ICAR TECHNOLOGIES

BIOPESTICIDES

FOR ECO-FRIENDLY PEST MANAGEMENT

भाकृअनुप
ICAR

Indian Council of Agricultural Research
Krishi Bhavan, New Delhi 110 001

ICAR TECHNOLOGIES

BIOPESTICIDES

FOR ECO-FRIENDLY PEST MANAGEMENT

Indian Council of Agricultural Research
Krishi Bhavan, New Delhi 110 001

Printed:

July, 2021

Citation:

Saxena A.K., Chakdar H., Kumar M., Rajawat M.V.S., Dubey S.C. and Sharma T.R. 2021. ICAR Technologies: Biopesticides for Eco-friendly Pest Management. Indian Council of Agricultural Research, New Delhi

Conceived by:

Dr. Trilochan Mohapatra, Secretary, Department of Agricultural Research and Education and Director General, Indian Council of Agricultural Research, Krishi Bhavan, New Delhi 110 001

Compiled by:

Dr. Anil Kumar Saxena, Director, ICAR-National Bureau of Agriculturally Important Microorganisms, Kushmaur, Mau 275 103

Edited by:

A.K. Saxena, H. Chakdar, Kumar M., M.V.S. Rajawat, S.C. Dubey and T.R. Sharma

Contributors:

All the developers of the Biopesticides

Secretarial Assistance:

Mr. Siddharth Arora, Personal Assistant, ICAR-NBAIM

Published by:

Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, KAB-1, Pusa Campus, New Delhi 110 012.

Printed at: M/s. Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi 110 028

त्रिलोचन महापात्र, पीएच.डी.
सचिव एवं महानिदेशक
TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001
GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI 110 001
Tel.: 23382629; 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

FOREWORD

Indiscriminate use of chemical fertilizers and pesticides post green revolution taught us a tough lesson that sustainable utilization of the resources is the way forward for prolonged growth in agricultural production sans deterioration of soil health. Just as biofertilizers are emerging as green alternative to chemical fertilizers, biopesticides have a huge role to play in sustainable management of crop pests and pathogens. In contrast to chemical pesticides, application of ecofriendly biopesticides does not lead to development of any resistance in pests and pathogens. Still this sustainable alternative is struggling to find its place in the market over its chemical counterpart owing to technological challenges and acceptance among the farming community.

National Policy for Farmers (NPF), 2007, which aims to improve economic viability of farming and increase net income of farmers, strongly recommends the promotion of biopesticides. In spite of these efforts the biopesticides represent only 4.2% of the overall pesticide market in India compared to 40% in USA and 20% each in Europe and Oceanic countries.

Indian Council of Agricultural Research, recognizing the importance of biopesticides started All India Coordinated Research Project (AICRP) on Biological control of Crop Pests and Weeds way back in 1977. Since the inception of this project different ICAR institutes accelerated the works on biocontrol and developed biopesticides against a number of crop pests and diseases. At present more than 970 biopesticide products have been registered with Central Insecticide Board and Registration Committee (CIB & RC) which is a governing body for insecticide registration in India. Most biopesticide producing companies are dependent on either a single strain or a handful of microbes for commercial production. Most of

the times, the products developed using these strains have limited application and their activity range is narrow. To overcome this issue, there should be many bioagents available that are active against a wide range of pests and pathogens. Once there is availability of many bioagents to select upon, the challenges faced by biopesticides in the market can be handled well.

This compendium entitled "***ICAR Technologies: Biopesticides for Eco-friendly Pest Management***" is a compilation of microbial formulations developed by ICAR against crop pests and pathogens that are at various stages of registration and commercialization. It can be a useful source of information for students, researchers, scientists, entrepreneurs and most importantly farming community and policy makers.

Dated: 30th July, 2021 **(T. Mohapatra)**
New Delhi

PREFACE

In India, crop pests and pathogens are implicated in 15–20% yield loss in major field and horticultural crops. The profile of key pests and pathogens has been changing rapidly owing to climate change, indiscriminate use of chemical pesticides and other anthropogenic interventions. Non judicious use of chemical pesticides has led to deterioration of soil health and environmental pollution. Biopesticides, in contrast to their chemical alternatives can help to manage pests and pathogens without negatively influencing the soil health and environment. Govt. of India has encouraged the use of biopesticides by including them as a component in several agricultural programs. Still, biopesticides are facing many challenges at farm level due to declining interest among farmers.

Application of biopesticides like *Bacillus thuringiensis, Trichoderma, Pseudomonas, Metarhizium, Beauveria* and others can have significant effect on crop protection in a sustainable manner. Microbial biopesticides in the Indian market come under different categories *viz.*, fungi, bacteria, and viruses. At present, there are about 20 microorganisms registered as biopesticides with Central Insecticide Board and Registration Committee (CIB & RC).

Indian Council of Agricultural Research (ICAR) through its constituent institutes is engaged in development and evaluation of microbial biopesticides since last few decades. Some of the biopescticide formulations developed at ICAR are being validated through the network of AICRP-Biological Control of Crop Pests and Diseases. The recent invasions of fall armyworm (FAW) infesting maize and devastating infection of banana by *Fusarium cubense* TR4 have been successfully managed with microbial agents developed by ICAR.

This compendium on "***ICAR Technologies: Biopesticides for Eco-friendly Pest Management"*** is a timely initiative as microorganisms will be playing a vital role in shaping the future of agriculture. With great pleasure I extend my sincere thanks to Dr. T. Mohapatra, Hon'ble Secretary, Department of Agricultural Research and Education and Director General, ICAR for guidance and support in preparation of this compendium. I congratulate all the developers of technologies and thank other editors of this compendium.

(T.R. Sharma)
Deputy Director General (Crop Science)
Indian Council of Agricultural Research

CONTENTS

INTRODUCTION

Pests and pathogens cause a major loss of agricultural produce every year. Management of these menace using chemical pesticides and fungicides has come at the cost of long term agricultural sustainability. This non-judicious use of agrochemicals coupled with climate change worsened the situation leading to changes in pest and pathogen behaviour and development of resistance. Microorganisms due to their extraordinary metabolic diversity are known to produce a battery of secondary metabolites including antimicrobial peptides, volatiles, toxins and enzymes. Many such microorganisms have been substantially utilized as biopesticides to control several phytopathogenic fungi, bacteria, nematodes and insect pests. Unlike their chemical counter parts, biopesticides aid to manage pests and pathogens without any adverse effects on soil health and environment. Microbial biopesticides developed with microorganisms like *Trichoderma, Beauveria, Metarhizium, Bacillus, Pseudomonas* are known for their role in management of pests and pathogens. With the increasing reports on emerging pests and pathogens, the biopesticides are expected to play a major role in sustainable management. Currently, about 20 microorganisms are registered as biopesticides with Central Insecticide Board and Registration Committee (CIB & RC).

