The 3 A's of Division of Crop Protection…

Achievements, Aspirations and Action Plan

भाकृअनुप-केन्द्रीय कन्द फसल अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)
श्रीकार्यम, तिरूवनन्तपुरम 695 017, केरल,भारत
ICAR-Central Tuber Crops Research Institute
(Indian Council of Agricultural Research)
SREEKARIYAM, THIRUVANANTHAPURAM 695 017, KERALA, INDIA

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Diamond Jubilee of ICAR-CTCRI

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July 2024

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From the Director

Dr. G. Byju

Tropical tuber crops are resilient to climate change and support sustainable production, providing essential nourishment, livelihoods, and cultural significance. However, because these crops are vegetatively propagated, pests and diseases are often carried through the planting material, causing significant damage. Over the past sixty years, Division of Crop Protection at ICAR-CTCRI has developed integrated and organic management strategies to combat various pests and diseases. Biopesticides derived from cassava leaves have proven effective against many economically significant sucking and borer pests, and biocapsules and bioformulations have been developed to enhance pest and disease control with promotion of growth.

The division has also developed advanced early disease diagnosis techniques, helping to prevent losses from initial infections. Additionally, they focus on forecasting pest and disease outbreaks to provide farmers with timely warnings. In addition to the use of gene transformation to develop disease-resistant transgenic crops, new technologies such as gene editing have also been initiated to make tailor made pestand disease resistant tuber crops.

This publication offers a comprehensive overview of significant achievements, future aspirations, and strategic plans the Division of Crop Protection. It serves as a valuable resource for stakeholders aiming to strengthen the tuber crops sector in India, providing insights, inspiration, and a roadmap for sustainable development.

G. Byju
Director

01 July 2024

Our Mission

- To identify, characterize and develop tools for diagnosis for pests and diseases of tropical tuber crop.
- To monitor the emergence of pests and diseases through survey and surveillance
- To develop and refine suitable management strategies for pests and diseases of tropical tuber crops

Our Team

Scientists: 6

Sl.No.	Name	Designation	Cadre Discipline
1.	Dr.T. Makeshkumar	Principal Scientist & Head	Plant Pathology
2.	Dr. M.L. Jeeva	Principal Scientist	Plant Pathology
3.	Dr. S.S.Veena	Principal Scientist	Plant Pathology
4.	Dr. E.R. Harish	Senior Scientist	Agricultural Entomology
5.	Dr. H. Kesava Kumar	Senior Scientist	Nematology
6.	Dr. B. G. Sangeetha	Scientist (SS)	Agricultural Biotechnology

Technical Staff - 3

Sl.No.	Name	Designation
1.	Dr. L.S. Rajeswari	Chief Technical Officer
2.	Dr. S. Karthikeyan	Senior Technical Assistant
3.	Mr. T.M. Shinil	Senior Technician

Skilled Support Staff - 1

Sl.No.	Name	Designation
1.	Mrs. P. Vidhya	Skilled Support Staff

Others - 19

Sl.No.	Category	Number
1.	Ph. D. Scholars	11
2.	Post-Doc Fellows	2
3.	Young Professional	3
4.	Contractual Staff	3

What have we delivered?

- Basic and molecular techniques for the identification and characterization of pests and diseases
- Tools/ Protocols for early diagnosis of diseases of tuber crops
- Integrated and organic management strategies for pest and diseases
- Technologies for production of bioformulations from crop residues
- Protocol for production of virus free plants of tropical tuber crops
- Identified sources of resistance for pests and diseases of tropical tuber crops
- Biotechnological interventions in pest and disease management
- DNA barcoding of insect pests
- Identified antimicrobial molecules from endosymbiotic bacteria associated with nematodes
- Multipronged rhizospheric and endophytic bioagents for pathogen suppression and growth promotion

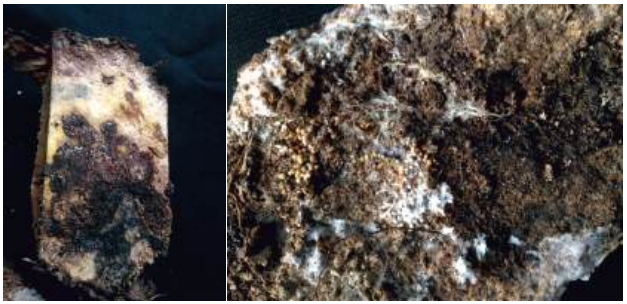
SALIENT ACHIEVEMENTS

1. Basic and molecular techniques for the identification and characterization of pests and diseases

Using basic and molecular identification techniques, following pests and diseases of tropical tuber crops were well characterized.

