INNOVATE AG

SERO-X®

Technical Manual

SUSTAINABLE FARMING SOLUTIONS

Harness the power of nature

Partnering with Innovate Ag for exclusive distribution in VIC, SA, TAS, WA, southern NSW (Riverina & Murray districts)

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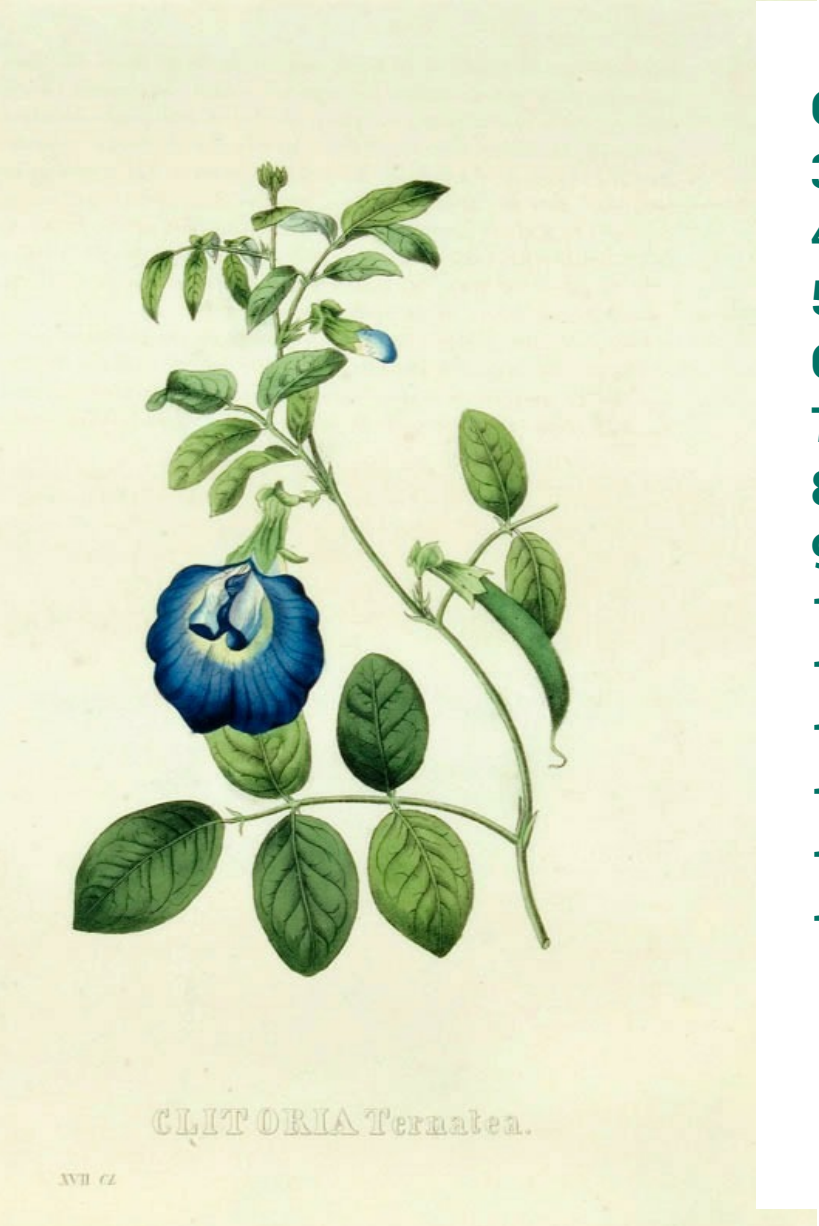


Introduction

Sero-X® is a world first plant extract bio-pesticide which has a revolutionary set of peptides as the primary active compounds.

