

FIGHTING BACK AGAINST DISEASES AND PESTS OF TARO

Diagnostic software and virus-free germplasm are spearheading efforts to protect taro's value to the South Pacific, reports Gio Braidotti

The impact of diseases and pests on taro production in the South Pacific has been mounting steadily in recent years, reaching devastating proportions in Samoa in 1993 when the fungus that causes taro leaf blight effectively wiped out the crop, causing export earnings to fall from 9.5 million to 158,000 Tala in just one year. This economic loss was coupled with an increase in export costs – staple foods had to be imported to replace taro. With many other Pacific countries similarly at risk, several ACIAR projects are providing the scientific resources to help build more effective disease and pest management programs.

Taro is cultivated for its potato-like root or corm, edible stem and spinach-like leaves, which provide the South Pacific with food security, cash and export income. Additionally, taro carries cultural value as a prestige crop with a role in gift-giving and ceremonial activities.

About 130 pests and diseases of taro have been documented, with impacts ranging from mild to lethal. These pests and diseases do not, however, occur in all countries in the region. Indeed, the majority of severe pathogens have restricted distributions, occurring in only a few locations. But it leaves many countries highly susceptible to the kind of outbreak that affected Samoa through a lack of resistance.

The Secretariat of the Pacific Community (SPC) Plant Protection Service in Suva, Fiji, has a large brief to deal with plant health and is working to combat factors that can ruin taro production. These include an increasing risk of exposure to lethal pathogens and susceptible plant varieties, plus inadequate diagnostic, screening and pest management procedures.

In 1993, a breeding program was established based on disease-resistant taro varieties in Papua New Guinea (PNG) but efforts to

exploit the country's rich genetic resources fell hostage to a disease 'Catch-22' situation. The PNG germplasm could not be moved to other countries for fear of also transmitting the two viruses thought to cause the lethal taro disease *alomae*. To help SPC break the deadlock, ACIAR provided support for Associate Professor Rob Harding, of the Queensland University of Technology, to lead a multinational research effort to characterise taro viruses and develop reliable detection tests.

"Increased knowledge of *alomae* would also benefit growers as the disease is now one of the main constraints on taro production in PNG and the Solomons," says Prof. Harding. "Elsewhere it seems that the two viruses do not occur together and when only one virus is present, disease symptoms are much milder."

Infected taro samples from 11 countries, including PNG, Solomon Islands, Fiji, New Caledonia and Vanuatu, provided the raw material for the team to clone and partially sequence the genomes of all known taro viruses. The sequence data was used to design diagnostic tests based on PCR (polymerase chain reaction), that were subsequently applied to about 450 tissue culture taro lines held in SPC's TaroGen collection. The cell lines were sent to Brisbane and grown in Australian Quarantine and Inspection Services greenhouses prior to virus testing.

Prof. Harding says that of these, 159 have been indexed for each of the taro viruses according to an internationally recommended schedule in order to facilitate safe international movement of taro germplasm.

Molecular techniques were also applied to the taro genome itself, allowing the cataloguing of the region's germplasm collections. This work was done by a collaborator at the University of Queensland,



JACQUI WRIGHT

Ian Godwin. The researchers mapped genetic diversity in the entire taro germplasm collections from Fiji, Samoa, Tonga, Niue, Palau and Cook Islands. Another 20 per cent of samples were tested from collections in PNG, Solomon Islands, Vanuatu and New Caledonia.

“From the overall collection of 2206 accessions, 527 were DNA-fingerprinted,” says Prof. Harding. “It was evident that most – if not all – of the genetic diversity within South Pacific taros could be sampled from Papua New Guinea and the Solomons. These countries should be seen as major sources of diversity for genetic improvement programs.”

While retaining at least 85 per cent of that diversity, the size of the collection was reduced to about 10 per cent, allowing the core collection to be conserved and used more effectively. In total, 211 accessions were stored as in vitro tissue cultures, primarily at the Regional Germplasm Collection at SPC in Suva, Fiji.

Duplicate collections are now kept at the University of the South Pacific, Alafua Campus, Samoa, with plans to maintain a sample at the International Potato Centre in Peru. Australian researchers and growers in northern Queensland have already requested and received accessions from SPC.

In a separate project, ACIAR is helping to develop a broader diagnostic tool for the full spectrum of taro pests and diseases. In conjunction with SPC, Dr Anthony Clarke, of the Queensland University of

Technology, aimed to develop a computer-based package to facilitate identification of pests, pathogens and disease symptoms using the Lucid software system.

