



ACP Research for Sustainable
Development (Caribbean and Pacific)

Developing sustainable disease management strategies to improve vegetable production towards self-sufficiency and food security in the Caribbean region



Regional Sustainable Plant Disease Management Workshop on vegetables, UWI, St. Augustine, Trinidad and Tobago (June 2016).

SUMMARY OF RESULTS

Disease assessment surveys for tomato, cowpea and pumpkin were carried out in Trinidad and Tobago, St. Vincent and Grenadines and Guyana: disease incidences were recorded and new diseases identified. For full proof identification of diseases, several classical and advanced DNA-based diagnostic methods were developed and optimised for all the pathogens observed. Integrated Disease Management (IDM) methods were then developed and demonstrated in farmer's fields, and were found to be more economical and environmentally sustainable compared to conventional disease management methods. The disease diagnosis methods and IDM practices were transferred to agricultural officers, researchers, lead farmers and representatives of NGOs involved in sustainable agriculture in the Caribbean. The Plant-Microbe research laboratory at UWI continues to assist vegetable growers, the Ministry of Agriculture and farmer associations on diagnosing plant disease problems. Elite seed lines of tomato, cowpea and pumpkin were collected and preliminarily tested for disease resistance.

BACKGROUND

For the Caribbean region, there is no published data-based evidence on the list of diseases prevailing in major vegetable crops (tomato, *Solanum lycopersicum*, cowpea, *Vigna unguiculata*, and pumpkin, *Cucurbita pepo*) including emerging diseases which were possibly introduced from outside the region or transported between the islands, through breeding of pathogens or as an effect of climate change phenomenon. This may be related to the absence of a permanent tracking mechanism or system (like trap plots) to monitor the prevalence of pathogens. There is also limited technical and infrastructural capacity available in crop disease diagnosis and pathogen detection, and this is likely the reason for the absence of effective disease management systems. Vegetable growers are unaware or sceptical of integrated disease management (IDM) practices and sustainable disease management practices involving minimum chemical usage. Growers currently practice control methods which are primarily chemical dependent and less sustainable. The use of chemicals needs to be limited by incorporating multiple treatments and approaches in the form of IDM systems for individual crops. Adoption of IDM systems will, therefore, make plant protection strategies more sustainable, environmentally friendly and economically sound.

The project has:

- quantified the prevalence of diseases of tomato, cowpea and pumpkin in the Caribbean region through disease assessment surveys and disease management trials;
- developed tools and techniques for early and efficient diagnosis of plant diseases;
- developed IDM practices for growers with respect to field and post-harvest diseases;
- established a varietal collection of locally grown as well as of exotic vegetable cultivars for continual performance and disease resistance evaluation.

The acquired knowledge was transferred to farming communities (farmers and farmers' organisations) and agricultural extension personnel (mainly public) through training events and information networks.

The direct beneficiaries of the project results were: growers' associations and small farmers' groups; agriculture ministries / divisions of the Caribbean member states; vegetable processing units; vegetable marketing associations; small agri-business owners; agricultural co-operatives; consumer associations and universities.

GRANT

EUR 498,970.00

PROJECT IMPLEMENTATION PERIOD

August 2012 – September 2016

CONSORTIUM

- The University of the West Indies (UWI), Trinidad and Tobago
- National Agricultural Research and Extension Institute (NAREI), Guyana
- Ministry of Agriculture, Rural Transformation, Forestry and Fisheries, St. Vincent and the Grenadines