ICAR through its constituent institutes and All India Coordinated Research Projects (AICRPs) has developed and validated various formulations of biopesticides. Challenges faced by biopesticides are lower efficacy and shelf life, narrow host range, inability to reproduce the results under field conditions. Constant efforts are being made by ICAR to overcome these challenges. This bulletin is a compilation of **31 biopesticides** developed by ICAR that are at various stages of registration and commercialization.

ABBREVIATIONS

AAU	:	Anand Agricultural University
AICRP	:	All India Coordinated Research Project
ANGRAU	:	Acharya N.G. Ranga Agricultural University
ARS	:	Agricultural Research Station
BCCP&D	:	Biological Control of Crop Pests and Diseases
CAZRI	:	Central Arid Zone Research Institute
cfu	:	Colony Forming Unit
CIB&RC	:	Central Insecticide Board and Registration Committee
DARE	:	Department of Agricultural Research and Education
FYM	:	Farmyard Manure
GAU	:	Gujarat Agricultural University
IARI	:	Indian Agricultural Research Institute
ICAR	:	Indian Council of Agricultural Research
IIHR	:	Indian Institute of Horticultural Research
IIOR	:	Indian Institute of Oilseeds Research
IISS	:	Indian Institute of Seed Science
ITCC	:	Indian Type Culture Collection
JNKVV	:	Jawaharlal Nehru Krishi Vishwavidyalaya
KVK	:	Krishi Vigyan Kendra
MCC	:	Microbial Culture Collection (now National Centre for Microbial Resource)
MTCC	:	Microbial Type Culture Collection
MPKV	:	Mahatma Phule Krishi Vidyapeeth
NAIMCC	:	National Agriculturally Important Microbial Culture Collection
NBAIM	:	National Bureau of Agriculturally Important Microorganisms
NBAIR	:	National Bureau of Agricultural Insect Resources
NRC	:	National Research Centre

NRRI	:	National Rice Research Institute
OUAT	:	Odisha University of Agriculture and Technology
PRSS	:	Pulses Research Substation
RARS	:	Regional Agricultural Research Station
SKUAST	:	Sher-e-Kashmir University of Agricultural Science and Technology
TNAU	:	Tamil Nadu Agricultural University
UAS	:	University of Agricultural Sciences

1. Shatpada Aphid Kill

- **Microbial Constituent:** *Beauveria bassiana* ICAR-NBAIR Bb-5a (NAIMCC-F-00396)
- **Type:** Oil formulation; 1×10^8 cfu/mL
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** Aphids in chilli and brinjal (*Aphis gossypii*); cabbage (*Brevicoryne brassicae*) and cowpea (*Aphis craccivora*)
- **Method of application:** Three foliar sprays at 5 mL/L of water at 15 days interval after pest incidence; Water required for each spray: 200 L/ha
- **Target agroecological zones/states:** Karnataka
- **Validation:** In Bengaluru, Karnataka during 2017 and 2018
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 50-83% pest reduction
  - 20-33% increase in yield

Treated Control

Effect of Shatpada Aphid Kill on brinjal aphid in Bengaluru, Karnataka during 2017

Treated Control

Effect of Shatpada Aphid Kill on cabbage aphid in Bengaluru, Karnataka during 2017

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

2. Shatpada Rugose Whitefly Kill

- **Microbial Constituent:** *Isaria fumosorosea* ICAR-NBAIR Pfu5 (NAIMCC-F-02139)
- **Type:** Talc; 1×10^8 cfu/g; Oil formulation; 1×10^8 cfu/mL
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** Rugose Spiralling Whitefly (*Aleurodicus rugioperculatus*) in coconut and oil palm
- **Method of application:** Two-three foliar sprays at 5mL/L of water (or 5 g/L of water for talc formulation) at 15 days interval after pest incidence; Water required for each spray: 900 L/ha
- **Target agroecological zones/states**: Karnataka, Andhra Pradesh, Tamil Nadu and Kerala
- **Validation:** Coastal Andhra Pradesh on Coconut and Oil Palm for two years; Coastal and Southern Karnataka, Kerala and Tamil Nadu on Coconut for two years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 70-75% pest reduction

Before spraying

After spraying

Effect of Shatpada Rugose Whitefly Kill on Coconut (var. ECT) Rugose spiralling whitefly (RSW) in coastal Andhra Pradesh during 2019

Infection of NBAIR Pfu-5 on Coconut RSW eggs, third and fourth instar nymphs and adult

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

3. Shatpada Sucking pest Hit

- **Microbial Constituent:** *Lecanicillium lecanii* ICAR-NBAIR Vl-8 (NAIMCC-F-01851)
- **Type:** Oil formulation; 1×10^8 cfu/mL
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** Aphids in chilli (*Aphis gossypii*) and cowpea (*Aphis craccivora*)
- **Method of application:** Three foliar sprays at 5 mL/L of water at 15 days interval after pest incidence; Water required for each spray: 900 L/ha
- **Target agroecological zones/states:** Karnataka
- **Validation:** Bengaluru, Karnataka for two years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 75-78% pest reduction
  - 24-27% increase in yield

Treated

Control

Effect of Shatpada Sucking pest Hit on chilli aphids in Bengaluru, Karnataka during 2018

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

4. Shatpada Grubicide

- **Microbial Constituent:** *Metarhizium anisopliae* ICAR-NBAIR Ma 4 (NAIMCC-F-01296)
- **Type:** Talc formulation; 1×10^8 cfu/g
- **Shelf life:** 12 months at 25-35°C
- **Target pest and crop:** White grubs (*Holotrichia* spp.) in sugarcane
- **Method of application:** Soil application at 2.5 kg mixed with 250 kg farmyard manure per hectare. The application has to be done twice in a year during June/July and July/August at 30 days interval
- **Target agroecological zones/states**: Karnataka, Andhra Pradesh and Maharashtra
- **Validation:** AICRP-BCCP&D centres at UAS-Raichur, Karnataka and RARS, ANGRAU, Anakapalle, Andhra Pradesh for two years
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2020; Available for licensing
- **Benefits:**
  - 75-96% pest reduction
  - 33-62% increase in yield

Treated Control

Effect of Shatpada Grubicide on sugarcane (var. CO-86032) white grub in Raichur, Karnataka during 2017-18

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

5. Shatpada Larvicide

- **Microbial Constituent:** *Metarhizium anisopliae* ICAR-NBAIR Ma 35 (NAIMCC-F-04130)
- **Type:** Talc; 1 × 10^8 cfu/g; Oil formulation; 1 × 10^8 cfu/mL
- **Shelf life:** 12 months at 25-35°C
- **Target pest and crop:** Fall armyworm (*Spodoptera frugiperda*) in maize
- **Method of application:** Three foliar sprays at 5 mL/L of water (or 5 g/L of water for talc based formulation) at 20, 30 and 40 days after sowing; Water required for each spray: 200 L/ha
- **Target agroecological zones/states:** Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra
- **Validation:** Southern Karnataka; AICRP-BCCP&D centres at RARS, ANGRAU, Anakapalle, Andhra Pradesh; TNAU, Coimbatore, Tamil Nadu and MPKV, Pune, Maharashtra for two years
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 33-76% reduction in plant damage
  - 38-53% increase in yield

