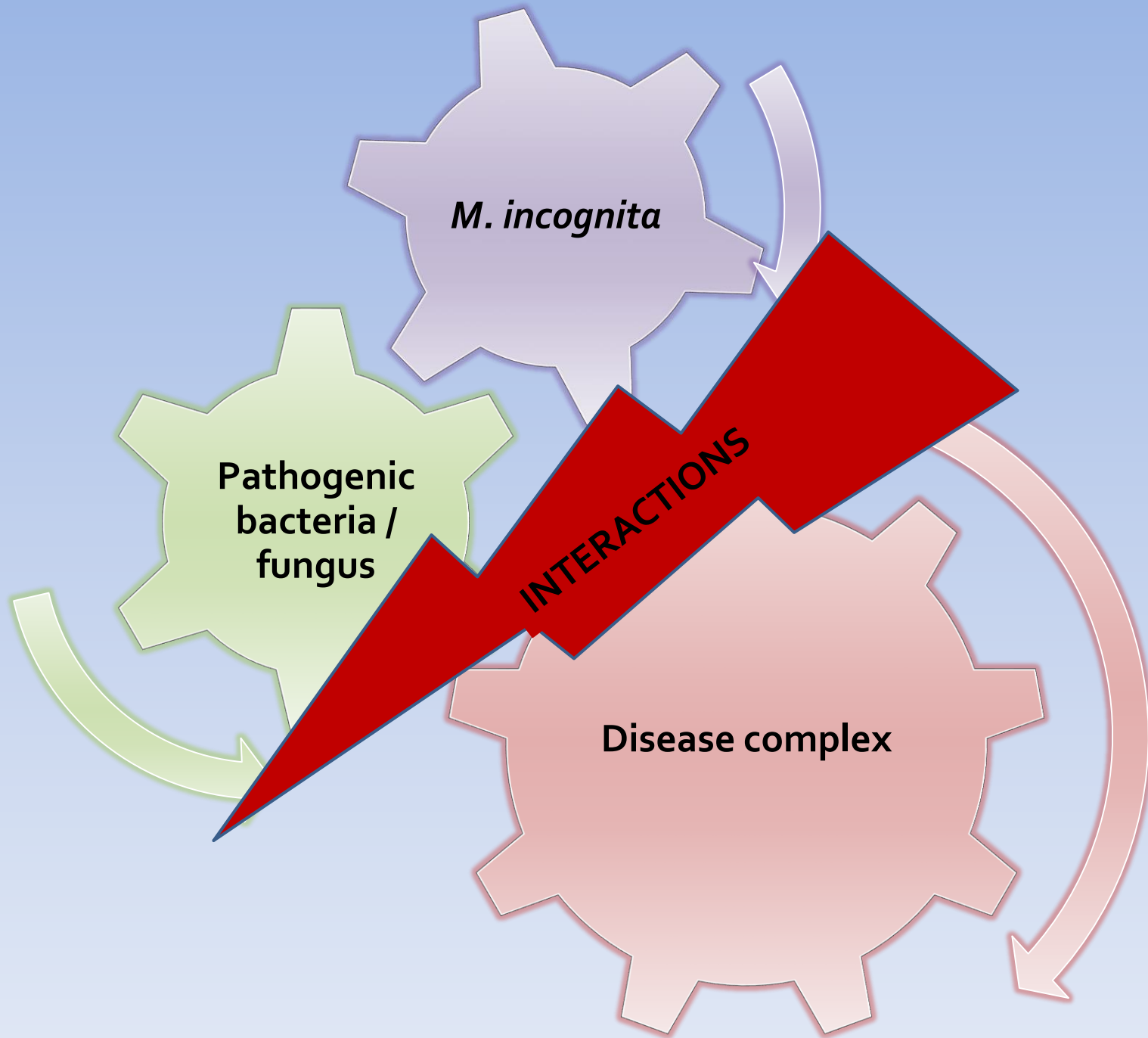




Bio-pesticides for sustainable agriculture

Dr. M. S. Rao
Principal Scientist
Head, Division of Entomology and
Nematology
IIHR, Bangalore







DISEASE COMPLEX

Nematodes predisposes *fungus pathogens* to cause *disease complex*.

Meloidogyne* + *Fusarium* spp. \longrightarrow *Disease complex in guava





Nematode wilt complex in guava nurseries





Nematode problems in pomegranate. It is very serious. The problem is seen in most of the pomegranate growing areas in India.





**Root-knot Nematodes
on Muskmelon**

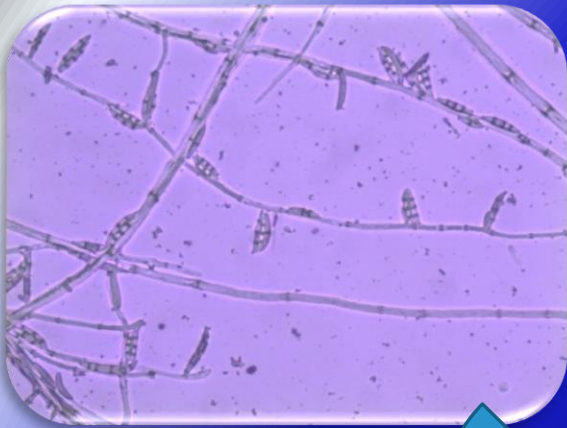


**Root-knot Nematodes
on Gerkins**



Increase in disease complex
caused by
nematodes + fungi/bacteria

DISEASE COMPLEX IN OKRA



Fusarium oxysporum
f.sp. *vasinfectum*



M. incognita



Wilted Okra Plant

Pathogens

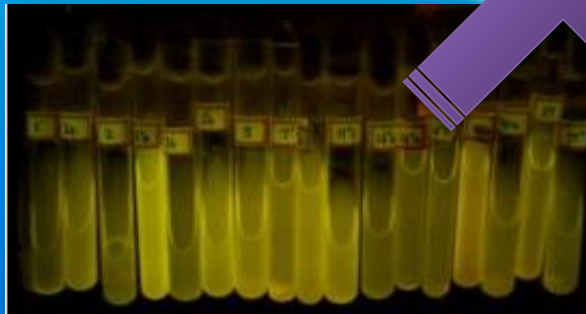


Fusarium oxysporum f.sp.*lycopercisi*.