PROJECT CONTACT

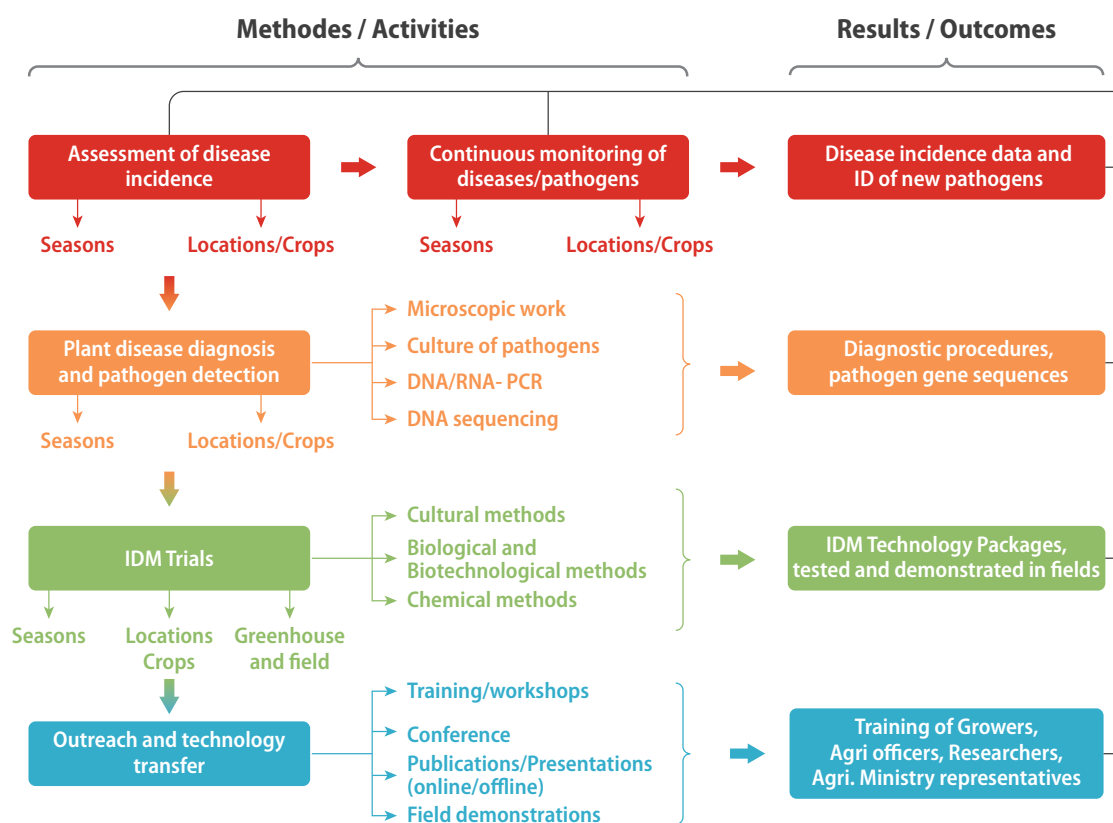
Prof. Jayaraj Jayaraman
The University of the West Indies (UWI)
Faculty of Science and Technology
Department of Life Sciences
St. Augustine Campus
St. Augustine
Trinidad and Tobago
Tel: +1-868-662-2002 ext. 83092
jayaraj.jayarajan@sta.uwi.edu
www.sta.uwi.edu

FACEBOOK

Plant-Microbe ACP EU



METHODOLOGY



Assessment of disease incidence

- Extensive field surveys were conducted in the Eastern and Southern Caribbean region (Trinidad and Tobago, Guyana, Barbados, St. Vincent and Grenadines, St. Lucia, Dominica, Antigua and Grenada) on the prevalence of diseases in the vegetable crops tomato, cowpea and pumpkin.
- The diagnosed plant diseases were verified for the causal agents by laboratory analysis involving pure culture / microscopy and molecular methods.
- Permanent trial plots were established at multiple Caribbean locations (Trinidad and Tobago, St. Vincent and Grenadines, and Guyana) to constantly track the activity of pathogens.
- Interviews and baseline surveys were conducted in the cropping regions for collection of data on disease incidence, pesticide usage, disease management methods and cultivation practices.

Plant disease diagnosis and pathogen detection

Development of disease / pathogen diagnostic tools

- Disease / pathogen diagnostic tools were developed, including oligo nucleotide primers, and polymerase chain reaction (PCR) procedures which can be used for DNA and RNA-PCR techniques.
- The PCR diagnostic methods were optimised by laboratory work.

IDM Trials

Field and greenhouse experiments

- Field and greenhouse experiments were conducted to develop and evaluate integrated disease management (IDM) practices which include cultural, biological, chemical and non-conventional methods. Treatments comprising of inputs including soil amendments, biological agents, plant products, micronutrients, elicitor compounds and plant activator biomolecules were evaluated. Chemicals with low residual toxicity, broad spectrum of activity and possessing minimum environmental risks were screened and suggested for needs-based use.
- Demonstration plots were laid out in farmers' holdings for method demonstration and evaluation of efficiency by farmers themselves.

