Sterile Insect Technology (SIT)

INTRODUCTION

Invasions by fruit flies into citrus, stone fruit and other crops cause unwanted disruption to these agricultural industries in Australia. Agriculturalists have most often used chemical pesticides in the past to try to eradicate the pest. Sterile Insect Technology (SIT) is the first insect pest control method based on genetics. A three-year project is underway at the SIT facility recently built in Port Augusta. This will enable scientists and farmers in the Australian horticultural industry to treat the Queensland fruit fly without the extensive use of herbicides on their crop, plants and produce. [iii]

Topic briefly introduced

This South Australian project highlights one example of how scientific research is developing a new solution to an existing problem that causes significant economic loss to the agricultural industry.

SHE concept, application, stated

RELEVANT AGRICULTURAL CONCEPTS

There are many species of fruit fly but not all are harmful to crops. The Queensland fruit fly, *Bactrocera tryoni*, is the species that is a pest in Australia. [xi] It is essential to understand the damage the Queensland fruit fly does to the horticultural industry in Australia. According to Queensland department of Agriculture and Fisheries[i], the flies lay eggs inside fruit and their larvae eat the flesh of the fruit. It is easy to identify the effected fruit as it develops rot and dark spots and the skin of the fruit around where the eggs were laid becomes discoloured. Contaminated fruit is unfit for sale, causing economic loss after a large outbreak. Dan Ryan[ii] is the director of the Sterile Insect Technology, run by Horticulture Innovation Australia, project in South Australia. Mr Ryan stated that the "Sustainable management of Queensland fruit fly is vital to Australia's $9 billion horticultural sector".

FIGURE 1: Adult Queensland fruit fly www.daf.qld.gov.au

FIGURE 2: Larvae of Queensland fruit fly with damaged (darker) areas of fruit. www.daf.qld.gov.au

Courtney Fowler at the ABC[iii] has reported that scientists in South Australia are researching newer, more sustainable ways of controlling the Queensland fruit fly in Australia. The sterile insect technology (SIT) project will create a safeguard for the horticultural industry in South Australia and Victoria. SIT is the first insect pest control that uses genetic technology as a way to eradicate the pests rather than using a 'solution in a can' and spraying the pests with herbicides. Male fruit flies are sterilised using x-rays and then released into the wild to breed with wild female fruit flies. The resulting offspring are all sterile. Eventually the number of sterile fruit flies becomes greater than the number of wild fruit flies, who then die out.

Science concept explained

Connie Banos at ANSTO[iv] was a part of developing the facility at Port Augusta. She stated that this technique has been used since 1988, by the NSW department of Primary Industries, to reduce numbers of the Queensland fruit fly, but only in smaller scale, and the sterile flies were not available in South Australia. Now with the new facility available, and more research being developed after funding from 3 different Australian States (NSW, Victoria and South

Australia) and the Commonwealth, scientists aim to release sterile fruit flies on a weekly basis for up to nine moths per year.

INTERACTION BETWEEN AGRICULTURAL SCIENCE AND SOCIETY

There were various investors in this technology, such as the South Australian, New South Wales and Victorian Governments, the commonwealth, who matched the government funds, ANSTO (Australian Nuclear Science and Technology Organisation), PIRSA and Horticulture Innovation Australia[v]. These investors were all interested in the SIT project because the Queensland fruit fly detrimentally effects their industries or sectors both economically and environmentally. The effect of fruit fly damage on the economy is very harmful to farmers, their families, businesses and overseas exports. Contaminated produce cannot be sold, creating detrimental losses. Some produce treated with chemicals and herbicides cannot be exported overseas, limiting the amount of produce being sold and shipped overseas. Not only do the chemicals limit sales, but have environmental effects as well. With herbicide resistance becoming a large issue in parts of the country, farmers need to have access to other options to control pests. The SIT program will provide for this, helping farmers and horticulturalists to turn away from a 'solution in a can' and solve pest problems in a more sustainable and long-term manner[vi]. The Emmetts blog[vii] states that this new facility will create a powerful defence against the pest and will be a major breakthrough in fruit fly control. Horticulture Innovation Australia Chairman, Selwyn Snell, reported that the facility in Port Augusta is to be one of the most progressive and advanced in the world.

Importance of collaboration between various agencies explained

Without the development of the $3.8 million-dollar facility built in Port Augusta, the sterile insect technology program would not be possible because scientists would not be able to effectively treat the insects for release. The team at ANSTO provide and measure the amount of radiation used for each insect[viii]. This process is very precise. It only needs a very low dose of radiation, between 70 and 75 Gy, to ensure the insect is sterile, but still healthy.