Healthy larva Mycosed larva

Effect of Shatpada Larvicide on maize
Fall armyworm in Bengaluru, Karnataka during 2019

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

6. Shatpada Armour

- **Microbial constituent:** *Bacillus thuringiensis* var. *kurstaki* ICAR-NBAIR BT25
- **Type:** Liquid; 1×10^8 cfu/mL
- **Shelf life:** 12 months at 25-35°C
- **Target pest and crop:** Fall armyworm (*Spodoptera frugiperda*) in maize
- **Method of application:** Two to three foliar sprays at 10 mL/L of water at 25, 35 and 45 days after sowing; Water required for each spray: 200 L/ha
- **Target agroecological zones/states:** Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, Gujarat and Odisha
- **Validation:** Field evaluation carried out under AICRP-BCCP&D at Regional Agricultural Research Station (RARS), Anakapalle, Andhra Pradesh, Odisha University of Agriculture & Technology (OUAT), Bhubaneshwar, Odisha and Anand Agricultural University (AAU), Anand, Gujarat during 2018-19 and 2019-20
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 85-90% reduction in pest
  - 33-40% increase in yield

Treated Control

Effect of Shatpada Armour on maize at Anakapalle, Andhra Pradesh during 2018-19

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

7. Shatpada Terminator

- **Microbial constituent:** *Bacillus thuringiensis* var. *kurstaki* ICAR-NBAIR BTG4
- **Type:** Liquid; 1×10^8 cfu/ml
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** Legume pod borer (*Helicoverpa armigera, Maruca* sp.), diamondback moth (*Plutella xylostella*), spotted stem borer (*Chilo partellus*), rice leaf folder (*Cnaphalocrocis medinalis*), brinjal shoot borer (*Leucinodes orbonalis*) and red hairy caterpillar (*Amsacta albistriga*)
- **Method of application:** Two to three foliar sprays at 20 mL/L of water at pre flowering and post flowering stages; Water required for each spray: 200 L/ha
- **Target agroecological zones/states:** Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, Gujarat and Odisha
- **Validation:** The technology was tested at UAS, Raichur, Karnataka, AAU, Anand, Gujarat, RARS, Anakapalle, Andhra Pradesh, TNAU, Coimbatore; Tamil Nadu, OUAT, Bhubaneshwar, Odisha during 2016-17, 2017-18, 2018-19 and 2019-20
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Commercialized in 2020; Licensed to three private companies
  - M/s Ponalabs, Bengaluru, Karnataka
  - Allwin Industries, Pithampur, Dhar, Madhya Pradesh
  - Agri Bio Care, Kottayam, Kerala
- **Benefits:**
  - 83-85% reduction in pest
  - 19-35% increase in yield

Treated Control

Effect of Shatpada Terminator on pod borer in pigeon pea at Raichur, Karnataka during 2016-17

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

8. Shatpada All Rounder

- **Microbial constituent:** *Pseudomonas fluorescens* NBAIR-PFDWD
- **Type:** Talc based; 1×10^8 cfu/g
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** *Thrips* spp. in capsicum and Fusarium wilt of red gram
- **Method of application:** Foliar application at 20 g/L of water at 20, 30, 40 and 50 days after transplanting for the management of thrips in capsicum; Water required: 200 L/ha; Soil application in the root zone during 25, 40 and 55 days after sowing at 2.5 kg/ha for management of red gram wilt; Mix 2.5 kg of formulation in 250 kg farmyard manure and apply
- **Target agroecological zones/states:** Karnataka and Telangana
- **Validation:** The technology was tested at ICAR-NBAIR, Bengaluru, Karnataka during 2018 and 2019 for thrips management in capsicum; Validated at KVK, Palem, Telangana for management of Fusarium wilt of red gram during 2020
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Commercialized in 2020; Licensed to two organizations
  - Siddaganga Oil and Bio Industries LLP, Tumakuru, Karnataka
  - Anand Agricultural University (AAU), Anand, Gujarat
- **Benefits:**
  - 70-90% thrips reduction; 50-60% Fusarium wilt reduction
  - 48-53% increase in yield

Treated Control

Effect of Shatpada All Rounder on yield of capsicum at ICAR-NBAIR, Bengaluru, Karnataka during 2018

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

9. Shatpada Master Blaster

- **Microbial constituent:** *Bacillus albus* NBAIR-BATP
- **Type:** Talc based; 1×10^8 cfu/g
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** Fall armyworm (*Spodoptera frugiperda*) of maize, tomato pin worm (*Tuta absoluta*) and Fusarium wilt of cucumber (*Fusarium oxysporum* f. sp. *cucumerinum*)
- **Method of application:** Foliar application at 20 g/L of water at 20, 30, 40 and 50 days after sowing for management of fall armyworm of maize and tomato pin worm; Water required: 200 L/ha; Soil application in the root zone during 25, 40 and 55 days after sowing at 2.5 kg/ha for management of cucumber wilt; Mix 2.5 kg of formulation in 250 kg farmyard manure and apply
- **Target agroecological zones/states:** Karnataka and Andhra Pradesh
- **Validation:** The technology was tested at ICAR-NBAIR, Bengaluru, Karnataka and RARS, Anakapalle, Andhra Pradesh during 2019-20 and 2020-21 for fall armyworm and tomato pinworm; Kanakapura and Kolar districts, Karnataka for management of cucumber wilt during 2020-21
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 70-80% Fall armyworm reduction, 80-90% tomato pin worm reduction and 45-50% Fusarium wilt reduction
  - 26-29% increase in maize yield; 30-40% increase in tomato yield and 22-24% increase in cucumber yield

Control Treated

Effect of Shatpada Master Blaster on tomato pin worm

Contact:
Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru-560024;
e-Mail: director.nbair@icar.gov.in

10. ICAR-FUSICONT

- **Microbial Constituent:** *Trichoderma reesei* CSR-T-3 (NAIMCC-SF-0030)
- **Type:** Wettable powder; 1×10^7 cfu/g
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** Fusarium wilt of banana (*Fusarium oxysporum* f. sp. *cubense* Tropical race 4 and race 1)
- **Method of application:** 3% of WP (w/v) in water as soil drenching at 1 L per plant 4 times (3rd, 5th, 9th and 12th month after planting); Water required; 1500 L/ha
- **Target agroecological zones/states**: Uttar Pradesh, Bihar, Andhra Pradesh, Tamil Nadu, Assam, Nagaland, West Bengal and Gujarat
- **Validation:** Validated under AICRP-Fruits in Andhra Pradesh, Gujarat and Tamil Nadu; Assam Agricultural University, Jorhat, Assam and Central Institute of Horticulture, Medziphema, Nagaland for two years; farmers' fields at different districts of Bihar and Uttar Pradesh
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2020; Available for licensing
- **Benefits:**
  - 85-90% reduction in disease incidence