Collection of crop varieties, local selections and clones

- Crop varieties, local selections and clones of the vegetable crops were collected from the Caribbean and maintained at UWI as a collection for future studies on disease resistance screening and growth adaptability.

Outreach and technology transfer

Training workshops

- Government-agricultural field officers, technicians and vegetable growers from the Southern Caribbean were trained through workshops and training programmes on classical and molecular diagnosis of plant diseases and IDM technologies.

Dissemination

- The data on disease incidence and etiology of pathogen occurrence, disease / pathogen diagnostic protocols, and IDM trials and methodologies were published.
- Several publications were produced in several formats (including online) and made accessible to growers, government-agricultural field officers and technicians free of charge, for non-profit use.
- Research results were disseminated at training workshops and conferences conducted by the research group.
- Governmental, educational and research institutions, as well as NGOs and Ministries of Agriculture from Trinidad and Tobago and other southern Caribbean states were advised, through periodical reports and meetings, of the project outputs for possible inclusion in development and formulation of future policy. The importance of IDM practices were emphasised at local, national and regional level. The project partners regularly participated in various outreach meetings and workshops organised by the Ministry of Agriculture and farmers' associations from Trinidad and Tobago.

Stakeholders' participation

- 14 groups: growers' associations and small farmers' groups; agriculture ministries / divisions of Caribbean member states, vegetable processing units; vegetable marketing associations, small agri-business owners; agricultural co-operatives; consumer associations; UWI; University of Guyana.

RESULTS

→ Outputs

Disease and pathogen identification

- 5 databases on diseases and disease management.
- 4 identification keys on diseases and pathogens.
- Novel strains of viruses.
- Simple, fast and accurate RNA/DNA-based pathogen / disease diagnostic methods.

Crop protection

- Multiple low-cost organic crop protection methodologies.
- IDM components of major vegetable crops (efficiency demonstrated in the field).
- IDM methods involving cultural, biological and chemical methods and technologies evaluated under field conditions and demonstrated to farmers.

Collections

- Local germplasm for conservation and future varietal improvement research.

Capacity building

- 6 training workshops on disease identification and IDM methods: 150 participants (60 female, 90 male) - farmers, agricultural extension officers, technicians, public servants and researchers.

Recommendations

- List identifying high toxicity and persistent chemicals to avoid their usage in regular cropping.
- Judicious usage of low toxic and low persistent chemicals for the agriculture ministries of Southern Caribbean states.
- Minimum usage of chemicals in farming systems for government-agricultural field officers, technicians and researchers.

Documents

- 4 technical manuals on disease and pathogen identification and IDM prepared and distributed to agricultural personnel.
- 55 published research publications: research papers, reports, brochures, posters, research abstracts, proceedings, book articles, review articles, newspaper articles.

Presentations

- 33 presentations (oral / posters) at 13 international conferences.
- 10 seminar / guest lectures.

Visibility

- 4 press releases.

Publications (examples)

- Ramkissoon A., Francis J., Bowrin V., Ramjagathesh R., Ramsubhag A., Jayaraj J., 2016. Bio-efficacy of a chitosan based elicitor on *Alternaria solani* and *Xanthomonas*

vesicatoria infections in tomato under tropical conditions. *Annals of Applied Biology*. DOI: 10.1111/aab.12299 (John Wiley).

- Ramkissoon A., Ramsubhag A., Jayaraj J., 2017. Phytoelicitor activity of three native seaweed species on suppression of tomato diseases in Trinidad, West Indies. *Journal of Applied Phycology*. DOI: 10.1007/s10811-017-1160-0 (Springer) (In Press).

