

Update on invasive species work in the region with specific reference to recent incursions

Litta Paulraj

Caribbean Agricultural Research and Development Institute, P O Box 64, Cave Hill Campus,
University of the West Indies, St. Michael, Barbados

ABSTRACT

The Caribbean region provides many ports of entry both for the travellers and commodities. These multiple entry points expose the region to the invasion of unwanted species of plants, animals, pests and diseases. The number of incidences of invasive species infiltration in the region is increasing. This poses a threat to the region's agriculture, biodiversity, trade and tourism. The regional economies depend on the above mentioned sectors. There are many instances in which an invasive organism enters an island and establishes itself. It is important to manage the newly entered species in a manner so as to cause minimum damage to the ecosystem and to the environment. CARDI has been a leading organisation in the implementation of management programmes to control invasive species. CARDI's research teams through integrated pest management programmes achieved success in many instances. This paper discusses the work conducted by CARDI and some of the ongoing programmes.

INTRODUCTION

Invasive species get introduced into the islands intentionally or unintentionally. A compilation by Kairo et al., 2003 listed 552 invasive species and 416 naturalised and /or invasive in the insular Caribbean. Some examples of invasive species that have entered / re-emerged and become an established threat to the region's agriculture include the Pink Hibiscus Mealybug, *Maconellicoccus hirsutus* (Green); Papaya Mealybug, *Paracoccus marginatus* (Williams); *Thrips palmi* (Karny); *Bemisia tabaci* (Gennadius) (B biotype); Citrus Leaf Miner, *Phyllocnistis citrella* (Stainton); Brown Citrus Aphid, *Toxoptera citricida* (Kirkaldy); Citrus Blackfly, *Aleurocanthus woglumi* (Ashby); Imported Red Fire Ant, *Solenopsis invicta* (Buren); Coconut Whitefly *Aleurodicus pulvinatus*; Coconut Mite, *Eriophyes guerreronis* (Keifer); Coconut Red Palm Mite, *Raoiella indica* (Hirst); Varroa Mite *Varroa destructor* (Anderson and Trueman) and Tropical Bont Tick, *Amblyomma variegatum* (Fabricius) to name a few.

CARDI'S CONTRIBUTION TO INVASIVE SPECIES CONTROL PROGRAMMES IN THE REGION

Pink Hibiscus Mealybug

The Pink Hibiscus Mealybug was found in the Caribbean in 1994 for the first time. Despite heightened quarantine efforts the mealybug spread quickly within the region. In 1995 a regional action programme was developed which had a biologically based management focus (Gautam

1996, McComie 1996). CARDI identified an expert from the Indian Research Institute, Dr. R D Gautam and the programme was instituted using biological control agents, the ladybird beetles *Cryptolaemus montrouzieri* (Mulsant), *Scymnus coccivora* (Aiyar) and parasitic wasps *Anagyrus Kamali* (Moursi) and *A. dactylopi* (How). The biological control agents were successful in controlling the pink mealy bug.

Whitefly and whitefly transmitted geminiviruses

Three vector species, namely, *Trialeurodes abutilonea* (Haldeman), *T. vaporariorum* (Westwood) and *Bemisia tabaci* (Gennadius) are known to occur in the Caribbean and Central America. *B. tabaci* is probably the most challenging and has invaded territories throughout the Americas and the Caribbean. Over 900 host plants have been recorded for *B. tabaci* and it reportedly transmits 111 virus species (GIS database). In Latin America and the Caribbean, *B. tabaci* is a pest of at least 17 crops both as a vector of geminiviruses and/or as a direct pest (Brown 1992). In a priority setting exercise, whitefly and whitefly-transmitted geminiviruses was identified as a priority, common to 13 of 16 member countries of PROCICARIBE Caribbean Integrated Pest Management Network (CIPMNET). Scientists throughout the region have actively researched various aspects of this pest complex and its management. In 2002, CARDI was contracted under the EU-CARIFORUM Integrated Pest Management Project to conduct an information gathering exercise to compile all the information on past and current research activities within the region on whitefly and whitefly-transmitted geminiviruses. This exercise was based on the identification that there was not enough information sharing amongst researchers within the region which forfeits the benefits of collaborative research on common issues. An analysis of the inventory of activities also facilitated a gap analysis that could guide the planning of future research to address existing needs.

