International Atomic Energy Agency

IAEA Impact: How a Nuclear Technique Helped Save the Western Cape's Orange Industry

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28 June 2016

Citrus fruit is the second most important agricultural export commodity in South Africa, with most of the production destined for exports. The industry employs 10% of the country's agricultural labour force. (Photo: M. Gaspar/IAEA)

Citrusdal, South Africa – Every morning at 7 a.m. a small airplane takes off to swoop around a fertile valley amidst the scenic mountains of Western Cape in South Africa, offloading its cargo of 1 000 000 ready-to-mate moths. The insects have been mass-reared and sterilized using equipment and a gamma irradiator donated by the IAEA in 2007. The result: citrus orchards free of the devastation of the false codling moth in the Elephant's River Valley, and an industry, once on the brink of extinction, is now thriving again.

"In just five years the infestation is gone," says Martli Slabber, who grows oranges, clementine and lemons on her 100-hectare farm. "From two infested fruits per tree every week we are down to a single one in the entire orchard per season."

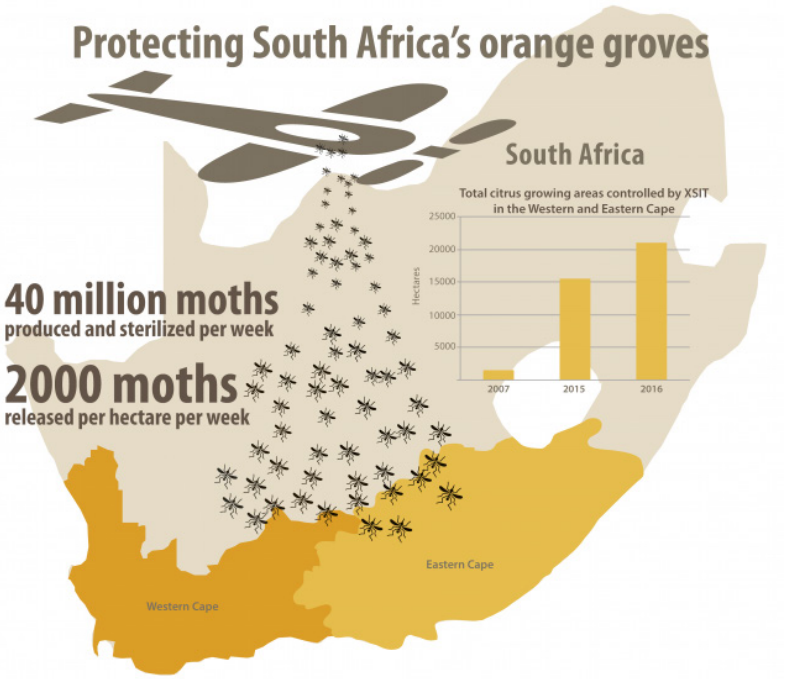
The suppression of the moth has saved the livelihoods of close to 10,000 people, adds grower Gerrit van der Merwe (See video). "Without citrus, there would be no jobs here."

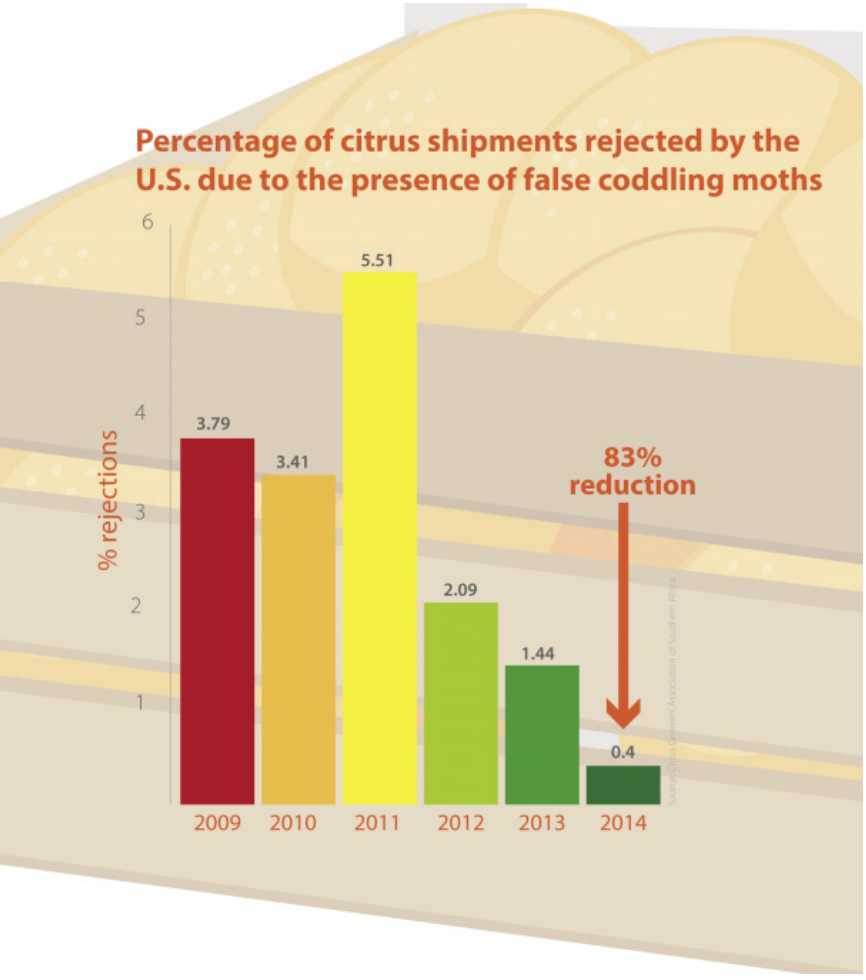
Slabber and van der Merwe are two of 400 citrus farmers who use the services of XSIT, a company owned by the Citrus Growers' Association, to deal with the false codling moth, which naturally resides in some parts of the country, including the Elephant's River Valley. The moths' larvae feed on citrus fruit, destroying the pulp.