- Ali N., Ramkissoon A., Ramsubhag A., Jayaraj J., 2016. *Ascophyllum* extract application causes reduction of disease levels in field tomatoes grown in a tropical environment. *Crop Protection* (Elsevier) 83: 67-75. DOI: 10.1016/j.cropro.2016.01.016

- Chinnaraja C., Ramkissoon A., Ramsubhag A., Jayaraj J., 2016. First report of whitefly-transmitted Tomato yellow leaf curl virus infecting tomato in Trinidad. *Plant Disease (APS)* DOI: 10.1094/PDIS-09-15-0988-PDN

- Chinnaraja C., Ramkissoon A., Rajendran R., Tony S.T., Ramsubhag A., Jayaraj J., 2015. First report of Zucchini yellow mosaic virus and Squash mosaic virus infecting cucurbits in Trinidad. *Plant Disease (APS)*. DOI: 10.1094/PDIS-09-15-0988-PDN

- Ali N., Farrell A., Ramsubhag A., Jayaraj J., 2015. The effect of *Ascophyllum nodosum* extract on the growth, yield and fruit quality of tomato grown under tropical

conditions. *Journal of Applied Phycology* (Springer). DOI: 10.1007/s10811-015-0608-3

- Jayaraj J., 2018. Induced resistance - a sustainable biotechnological approach of plant disease management. In: *Plant, Pathogens and People*. Editors, P. Sharma et al., Indian Phytopathological Society, New Delhi, India. (In Press).

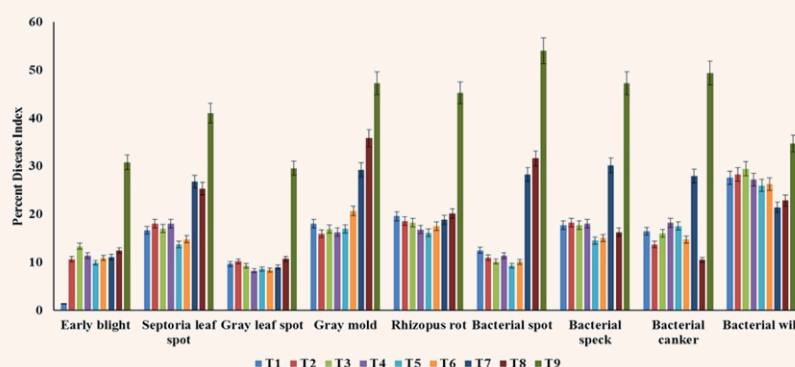
- Jayaraj J., Ali N., 2015. Use of seaweed extracts for disease management of vegetable crops. *Sustainable crop disease management using natural products*, Editors, S. Sangeetha, V. Kurucheve and J. Jayaraj, CABI publications, 160-183.

- Jayaraj J., Alleyne A., 2015. Biocontrol agent formulations for sustainable plant disease control of plants. *Sustainable crop disease management using natural products*, Editors, S. Sangeetha, V. Kurucheve and J. Jayaraj, CABI publications, 213-233.

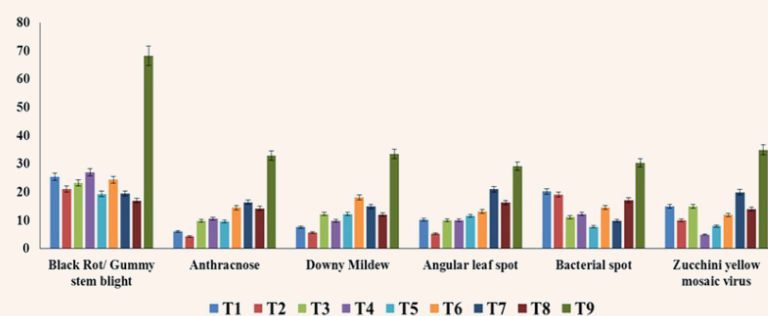
- Rajendran R., Jayaraj J., 2015. Chitosan for plant disease management - Prospects and problems. *Sustainable crop disease management using natural products*, Editors, S. Sangeetha, V. Kurucheve and J. Jayaraj, CABI publications, 198-213.

- Sangeetha S., Kurucheve V., Jayaraj J. (Eds.), 2015. *Sustainable crop disease management using natural products*, CABI publications, 413p. DOI: 10.1079/9781780643236.0000 (Research reference book).