Bioagents



Meloidogyne incognita



Fluorescent pseudomonads

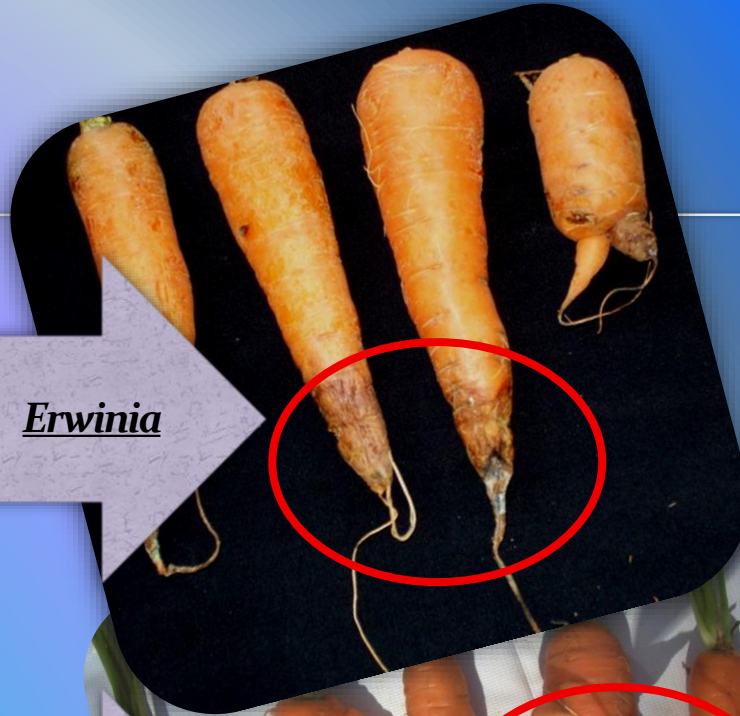


Paecilomyces lilacinus

DISEASE COMPLEX IN CARROT



Erwinia



M. incognita



DISEASE COMPLEX IN GERBERA

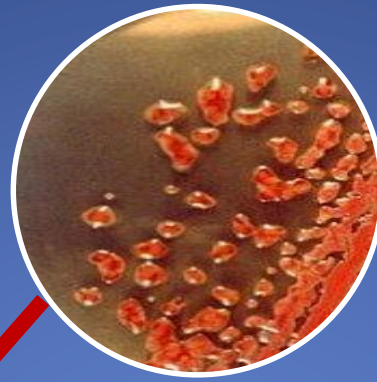


Phytophthora cryptogea



Meloidogyne incognita





• *Ralstonia*

Disease complex in Capsicum

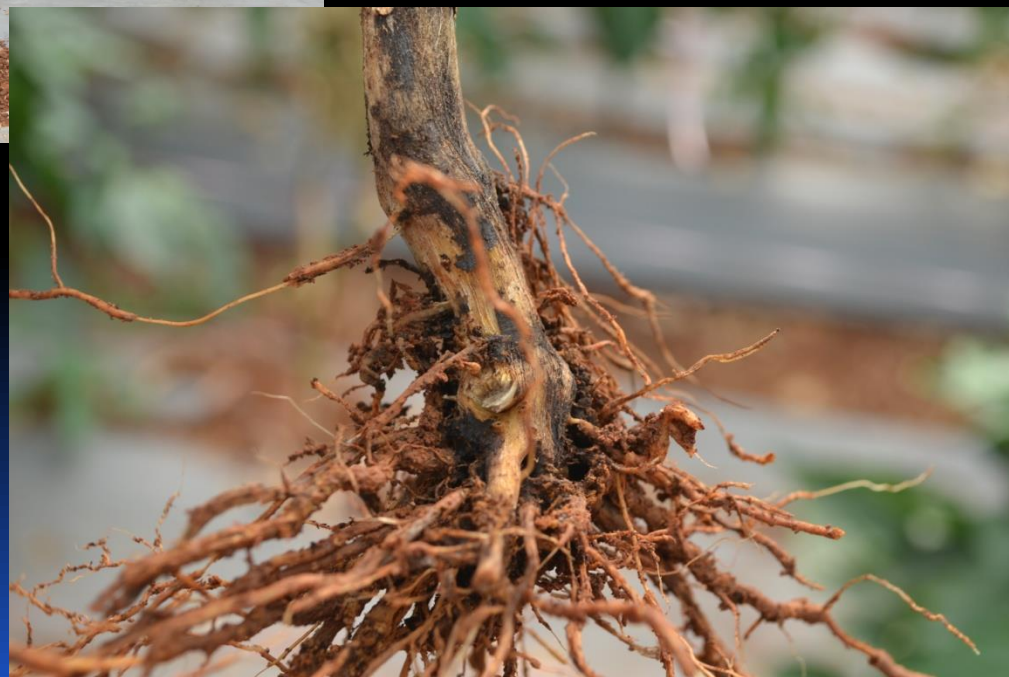


• *M. incognita*

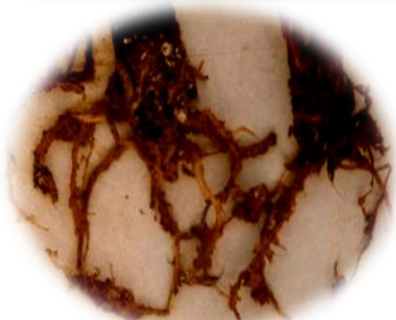
Problems in crops grown in protected conditions



Disease incidence in Capsicum in polyhouses



Disease incidence in CARNATIONS



Affected roots

Problems in crops grown in protected conditions



Gerbera roots infected with *M. incognita*

Nematode (*M. incgonita*) infestation in Musk melon



Disease incidence in Banana root system



Advantages of using bio-pesticides



GROWTH PROMOTION



ECO-FRIENDLY

Bio-pesticides



DISEASE SUPPRESSION



CROP YIELD

Application methods



SEED TREATMENT



SUBSTRATE TREATMENT

Bio-pesticides



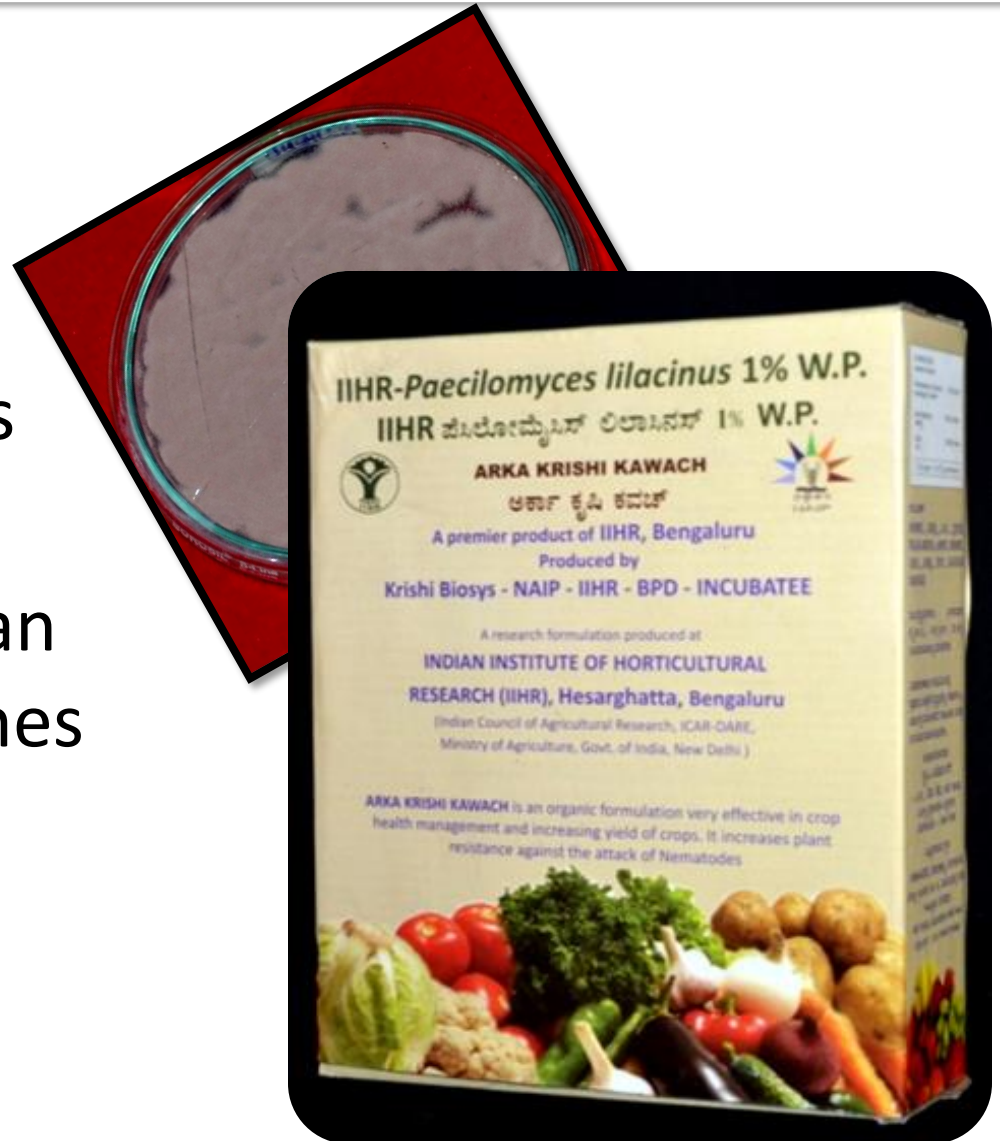
FOLIAR SPRAY



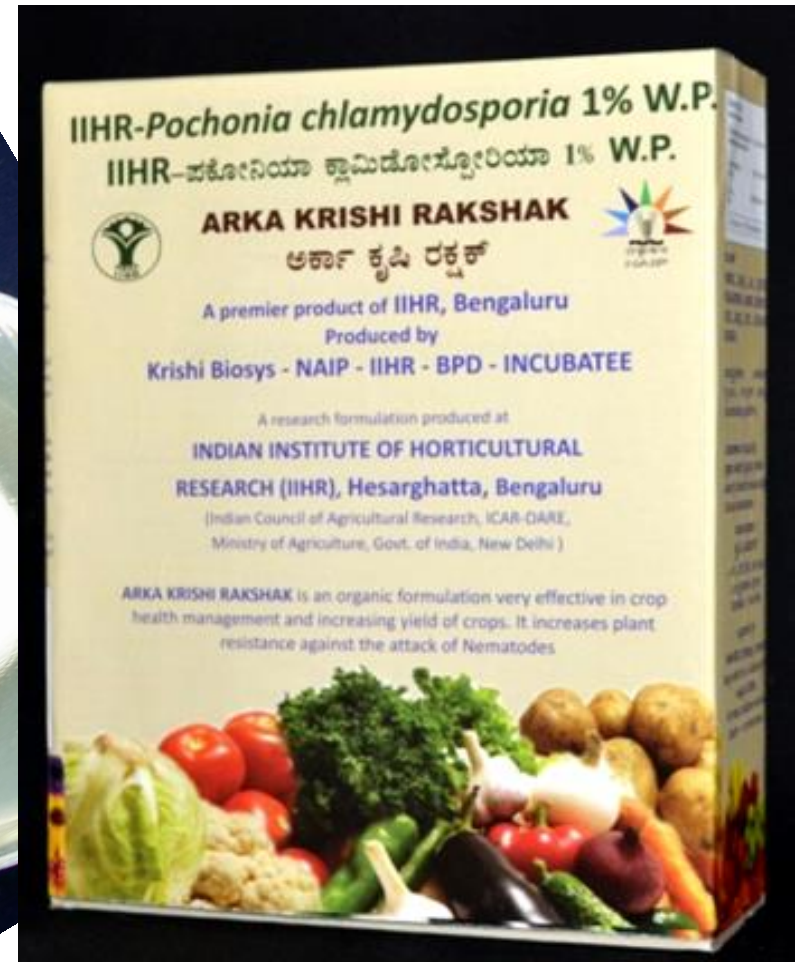
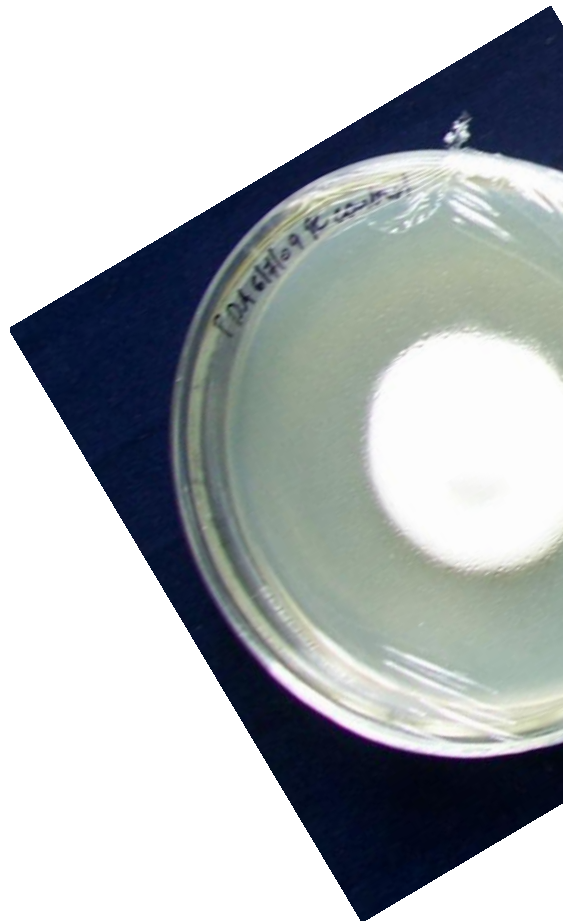
DRENCHING