As part of the collaboration, Dr Clarke has already developed an experimental Lucid ‘key’, a set of questions that drives the diagnostic process, designed to help field extension officers and research staff make reliable diagnoses.

The software package is undergoing a 12-month testing process to ensure scientific accuracy and user-friendliness. The system is also designed to interlink to fact sheets with information about appropriate pest-management strategies. Once completed, the diagnostic package will be delivered to SPC who will be responsible for updating the tool and training staff.

Dr Clarke relates the need for such a broad diagnostic capability to changes in the way taro is farmed. “Traditionally in Papua New Guinea, an area would be cleared and taro cultivated for one or two years exhausting the soil, at which point the farmer would walk away for 10 to 15 years,” he says. “That allows any build-up of taro pests and diseases to die out. But the trend now is for more intensive, continuous cropping with less inter-planting and biodiversity.

“That creates the same problem intensive farming experiences anywhere: the more intensive the agriculture, the greater the problem with disease and pests.”

Villagers from Morobe Province, PNG, inspect a taro crop with Mathew Boang, Chairman for Lands and Physical Planning in the Morobe Provincial Government.

PARTNER COUNTRIES: Fiji, Papua New Guinea, Samoa
PROJECT: CP/1994/043: Virus indexing and DNA fingerprinting for the international movement and conservation of taro germplasm
DESCRIPTION: Taro growers across the Pacific stand to benefit from more effective disease and pest management programs
CONTACT: Rob Harding, 61 7 3864 1379, fax 61 7 3864 1534, r.harding@qut.edu.au

READ MORE ON TARO PEST CONTROL

BATTLING THE BEETLE





4 - HEAVY DAMAGE
USELESS

Taro beetle
damage to corms.

SECRETARIAT OF THE PACIFIC COMMUNITY

BATTLING THE BEETLE

Helen McGlashan reports on a project that aims to combat the devastating taro beetle

Burrowing deep into the bulbous corms of the taro plant, forming holes and tunnels up to two centimetres in diameter, taro beetles (*Papuana* spp and *Eucopidocaulus* spp) are the nemesis of taro growers across the Pacific Islands. The taro plant is grown throughout the tropics and is an important food source for many Pacific Islands. The root crop is grown by subsistence and commercial farming and, once nurtured to maturity, is uprooted and the bulbous corms, stems and leaves prepared to feed the family.

However, the taro beetle plays havoc with these plans by burrowing into the plant's corms and forming holes and tunnels that make the taro unappealing to eat or buy and expose the corm to fungal infection. When populations are high, taro beetles can cause severe damage to the base of the new plant, leading to plant death. Other root crops such as sweet potatoes and yams and banana experience similar damage. Changes in cultivation patterns associated with increasing population density continue to intensify the damage caused by the taro beetle.

In countries such as Papua New Guinea (PNG) and Fiji the beetles can cause up to 30 per cent yield loss. In PNG, 99,600 tonnes of taro was damaged by the beetle in 2000, resulting in an estimated annual loss of A\$45.9 million.

In 2001, a team of entomologists, agronomists, scientists and plant protection, research and extension professionals from PNG, Fiji, Vanuatu, Solomon Islands and Kiribati banded together to work on strategies to combat this insect pest.

With support from ACIAR, the Land Resources Division of SPC implemented a four-year project on taro beetle management – the TBM project – built on previous work supported by the European Union and the Food and Agriculture Organization. The EU also provided funding for field research activities in Vanuatu and Solomon Islands and some activities in Fiji.

The project focused on assessing and developing insecticidal measures, alone or in combination, and with biological control – a fungus, *Metarhizium anisopliae*, and a baculovirus extracted from the rhinoc-

eros beetle. The aim was to develop an integrated crop management package to minimise damage caused by taro beetles. The project team identified two specific chemicals as providing the best control, but more work is needed to determine the best application methods, dosage rates and frequency of applications.

In December 2005, the project team geared up for the next phase of the project, which will involve participatory research and technology development activities such as farmer field trials and on-farm demonstrations.

The TBM project is important for the Pacific as the knowledge gained from research and field trials conducted in Fiji and Papua New Guinea, Vanuatu and Solomon Islands will be transferred to other Pacific Island countries and territories.

The director of SPC's Land Resources Division, Aleki Sisifa, says it is vital that research on the development of control strategies for the taro beetle continue.

"Taro is a staple food and cash crop and is particularly important in Pacific Island culture," he says. "The taro beetle pest, therefore, is of great concern to taro production in the affected countries."