Crop	Diseases	Insects	Nematodes
Cassava	Cassava mosaic disease, Tuber rot, Leaf spots, Stem and root rot	Mealy bug, Mites, Whitefly, Spiralling whitefly	-
Sweet potato	Feathery mottle, Leaf curl, Mild mottle and Chlorotic leaf distortion	Weevil, Vine borer	Root knot nematode
Yams	Anthracnose, Yam mild mosaic virus, Yam mosaic virus, Yam mild mottling mosaic virus	Mealy bugs, Scales	Root knot nematode
Elephant foot yam	Collar rot, Leaf and stem rot, Mosaic and Postharvest rot	Mealy bugs, Chrysomelid beetle	Root knot nematode Lesion nematode Reniform nematode
Taro	Leaf blight, Mosaic	Aphids, Leaf eating caterpillars	Root knot nematode
Chinese potato	-	-	Root knot nematode

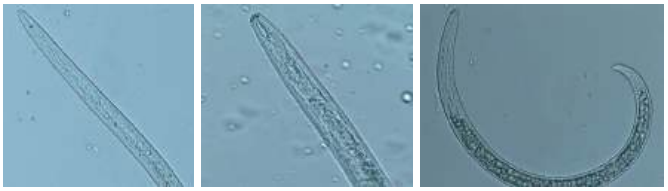

Sweet potato leaf curl virus *Yam mild mosaic virus*



Postharvest rot in elephant foot yam

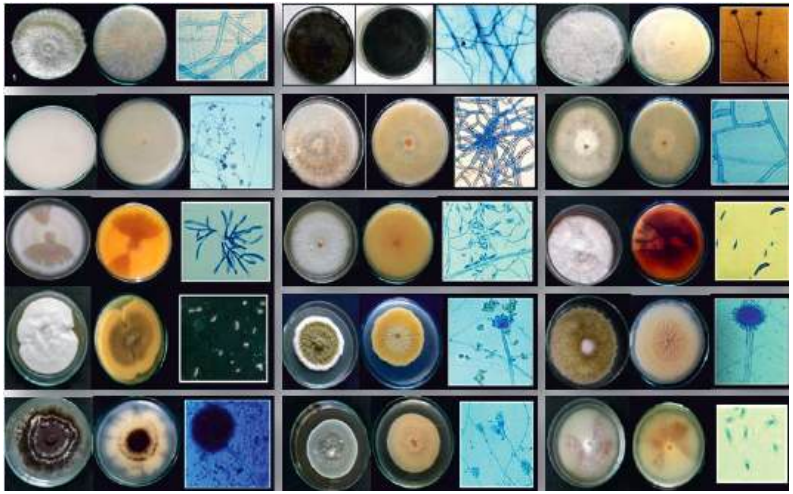

Chrysomelid beetle (*Sphenoraia hopei*)

Vine borer (*Omphisa anastomosalis*)



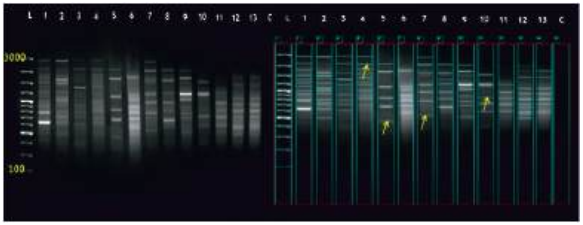
Plant parasitic nematodes isolated from elephant foot yam tubers

- Deciphered pathogens associated with postharvest rot in elephant foot yam



- Cassava biotype and sweet potato biotype of *Bemisia tabaci* were identified for the first time

- Two biotypes of cassava whitefly (*Bemisia tabaci*), Asia II5 and Asia I were reported in cassava
- Endosymbiotic bacteria, *Arsenophonus* found in Asia II5 is an 'indirect helper' for virus spread by protecting viral coat protein from degradation in insect system with their GroEL chaperones



Unique bands showing Asia II5 and Asia I genetic variants of *Bemisia tabaci*

2. Tools/ Protocols for early diagnosis of diseases of tuber crops

- Developed following diagnostic tools for major viruses and fungal pathogens infecting tropical tuber crops in India