1. *Paecilomyces lilacinus* (IIHR PL-2, ITCC NO. 6887)

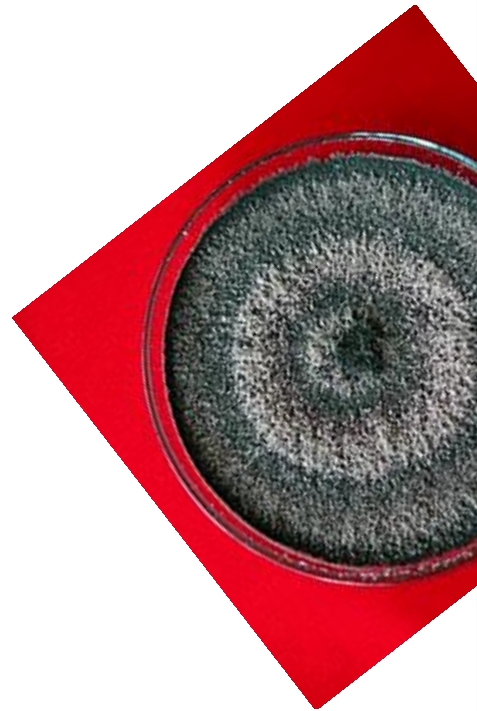
- Bio-Nematicide
- nematophagous fungus
- parasitising the eggs of nematodes
- produce proteases and a chitinase, enzymes that could weaken nematode egg shell






2. *VERTICILLIUM CHLAMYDOSPORIUM* (*POCHONIA CHLAMYDOSPORIA*, IIHR VC-3, ITCC NO. 6898)



3. *TRICHODERMA HARZIANUM* (IIHR TH-2, ITCC NO. 6888) - 1% W. P.



ARKA TRICHORICH
ORGANIC FORMULATION OF
TRICHODERMA HARZIANUM



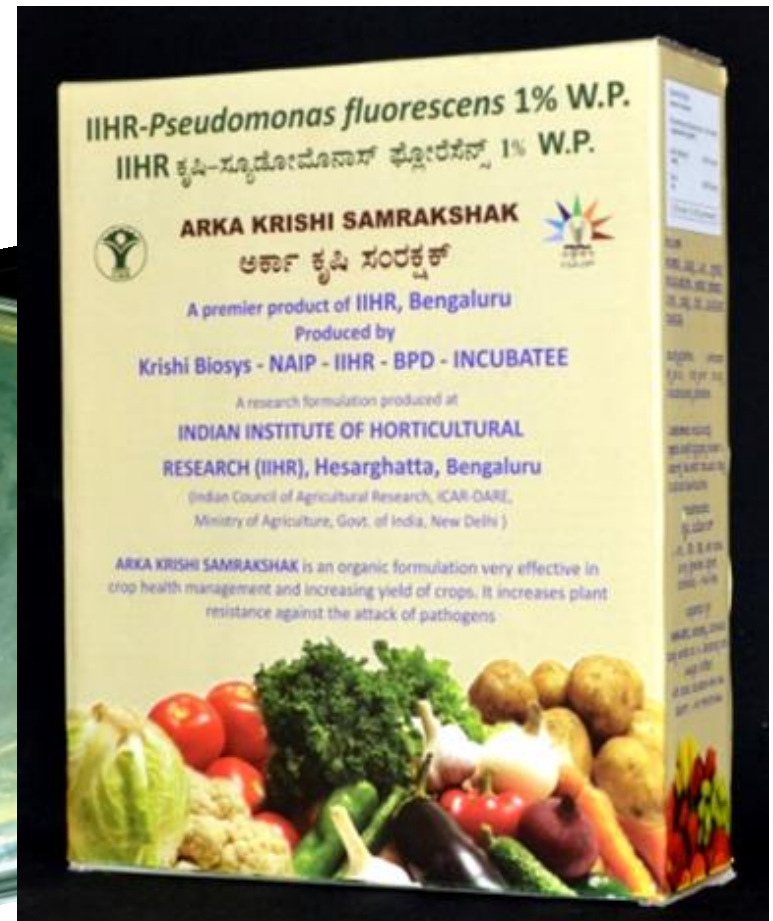
INNOVATION FROM NEMATOLOGY
LABORATORY, IIHR, BENGALURU

A research formulation produced at

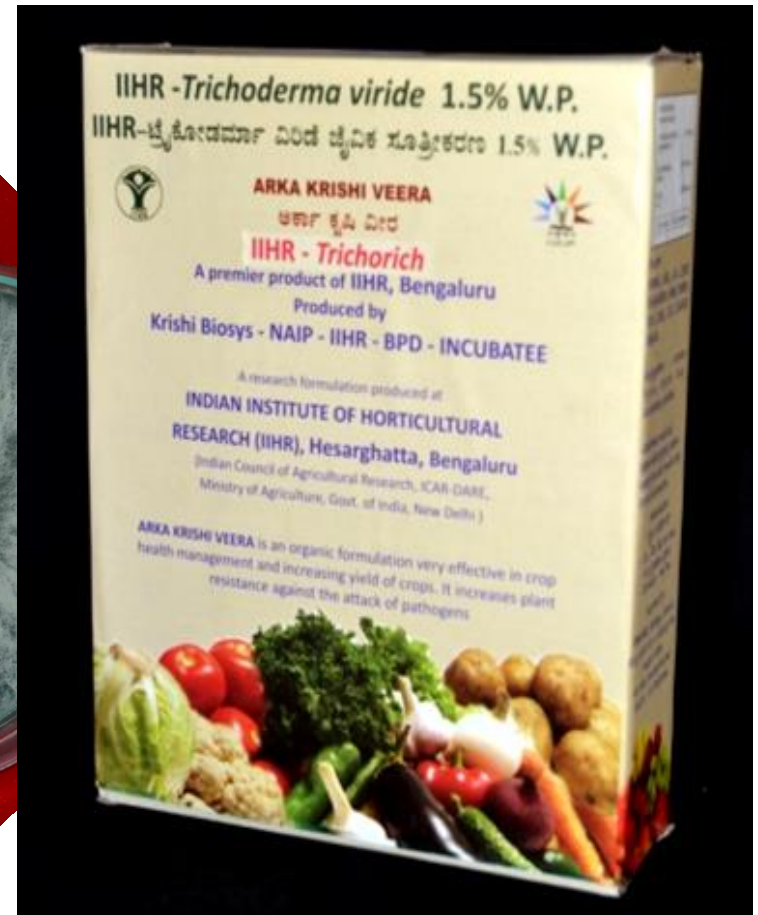
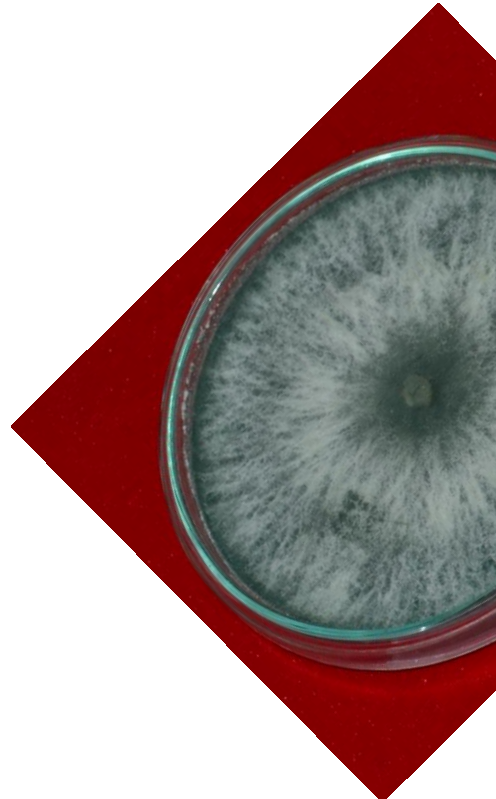
**Indian Institute of Horticultural Research (IIHR),
Hessaraghatta, Bengaluru**

(Indian Council of Agricultural Research, ICAR-DARE,
Ministry of Agriculture, Govt. of India, New Delhi)

4. *PSEUDOMONAS FLUORESCENS* (IIHR PF-2, ITCC NO. B0034) - 1% W. P.