XSIT — named after the nuclear-based sterile insect technique (SIT) — produces and releases 40 million sterile moths every week in an area of over 15 000 hectares in the provinces of Western and Eastern Cape. (See this photo essay.) Fed on an optimized diet of maize, wheat germ and milk powder, they are irradiated

and released when they are at the height of their sexual potential. (See this 9 second video of the irradiation process.) The sterile moths mate with wild insects, but this mating does not produce any offspring, thereby diminishing the population over time (see box The Science).

"SIT has allowed us to go green and not use chemicals against the moth anymore," says Piet Smit, who produces 11 000 tons of citrus a year on 250 hectares of land. "We also no longer have problems with insecticide residue levels on the fruit."





Thanks to the reduced use of chemicals, wild life has returned to the orchard, van der Merwe adds.

Citrus, the lifeblood of the region's economy

South Africa is the second largest exporter of citrus fruit in the world, with exports worth over US $1.4 billion in 2014. Citrus is the country's second most important agricultural export commodity after wine. The industry employs 10% of South Africa's agricultural labour force.

Back in 2005, the main export market for the region's citrus fruit, the United States, tightened import quality and infestation reduction measures, as U.S. agriculture authorities grew concerned about the spread of this moth pest to their country, potentially threatening their citrus and cotton industries.

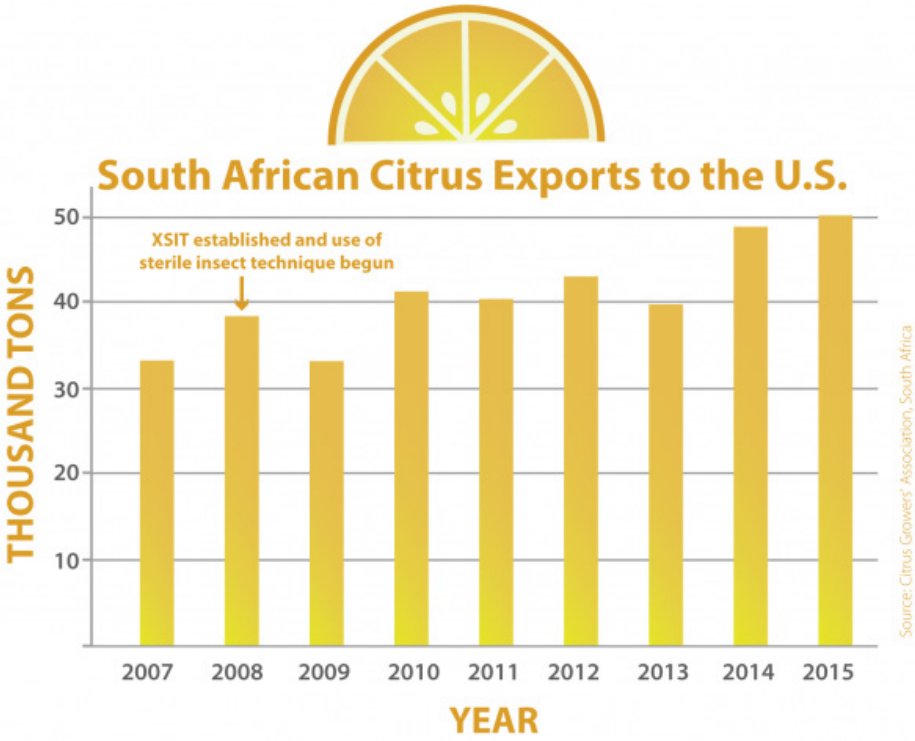
"We were in danger of closing down," van der Merwe says. "The old methods of using insecticides for moth control were no longer working."