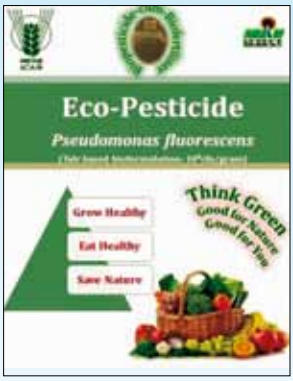
Treated sick plot

Control sick plot

Effect of ICAR-FUSICONT on banana (cv. Grand Naine) wilt in Ayodhya, Uttar Pradesh during 2018-19

Contact:
Director, ICAR-Central Soil Salinity Research Institute, Karnal-132001;
e-Mail: director.cssri@icar.gov.in

11. Eco-Pesticide



- **Microbial constituent:** *Pseudomonas fluorescens* (NAIMCC-SB-0053)
- **Type:** Talc formulation; 1×10^8 cfu/g
- **Shelf life:** 12 months at 25-35°C
- **Target pests and crops:** Spot blotch of wheat, sheath blight of rice and wilt of tomato and chickpea
- **Method of Application:** Seed treatment (10 g/kg seed)
- **Target agroecological zones/states:** Uttar Pradesh
- **Validation:** Field trials at ICAR-NBAIM, Mau, Uttar Pradesh in tomato, rice, and wheat; KVK, Ghazipur, Uttar Pradesh in chickpea; KVK, Azamgarh, Uttar Pradesh in direct seeded rice; ICAR-IISS, Mau, Uttar Pradesh in wheat; farmers' fields on chickpea and wheat
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 45-55% reduction in spot blotch disease of wheat, sheath blight in rice and wilt of tomato
  - 15-25% reduction in usage of chemical pesticides

Treated

Control

Effect of Eco-Pesticide on wheat (var. HUV 234) at ICAR-NBAIM, Mau, Uttar Pradesh during 2016-17

Contact:
Director, ICAR-National Bureau of Agriculturally Important Microorganisms, Mau-275103; e-Mail: director.nbaim@icar.gov.in

12. Bio-Pulse

- **Microbial constituents:** *Trichoderma harzianum* (NAIMCC-SF-0036) and *Bacillus amyloliquefaciens* (NAIMCC-SB-0052)
- **Type:** Talc formulation; 1×10^7 cfu/g each
- **Shelf life**: 12 months at 25-35°C
- **Target pests and crops**: Wilt of chickpea, lentil, pea, pigeon pea; damping off/seedling mortality in papaya; Target fungi: *Rhizoctonia, Sclerotium, Sclerotinia, Fusarium, Pythium, Ralstonia, Macrophomina, Bipolaris* and *Phoma*
- **Method of Application**: Seed treatment (10 g/kg seeds)
- **Target agroecological zones/states**: Uttar Pradesh, Bihar and Chhattisgarh
- **Validation:** Four KVKs of Madhya Pradesh at Hamirpur, Chhattarpur, Tikamgarh and Panna on chickpea; KVK Ghazipur, Uttar Pradesh on chickpea; KVK Azamgarh, Uttar Pradesh on rice; ICAR-NBAIM, Mau, Uttar Pradesh on tomato, wheat and maize; farmers' fields at Mau, Uttar Pradesh on chickpea, pea, lentil, vegetables and wheat; farmers' fields at Begusarai, Hazaribagh and Bhabhua, Bihar on papaya
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - Reduce the wilt incidence by 40-75% in chickpea, 30-55% in lentil, 45-60% in pea, 25-40% in pigeonpea and 60-75% reduction in damping off/seedling mortality in papaya
  - Yield increase in chickpea, pea and lentil by 10-15%

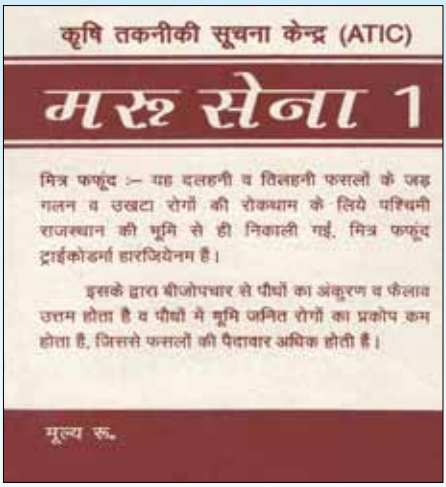
Treated

Control

Effect of inoculation of Bio-Pulse on chickpea (var. JG 62) in Ghazipur, Uttar Pradesh during 2016-17

Contact:
Director, ICAR-National Bureau of Agriculturally Important Microorganisms, Mau-275103; e-Mail: director.nbaim@icar.gov.in

13. Maru sena 1



- **Microbial Constituent:** *Trichoderma harzianum* ICAR-CAZRI AZNF-5 (MCC 1723)
- **Type:** Carrier based formulation; 1×10^8 cfu/g
- **Shelf life:** 4 months at 55°C
- **Target pathogen and crops:** *Fusarium oxysporum* f. sp. *cumini* in cumin
- **Method of application:** Seed treatment (4 g/kg seed) and soil application (1 kg/ha with 50 kg FYM) before sowing
- **Target agroecological zones/states**: Arid and semi arid regions of Rajasthan
- **Validation:** Experimental farms at ICAR-CAZRI, Jodhpur, Rajasthan; farmers' fields at Pali and Jodhpur, Rajasthan for two years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 34-52% reduction in plant mortality
  - 14.5-25.8% yield increase

Treated

Control

Effect of Maru sena 1 on Cumin (var. GC-4) at ICAR-CAZRI, Jodhpur, Rajasthan during 2015-16

Contact:
Director, ICAR- Central Arid Zone Research Institute, Jodhpur-342003;
e-Mail: director.cazri@icar.gov.in

14. Maru sena 3

- **Microbial Constituent:** *Bacillus firmus* ICAR-CAZRI AZ-1 (MCC 0122)
- **Type:** Carrier based formulation; 1×10^8 cfu/g
- **Shelf life:** 6 months at 25-35°C
- **Target pathogen and crops:** *Macrophomina phaseolina* in legumes and oil seed crops
- **Method of application:** Seed treatment (30 g/kg seed with jaggery solution) before sowing
- **Target agroecological zones/states**: Arid and semi arid region of Rajasthan
- **Validation:** Experimental farm at ICAR-CAZRI, Jodhpur; farmers' fields at Nagaur and Jodhpur, Rajasthan for three years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Patent granted in 2019 (Patent No. 309385); Available for licensing
- **Benefits:**
  - 37-54% reduction in plant mortality
  - 23.2-31.6% yield increase