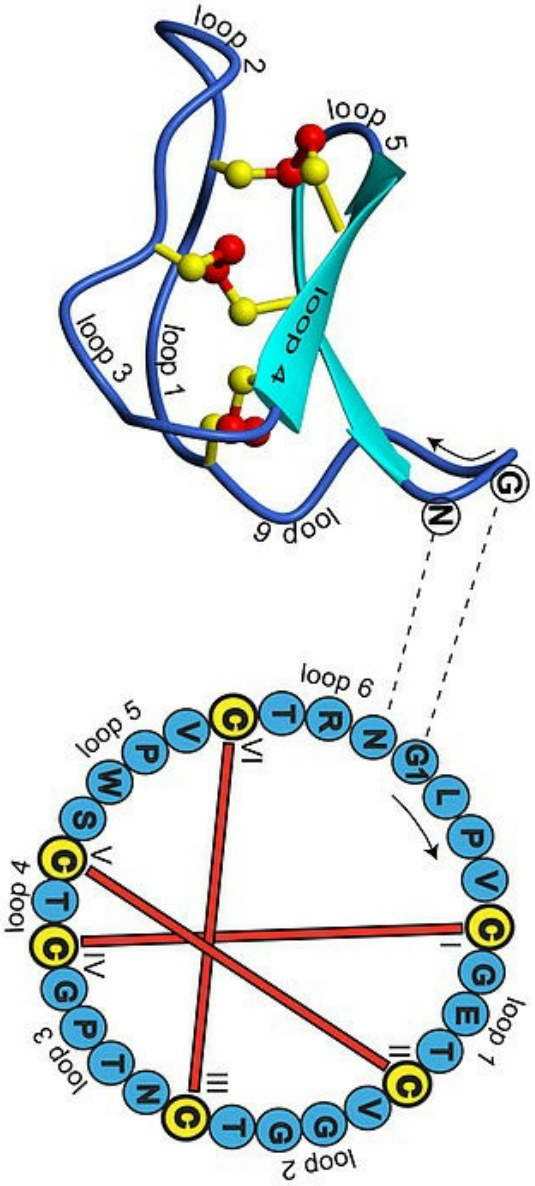
The active constituent of Sero-X is *Clitoria ternatea* Extract which is the worlds first approved active constituent to contain the bioactive peptides known as cyclotides. Ultra stable peptides like cyclotides meet the challenge of providing environmentally positive and socially acceptable food security to the world's growing population.

The product is formulated from *Clitoria ternatea,* a plant that exhibits insect pest behaviour modification (semiochemical) and insecticidal properties. It minimises damage caused by a range of insect pests in a number of target fibre and food crops.

Sero-X and its bio-active compounds are the centre of much global research but brought to you in a product for the very first time right here in Australia by an Australian regional company. Never before has Australian agricultural research and development had a new active constituent pass the regulatory approval requirements and given Australian growers first access to such an exciting new product.

- Safe for Bees and other pollinators.
- Leading the field in natural crop protection.
- Regional Australian owned and developed.
- Non toxic to mammals and beneficial insects.
- APVMA approved and registered Product
- An organic, non-synthetic extract with equivalent or better results as synthetic chemicals.
- Cutting edge research in agricultural applications of bio-active Peptides.
- Controls a broad spectrum of pests with no withholding periods.
- Important tool in resistance management.

The Actives - Cyclotides

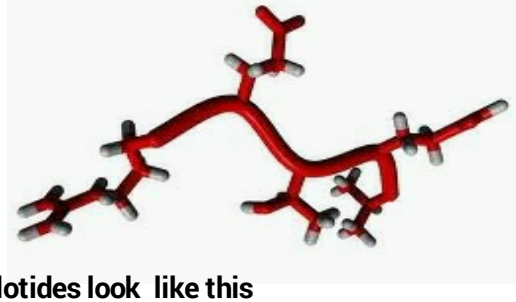


Significant research and investment has gone into investigating the active constituents of Sero -X®. The answer lies in a unique group of compounds called cyclotides. The discovery of these compounds and their application to agriculture is set to revolutionise the approach to pest control.