Coconut Lethal Yellowing

Technical assistance from CARDI was sought by Nevis in 2004 to identify the cause of coconut and other palm diseases in Nevis. CLY was confirmed in Nevis in 2005. (Myrie and Paulraj 2006). The disease is caused by a phytoplasma transmitted by the vector planthopper (*Myndus crudus* Van Duzee) which completes part of the life cycle in grasses; it affects more than 35 species of palms. Coconut Lethal Yellowing has infected coconut palms and other ornamental palms in Nevis and is a disease of quarantine importance. In the Caribbean chain of islands this disease was first reported in Jamaica, but prior to its establishment in Nevis it had been confined to the Greater Antilles. There is no report to date of the disease in the Windward Islands. The spread of the disease to the Leeward Islands however causes tremendous concern. Through the CARDI work programme in St Kitts and Nevis technical assistance for the control of coconut lethal yellowing disease is being provided. A comprehensive control strategy has been developed and is being implemented.

Pepper viruses

CARDI has a hot pepper germplasm collection of some 120 accessions from the Caribbean and beyond. The hot pepper industry is important to the region, but the hot pepper farmers in the region are continuously affected by yield losses due to viruses. In Barbados ten viruses have been reported, they are Cucumber Mosaic Virus (CMV), Chilli Veinal Mottle Virus, Potato Virus Y, Tomato Mosaic Virus, Pepper Mild Mottle Virus, Tomato Spotted Wilt Virus, Watermelon Silver Mottle Virus, Broad Bean Wilt Virus, Tomato Chlorosis Virus and Tomato Infectious Chlorosis Virus (Roberts and Paulraj, 2005). The two major viruses are Cucumber Mosaic Virus

and Potato Virus Y, more than 50 % of the samples from the CARDI trials tested positive for these viruses. Screening of the accessions for the resistance/tolerance is continuing. Once the potential candidate for hybridisation is identified aggressive breeding programme will be implemented.

Chilli Thrips

Reported in Barbados, Jamaica, St. Lucia, St. Vincent, Tobago and Trinidad (Hodges et al, 2005) Chilli Thrips (*Scirtothrips dorsalis* Hood) (Thysanoptera: Thripidae) has a wide host range. More than 100 plant species are known to be affected. Through the CARDI regional hot pepper programme technical assistance is being provided to the affected farmers for control.

Coconut Red Palm Mite

Coconut Red Palm Mite, *Raoiella indica* is a pest of coconut, areca palm, and date palms in tropical and subtropical regions. In the Western Hemisphere it was first reported in Martinique (Flechtmann and Etienne 2004). It has since been confirmed in St Lucia (2005), Dominica (2005), Trinidad (2006) (Wellbourne 2005).

Infestation was observed on banana plants (*Musa* spp., Musaceae) in Dominica and Trinidad with additional infestations observed on heliconias and gingers. This pest is a possible threat to the entire Caribbean region, North and South America.

CARDI provided the technical assistance in the identification of the pest and biometric support for the survey for the pest in Dominica. CARDI has set up an e-mail list server to enable the researchers in these three countries to talk to each other and to experts from the United States Department of Agriculture Animal and Plant Health Inspection Service and from CAB International.

Black Sigatoka

Black Sigatoka has been reported in Trinidad (Fortune et al, 2005). The causative agent is the fungi, *Mycosphaerella fijiensis* Morelet. This disease is threatening the Windward Island banana industry. The disease presence in Trinidad has caused St Lucia to stop the import of fresh produce from Trinidad. CARDI assisted St Lucia with a surveillance exercise to look for Black Sigatoka in that country and the disease was not found

Citrus Tristeza Virus

CARDI Dominica in collaboration with that country's Ministry of Agriculture and the Environment is evaluating resistance to citrus rootstocks and rootstock/scion combinations. This programme is ongoing.

Nutmeg Root Rot

CARDI with assistance from the CARIFORUM Agribusiness Research & Training Fund (CARTF) and in collaboration with Grenada Co-operative Nutmeg Association (GCNA) and Ministry of Agriculture, Lands, Forestry and Fisheries embarked on a project in 2002 to determine the causal agent/s and to develop a control strategy for a wilt disease of nutmeg (*Myristica fragans* (Houtt)) in Grenada. The causative organism was identified as an oomycete

Pythium splendens Baut (identified by Dr. John David, CABI). It appears the infection is from soil to roots. It is a fungal root rot disease (CARDI, 2004). The biocontrol agent phosphonic acid was recommended as a control agent.

Giant African Snail

Reported in a few countries in the Caribbean region, *Achatina fulica* Ferrussac is considered to be one of the most damaging snails in the world. It is known to eat many plant species. CARDI participated in an evaluation workshop conducted by FAO on the management of the Giant African Snail in 2004. CARDI scientists in the affected countries work with the ministry of agriculture staff in assisting farmers in the control of Giant African Snail.

Sweet potato pests

Sweet potato is important for the region and CARDI is building an *in vitro* germplasm bank. Currently 30 accessions are established *in vitro* culture and another 25 are being prepared to establish in culture.