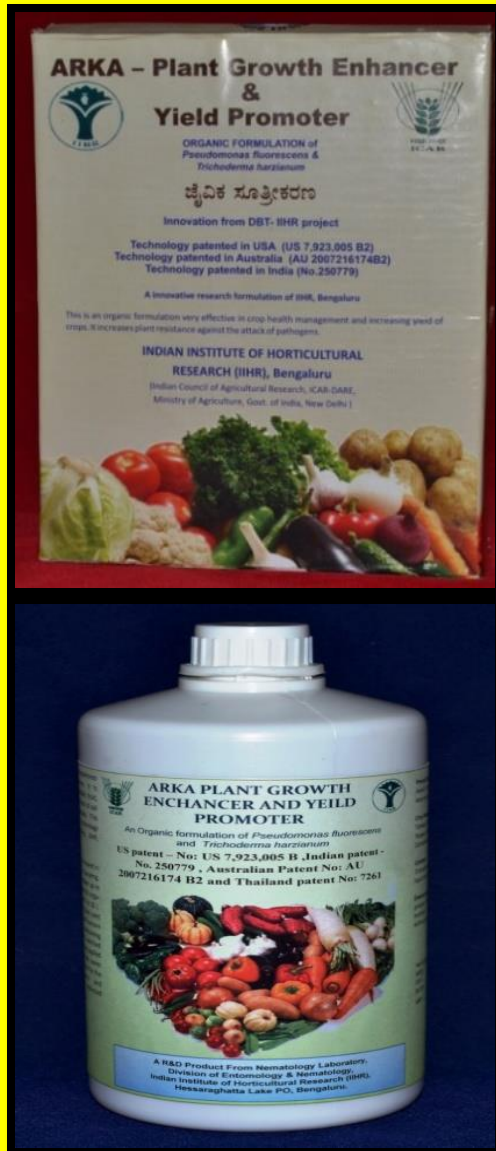


5. *TRICHODERMA VIRIDE* (IIHR TV-5, ITCC NO. 6889)



ARKA – PLANT GROWTH ENHANCER & YEILD PROMOTER

Technology Description



- **US patent – No: US 7,923,005 B,**
- **Indian patent - No. 250779,**
- **Australian Patent No: AU 2007216174 B2**
- **Thailand patent No: 7261**
- **Its Dual Action formula helps in reducing the disease incidence caused by disease complexes caused by nematode, fungal and bacterial pathogens and increases the plant growth and yield.**
- **As the formulation is organic in nature these bio-agents establish very well in the soil eco-systems**

Seedlings produced using bio-pesticide Consortia





Comparison of plant (root and shoot) growth of cauliflower in control and treatment



Effect on root colonization of bio-agents in capsicum

Treatment	CFU of <i>T. viride</i> (× 10 ⁵ /1 g root)	CFU of <i>P. fluorescens</i> (× 10 ⁶ /1 g root)
T1-TH+SB+SD	1.73	0
T2-PF+SB+SD	0	1.82
T3-TH+PF+SB+SD	1.65	1.72
T4-Control	0	0
CD-5%	0.58	0.63

Evaluation of Bio-efficacy of organic formulation in the management of *M. incognita* infecting Capsicum

T1: Treatment of coco peat or substrate with 10g of consortia of bio-agents for producing seedlings of Capsicum in protrays.

T2: T1 + Application of 1 ton of vermicompost enriched with 2.5 kg of consortia of bio-agents / ha

T3: T1 + Application of 1 ton of vermicompost enriched with 3.5 kg of consortia of bio-agents / ha

T4: T1 + Application of 2 tons of vermicompost enriched with 3.5 kg of consortia of bio-agents / ha

T5: T1 + Application of 2 tons of vermicompost enriched with 5 kg of consortia of bio-agents / ha

T6: Carbofuran

T7: Application of 2 tons of vermicompost/ha

T8: Control

Plot size: 4 x 2.5m

No. of replicates: 5

Design: RBD

Experiments were conducted in 2 seasons during 2010-2012.

Observations recorded:

Root-knot galling index

Yield per plot in Kgs.

% increase in the yield.

TREATMENTS	Root galling index on 1-10 Scale	Yield Per plot of 4 x 2.5m (kg)	% increase in yield
T1	7.5	16.6	5.3
T2	7.4	17.0	7.3
T3	5.2	17.9	13.6
T4	4.5	18.2	15.5
T5	3.8	18.5	17.2
T6	5.5	17.7	12.1
T7	8.0	16.4	4.3
T8	9.2	15.8	--
C.D – 5%	0.35	2.25	--

Results:

- Data indicate clearly that vermicompost enriched with consortia of bio-agents significantly reduced root galling caused by *M. incognita* on capsicum.
- These treatments also increased the yield significantly

HEALTHY CROPS WITH INCREASED YIELD



Recovery of wilted Guava using Bio-pesticide



Effect of
bio-pesticides



Useful in production of healthy root-stocks and seedlings



Crops where the product was used



SUCCESS STORY OF NURSERY FARMER MR SURENDAR



Success story of managing nematode wilt disease complex in pomegranate using biopesticides



SUCCESS STORIES



TOMATO



CAPSICUM



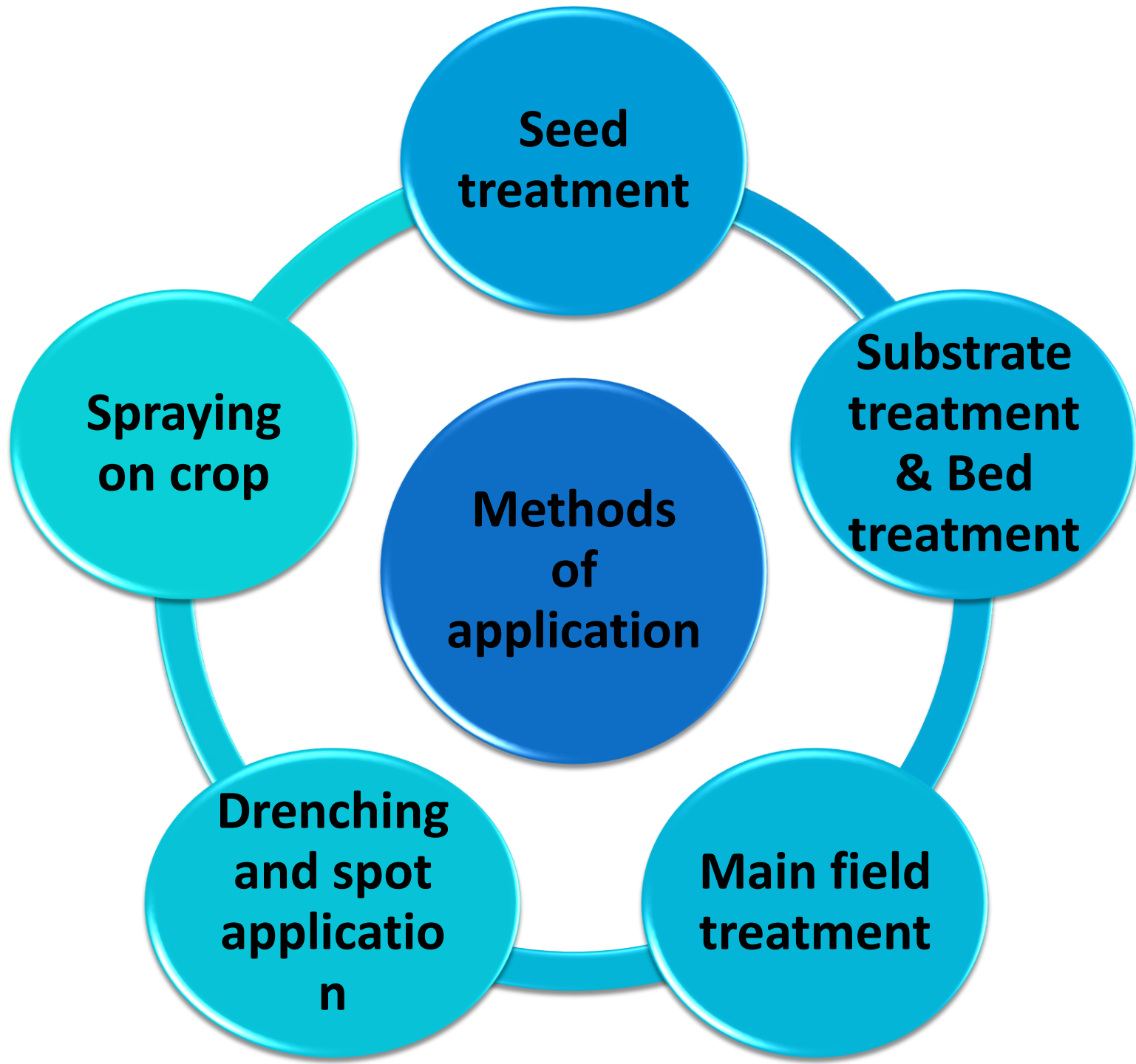
OKRA



CABBAGE



CAULIFLOWER



**Seed
treatment**

**Substrate
treatment
& Bed
treatment**

**Main field
treatment**

**Drenching
and spot
applicatio
n**

**Spraying
on crop**

**Methods
of
application**



**SEEDLING
PRODUCTION**



SUBSTRATE TREATMENT



SEED TREATMENT





1. Enrichment of Coco peat with bio-pesticides



2. Filling of trays with enriched coco peat



3. Seed Treatment



4. Trays with treated seeds

Seed Treatment



talc based formulations
@20g/kg of seed.