Peptides

- Peptides are a small chain of amino acids that aren't quite long enough to be considered a full protein (less than 50 units).
- They are, in essence, the building blocks that create a protein.
- Peptides are commonly used for their anabolic effect on an athlete's muscle mass.

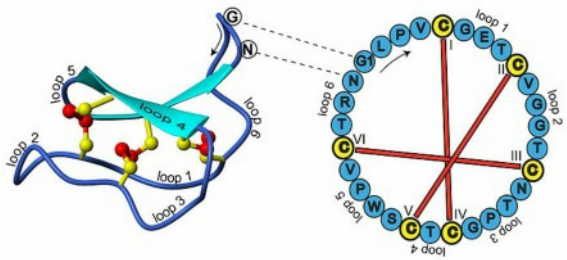
Peptides look like this



Cyclotides

- Cyclotides are small peptides isolated from plants.
- Cyclotides are exceptionally stable and are resistant to being denatured by thermal, chemical or enzymatic treatments.
- Thus they can continue to perform their function after manipulation/extraction from the plant.
- They are a secondary plant compound – a defensive peptide that protects against pests.

Cyclotides look like this

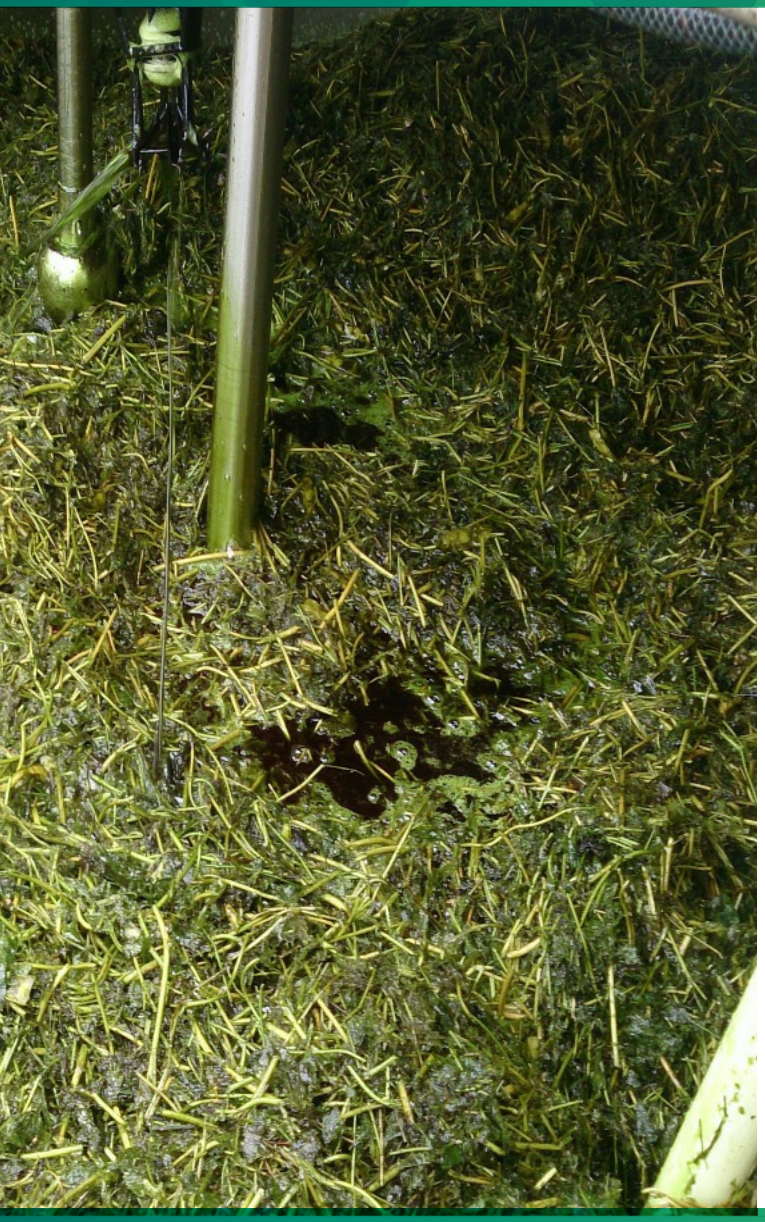


Biological Significance

Cyclotides have been proven to have a wide range of biological activities, including anti-HIV, insecticidal, anti-tumour, antifouling, anti-microbial, hemolytic, neurotensin antagonism, trypsin inhibition and uterotonic activities.

The potent insecticidal activity of cyclotides indicate that cyclotides act as plant host-defence agents. The observations that dozens or more cyclotides may be present in a single plant and the cyclotide architecture displayed suggest that cyclotides may be able to target many pests/pathogens simultaneously.

How Sero-X is made



The production process of Sero-X is a complex procedure that involves husbanding the *Clitoria ternatea* crop to maximise the expression of the natural insect defense compounds.

It is the ultra stable peptides that provide the bioactivity of Sero-X and after the crop has been harvested a specific procedure is undertaken to extract these compounds and formulate the product into an emulsified concentrate.

Crop Production

At various locations in regional Australia *Clitoria ternatea* is grown under contract by primary producers.

Harvest and transport

The crop is harvested, baled and transported to the production facility in Goondiwindi QLD.

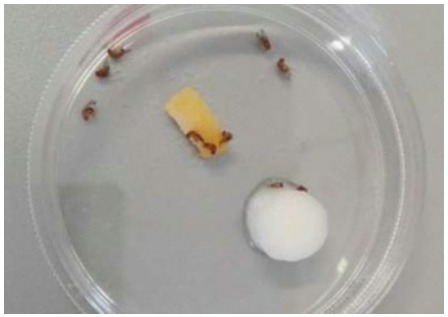
Extraction/Active Constituent