Slabber, van der Merwe and other farmers in the area used to lose between 10% and 15% of their production to the pests before harvest, but the real losses came from the pest-infested fruits that made it into shipments and were returned by U.S. inspectors. If they found just three larvae in a shipment of 160 000 oranges, they would return the entire consignment. "We were seriously considering alternative crops," Slabber recalls.

The search for a new method

It was time to find a new pest control method, explains Vaughan Hattingh, a biologist and researcher, and now CEO of Citrus Research

International (CRI), an industry-funded research outfit associated with the University of Stellenbosch. Some preliminary research on the irradiation of the false codling moth had been carried out in the 1960s, but there was no data available on whether it would work in practice. It was always going to be a gamble, he says.



Researchers at CRI and the country's Agricultural Research Council were familiar with work by the IAEA, in cooperation with the Food and Agriculture Agency of the United Nations (FAO), in using SIT against the Mediterranean fruit fly. They began research in radiation biology and rearing techniques to see if the method could be adapted for the false codling moth. The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, along with the United States Department of Agriculture, provided expertise and access to a network of specialists working on using SIT against other pests.

Thanks to funding from the IAEA's Technical Cooperation Programme, Hattingh and his colleagues got a first-hand look at a rearing facility of a related codling moth in Canada. This helped them lay the groundwork to eventually rear and sterilize enough insects to test the technique on a 35-hectare plot in an isolated and particularly infestation-prone part of Slabber's orchard.

"You did not want to drive through it because of all the fallen oranges on the ground," Slabber recalls. "There were wasted oranges under each tree at any given time. It was a depressing sight."

"The results of the test surpassed our expectations," Hattingh says. "We realized that the false codling moth was a sedentary insect, so we could treat areas in isolation." It is this characteristic that makes the moth a prime candidate for SIT: controlling the insect population in a defined geographical area, even down to a single orchard, keeps the area insect-free long term, because moth populations do not tend to fly far.

Public-private partnership for moth control

Following the success of the trial, the Citrus Growers' Association and the government co-founded XSIT in order to industrialize the use of the technique. As of last March, the association fully owns XSIT, which charges farmers for its services and runs on a fully commercial basis. The area it serves has increased more than ten-fold since 2007, and it has contracts in place to further expand to a total of 21 000 hectares. At that point, its rearing facility on the edge of Citrusdal will be operating at full capacity, and any further expansion will require a new extension of the factory, or setting up operations in a new location, said General Manager Sampie Groenewald.

While the technique saved the area's citrus industry, much work remains to be done. "First we thought SIT would be a silver bullet, but it wasn't," Groenewald said. In certain pockets of the valley it was not effective enough and moth populations would return.

Groenewald now advises his clients to use a mating disruption technique, along with SIT, particularly in moth hot spots. Under this technique, pheromones of the female moth are spread around the orchards in order to confuse males, which find females for mating based on their pheromones. Due to the presence of the artificial pheromones, they fly around without finding females to mate with and, after around five days, they lose their potential to mate and slowly die.

At XSIT, research is ongoing not only to further perfect the technique, but also to make it available in far flung areas of the country. The current method of producing sterile insects in Citrusdal and transporting them to other areas for release works well for neighbouring Eastern Cape, but it is not feasible for faraway places, such as Mpumalanga and the Northern Province. XSIT's researchers, with support from the IAEA and FAO, are working on a technique that involves transporting the pupae, which would then be irradiated at another location in the north eastern part of the country. "We believe, the pupae would be less sensitive to transport," Groenewald said.

XSIT has recently been contacted by growers of other fruits, which are increasingly infested by the false coddling moth.

THE SCIENCE:

Birth control for insect pests

The sterile insect technique (SIT) is a form of insect pest control that uses ionizing radiation to sterilize pests that are mass-produced in special rearing facilities. The sterile insects are released systematically from the ground or by air over pest-infested areas, where they mate with wild populations, which subsequently do not produce offspring. In the few cases when sterilized males and wild females do have an offspring, it is always a completely sterile male.

As a result, this technique can suppress and, in some cases, eventually eradicate populations of insect pests. SIT is among the most environmentally friendly control tactics available, and is usually applied as part of an integrated campaign to control insect populations.

The IAEA, in cooperation with the FAO, supports about 40 SIT field projects delivered through the IAEA technical cooperation programme, in different parts of Africa, Asia, Europe and Latin America. While most of these programmes target pests that affect crops and livestock, research is also under way to use the technique against various species of disease-transmitting mosquitoes, including carriers of the Zika virus and malaria.