Substrate (coco peat) Treatment and Enrichment

@ 2 kg/ton.



1000kg (1 ton) Coco peat

2 kg of
Bio-pesticides

Fill to
seedling
trays/pots

Bio-agent colonized seedlings



DELIVERY SYSTEMS TO MAIN FIELD BEFORE PLANTING

Neem cake & Bio - pesticide

2 kg bio-pesticide



Enrich for 15 days by mixing bio- inocula under shade

200kg Neem cake

Apply
@200Kg/acre
land

FYM-compost & Bio - pesticide

2 kg bio-pesticide



**in 2000kg (2 tons) of
FYM**

**Enrich for 15
days by mixing
bio- inocula
under shade**

**Apply @
2000 kg (2
tons) /acre of
land**

Vermi-compost & Bio - pesticide

2 kg bio-pesticide



Enrich for 15 days by mixing bio- inocula under shade

500kg (0.5 ton) vermi-compost

**Apply @
500Kg/acre**

Delivery systems to main field
after planting

Banana, papaya, pomegranate, acid lime, any citrus tree, grapes	Formulation enriched FYM 5kg / plant	Apply at planting
	Formulation enriched FYM 2kg / plant	Apply once in 6 months
Crops under protected conditions- carnations, gerbera, capsicum, tomato, musk melon and water melon	Formulation enriched neem cake/vermicompost 20g / m ²	<u>Treatment of beds</u> at interval of 30 days
	5g formulation / L	<u>Drench</u> the beds @ 3lit/m ² at interval of 30 days
All above crops	3g formulation / L of water	<u>Spray</u> once in a month



Enrichment of
vermicompost & Neem
cake using bio-pesticides

Preparation of nursery bed
for raising nursery
seedlings using
biopesticides



LIQUID FORMULATION OF *PSEUDOMONAS FLUORESCENS* – 1% A.S.

Technology Description



Developed in DBT
project

- ✓ This formulation is extremely useful in the management of bacterial diseases in crops and helps in inducing systemic resistance in plants.
- ✓ Has higher shelf life and higher CFU of the bio-agent
- ✓ Liquid formulation helps in faster establishment and multiplication of bio-agents in the soil eco-systems.
- ✓ The efficacy is tested and proven effective in open field and protected cultivations
- ✓ As it is a PGPR this formulation can be sprayed at any stage of crop
- ✓ Bio-efficacy data generated at IIHR, Bengaluru.
- ✓ Toxicology data available with IIHR, Bengaluru.

LIQUID FORMULATION OF *BACILLUS SUBTILIS* 1% A.S.

Technology Description



Developed in DST project

- This formulation has higher shelf life and higher CFU of the bio-agent
- Has a highly useful bio-agent for the management of nematodes and nematode induced disease complex in crops grown under protected conditions
- As it is a PGPR this formulation can be sprayed at any stage of crop
- Induces systemic resistance in the plants against the disease causing nematode, fungal and bacterial pathogens
- Bio-efficacy data generated at IIHR, Bengaluru
- Toxicology data available with IIHR, Bengaluru

SOIL CHANGE IN NEMATODE INFESTED POLYHOUSE



Bed preparation



TREATMENTAL DIFFERENCES OBSERVED





Success of Organic formulation



Evaluation of bioefficacy of *P. fluorescens* & *T. harzianum*



Disease MANAGEMENT IN CARNATIONS



Control



Product treated bed



GROWTH PROMOTION



INCREASED YIELD



NEMATODE SUPPRESSION

Success story in capsicum



Generation of awareness among the coffee seedling growers and coffee growers in Coorg region



Trichoderma for sustainable increase in the yield



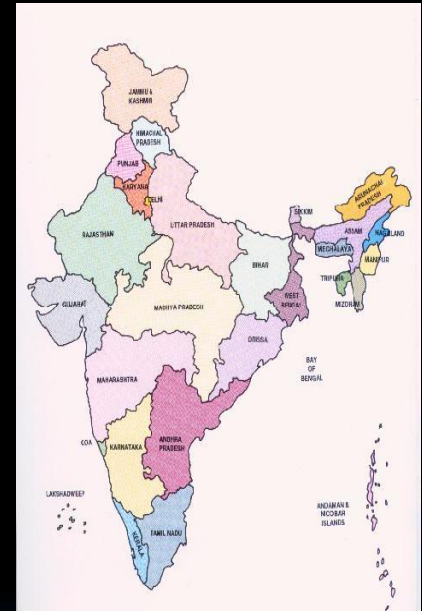
Trichoderma for sustainable increase in the yield



Validation of Strains bio-efficacy

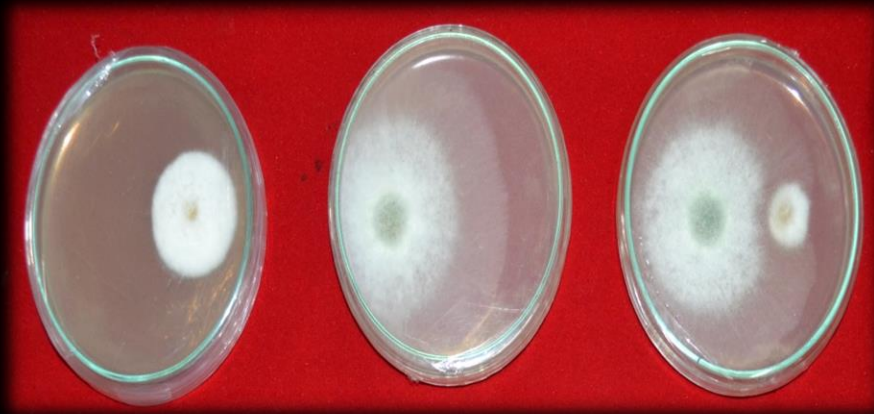
The strains bio-efficacy had been evaluated by 23 scientists in different agro-climatic regions in India for a decade under ICAR – AICRP scheme.

Most of them found the strains as very effective.



In vitro bio-efficacy against *M. incognita* and *F. oxysporum*

FO inhibited by *Trichoderma* strain



CONTROL

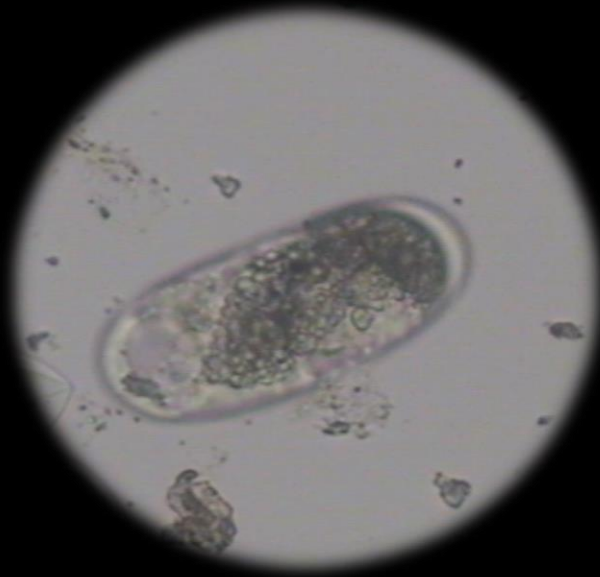
TREATED

Strain *Trichoderma* showed highest (82.45%) growth inhibition

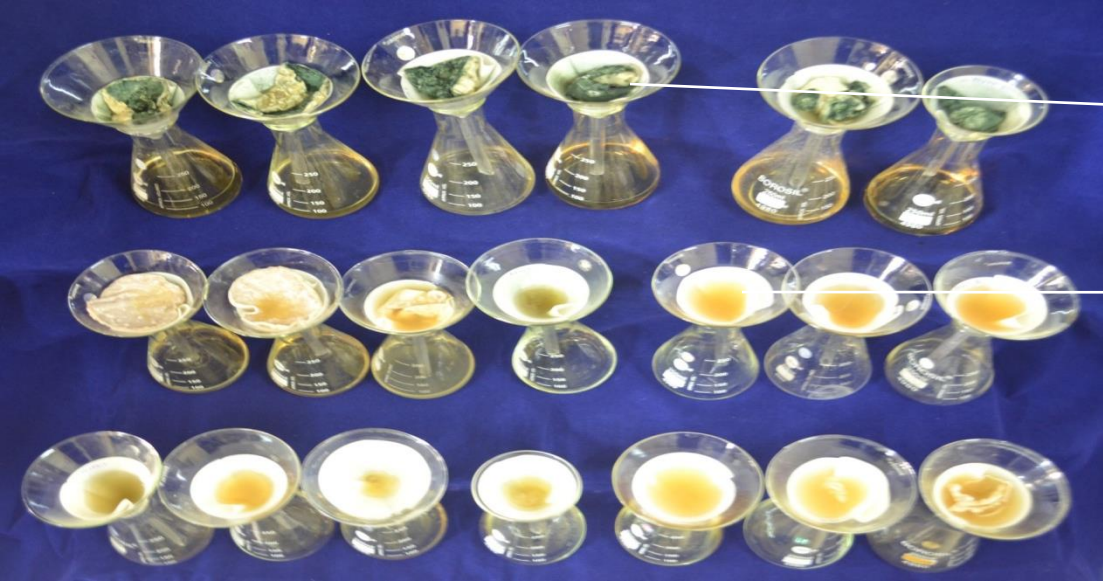
MI Hatching inhibited by *Trichoderma viride*