Chaffed plant material is put through an extraction process that targets the bio-active compounds. These compounds are dissolved into solution creating an emulsified concentrate.

Formulated Product

After pressing and filtering out the inert plant material, the active constituent *Clitoria ternatea* Extract is formed. *Clitoria ternatea* Extract is then formulated into the final product - Sero-X.

Pest Control & Mode of Action



Sero-X® contains the active constituent *Clitoria ternatea* Extract. *Clitoria ternatea* Extract includes many different biologically active compounds which in combination reduce the economic damage caused by target pests through insecticidal and behaviour modification activity such as egg laying disruption and anti feeding. There are over 40 active cyclotides in Sero-X and each have a various role to play in pest control and are active against different types of pests. These compounds are only active against phytophagous species, that is, it only works against insects that feed on plant Material.

The cyclotides in Sero-X, extracted from *Clitoria ternatea* have no toxicity to predatory insects and Pollinators.

Sero-X does not rely solely on direct mortality to provide crop protection. Sero-X works in three ways to control the pests in crops:

1. Direct Toxicity : soft bodied-small larvae and nymphs are killed directly when contacted with the product.
2. Anti-feedant/Repellence: The presence of the cyclotides from Sero-X on treated plants deter pest feeding. Pests choose to starve rather than eat a crop treated with Sero-X.
3. Ovi-position Deterrent: The presence of the residues of Sero-X on treated plants can deter pest egg lay. Pests may avoid landing, or laying eggs on areas treated with Sero-X.

With these three modes of action the likelihood of resistance developing amongst target pests is highly unlikely.

It can be used as a protective treatment when applied at regular intervals or as a knockdown treatment to control existing pests. This product is suitable for use in a Integrated Pest Management (IPM) program. Effects on insect predators or parasites have been demonstrated as low.