In 2001, virus disease symptoms were reported in sweet potato crops in Barbados. The disease is probably caused by a synergistic effect of Sweet Potato Feathery Mottle Potyvirus (SPFMV) and Sweet Potato Chlorotic Stunt Crinivirus (SPCSV). However, other virus combinations may cause similar symptoms. A recent study showed that SPFMV, SPVG and LSU-2 (Louisiana strain) were the major viruses present in sweet potato (James et al, 2003). Work is currently on going to clean up the sweet potato commercial varieties using meristem tip culture.

Currently in Jamaica the National Coordinating Committee for Agricultural Research and Development (NCCARD) sweet potato sub-committee has an IPM programme for the control of sweet potato viruses

Sweet Potato Weevil (*Cylas formicarius*), Sweet Potato Leaf Beetle (*Typophorus viridicyaneus* Crotch) and Wire Worm (*Diabrotica spp. and Systema spp.* complex) reduce yield significantly in Jamaica (CARDI, 2002). An integrated pest management approach (Dalip K M. 2002a, Dalip et al 2002b) has been applied to assist farmers.

In collaboration with the Ministry of Agriculture, Lands and Fisheries, CARDI St Vincent has an ongoing project to identify entomopathogen for the white grub *Phyllophaga* spp. CARDI St Kitts is also evaluating an appropriate pest management systems and entomopathogen performance in sweet potato.

Imported Red Fire Ant

Imported Red Fire Ant is a pest in a few of Caribbean islands. CARDI, St Kitts has an ongoing technical assistance programme.

Asian Soybean Rust

One of the newly introduced pests to Belize is Asian Soybean Rust (*Phakospora pachirhizi* Sydow). CARDI, Belize has begun an IPM programme to control soybean diseases.

Pests of sugarcane

CARDI successfully executed the Sugarcane Moth Borer biological control programme in Barbados. The Sugarcane Moth Borer *Diatraea saccharalis* (F.) (Lepidoptera: Pyralidae: Crambinae) parasitoid *Cotesia flavipes* (Cam.) (Hymenoptera: Braconidae) was first reared and released in the field in 1994.

Sugarcane Ratoon Stunting Disease (RSD) is caused by a bacterium *Leifsonia (Clavibacter) xyli* pv *xyli* (Davis) Evtushenko. RSD has no easily recognised external symptoms. CARDI is assisting the Barbados and Guyana sugar industries to identify the presence of RSD using ELISA and is recommending control measures.

DISCUSSION

The impacts of invasive species are particularly devastating to island ecosystems. Among the invasive species present in the region from the top 100 listed in the global invasive species list are the *Bemisia tabaci*, which has been reported from on continents except Antarctica; Cane Toad, *Bufo marinus* L; Water Hyacinth, *Eichhornia crassipes* (Mart) Solms and *Lantana camara* L a significant weed. *Leucaena* is widely promoted for tropical forage production and reforestation whilst at the same time it is spreading naturally and is widely reported as a weed.

Useful initiatives, which contribute to better management practices can reduce incidence of biological invasion. The model used for addressing the emergent Pink Hibiscus Mealybug, demonstrated the benefits of multi-agency involvement and regional co-ordination. The regional co-ordinating mechanism facilitated the implementation of the regional programme while providing support to national efforts in technical and financial areas. The threat to newly invaded countries has declined somewhat as the region now had readily available technology and an efficient emergency response mechanism. This regional system has been beneficial to the US Virgin Islands, Puerto Rico and The Bahamas (Meyerdirk and De Chi 2003).

However, much remains to be done as Invasive species continue to threaten the region, with potentially devastating effects on agriculture, other economic activities and biodiversity. The strategy to meet this challenge must be multifaceted, as the issue is complex, involving not only completely differing species/taxonomic groups but also different ecosystems and locations that are influenced by varying human actions. (Clarke-Harris and Lauckner 2005).

CARDI is working with our Caribbean partners and international organisations to prevent the introduction of invasive species, to develop control systems and to react in a timely manner to prevent the spread and hasten the eradication of the invasive species should they arrive.