EFFECT OF *TRICHODERMA HARZIANUM* ON EGGS & JUVENILES



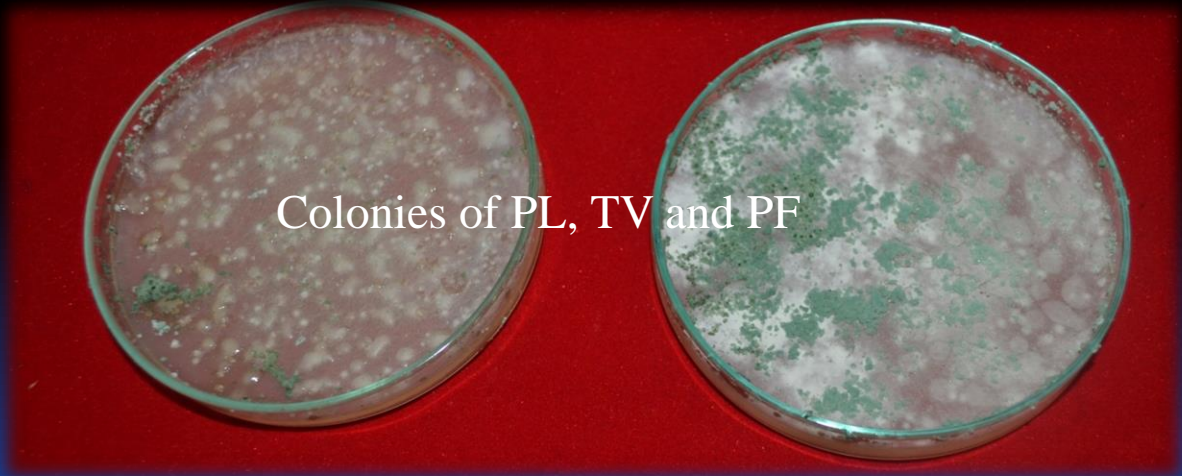
Broth experiment of *T. viride*, *P. fluorescens* & *P. lilacinus*



TV+PF+PL

PF+PL

P. lilacinus *T. viride*
P. fluorescens



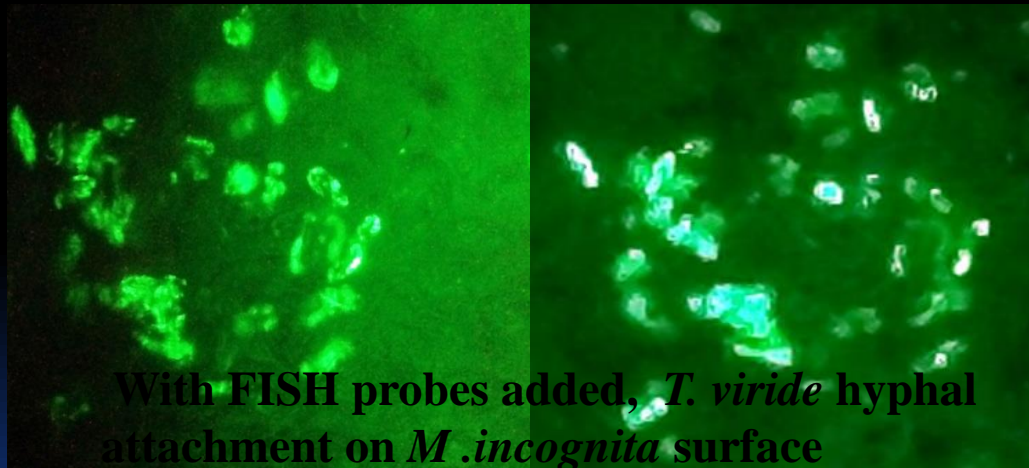
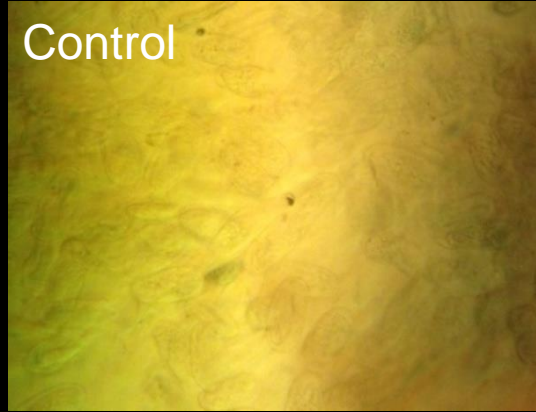
Colonies of PL, TV and PF

Chi18-5 gene is vital for *Trichoderma viride* to parasitize *Meloidogyne incognita* eggs

- ✓ Effect of *Trichoderma viride* on root-knot nematode *Meloidogyne incognita* was tested *in-vitro* based on the expression of chitinase gene, *chi18-5*, upon parasitizing nematode eggs
- ✓ House keeping gene α -tubulin was used as a reference to detect the expression level of *chi18-5* gene.
- ✓ RT- PCR was performed to estimate the gene expression of *chi18-5* which revealed that it was up-regulated after 2 hpi (Hours Post Inoculation) of parasitizing eggs. Maximum expression was observed at 5 hpi and thereupon decreased gradually up to 19 hpi.
- ✓ Nematode egg masses were placed near the edges of *T. viride* cultures and microscopic observations were made to identify the *T. viride* hyphal attachment to the *M.incognita* egg masses using fluorescence *In Situ* hybridization (FISH) technique.

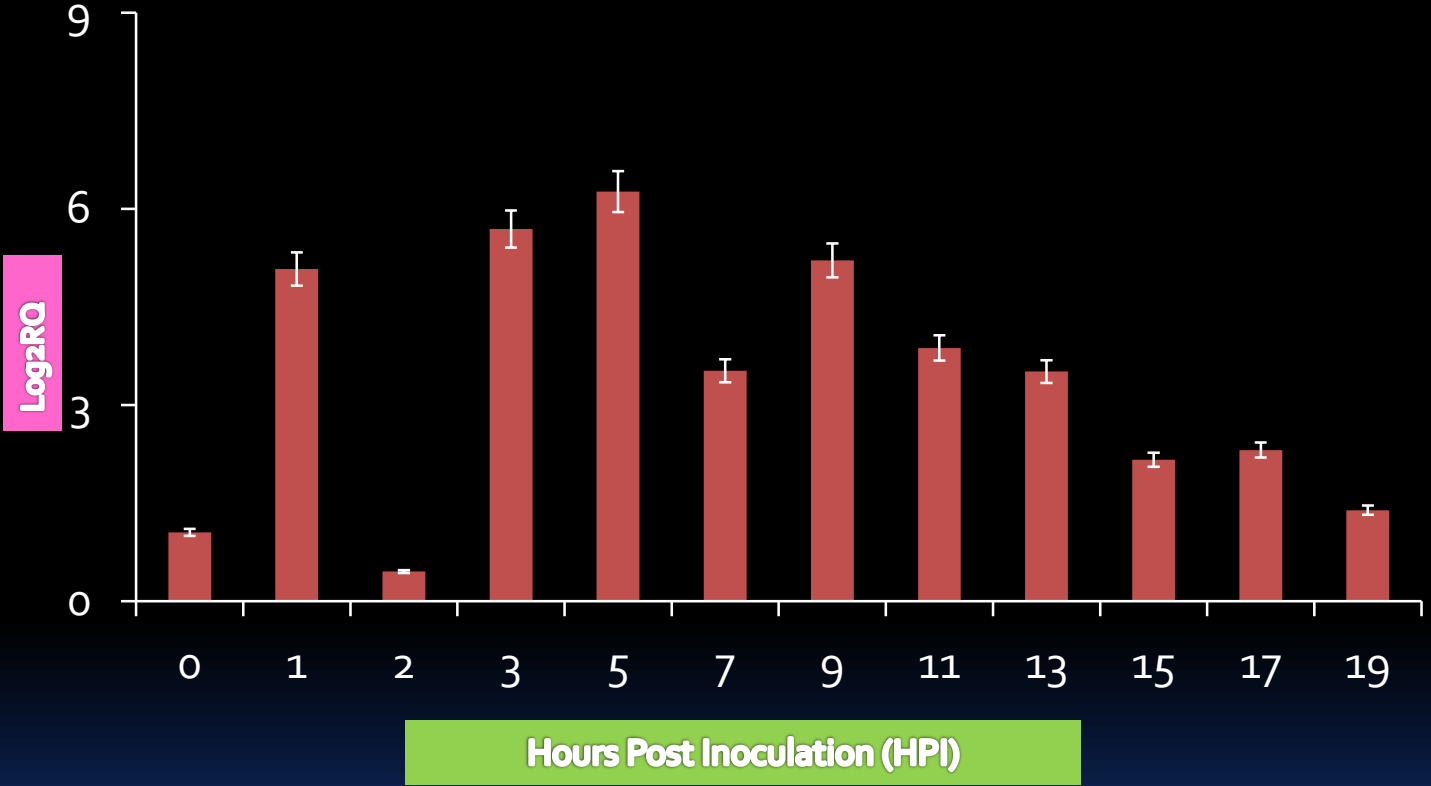
- ✓ FISH technique was used to detect the entry of *T. viride* hypha directly in to *M. incognita* eggs

Control



T. viride hyphal attachment on *M. incognita* eggs using FISH probes (1.Control - without FISH probes. (2) & (3) With FISH probes added, *T. viride* hyphal attachment on *M. incognita* surface).