Sl.No	Crop	Pathogen	ELISA	DIBA	LFD	PCR/RT-PCR	qPCR	LAMP	RCA	NASH
1	Cassava	ICMV	✓	✓		✓	✓	✓	✓	✓
		SLCMV	✓	✓		✓	✓	✓	✓	✓
		Phytophthora palmivora				✓	✓			✓
2	Sweet potato	SPFMV	✓	✓	✓	✓		✓	✓	✓
		SPLCV				✓			✓	
3	Yams	YMV	✓			✓				

		YMMV	✓			✓				
		CMV	✓	✓	✓	✓	✓	✓	✓	✓
		DBV	✓	✓		✓				
		Colletotrichum gloeosporoides				✓	✓	✓		
4	EFY	DsMV	✓	✓	✓	✓	✓	✓	✓	✓
		Sclerotium	✓	✓	✓	✓	✓	✓	✓	✓
5	Taro	DsMV				✓	✓			✓
		Phytophthora colocasiae	✓	✓	✓	✓	✓	✓		✓

ICMV- *indian cassava mosaic virus*; SLCMV-S*ri Lankan cassava mosaic virus*; SPFMV- *Sweet potato feathery mottle virus*; SPLCV- *Sweet potato leaf curl virus*; YMV- *Yam mosaic virus*; YMMV- *Yam mild mottle virus*; CMV- *Cucumber mosaic virus*; DBV- *Dioscorea bacilliform virus*; DsMV- *Dasheen mosaic virus*

RT-LAMP

Dip stick

Dasheen mosaic virus ELISA kit

- Developed rapid screening techniques for locating resistance against taro leaf blight and collar rot

- Developed CTCRI formulation for growth promotion and pathogen suppression Water (10 l), Cow urine (2 l), neem cake (1kg), 21 numbers of leaves of each, neem, bel, custard apple, peepal, eucalyptus and castor were taken in an earthen pot, mixed thoroughly and the

mouth was tightly tied with polythene sheet and allowed to decompose and ferment for 3 weeks. Finally it was filtered with muslin cloth and diluted to 100 l before aplication

- Studied epidemiology of taro leaf blight and disease progression

3. Integrated and organic management strategies for pests and diseases

- Integrated disease management techniques for cassava tuber rot, CMD, greater yam anthracnose, collar rot and post harvest rot of elephant foot yam and taro leaf blight were developed. Adhoc recommendations for cassava stem and root rot and stem and leaf rot of EFY were developed





- Organic management of collar rot and postharvest rot in elephant foot yam


- Pheromone technology based IPM for sweet potato weevil (SPW)
- IPM developed for whitefly, mealy bug, scales, mites, spiralling whitefly, sweet potato weevil and storage pests


Indigenous pheromone technology for the management of sweet potato weevil

- Organic management practices for the management of greater yam anthracnose, collar rot and post harvest rot of elephant foot yam and taro leaf blight were developed.



4. Technologies for production of bioformulations

- Developed three biopesticides from cassava crop residues- *Nanma, Shreya* & *Menma* from cassava which is effective against pseudo stem weevil in banana & sucking pests in vegetables


Biopesticide Extension Unit

Nanma, Menma, Shreya

Patent for Biopesticides extraction unit

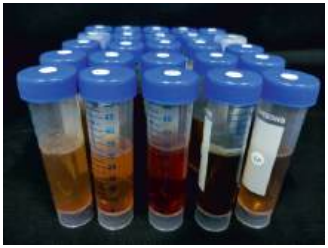
Patent No **:** 368943; **Doi** : 09.06.2021

Valid up to : 04.03.2032

Commercialized: Green Edge Agri Imports Pvt Ltd, Tiruchirappalli, TamilNadu (Rs. 5.9 lakhs)-2023

- Cassava tuber based medium for the multiplication of *Trichoderma* and vegetable waste based liquid formulation for an endophyte, *Bacillus subtilis* were developed for managing TLB, collar rot and greater yam anthracnose

Cassava tuber based medium



Vegetable waste based liquid medium

- Identified new strains of entomopathogenic nematodes, *Heterorhabditis* sp. and *Steinernema* sp. for pest management in tuber crops

Galleria cadaver killed by *Steinernema siamkayai*

- Proved the compatibility of *Trichoderma asperellum* with fungicides, insecticides, weedicides and fertilizers

5. Protocol for production of virus free plants of tropical tuber crops

- Protocols developed for production of virus free cassava, sweet potato, greater yam and elephant foot yam

Lateral bud-sprouted | Friable callus | Microshoots | *In vitro* plants | *In vitro* rooting | Hardened plant