REFERENCES

- Brown J K. 1993. A critical assessment of biotypes of the sweet potato whitefly in the Americas and adjacent locales from 1989-1992. In: Proceedings of Taller Centroamericano y del Caribe sobre Moscas Blancas, 3-5 August 1992. Turrialba, Costa Rica. 1-9
- CARDI. 2003. Annual report 2002. St. Augustine, Trinidad and Tobago: Caribbean Agricultural Research and Development Institute
- CARDI. 2003. Final Project Report. Whitefly and whitefly-transmitted geminiviruses-intervention in selected CARIFORUM countries. Caribbean Agriculture and Fisheries Programme (CAFP) funded by the European Union (EU).
- CARDI. 2004. Annual report. St. Augustine, Trinidad and Tobago: Caribbean Agricultural Research and Development Institute
- CariPestNet. 2006. *Raoiella indica* Hirst (Red Palm Mite) [Internet]. CariPestNet. Available from: <http://caripestnet.org/dynamicdata/data/docs/raoiella%20indica.pdf>
- Clarke-Harris D and Lauckner B. 2005. Research efforts to deal with invasive species in the Caribbean region. Proceedings Caribbean Food Crops Society, 41(1), 125-134.
- Dalip K M. 2002b. Integrated pest management: General principles of IPM and strategies used against the sweet potato weevil *Cylas formicarius*. Presentation at the Sweet potato Open day/Symposium, St Kitts, 26 November, 2002
- Dalip K M, Webb F, Lawrence K and Robinson D E. 2002a. Rearing of *Cephalonomia stephanoderis* under laboratory conditions in Jamaica. A paper presented at the Thirteenth Annual Conference of the Jamaican Society of Agricultural Sciences, Bodles, Jamaica, 18-19 June 2002
- Flechtmann, C H W and Etienne J. 2004. The red palm mite, *Raoiella indica* Hirst, a threat to palms in the Americas (Acari: Prostigmata: Tenuipalpidae). Systematic & Applied Acarology, 9, 109-110
- Fortune M P, Gosine S, Chow S, Dilbar A, St. Hill A, Gibbs H and Rambaran N. 2005. First report of black sigatoka disease (causal agent *Mycosphaerella fijiensis*) from Trinidad. Plant Pathology, 54(2), 246
- Gautam R D, De Chi W, Lessey M, Ali R and Phago P. 1996. A note on the economics of chemical control versus biological control of the Hibiscus Mealybug, *Maconellicoccus hirsutus* (Green). In: Management strategies for the control of the Hibiscus Mealybug: proceedings of the Second Seminar on the Hibiscus Mealybug, 14 November, 1996. Trinidad and Tobago: Ministry of Agriculture, Land Marine Resources, 37-43
- Global invasive species database [Internet]. Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission. Available from: <http://www.issg.org/database/welcome/content.asp>

- Hodges C, Edwards G B and Dixon W. 2005. Chilli thrips *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) a new pest thrips for Florida. Pest Alert series. Florida: Florida Department of Agriculture & Consumer Services, Division of Plant Industry
- James M S, Philip M T, Salazar L F and Fuentes S. 2003. A study on the cause of sweet potato virus disease in Barbados. A paper presented at the 2003 National Agricultural Research Conference. Graeme Hall, Barbados: Ministry of Agriculture and Rural Development
- Kairo, M T K, Ali B S, Cheesman O, Haysom K, and Murphy S T. 2003. Invasive species threats in the Caribbean Region. CAB International.
- Kane, E C, Ochoa R, Mathurin G, and Erbe E F. 2005. *Raoiella indica* Hirst (Acari: Tenuipalpidae): an island-hopping mite pest in the Caribbean. Maryland, USA: Systematic Entomology Laboratory, United States Department of Agriculture. Available from: <http://www.sel.barc.usda.gov/acari/PDF/Raoiella%20indica-Kane%20et%20al.pdf>
- McComie L D. 1996. Status of the Hibiscus (Pink) Mealybug *Maconellicoccus hirsutus* (Green) Programme in Trinidad. In: Management strategies for the control of the Hibiscus Mealybug: proceedings of the Second Seminar on the Hibiscus Mealybug, 14 November 1996. Trinidad and Tobago: Ministry of Agriculture, Land and Marine Resources, 12-18
- Mendonga, R S, Navia D, and Flechtmann C H W. 2006. *Raoiella indica* Hirst (Acari: Prostigmata: Tenuipalpidae), The Red Palm Mite - A Threat to Palm Trees in the Americas. Brasilia: Embrapa Recursos Geneticos e Biotecnologia (in Portuguese). Available from: <http://www.cenargen.embrapa.br/publica/trabalhos/doc146.pdf>
- Meyerdirk D E and De Chi L W. 2003. Models for minimizing risks of dangerous pests: the pink Hibiscus Mealybug and Papaya Mealybug. Proceedings Caribbean Food Crops Society, 39, 47-55
- Roberts R and Paulraj L. 2005. Pepper viral diseases affecting production of selected germplasm at CARDI Hot Pepper Breeding Centre. Proceedings Caribbean Food Crops Society, 41(2), 488-495.
- Welbourn C. 2006. Red palm mite *Raoiella indica* Hirst (Acari: Tenuipalpidae). Pest Alert series. Florida: Florida Department of Agriculture & Consumer Services, Division of Plant Industry. Available from: <http://www.doacs.state.fl.us/pi/enpp/ento/r.indica.html>