Treated

Control

Effect of Maru sena 3 on guar (var. RGC 936) at ICAR-CAZRI, Jodhpur, Rajasthan during 2007-08

Contact:
Director, ICAR- Central Arid Zone Research Institute, Jodhpur-342003;
e-Mail: director.cazri@icar.gov.in

15. Mishrit Maru sena

- **Microbial Constituent:** *Trichoderma harzianum* ICAR-CAZRI AZNF-5 (MCC 1723) and *Bacillus firmus* ICAR-CAZRI AZ-1 (MCC 0122)
- **Type:** Carrier based formulation; 1 × 10^8 cfu/g of each
- **Shelf life:** 4 months at 55°C
- **Target pathogen and crops:** *Macrophomina phaseolina* in legumes and oil seed crops
- **Method of application:** Seed treatment (10 g/kg seed with jaggery) and soil application (1 kg/ha with 40 kg FYM) before sowing
- **Target agroecological zones/states**: Arid and semi arid regions of Rajasthan
- **Validation:** Experimental farms at ICAR-CAZRI, Jodhpur; farmers' fields at Pali and Jodhpur, Rajasthan for two years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Patent granted in 2019 (Patent No. 326803); Available for licensing
- **Benefits**
  - 37-56.4% reduction in plant mortality
  - 20-23% yield promotion

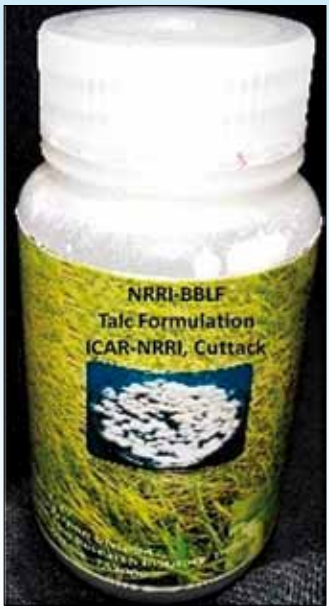
Treated

Control

Effect of Mishrit Maru sena on guar (var. RGC 1033) at ICAR-CAZRI, Jodhpur, Rajasthan during 2015-16

Contact:
Director, ICAR-Central Arid Zone Research Institute, Jodhpur-342003;
e-Mail: director.cazri@icar.gov.in

16. NRRI-BBLF



- **Microbial Constituent:** *Beauveria bassiana* TF6 (MTCC 12233)
- **Type:** Talc formulation; 1×10^9 cfu/g
- **Shelf life:** 8 months at 25-35°C
- **Target pests and crops:** Rice leaf folder (*Cnaphalocrocis medinalis*)
- **Method of application**: Foliar spray at 2 g/L; Water required: 500 L/ha
- **Target agroecological zones/states:** Odisha
- **Validation:** Farmers' fields of Mahanga, Nischintakoili and Santpur village of Odisha; experimental fields of NRRI, Cuttack, Odisha for four consecutive seasons
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Patent filed (260/KOL/2015 dated 10.03.2015); Available for licensing
- **Benefits**:
  - 74% leaf folder mortality

Effect of application of *B. bassiana* (a) on rice leaf folder larvae (b)

Contact:
Director, ICAR-National Rice Research Institute, Cuttack-753006, Odisha;
e-Mail: director.nrri@icar.gov.in

17. NRRI-MALF

- **Microbial Constituent:** *Metarhizium anisopliae* TF19 (MTCC 11644)
- **Type:** Talc formulation; 1×10^9 cfu/g
- **Shelf life:** 8 months at 25-35°C
- **Target pests and crops:** Rice leaf folder (*Cnaphalocrocis medinalis*)
- **Method of application:** Foliar spray at 2 g/L; Water required: 500 L/ha
- **Target agroecological zones/states**: Odisha
- **Validation:** Farmers' fields of Mahanga, Nischintakoili and Santpur village of Odisha; experimental fields of NRRI, Cuttack, Odisha for four years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Patent filed (265/KOL/2015 dated 10.03.2015); Available for licensing
- **Benefits:**
  - 77% leaf folder mortality

Rice leaf folder larvae infected with *M. anisopliae*

Contact:
Director, ICAR- National Rice Research Institute, Cuttack-753006, Odisha;
e-Mail: director.nrri@icar.gov.in

18. Triguard Th-L

- **Microbial Constituent:** *Trichoderma harzianum* Th4d (NAIMCC-F-02188)
- **Type:** Liquid suspension concentrate; 1×10^9 cfu/mL
- **Shelf life:** 18 months at 25-35°C
- **Target pests and crops:** Phytophthora seedling blight, Macrophomina root rot and Fusarium wilt of safflower and gray mold of castor, Alternaria aster leaf blight and powdery mildew of sunflower
- **Method of application:** Seed treatment at 1 mL suspension concentrate/kg of seeds, Foliar spray at 1-2 mL/L of water; Water required for spray: 500 L/ha
- **Target agroecological zones/states**: Telangana, Maharashtra and Tamil Nadu
- **Validation:** Evaluated under AICRP-Oilseeds on sunflower, safflower and castor for five years
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2015; Licensed to 4 companies
  - M/s Dhampur Sugars Pvt. Ltd., Dhampur, Uttar Pradesh
  - M/s Shri Ram Bioorganics, Jaspur, Uttarakhand
  - M/s Vidarbha Biotech, Yavatmal, Maharashtra
  - M/s Agricos Pvt. Ltd., Yavatmal, Maharashtra
- **Benefits:**
  - Symbiotic colonizer
  - Effective against a wide range of diseases
  - Helps to achieve high yield

Treated Control

Effect of Triguard Th-L on safflower (var. PBNS 12) at Parbhani, Maharashtra during 2015-16

Contact:
Director, ICAR-Indian Institute of Oilseed Research, Rajendranagar, Hyderabad-500030;
e-Mail: director.iior@icar.gov.in

19. Triguard Th-P

- **Microbial Constituent:** *Trichoderma harzianum* Th4 (NAIMCC-F-02188)
- **Type:** Wettable powder; 1×10^9 cfu/g
- **Shelf life:** 18 months at 25-35°C
- **Target pests and crops:** Phytophthora seedling blight, Macrophomina root rot and Fusarium wilt of safflower and Fusarium wilt of castor and Aspergillus root rot in groundnut
- **Method of application:** Seed treatment at 10 g/kg of seeds
- **Target agroecological zones/states**: Telangana, Maharashtra and Tamil Nadu
- **Validation:** Evaluated under AICRP-Oilseeds on sunflower, safflower and castor for eight years
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Licensed to M/s M R Biologics Pvt Ltd., Hyderabad, Telangana
- **Benefits:**
  - Symbiotic colonizer
  - Effective against a wide range of diseases
  - Helps to achieve high yield