Data gathered since 1988 by the NSW Department of Primary Industries at ANSTO has been used by scientists to develop the idea further to create the much larger, successful program it is today. Many organisations collaborated to make the program possible, and help it come together. The Sterile insect technology program is led by Horticulture Innovation Australia, in partnership with Primary Industries and Regions SA, South Australian Research and Development Institute, Victorian Department of Economic Development, Jobs, Transport and Resources, CSIRO, Plant and Food Research Australia, NSW Department of Primary Industries and Macquarie University. [iii] Without collaboration between these organisations, the program would not have received the funding to build the Port Augusta facility, or have ANSTO available to provide the radiation treatment to the Queensland fruit flies.

Importance of collaboration between various agencies explained

POTENTIAL IMPACT OF THE SIT TECHNOLOGY

There are many possible avenues for future developments of the SIT program. Sterile Insect technology has been used in other areas of agriculture, to sterilise insects and reduce their populations in farming areas. [xi] Eradication of the screwworm from the United States and Mexico has been well-documented. Projects to reduce numbers of the basic blowfly and other insects are already in place. However not all insect species can be treated effectively using this radiation technique and so other methods of insect control must incorporated into an integrated pest management program. Another limitation of using SIT may be a flow-on effect for the food chain. Another pest may increase in population if the Queensland fruit fly is killed off or some insect populations may decrease because they will be without food[ix.]

Benefits and limitations explained

Queensland fruit fly destroys an estimated $300 million of fruit and vegetable crops every year. [iii] The farming communities will benefit greatly from these developments; less produce will be lost or potentially affected therefore the economy will not suffer from lost produce or

failed overseas exports. The environmental benefits of SIT are also significant, as chemical use will be lessened.

CONCLUSION

It is clear that SIT is improving Australia's horticultural industry. It limits the amount of herbicides being used on produce, and being emitted to the environment, therefore improving the chances of large export overseas, and the condition of the farmland.

The SIT program would not be possible without the funding from numerous organisations and the dedication of scientists and farmers from across Australia working for better ways to reduce the impact of the Queensland fruit fly. The use of this technology illustrates how the scientific knowhow in one area of science, genetics has influenced another area of science, agriculture.

SHE concept, influence

Overall A standard Stage 2

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[i] Queensland department of Agriculture and Fisheries 2012, Queensland fruit fly, accessed 21 November 2017, https://www.daf.qld.gov.au/plants/fruit-and-vegetables/a-z-list-of-horticultural-insect-pests/queensland-fruit-fly

[ii] Ryan, D 2017, SITplus partnership, accessed 18 November 2017, http://horticulture.com.au/what-we-do/sitplus/

[iii] Courtney, F 2017, How Sterile Insect Technology could combat one of horticulture's most damaging pests, accessed 17 November 2017, http://www.abc.net.au/news/rural/2017-08-01/how-sterile-insect-technology-could-combat-fruit-flies/8748348

[iv] Banos, C 2016, Sterile Insect Technique, accessed 18 November 2017, http://www.ansto.gov.au/ResearchHub/OurResearch/LifeSciences/LifeSciencesCapabilities/RadiationTechnologynew/SterileInsectTechnique/index.htm

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[vi] Ryan, D 2017, SITplus partnership, accessed 18 November 2017, http://horticulture.com.au/what-we-do/sitplus/

[vii] Emmetts 2016, National Sterile Insect Technology Facility Opens in Port Augusta, accessed 18 November 2017, http://blog.emmetts.com.au/national-sterile-insect-technology-facility-opens-in-port-augusta

[viii] Banos, C 2016, Sterile Insect Technique, accessed 18 November 2017, http://www.ansto.gov.au/ResearchHub/OurResearch/LifeSciences/LifeSciencesCapabilities/RadiationTechnologynew/SterileInsectTechnique/index.htm

[ix] Queensland department of Agriculture and Fisheries 2012, Queensland fruit fly, accessed 21 November 2017, https://www.daf.qld.gov.au/plants/fruit-and-vegetables/a-z-list-of-horticultural-insect-pests/queensland-fruit-fly

[x] New World Encyclopaedia, Fruit fly. accessed 21 November 2017, http://www.newworldencyclopedia.org/entry/Fruit_fly#Tephritidae

[xi] The Sterile Insect Release Method and Other Genetic Control Strategies
Alan C. Bartlett, accessed 21 November 2017, https://ipmworld.umn.edu/bartlett

FIGURE 1: Queensland department of Agriculture and Fisheries 2012, Queensland fruit fly, accessed 21 November 2017, https://www.daf.qld.gov.au/plants/fruit-and-vegetables/a-z-list-of-horticultural-insect-pests/queensland-fruit-fly

FIGURE 2: Queensland department of Agriculture and Fisheries 2012, Queensland fruit fly, accessed 21 November 2017, https://www.daf.qld.gov.au/plants/fruit-and-vegetables/a-z-list-of-horticultural-insect-pests/queensland-fruit-fly