Taro earns many Pacific Islanders a livelihood and contributes greatly to national economies. Known in Fijian as 'dalo', the root crop, along with cane sugar, is a major agricultural export commodity for Fiji, earning A\$25-30 million a year. Taveuni – 'the Garden Island of Fiji' – contributes about A\$12.45 million annually to the Fijian economy through its taro industry. The dalo of Taveuni is widely regarded as the best-tasting in Fiji and finds its way on to dinner plates throughout Fiji and overseas. It is estimated that 70 per cent of export taro comes from Taveuni, where the soil-dwelling pest is yet to venture.

Taro beetles are native to the Indo-Pacific region. Six species of taro beetle are endemic to PNG, four to the Solomon Islands and two to Vanuatu. Taro beetles have spread to Fiji, Kiribati and New Caledonia. Other countries are considered to be at risk of playing host to the pest and quarantine regulations are in place. The subsequent annual loss in trade across the region was estimated to be A\$40 million in 2000.

The spread of the taro beetle also has adverse environmental and social impacts. Farmers burn and abandon beetle-infested taro plots and cultivate new land in the hope that it will remain infestation-free for one crop cycle. According to TBM project coordinator Sada Lal, the success of the project will benefit taro farmers and the environment.

"Coming up with a recommendation to control taro beetle is very significant to farmers as they currently do not have any effective control method," Mr Lal says. "Many farmers have lost faith in planting taro, so developing a control measure will restore confidence in this important crop. Farmers will also be able to return to previously infected crops and will no longer need to rely on shifting cultivation, which is detrimental to the environment and is very labour-intensive and costly to the farmer."

While the TBM project investigated a combination of chemical and biological controls with the objective of developing an integrated control measure, Mr Lal says the results steered researchers towards the use of chemical insecticides.

"Biological control would be ideal but unfortunately, despite a lot of effort and work in this area, it has not been very effective in the control of the taro beetle," he says. "The results have shown that the metarhizium fungus can only provide up to 30 per cent control of the beetle – which is not enough. The fungus takes two to three weeks to kill the beetle and within that time the beetle has already done its damage."

In PNG, the scientist-in-charge, Dr John Moxon, found that applying metarhizium fungus with the chemical insecticide Imidacloprid

gave consistently good control, yet the fungus is too expensive for farmers in the Pacific to produce.

Mr Lal says it is essential the project identify a control measure that is effective but also affordable and accessible. "Ideally we want to recommend a low-cost technology that can be adopted by farmers in the village," he says.

Four years of research and trials culminated in proving Imidacloprid to be the most effective and accessible measure. Although this is an important discovery, Mr Lal says that chemical insecticides must be used with caution.

"Imidacloprid is the second largest selling pesticide in the world and is used extensively for the control of insects on many crops in many situations, yet its use should be closely monitored," he says. "Insecticides are poisons and all care must be taken to see that they are properly used when recommending them to farmers."

"There is also the risk the chemical could seep into the environment as taro is typically grown in moist conditions and subsistence farms are usually near creeks or on river banks."

The project team, therefore, is conducting trials to determine the best way to apply chemical insecticides. Other groups of insecticides (organophosphates and carbamate) will also undergo screening to ensure an effective control program can be formulated.

Mr Lal says residual analysis of the chemical insecticide was another important feature of the research, as it is not yet known how long the chemical residue lasts in taro plantations.

"We want to determine the latest time that a farmer can apply the chemical before harvesting, so we can provide protection for the taro plant right up until the time of harvest yet also achieve minimal residue and environmental impact."

"The aim is to be able to lower the dosage rate but increase the frequency of the application. This would hopefully give farmers better control of the pest and have less residual and environmental impact than higher dosages."

Samples extracted at the University of the South Pacific will be sent to the Queensland Health Scientific Services laboratory in Brisbane for residue analysis.

The re-establishment of taro as a leading crop in the Pacific will ultimately contribute to the enhancement of food security, income generation and export earnings. It is hoped it will also reinstate the value of taro export markets in Fiji, as well as make the potential for taro to be an export cash crop for PNG and Vanuatu a reality for the first time.

Helen McGlashan is an Australian Youth Ambassador for Development working in the Land Resources Division of the Secretariat of the Pacific Community in Suva, Fiji Islands.

PARTNER COUNTRIES: Papua New Guinea, Fiji

PROJECT: Taro Beetle Management in PNG and Fiji (CP/2000/044)

DESCRIPTION: The project is developing biological controls for the taro beetle and investigating the combined actions of pesticide and bio-control

CONTACT: Sada Lal, TBM Project Coordinator, sadanl@spc.int; Mr Aleki Sisifa, Director, Land Resources Division SPC, alekis@spc.int



Taro bundles being sold at a market in Papua New Guinea.