Treated | Control | Control | Treated

Effect of Triguard Th-P on groundnut (var. K-6) at Palem, Telangana during 2018-19

Contact:
Director, ICAR-Indian Institute of Oilseed Research, Rajendranagar, Hyderabad-500030;
e-Mail: director.iior@icar.gov.in

20. Triguard Ta-P

- **Microbial Constituent:** *Trichoderma asperellum* Ta DOR 7316 (MTCC 5623)
- **Type:** Wettable powder; 1×10^9 cfu/g
- **Shelf life:** 18 months at 25-35°C
- **Target pests and crops:** Phytophthora seedling blight, Macrophomina root rot and Fusarium wilt of safflower and Fusarium wilt of castor
- **Method of application:** Seed treatment at 10 g/kg of seeds
- **Target agroecological zones/states**: Telangana, Maharashtra and Tamil Nadu
- **Validation:** Evaluated under AICRP-Oilseeds on sunflower, safflower and castor for five years
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Patent filed (1117/CHE/2013); Available for licensing
- **Benefits:**
  - 60% reduction in soil borne disease incidences
  - 3-5% increase in yield

Treated | Control

Effect of Triguard Ta-P on safflower (var. Phule Kusum) at Solapur, Maharashtra during 2013-14

Contact:
Director, ICAR-Indian Institute of Oilseed Research, Rajendranagar, Hyderabad-500030, Telangana; e-Mail: director.iior@icar.gov.in

21. Bioguard Bt-L

- **Microbial Constituent:** *Bacillus thuringiensis* var. *kurstaki* DOR Bt-127 (MTCC 5976/NAIMCC-B-01463)
- **Type:** Liquid suspension concentrate; 1×10^{11} cfu/mL
- **Shelf life:** 24 months at 25-35°C
- **Target pests and crops:** *Spodoptera litura* in soybean
- **Method of application:** Two foliar sprays at 3 mL/L of water at 10 days interval; Water required for each spray: 1500 L/ha
- **Target agroecological zones/states**: Madhya Pradesh, Karnataka, Manipur and Telangana
- **Validation:** AICRP-Soybean for three years; Farmers' fields on soybean at Hegdoli and Nizamabad, Telangana
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - 69-95% reduction in larval population
  - 26-49% increase in yield

Treated Control

Effect of Bioguard Bt-L on larval mortality of *Spodoptera litura*

Contact:
Director, ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad-500030, Telangana; e-Mail: director.iior@icar.gov.in

22. Mycoguard Bb-L

- **Microbial Constituent:** *Beauveria bassiana* (ITCC 4513)
- **Type:** Liquid suspension concentrate; 1 × 10^{12} cfu/mL
- **Shelf life:** 24 months at 25-35°C
- **Target pests and crops:** *Helicoverpa armigera* in pigeon pea

Suspension concentrate | Dispersion in water

- **Method of application:** Two to three foliar sprays at 0.3 mL/L of water at 10 days interval; Water required for each spray: 700 to 1000 L/ha
- **Target agroecological zones/states**: Maharashtra, Gujarat, Telangana and Andhra Pradesh
- **Validation:** AICRP-Pigeon pea and ICAR-IIOR experimental farms at Hyderabad, Telangana for three years
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2014; Available for licensing
- **Benefits:**
  - 24-45% reduction in pod damage
  - 21-33% increase in yield

Larval mortality due to *B. bassiana* infection

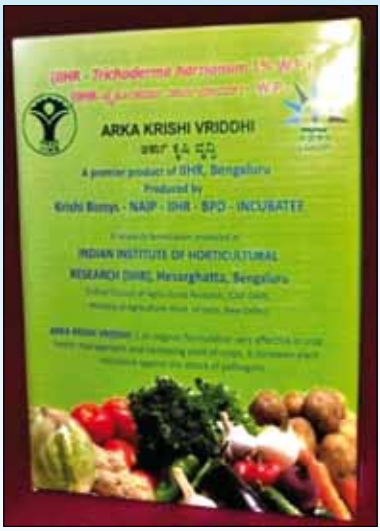
Healthy larva

Effect of Mycoguard Bb-L formulation on pigeon pea pod borer

Contact:
Director, ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad-500030, Telangana; e-Mail: director.iior@icar.gov.in

23. ARKA Krishi Vriddhi

- **Microbial Constituent:** *Trichoderma harzianum* ICAR-IIHR Th-2 (NAIMCC-SF-0033/ITCC 6888)
- **Type:** Wettable powder; 2×10^6 cfu/g
- **Shelf life:** 10 months at 25-35°C
- **Target pests and crops:**
  - Root knot nematode (*Meloidogyne incognita*)
  - Fungal pathogens–*Fusarium oxysporum* f. sp. *vasinfectum*, *Fusarium oxysporum* f. sp. *lycopersici*, *Sclerotium rolfsii* and *Fusarium solani*
  - Crops: Brinjal, tomato, carrot and okra
- **Method of application:** Seed treatment at 20 g/kg seed; nursery bed treatment at 50 g/m^2 for transplantable crops; soil application at 5 kg/ha after enrichment in 5 tons FYM before sowing or transplanting
- **Target agroecological zones/states**: All
- **Validation:** Karnataka, Odisha and Tamil Nadu for two seasons (2007-2009); AICRP on Nematodes, Vegetables, Floriculture and Fruits
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2008; Licensed to 113 companies
- **Benefits:**
  - 66-68% suppression in egg hatching of *Meloidogyne incognita*
  - 62-67% inhibition in growth of target fungi
  - 14.2–18.4% increase in yield in brinjal, tomato, carrot and okra



ARKA Krishi Vriddhi

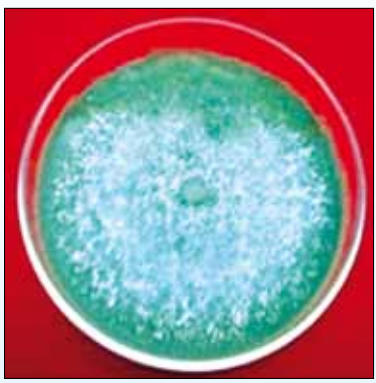
T. harzianum culture

Contact:
Director, ICAR-Indian Institute of Horticultural Research, Bengaluru-560089;
e-Mail: director.iihr@icar.gov.in