Current Label

Sero-X is registered for use in Cotton both by ground and Aerially

CROP	PEST	STATE	RATE	CRITICAL COMMENTS
Cotton	Cotton bollworm *(Helicoverpa armigera)*	QLD, NSW only	2 L / Ha	Apply as indicated by field checks and pest presence thresholds. Ensure good coverage. Note treatment effects may not be seen for 3 or more days. Suppression of pest numbers rather than control may occur if sufficient exposure is not possible.
	Native budworm(*Helicoverpa punctigera*)			**Budworm and Bollworm:** Applications should be timed to coincide with egg hatch and when small larvae up to 5 mm are present.
	Silverleaf whitefly (biotype b) (*Bemisia tabaci*)			**Silverleaf Whitefly, Green Mirid:** Apply at recommended threshold levels as indicated by field checks. A repeat application may be required at 14 to 20 days if conditions favour pest development.
	Green mirid *(Creontiades dilutus)*			

Research Permit

As of August 2018 there is an extended permit (PER86616) to allow supply and research of an Agricultural product into a wide range of horticultural crops. The purpose of the permit is to get a better understanding of efficacy across a large variety of pests and conditions. The following crops are permitted for use. Please note these are not label claims and the area per crop is limited. Contact Innovate Ag for a copy of the permit and further information.

Crop	Pest
Brassica including Broccoli, Cauliflower, Cabbages Head and Brussels sprouts	Diamond back moth, Cabbage white butterfly, Heliothis
Leafy vegetables (including Brassica leafy vegetables)	Heliothis
Fruiting vegetables, Cucurbits including pumpkin and melon	Silver leaf white fly, Two spotted mite
Fruiting vegetables, other than cucurbits including Tomato	Heliothis, Greenhouse white fly, Two spotted mite, Thrips
Bulb vegetables including onion	Western flower thrips, Thrips
Citrus fruits	Bronze orange bug, Spined citrus bug, Katydid, Scale, Leafminer

Crop	Pest
Pome fruits	Apple dimpling bug, Loopers
Berries and other small fruits, including Table grapes, blueberry, raspberry	Light brown apple moth, Jassids, Queensland Fruit Fly, Redlegged Earth Mite, Rutherglen Bug, Spider Mite, Strawberry Bug, Thrips
Assorted tropical and sub-tropical fruits – inedible peel, including Avocado	Avocado leafroller, Banana spotting bug, Fruit spotting bug, Monolepta beetle, Lantania scale, Red banded thrips, Queensland fruit fly
Tree nuts including; Macadamias Almonds	Fruit spotting bug, Two spotted mite, Bryobia mite, Carob moth

Rates & Dilution

Sero-X is registered for use in Cotton at 2lt per ha in 100lt of water.

This equates to a 2% v/v (volume by volume) dilution rate and current research indicates that the dilution/concentration rate is key to optimising the results of Sero-X.

In crops where high water rates are used it is important to maintain a %v/v rate of at least 1% (1lt of Sero-X in 100lt of water), however, a target of 2-6% depending on pest pressure is preferable where water rates allow.

Example: In 500lt of Water 2% v/v = 10lt of Sero-X per ha has demonstrable better efficacy than in 1000lt of water 1%v/v= 10lt Sero-X per ha

2 – 6 % v/v is ideal depending on pest pressure.
0.2 to 0.6% v/v (200ml - 600ml per 100lt) has demonstrated efficacy in crops where high water volumes are applied, however, results have varied.

Users are encouraged to consider lowering total spray volume applied as research indicates that in some crops an excessive amount of water is applied. Good coverage remains key.

Dilution/Concentration is key for optimising Sero-X.