Fig. Chitinase (*chi18-5*) gene expression of *T. viride* during egg-parasitism on *M. incognita*



- ✓ *Trichoderma viride* chitinase (*chi18-5*) gene expression pattern was studied at different time intervals (0, 1, 2, 3, 5, 7, 9, 11, 13, 15, 17 and 19 hpi)
- ✓ The Chitinase gene (*Chi18-5*) expression studies revealed that the *T. viride* possesses excellent bio-control characteristics against *M. incognita* by rupturing the egg shells and involved in direct nematode egg parasitism.
- ✓ Results indicated that chitinase gene (*chi18-5*) played an important role in *M. incognita* egg parasitism.
- ✓ This was clearly visualized through the FISH probes by which the *T. viride* parasitism was established in the eggs.

Management of root knot nematodes in okra

- Treat the seeds with *Trichoderma viride* – 1 % W.P. suspension at 20 g/kg seed.
- Soil application of 5 tons of FYM per ha enriched with *Trichoderma viride* (5 kg) *M. incognita* population in soil (by 70%) and roots (by 74%). It also decreases the Fusarium infection significantly.
- This increased the yield to the tune of 16 – 19 %.



Management of root knot nematodes in tuberose

- Dip the tuberose bulbs in *Trichoderma viride* – 1 % W.P. suspension at 10 g/lit of water for 10 min.
- Soil application of 5 tons of FYM per ha enriched with *Trichoderma viride* (5 kg) minimizes nematode population in soil (by 72%) and roots (by 76%). **It also decreases the Fusarium infection significantly.**
- This increases the flower yield to the tune of 18 – 20%.



Management of root knot nematodes in gerbera under protected condition

- Soil application of 25 tons of FYM per ha enriched with *Trichoderma harzianum* (25 kg) and before planting
- Treat the beds with 1 ton of neem cake enriched with *Trichoderma harzianum* before planting and once in 60 days after planting
- This can also be mixed with water and after filtering can be applied as drench or sent through the drip at 30 days intervals.
- This minimizes nematode population in soil (by 71 %) and roots (by 73%).
- This increases the flower yield to the tune of 24-27%.







Field day at Doddaballapur : Showcasing successful use of biopesticides in protected conditions



Neem cake enrichment by bio-pesticides



TECHNOLOGY DISSIMINATION ICAR-IIHR

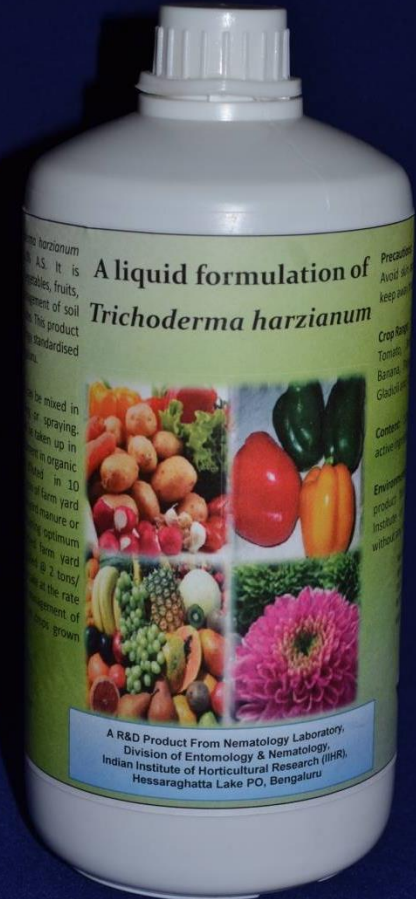
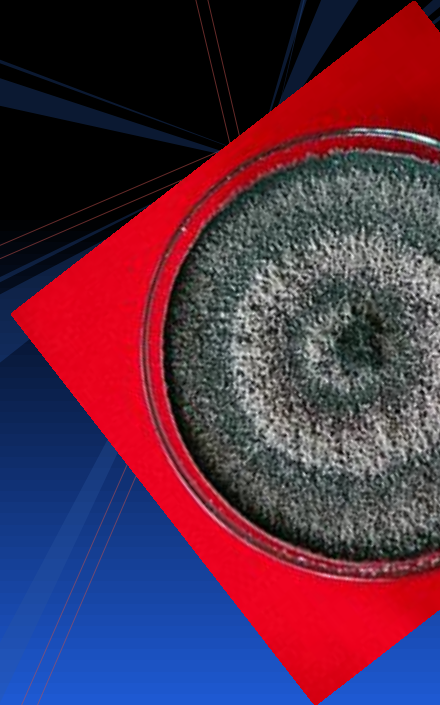


3. *TRICHODERMA HARZIANUM* (IIHR TH-2, ITCC NO. 6888)

Content: 1.0% *Trichoderma harzianum* as an active ingredient in liquid inert material.

Crop Range:

Tomato, Brinjal, Cabbage, Capsicum, Okra, Banana, Papaya, Acid lime, Tuberose, Gerbera, Gladioli & Carnations.

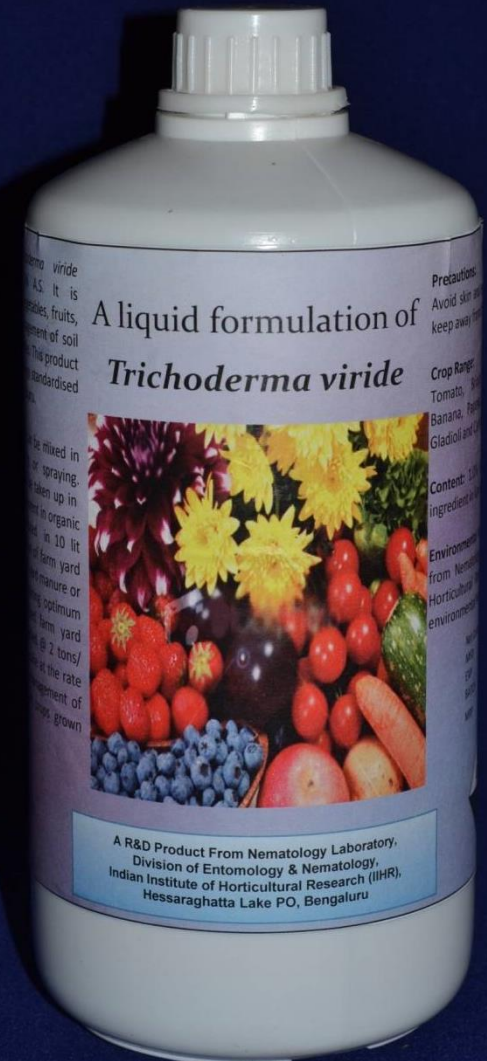
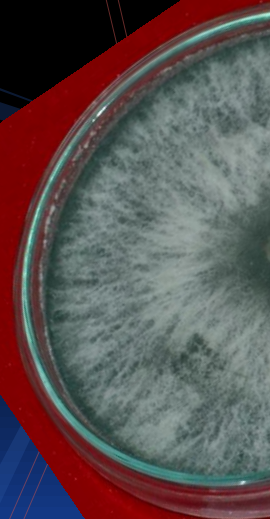


4. *TRICHODERMA VIRIDE* (IIHR TV-5, ITCC NO. 6889)

Content: 1.0% *Trichoderma harzianum* as an active ingredient in liquid inert material.

Crop Range:

Tomato, Brinjal, Cabbage, Capsicum, Okra, Banana, Papaya, Acid lime, Tuberose, Gerbera, Gladioli & Carnations.