Virus free elephant foot yam explant production

Meristem Virus free plantlet Micro propagation Hardening

Virus free cassava production

Virus free greater yam production

6. Sources of resistance for pests and diseases of tropical tuber crops

Cassava

- CMD resistant varieties (Sree Reksha, Sree Sakthi, Sree Suvarna, Sree Kaveri, PDP-CMR-1)
- CMD & CBSD – KBH 26/18 & Hybrid18-2 (KBH26/18XTME3)

Sweet potato -

- Wild species of tuberous *Ipomoea mauritiana* - against sweet potato weevil

Sweet potato

- Cultivar, Sree Bhadra was identified as a resistant trap crop for managing nematodes

Taro

- Muktakeshi and germplasm accessions (C-618, C-717, E-10, C-388, C-370,C-690, C-679, C-84, C-203 and U-8) – against leaf blight

Elephant foot yam

- Germplasm accessions (3No- Am-1, Am-128 & AmW-22) against collar rot

Yam

- Sree Karthika & Sree Keerthi – against anthracnose

7. Biotechnological interventions in pest and disease management viz., transgenic plants and genome editing

- Developed genetic transformation protocols for cassava and elephant foot yam
- Transgenic cassava (cv.H165) having RNAi construct for resistance against Sri Lankan cassava mosaic virus
- Role of micro RNAs in cassava mosaic disease development and recovery

Differential response of cassava cultivars to virus infection

- Full genome sequences were made for Indian cassava mosaic virus (2), Sri Lankan cassava mosaic virus (4), sweet potato leaf curl virus (6) and dasheen mosaic virus (1)
- Full genome sequence of taro leaf blight pathogen *Phytophthora colocasiae* and an endophytic biogeny bacillus subtilis
- Infectious clones of ICMV, SLCMV and SPLCV were developed
- Recombinant clones of coat protein gene of SLCMV, SPFMV and DsMV were developed in bacterial expression system for antibody production
- Transcriptomic analysis was done with *Cassava mosaic virus* and *Dasheen mosaic* virus infected samples and elucidated the gene expression during infection
- Sago as gelling agent in tissue culture medium in lieu of agar-agar

Barcode generated for cassava whitefly (*Bemisia tabaci*)

8. DNA barcoding of insect pests

- Barcodes were developed for the pests, cassava and sweet potato whitefly, spiralling whitefly infesting cassava and arrowroot, sweet potato leaf miner

9. Identified antimicrobial molecules from endosymbiotic bacteria associated with insects and nematodes

- Nineteen bioactive molecules were isolated and identified from the endosymbiotic bacteria associated with nematodes
- Novel isomers of cyclo (pro-leu), cyclo (pro-tyr) and stilbene derivatives were identified to have antibacterial and antifungal activities
- The structure of these compounds were elucidated as diketopiperazine derivatives which have good cytotoxic activity

10. Multipronged rhizospheric and endophytic biogents for pathogen suppression and growth promotion

- Demonstrated utilization of bio-agents for pathogen suppression (TLB, Collar rot and anthracnose) and growth promotion

Screening → Characterisation → Growth promotion (IAA) → NPK activity

Formulation ← Field assessment ← Disease suppression & Growth promotion (Pots)

Facilities and Infrastructure

Laboratories

- Molecular plant pathology lab
- Disease diagnostic lab
- Microbiology lab
- Virus elimination lab
- Plant pathology lab
- Plant virology lab
- Transgenic lab
- Biotechnology lab
- Entomology lab
- Nematology lab
- Biopesticides lab


Molecular plant pathology lab


Disease diagnostics Lab


Microbiology lab


Virus elimination lab


Plant Virology lab


Transgenic lab


Biotechnology lab


Entomology lab


Biopesticides lab

Equipments

- ELISA Reader
- Thermal cycler
- Real time PCR
- Gel electrophoresis unit
- Image analyser
- Hybridization oven
- Nanodrop spectrophotometer
- Referigerated centrifuge
- Referigerated incubator shaker
- Orbital shaker
- Temperature controlled water bath
- Thermo mixture
- Laminar flow
- Compound microscope
- Ice machine
- Helios gene gun
- Deep freezer
- ¯80 ºC Ultra freezer
- Stereo microscope
- Electro antenogram
- BOD incubator
- Autoclave
- pH meter
- Plant growth chamber
- Sett treatment devise
- Lyophilization unit


Real time qPCR


Gel imaging system


Lyophilization unit


Ultra centrifuge


Net house


Transgenic glass house

Other facilities

- Transgenic glass house
- Glass house
- Net house
- Screen house
- Hardening chamber