Integrated Disease Management in Tomato



Integrated Disease Management in Pumpkin



X axis represents different types of diseases prevalent in the crop during the experimental trial. T1-T8 are different sets of IDM treatments which incorporated cultural, biological and chemical methods. T9 is the negative control. Y axis represents percent disease incidence in tomato and pumpkin crop after application of treatments.

RESULTS

Outcomes

- Increased awareness on prevalent diseases in the region, their symptoms, causal agents and vectors by lead vegetable growers, government-agricultural field officers, technicians and researchers.
- Vegetable growers and agricultural officers able to track the prevalence of diseases by trap plots and surveys.
- Increased knowledge of agricultural officers, technicians and students on contemporary DNA/RNA-based diagnoses.
- Agricultural officers, technicians, research personnel and students able to apply molecular techniques for pathogen detection and disease diagnosis.
- Improved understanding of vegetable growers and agricultural officers on the importance of IDM practices as the only meaningful way for sustainable disease management and strategy to improve quality food production.

Impacts

Usage

- By practicing IDM methods which involve cultural, biological and chemical treatments, vegetable growers will cut down the use of chemicals (by at least 50% for those having participated in the project). They will use more cultural and biological methods, avoid the use of more toxic chemicals and replace these with low residual toxic chemicals.
- Farmers and agriculture ministries will continually monitor the diseases by means of trap plots.
- Cultural and biological based crop disease management methods will be increasingly adopted by growers to minimise the input costs.

Policy implications

- Ministries of Agriculture, Health and Environment and NGOs active in agriculture and food safety are convinced of the ill effects of chemical-based farming systems and will be developing policies to encourage sustainable farming methods and food production.
- Consumers are made aware of the ill effects of chemicals and can demand quality produce and may support the food produced through IDM systems.

Sustainability

- Farmers are interested to participate in further experimental research and adopt new farming methods.
- Farmers were taught and trained to use

only permitted and less toxic chemical fungicides which in fact resulted in low demand for highly toxic chemicals. Agrochemical dealers are also moving towards marketing alternative inputs and improved plant varieties.

- The Agricultural Society and the Ministry of Agriculture in Trinidad and Tobago have become lead beneficiary organisations. This will lead to a shift in farming technologies through internal training and outreach.
- UWI continues to provide technical and intellectual assistance.
- UWI continues to pursue research and outreach activities connected to sustainable disease management through other research initiatives and grants.

TESTIMONIALS



Alfred Koondaya, vegetable grower, Valencia, Trinidad

“The researchers in this project have worked with me for the past 4 years. They conducted several field experiments on my farm. I was very interested to learn about the new IDM practices developed through the project. I have followed these practices for the past 2 years when growing cowpea, sweet peppers and tomatoes. The quality of produce is extremely good. I am now able to export some of my sweet pepper which has brought me big revenue. This was all possible due to the new IDM methods developed by the researchers. I really owe a big thanks to them and I am very interested to continue to assist them in other research projects.”



Angela Laltoo, vegetable grower, Trinicity, Trinidad

“I have been farming on 10 acres of land for the past 35 years. Up until 2013, I was using routine methods of disease management which involved the continuous use of chemicals. The researchers in this project explained to me about the ill effects of chemical-based systems. They taught me the IDM methods which I have been using since 2015 and I am getting very good yields and high quality produce harvest of cowpea, pepper, tomatoes, eggplant and crucifers. I am now saving a lot of money by cutting down my costs spent on chemicals, and my friends and neighbouring growers are doing the same. I am very happy that I was able to learn about the new technologies from them which fully changed my way of growing crops. I am very enthusiastic to continue working with them in the future towards the betterment of growers and the country.”



**Deanne V. Ramroop
Deputy Director Research Crops, Ministry of Agriculture, Land and Fisheries (MALF), Trinidad and Tobago**

“I have benefited immensely from the workshops with lectures and hands-on training highlighting research work in a range of relevant areas. They were participatory, interactive and allowed for the exchange of information. The knowledge gained was shared with the agricultural professionals involved with plant disease diagnosis and management at our Ministry and further disseminated to the farming community. The research work is very timely and relevant. It will allow farmers to improve their crop management practices leading to improved production efficiency and subsequent reduction in costs. Beyond training, the UWI team is maintaining a very good working relationship with our Ministry in responding to our technical needs.”