Quality issues

Visits to industry

As per MOU we provide culture as and when required

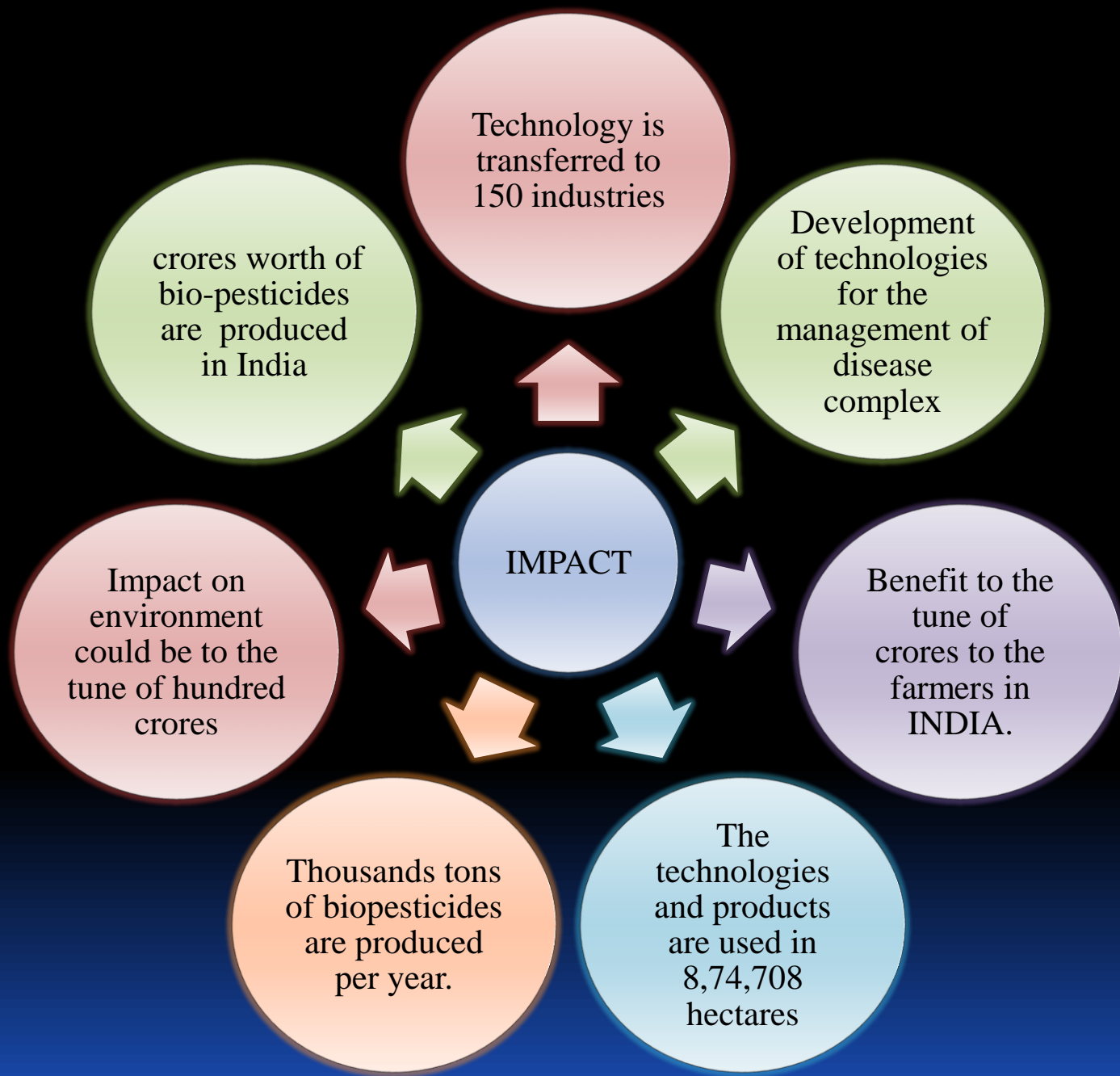
Consulted by CIB&RC, Ministry of Agriculture

Consulted by DBT, DST & state departments



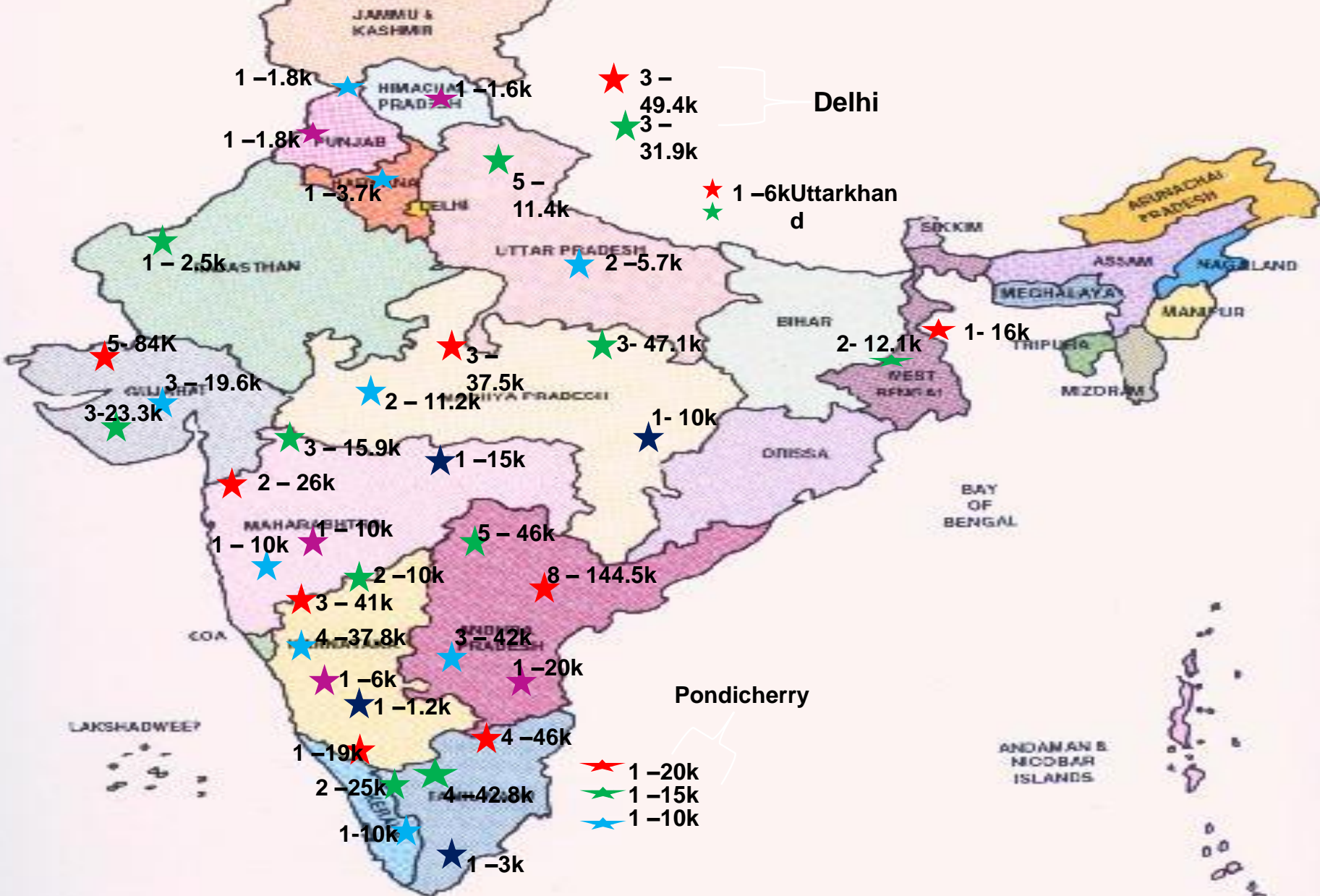
Market potential

- There is tremendous market potential
- It can be used in almost all the crops
- No government restrictions
- It is highly cost effective



State wise details –utilisation of IHR biopesticide technologies

(No of companies – area covered details)





**Sustainable
crop
production**





**Sustainable
crop
production**

Management of Nematode in cucumber

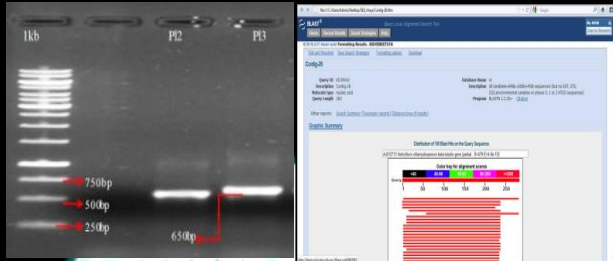


Treated



Nematode infected





It is not a job.
It is a Mission

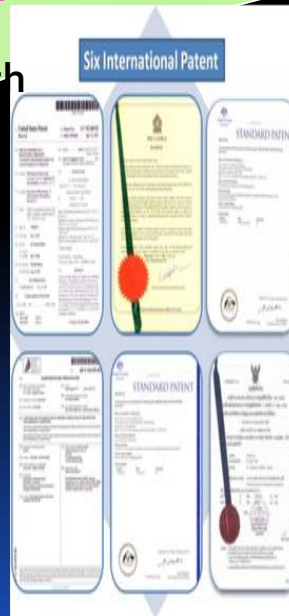
DISSEMINATION &
Commercialization

Persistence
patience &
perseverance

Basic &
Applied Research

PROBLEM IDENTIFICATION
&
CONCEPT DEVELOPMENT

1.



Thank you...



msraobio45@gmail.com