Technological Products

- Bioformulations - Nanma, Menma, Shreya
- Biocapsules - *Trichoderma asperellum*, *Bacillus sp* (Rhizospheric & Endophytic)
- Sree Pragathi - Trichoderma powder formulation
- Dasheen mosaic virus ELISA kit

External funded Projects

- No. of external funded projects completed : 38 (Rs. 2108.34292 lakhs)
- No. of contract research projects (ongoing : Nil

List of Externally funded projects

Sl.No	Name of the Scientist	Project Title	Funding Agency	Amount (in Lakhs)	Period
1	Dr. C. Mohandas	Nature of resistance in sweet potato and utilization of resistant varieties for the control of root knot nematode	31-1/93-Hort-II dated 03.03.1994	4.37	1994-1997
2	Dr. N.G. Nair	Micropropagation of tuber crops for distribution through mini-kit	Department of Horticulture, Ministry of Agriculture, Govt. of India	10.5	1995-2001
3	Dr. M.S. Palaniswami	Biocontrol agents and semio-chemicals for SPW management	8(34)/95-Hort-II dated 21.05.1996	20.80013	1997-1999
4	Dr. C. Mohandas	Studies on nematodes affecting Cassava	8(35)/95-Hort-II dated 08.02.1996	9.493	1997-1999
5	Dr. M.S. Palaniswami	Natural enemies of Bemisia tabaciGenn. And their potential as biocontrol components of IPM	USIF/USDA	60.1	1998-2003
6	Dr. T. Makeshkumar	Development of transgenic cassava resistant to CMD through pathogen derived resistance	ICAR – CGP-II	25.85170	2001-2003
7	Dr. M.S. Palaniswami	Utilization of Kairomone for SPW management and its potential as a component of Bio-intensive integrated pest management	ICAR, CGP-II	23.82482	2001-2003
8	Dr. P. Rajamma	Isolation, Biological activity and control of pheromone in Araecerus fasciculatus	DST	16.0	2001-2003
9	Dr. C. Mohandas	Formulation of Biopesticides from cassava based starch factory effluents	ICAR,CGP-II	29.13624	2001-2003
10	Dr. C. Mohandas	Screening plants for pesticidal principles for the formulation of Biopesticides	Science, Technology and Environment Department, Govt of Kerala	2.82	2001-2003

11	Dr. T. Makeshkumar	Development of molecular diagnostics techniques for early detection of Indian cassava mosaic virus	ICAR AP cess fund	9.20	2003-2006
12	Dr. C.A. Jayaprakas	Development of biopesticides from Tropical Tuber Crops against major pests of National Importance	ICAR AP Cess Fund	13.19	2003-2005
13	Dr. T. Makeshkumar	Development of mosaic resistant transgenic cassava	ICAR Network Project	196.00	2005-2015
14	Dr. R.S. Misra	Elicitor induced resistance in Colocasia against Phytophthora leaf blight	ICAR (AP Cess fund)	22.89	2005-2008
15	Dr. R. S. Misra	Management of Collar rot and other diseases of Amorphophallus	ICAR (AP Cess fund)	25.34	2005-2008
16	Dr. Vinayaka Hegde	ICAR network project on diagnostics of emerging plant viruses	ICAR Network Project	13.90	2005-2009
17	Dr. C.A. Jayaprakas	Olfacto-response of Sitophilus oryzae and Rhyzopertha dominica to semiochemicals isolated from stored products	KSCSTE	1.265	2006-2007
18	Dr. C. Mohandas	Antineoplastic molecules associated with bacteria from entomopathogenic nematodes	KSCSTE	8.94	2007-2010
19	Dr. R. S. Misra Dr. M. L. Jeeva (2011-2014)	AMAAS (Application of Microorganisms Agriculture and Allied Sectors) project on Isolation and development of Plant growth promoting organisms from high productivity regions of tropical tuber crops	ICAR Network Project	115.93	2007-2014
20	Dr. M.L. Jeeva	Development of virus free greater yam through molecular based techniques	DBT	28.73	2007-2010
21	Dr. M. L. Jeeva	Molecular diagnosis of fungal diseases of cassava, taro, Amorphophallus and Yam	ICAR, NFBSRA	77.39	2007-2012
22	Dr. C. Mohandas	Taxonomy and biology of entomopathogenic Rhabditis (Oscheius) sp. and its bacterial symbionts	DST	12.57	2008-2011
23	Dr.C. Mohandas	New bioactive molecules from bacteria associated with novel entomopathogenic nematodes	LSRB	24.88	2008-2011
24	Dr. C. A.Jayaprakas	Management of Coleopteran pests in stored cereals and pulses with biofumigant isolated from cassava	LSRB	14.45	2008-2011