24. ARKA Krishi Veera

- **Microbial Constituent:** *Trichoderma viride* ICAR-IIHR Tv-5 (NAIMCC-SF-0032/ITCC 6889)
- **Type:** Wettable powder; 2×10^6 cfu/g
- **Shelf life:** 10 months at 25-35°C
- **Target pests and crops:**
  - Root knot nematode (*Meloidogyne incognita*)
  - Fungal pathogens–*Fusarium oxysporum* f. sp. *vasinfectum*, *Fusarium oxysporum* f. sp. *lycopersici*, *Sclerotium rolfsii* and *Fusarium solani*
  - Crops: Brinjal, tomato, carrot and okra
- **Method of application:** Seed treatment at 20 g/kg seed; Nursery bed treatment at 50 g/m^2 for transplantable crops; Soil application at 5 kg/ha after enrichment in 5 tons FYM before transplanting or sowing
- **Target agroecological zones/states**: All
- **Validation:** Karnataka, Odisha and Tamil Nadu for two seasons (2007-2009); AICRP on Nematodes, Vegetables, Floriculture and Fruits
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2014; Licensed to 180 companies
- **Benefits:**
  - 56-58% suppression in egg hatching of *Meloidogyne incognita*
  - 63-72% inhibition in growth of target fungi
  - 12.8–16.2% increase in yield in brinjal, tomato, carrot and okra

ARKA Krishi Veera

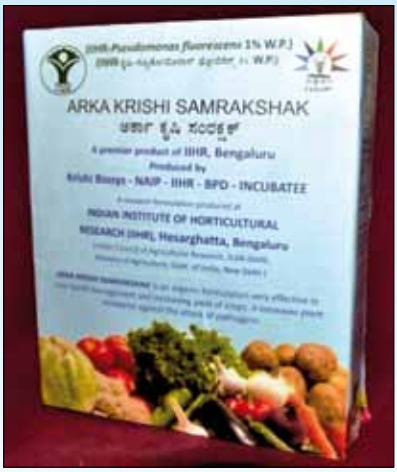


T. viride culture

Contact:
Director, ICAR-Indian Institute of Horticultural Research, Bengaluru-560089;
e-Mail: director.iihr@icar.gov.in

25. ARKA Krishi Samarakshak

- **Microbial Constituent:** *Pseudomonas fluorescens* ICAR-IIHR Pf-2 (NAIMCC-SB-0038/ITCC B0034)
- **Type:** Wettable powder; 2×10^8 cfu/g
- **Shelf life:** 10 months at 25-35°C
- **Target pests and crops:**
  - Root knot nematode (*Meloidogyne incognita*)
  - Bacterial pathogens– *Ralstonia solanacearum* and *Erwinia carotovora*
  - Fungal pathogens– *Fusarium oxysporum* f. sp. *vasinfectum* and *Fusarium solani*
  - Crops: Brinjal, tomato, carrot and okra
- **Method of application:** Seed treatment at 20 g/kg seed; Nursery bed treatment at 50 g/m^2 for transplantable crops; Soil application at 5 kg/ha after enrichment in 5 tons FYM before transplanting or sowing
- **Target agroecological zones/states**: All
- **Validation:** Karnataka, Odisha and Tamil Nadu for two seasons (2007-2009); AICRP on Nematodes, Vegetables, Floriculture and Fruits
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2006; Licensed to 171companies
- **Benefits:**
  - 71-74% suppression in egg hatching of *Meloidogyne incognita*
  - 60-72% reduction in growth of target fungi
  - 13.2–19.4% increase in yield of brinjal, tomato, carrot and okra



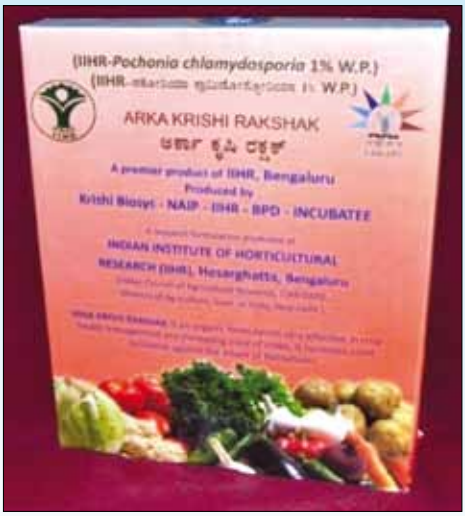
ARKA Krishi Samarakshak

P. fluorescens culture

Contact:
Director, ICAR-Indian Institute of Horticultural Research, Bengaluru-560089;
e-Mail: director.iihr@icar.gov.in

26. ARKA Krishi Rakshak

- **Microbial Constituent:** *Pochonia chlamydosporia (=Verticillium chlamydosporium)* IIHR- Vc-3 (NAIMCC-SF-0035/ITCC 6898)
- **Type:** Carrier based formulation; 2×10^6 cfu/g
- **Shelf life:** 10 months at 25-35°C
- **Target pests and crops:**
  - Root knot nematode (*Meloidogyne incognita*)
  - Crops: Brinjal, tomato, carrot and okra
- **Method of application:** Seed treatment at 20 g/kg seed; Nursery bed treatment at 50 g/m^2 for transplantable crops; Soil application at 5 kg/ha after enrichment in 5 tons FYM before transplanting or sowing
- **Target agroecological zones/states**: All
- **Validation:** Karnataka, Odisha and Tamil Nadu for two seasons (2007-2009); AICRP on Nematodes, Vegetables, Floriculture and Fruits
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2006; Licensed to 50 companies
- **Benefits:**
  - 61-64% suppression in egg hatching of *Meloidogyne incognita*
  - 62-76% parasitization of nematode eggs
  - 14.6-22.5% increase in yield of brinjal, tomato, carrot and okra



ARKA Krishi Rakshak

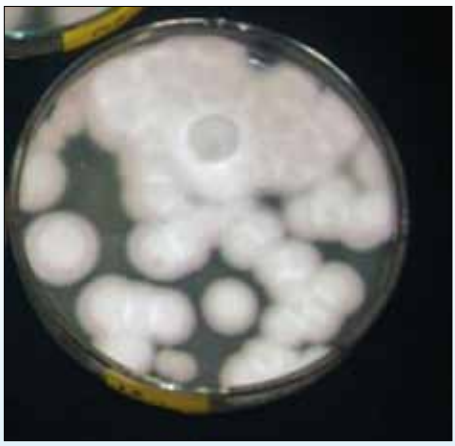
P. chlamydosporia culture

Contact:
Director, ICAR-Indian Institute of Horticultural Research, Bengaluru-560089;
e-Mail: director.iihr@icar.gov.in

27. ARKA Krishi Kawach

- **MicrobialConstituent:***Purpureocillium lilacinum (=Paecilomyces lilacinus)* IIHR- Pl-2 (NAIMCC-SF-0034/ITCC 6887)
- **Type:** Wettable powder; 2×10^6 cfu/g
- **Shelf life:** 10 months at 25-35°C
- **Target pests and crops:**
  - Root knot nematode (*Meloidogyne incognita*)
  - Crops: Brinjal, tomato, carrot and okra
- **Method of application:** Seed treatment at 20 g/kg seed; Nursery bed treatment at 50 g/m^2 for transplantable crops; Soil application at 5 kg/ha after enrichment in 5 tons FYM before transplanting or sowing
- **Target agroecological zones/states**: All
- **Validation:** Karnataka, Odisha and Tamil Nadu for two seasons (2007-2009); AICRP on Nematodes, Vegetables, Floriculture and Fruits
- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2006; Licensed to 86 companies
- **Benefits:**
  - 51-61% suppression in egg hatching of *Meloidogyne incognita*
  - 60-76% parasitization of nematode eggs
  - 14.3–17.8 % increase in yield of brinjal, tomato, carrot and okra