25	Dr. C.A. Jayaprakas	Identification and formulation of insecticidal active principles of cassava seeds	KSCSTE	7.84	2009-2012
26	Dr. R. S. Misra Dr. Vinayaka Hegde (2010-2011) Dr. M. L. Jeeva (2011-2017)	IISR outreach project on Phytophthora, Fusarium and Ralstonia (PhytoFuRa)	ICAR Network Project	157.45	2009-2017
27	Dr. C. Mohandas	Mining and characterization of therapeutically significant bioactive molecules from unique bacteria associated with novel entomopathogenic nematodes.	DST-DPRP	67.84	2010-2013
28	Dr .C. Mohandas	Novel molecules produced by unique bacteria and their bioactivity	DST-DPRP	67.84	2011-2014
29	Dr. C. Mohandas	Novel molecules produced by unique bacteria and their bioactivity	KSCSTE	13.10	2011-2014
30	Dr. C. A.Jayaprakas	Popularization of cassava biopesticide against borer of banana in three districts of Kerala	RKVY	50.00	2012-2014
31	Dr. C.A. Jayaprakas	Participatory technology transfer of based biopesticides for the management of vegetable pests	Department of Agriculture, Govt. of Kerala	30.00	2014-2017
32	Dr. T. Makeshkumar	Indo-Swiss Cassava Network Project	DBT	117.51	2014-2017
33	Dr. C.A. Jayaprakas	ORP on management of sucking pests of horticultural crops	ICAR	05.00	2014-2015
34	Dr. T. Makeshkumar	Disease diagnostics in tropical tuber crops	ICAR- CRP on Vaccines and Diagnostics	227.40203	2015-2024
36	Dr. C.A. Jayaprakas	On-farm trials of cassava biopesticides against borer pests of banana in Kerala	Department of Agriculture & Farmers Welfare, Govt. of Kerala	90.00	2018-2021
37	Dr. C.A. Jayaprakas	Augmentation of biopesticides production from cassava leaves using fully automated manufacturing facilities	Department of Agriculture & Farmers Welfare, Govt. of Kerala	398.00	2019-2021
38	Dr. C.A. Jayaprakas	Radiation technology for quality improvement of tuber crops and management of its by-products	Bhabha Atomic Research Centre (BARC)	40.95	2020-2022
			Grand Total	**2108.34292**	

Student Guidance

Ph.D. Guideship - University of Kerala, IARI, Digital University of Kerala

No. of Ph.Ds completed : 29

No. of Ph.D. Ongoing : 11

Post Doc : 4

List of Ph.D. Scholars Awarded in Crop Protection

Sl.No	Name	Title of Thesis	Year of Award
1	Binu Antony	*Bemisia tabaci* (Genn.) (Homoptera: Aleyrodidae): Ecobiology, Molecular Evidences for Indian Cassava Mosaic Virus Transmission and its Aphelinid Parasitoids with Partial Sequencing of 28S Ribosomal RNA	2004
2	Ganga G.	Sweet potato viruses: Development of molecular based methods for detection.	2009
3	Anitha Jose	Investigations on distribution, intensity and identification of cassava mosaic disease in Kerala	2009
4	Ajay Kumar Mishra	Elicitor induced resistance in taro against leaf blight casued by *Phytophthora colocasiae*	2009
5	Mary Josepha (Shery) A.V.	Role of *Bemisia tabaci* (Genn.) in the transmission of virus from cassava to mulberry and vice versa	2011
6	Kamal Sharma	Molecular marker studies on taro genetic diversity and identification of differentially expressed defense related genes	2011
7	Binoy Babu	Detection, identification and characterization of the viruses causing mosaic in elephant foot yam (*Amorphophallus paenifolius*)	2011
8	Deepa I	Metabolites of bacteria associated with entomopathogenic nematodes.	2012
9	Nishanth Kumar S.	Antineoplastic and antibiotic molecules associated with bacteria from entomopathogenic nematodes	2012

10	Siji J.V.	Pesticidal properties of plants and their utility as biopesticides	2012
11	Ragesh L.	Insecticidal activity of phytochemicals isolated from cassava on the major coleopteran pests of stored pulses.	2013
12	Sreerag R.S.	Biology and management of the Amorphophallus mealy bug, *Rhizoecus amorphophalli* (Betrem) (Homoptera: Pseudococcidae)	2013
13	Anjanadevi, I.P.	Microbial inoculants in elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson) with special emphasis on potassium solubilizers	2014
14	Vishnu S Nath	Role of virulence gene products and biocontrol agents for the management of leaf blight disease in taro caused by *Phytophthora colocasiae*	2014
15	Kamala S.	Diagnosis and management of Dasheen mosaic virus infecting *Amorphophallus paeoniifolius* through biotechnological approaches.	2014
16	Senthil @ Sankar	Biotechnological approaches for tuber rot disease management of cassava	2014
17	Neetha Soma John	Isolation, evaluation and characterization of biocontrol agent for the control of Amorphophallus	2015
18	Sangeetha B.G.	Diversity of entomopathogenic bacteria associated with Rhabditis (*Oscheius*) sp. and identification of metabolites produced by Enterobacteria sp.	2016
19	Mithun Raj	Characterization and diagnosis of *Colletotrichum gloeosporoides* causing Anthracnose/Dieback in greater yam (*Dioscorea alata*)	2016
20	Archana P. V.	Molecular diagnosis and characterization of *Phytophthora colocasiae* causing leaf blight disease of taro	2017
21	Deepthi D.C.	Molecular characterization of symptom recovery in cassava genotypes during cassava mosaic disease infection	2017
22	Pravi Vidyadharan	Molecular diagnosis and characterization of *Sclerotium rolfsii* causing collar rot disease in *Amorphophallus paeoniifolius*.	2017

23	Suja S.P.	Plant growth promoting rhizobacteria (PGPR) associated with Cassava and their use for the management of cassava mosaic disease.	2017
24	Jithu U Krishnan	Toxicological studies of the bioactive molecules isolated from cassava (*Manihot esculenta* Cranz.) on banana pseudostem weevil, *Odoiporus longicollis* Oliver.	2017
25	Dhanya Jayseelan	Developing virus resistance in cassava (*Manihot esculenta* Cranz.) by RNA interference	2017
26	Ajitha B. S.	Toxicological studies of cassava (*Manihot esculenta* Crantz.) leaf extract on teleost fish nile Tilapia, *Oreochromis niloticus*	2018
27	Sujina M.G.	Management of taro leaf blight using endophytes from medicinal plants.	2019
28	Prakash Krishnan B.S.	Replicase (AC1) gene mediated resistance in cassava (*Manihot esculenta* Crantz) rgainst Indian cassava mosaic virus	2020
29	Ajesh G	Insecticidal activity of biofumigant isolated from Cassava (*Manihot esculenta* Crantz.) against important insect pests of stored products.	2021

Trainings / Conference / Brainstorming / Webinar

- ICAR-NAIP training on molecular diagnostics for pathogens infecting crop plants
- National symposium on pathogenomic for diagnosis and management of plant diseases
- Brainstorming on cassava mosaic disease
- International webinar on cassava viruses-global status and strategies for disease control and prevention
- Brainstorming on cassava mealy bugs
- National symposium on plant health management: current trends and novel mitigation strategies
- National training on diagnosis of plant diseases through novel approaches

Important Awards and Recognition

Sl.No.	Award
1	Jawaharlal Nehru Award for Best Ph.D thesis
2	Department of Biotechnology overseas associateship
3	Prof. S.N. Dasgupta Memorial Award (Indian Phytopathological Society)
4	Fellow of Indian Phytopathological Society
5	Fellow of Indian Virological Society
6	Fellow of Entomological Society of India
7	Member, Task force - DST
8	Insitute Biosasety Committe • DBT nominee-ICAR-IISR, ICAR-NRCB • External member-ICAR-IISR, KAU
9	Member, Expert committee to formulate guidelines for identifying Endosulfan victims in state of kerala
10	Member, Kerala state award committee of department of agriculture
11	Kerala state farm scientist award
12	Best poster presentation award
13	Best oral paper presentations award
14	Young scientist award for presentations

Technology Commercialization

- Biopesticides from cassava leaves licensed to Green Edge Agri Imports Pvt. Ltd., Trichy
- Contract manufacturing of biopesticides with Six KVKs

Patents

- Biopesticides extraction unit - Patented technology [Patent No: 368943; Date of grant – 09.06.2021]

Technology certification by ICAR, New Delhi

- Integrated management package for postharvest rot in elephant foot yam (Lead developer)
- Organic management package for postharvest rot in elephant foot yam (Lead developer)

Technologies included in State Package of Practices (Kerala)

- Organic management of taro leaf blight
- Organic management of collar rot in EFY
- Organic management of postharvest rot in EFY