ARKA Krishi Kawach



P. lilacinum culture

Contact:
Director, ICAR-Indian Institute of Horticultural Research, Bengaluru-560089;
e-Mail: director.iihr@icar.gov.in

28. ARKA Krishi All Rounder and ARKA Plant Growth Booster

- **Microbial Constituent:** *Pseudomonas fluorescens* IIHR Pf-2 (NAIMCC-SB-0038/ ITCC B0034) and *Trichoderma harzianum* IIHR Th-2 (NAIMCC-SF-0033/ITCC 6888)
- **Type:** Liquid; 2×10^8 cfu/mL; Carrier based; 2×10^8 cfu/g
- **Shelf life:** 10-12 months at 25-35°C
- **Target pests and crops:**
  - Nematodes*:* Root knot nematode (*Meloidogyne incognita*)
  - Bacterial pathogens–*Ralstonia solanacearum* and *Erwinia carotovora*
  - Fungal pathogens –*Fusarium oxysporum* f. sp. *vasinfectum* and *Fusarium solani*
  - Crops: Tomato, capsicum, okra, brinjal, cabbage, cauliflower, chillies, carrot, onion, tuberose, gerbera, crossandra, gladioli, carnation, banana, papaya, pomegranate, acid lime, citrus and grapes; crops grown under protected conditions such as carnation, gerbera, capsicum, tomato, okra, muskmelon and watermelon
- **Method of application:** Seed treatment at 20 g or 20 mL/kg seed; substrate treatment with 10 mL or 10g/kg of cocopeat; soil application at 5 kg or 5 L/ha after enrichment in 5 tons FYM before transplanting or sowing
- **Target agroecological zones/states**: Karnataka
- **Validation**: Experimental farms at ICAR-IIHR, Bengaluru, Karnataka for two years

ARKA Plant Growth Booster

ARKA Krishi All Rounder

- Toxicological data required for CIB&RC registration already generated
- **Commercialization:** Commercialized in 2013; Granted patents in India (No. 250779); US (US 7,923,005 B), Australia (AU 2007216174 B2) and Thailand (No. 7621); licensed to one company
- **Benefits:**
  - Plant growth promotion and yield enhancement
  - Production of healthy and vigorous seedlings of horticultural crops
  - Management of plant parasitic nematodes and soil borne pathogens

Contact:
Director, ICAR-Indian Institute of Horticultural Research, Bengaluru-560089;
e-Mail: director.iihr@icar.gov.in

29. Manjari Vineguard

- **Microbial constituent:** *Trichoderma asperelloides* 5R (NAIMCC-SF-0026)
- **Type:** Liquid formulation; 5×10^{11} cfu/mL
- **Shelf life:** 3 months at 25-35°C
- **Target pests and crops:** Powdery mildew of grapes
- **Method of application:** Soil drenching at 2 mL/L of water; Water required for soil drenching: 1000 L/ha
- **Target agroecological zones/states:** Maharashtra, Karnataka, Tamil Nadu, Mizoram, and West Bengal
- **Validation:** Experimental farms at ICAR-NRC Grapes, Pune, Maharashtra for 3 years; farmers' fields in Pune for two years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - Significant reduction in powdery mildew incidence
  - Significant reduction in number of fungicide application

Treated

Control

Application of Manjari Vineguard for controlling powdery mildew of grapes (var. Thompson Seedless) at Pune, Maharashtra during 2017-18

Contact:
Director, ICAR-National Research Centre for Grapes, Pune- 413702;
e-Mail: director.nrcg@icar.gov.in

30. Manjari Rakshak

- **Microbial constituent:** *Trichoderma afroharzianum* (NAIMCC-F-01938)
- **Type:** Liquid; 5×10^8 cfu/mL
- **Shelf life:** 3 months at 25-35°C
- **Target pests and crops:** Powdery mildew of grapes
- **Method of application:** Foliar spray at 2.0 ml/L of water; Water required for spray: 1000 L/ha
- **Target agroecological zones/states:** Maharashtra, Karnataka, Tamil Nadu, Mizoram and West Bengal
- **Validation:** Experimental farms at ICAR-NRC Grapes, Pune, Maharashtra for 3 years; farmers' fields in Pune for two years
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Available for licensing
- **Benefits:**
  - Significant reduction in powdery mildew incidence
  - Significant reduction in number of fungicide application

Treated

Control

Application of Manjari Rakshak for controlling powdery mildew of grapes (var. Thompson Seedless) at Pune, Maharashtra during 2017-18

Contact:
Director, ICAR-National Research Centre for Grapes, Pune- 413702;
e-Mail: director.nrcg@icar.gov.in

31. Pusa 5SD

- **Microbial Constituent:** *Trichoderma harzianum* IARI P-4 (MTCC 5371)
- **Type:** Wettable powder; 10^8 cfu/g
- **Shelf life:** 25 months at 25±8°C
- **Target pests and crops:** *Fusarium oxysporum* f. sp. *ciceris, Sclerotium rolfsii* and *Sclerotinia sclerotiorum* in chickpea; *Rhizoctonia solani* and *R. bataticola* in chickpea and mungbean; *Fusarium oxysporum* f. sp. *lycopersici* in tomato; *Pythium ultimum* and *R. solani* in french bean; and major soil and seed borne fungal pathogens in various crops
- **Method of application:** Seed treatment at 4g/kg of seed
- **Target agroecological zones/states**: All
- **Validation:** AICRP on chickpea at 8 locations for three years; ICAR-IARI, New Delhi; JNKVV, Jabalpur, Madhya Pradesh; RAK College of Agriculture, Sehore, Madhya Pradesh; ARS, Durgapura, Jaipur, Rajasthan; ARS, Badnapur, Maharastra; GAU, Junagadh, Gujarat; College of Agriculture, Indore, Madhya Pradesh and PRSS, SKUAST, Samba, Jammu & Kashmir
- Toxicological data required for CIB&RC registration yet to be generated
- **Commercialization:** Patent granted in 2018 (Patent No. 292555); Available for licencing
- **Benefits:**
  - Effective against a wide range of soil and seed borne diseases
  - Enhanced growth of the plants
  - Increased seed germination
  - Increased grain yield under field conditions

Treated Control

Pusa 5SD evaluated against chickpea wilt

Contact:
Director, ICAR-Indian Agricultural Research Institute, New Delhi 110012;
e-Mail: director@iari.res.in

Notes

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

भाकृअनुप
ICAR

Indian Council of Agricultural Research
Krishi Bhavan, New Delhi 110 001