Aspirations

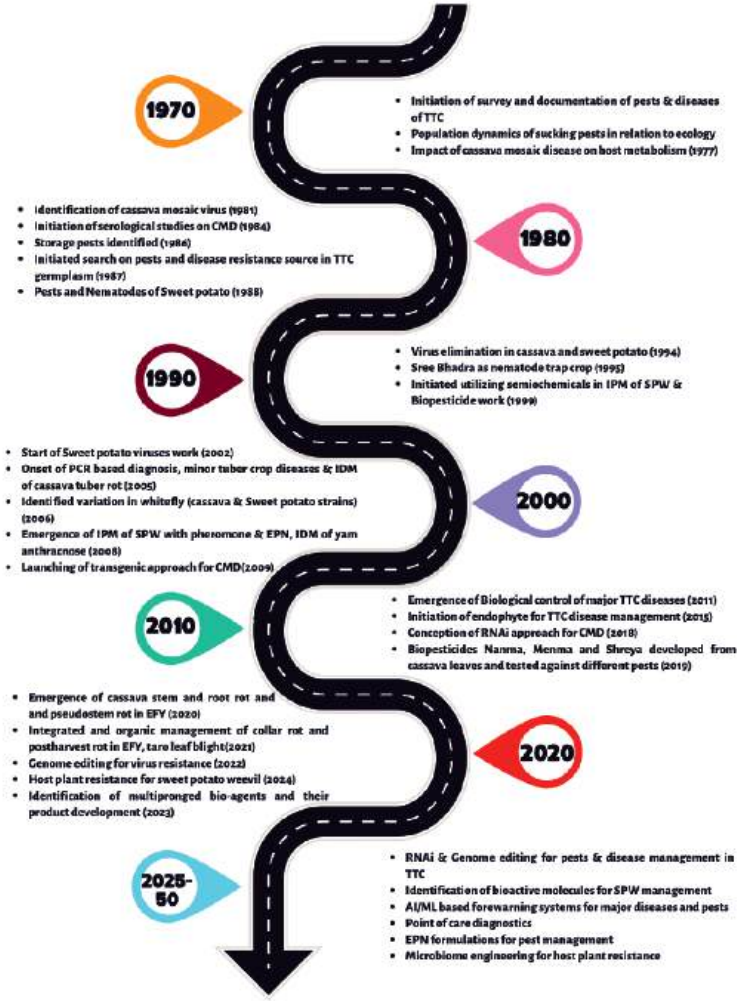
Integrated pest and disease management through eco-friendly strategies involving diagnosis, surveillance, decision support system and bio-intensive approaches for sustainable production and returns to tropical tuber crops

- Deciphering the pathogen / pest and developing management strategies for emerging problems
- Studies on soil factors, nutrient status and microbiome on disease incidence
- Strategies for developing agro based bio-formulations
- Decision support systems for major pest and diseases
- Comparative genomic studies for elucidating the genes involved in important pest and disease problems
- Developing apps for quick identification of pest and diseases using AI tools
- Development of management strategies for pests & diseases of tuber crops including traditional, biological and biotechnological approaches
- Application of next generation biotechnological tools (RNAi & Genome editing) for developing resistance to pest and diseases of tuber crops
- Role of small RNAs in viral diseases of tropical tuber crops
- Elucidating the molecular events leading to disease development in tropical tuber crops (CMD, DsMV, TLB)
- Identification of different miRNA, mRNA and genes in *Ipomoea* spp for weevil resistance
- Identification of genetic factors / pathways associated with kairamone production in sweet potato

Action Plan

- Investigations on pathogens /pests associated, characterization & devising suitable management options
- In depth study on soil factors correlated with soil borne diseases
- Screening and validation of fungicides / insecticides/nematicides, bio-agents, botanicals etc.
- Validation of DSS (Decision support system) for TLB and development of DSS for leaf and pseudostem rot in elephant foot yam
- Study on small RNA involved in disease development and matching with transcriptomic data and validation of result to elucidate the role of different genes and their network
- Testing of microbes (fungi and bacteria) for their role in managing the virus diseases and commercialization of the best one
- Genome editing in sweet potato (*Ipomoea batatas* L.) for sweet potato weevil resistance by CRISPR/Cas9 system
- Identification of candidate genes from wild *Ipomoea* sp. for developing host plant resistance in sweet potato against sweet potato weevil
- Development of eco-friendly pest management strategies for the management of nematodes in tuber crops
- Identification of potential isolates of entomopathogenic nematodes for management of pests

Milestones and Vision



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