Minimum of 2lt per Ha in up to 100lt of Water

Over 100lt of Water per ha use Minimum 1% with 2-6% (1lt with 2lt - 6lt per 100lt) preferable

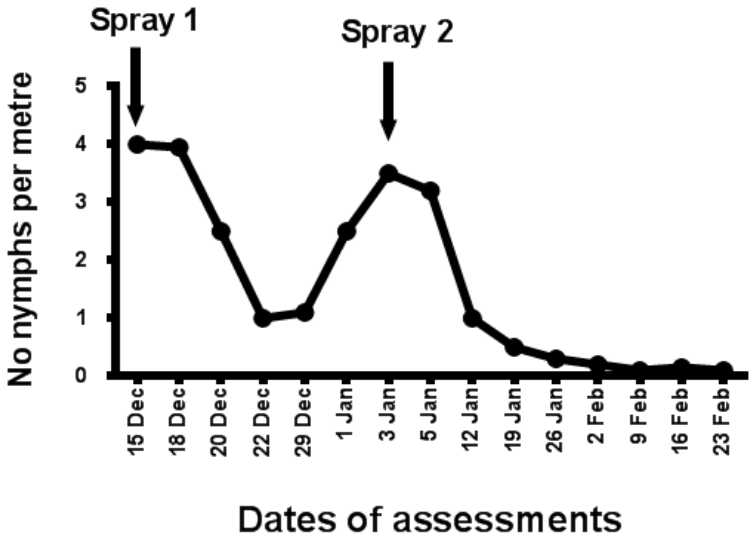
Timing of applications

The timing of Sero-X® applications is crucial to achieve consistent levels of insect control. The behaviour modification modes of action (repellency/ anti-feeding/ mating disruption) work better before high insect populations develop.
Using Sero-X prophylactically, as a prevention strategy in a consistent spray program is an excellent way to achieve high levels of control.

When used as a remedial in response to insect pressure the presence of adults means eggs are already laid on the crop.

In this situation two consecutive sprays 7-10 days apart may be required, because the eggs may have hatched to nymphs behind spray.

To effectively break the life-cycle a follow-up spray could be required



In a spray programme

- **Consider using as a preventative.**
- **10-14 day spray intervals for maximum control.**
- **Heavy rain may require shortening time frames.**

Remedial in response to pest populations

- **Apply before high populations of adults develop.**
- **A second spray may be required after eggs hatch.**

General Instructions

Monitoring

Detailed checks of pest numbers as per best practice pest management requirements, are recommended to ensure application can be made at the earliest suitable time to achieve the best result.

Mixing

Shake or agitate the container prior to mixing with water. Add the required quantity of Sero-X Insecticide to clean water in a half filled spray tank with agitator or by-pass in operation. Maintain agitation while filling tank with remainder of water. Agitation must also be maintained throughout the spray operation.

Storage and handling

Store in the closed, original container in a cool, well-ventilated area. DO NOT store for prolonged periods in direct sunlight.

Sero-X does not require storage in a cool room and temperature at time of application is also not critical to efficacy.

COVERAGE

As with most insecticides good coverage is essential for maximum efficacy.

Sero-X is a contact insecticide for direct toxicity.

The behaviour modification properties of Sero-X such as mating disruption do not require direct contact. It is crucial for the anti-feeding/ repellency mode of actions to work correctly that coverage be consistent and thorough.

Compatibility and application

Compatibility

Sero-X® Insecticide is an emulsifiable concentrate and is likely compatible with commonly used organic liquid fertilisers. Always check the physical compatibility with other products using a jar test in the correct proportions.
Whilst physical compatibility is likely with commonly used herbicides and insecticides, chemical compatibility has not been tested.

Surfactants

Sero-X Insecticide contains a surfactant. Additional surfactant such as esterified vegetable oils may only be necessary on hard to wet plants. Use as per surfactant label instructions.

Application

Sero-X Insecticide may be applied by ground rig with Aerial application for cotton approval expected in 2019 Thorough coverage is essential to ensure adequate control. Applications should be made using nozzles, pressures and other spray conditions to produce a fine / medium spray. An application volume of 50-200 L/Ha is recommended.

Paraffinic Oils

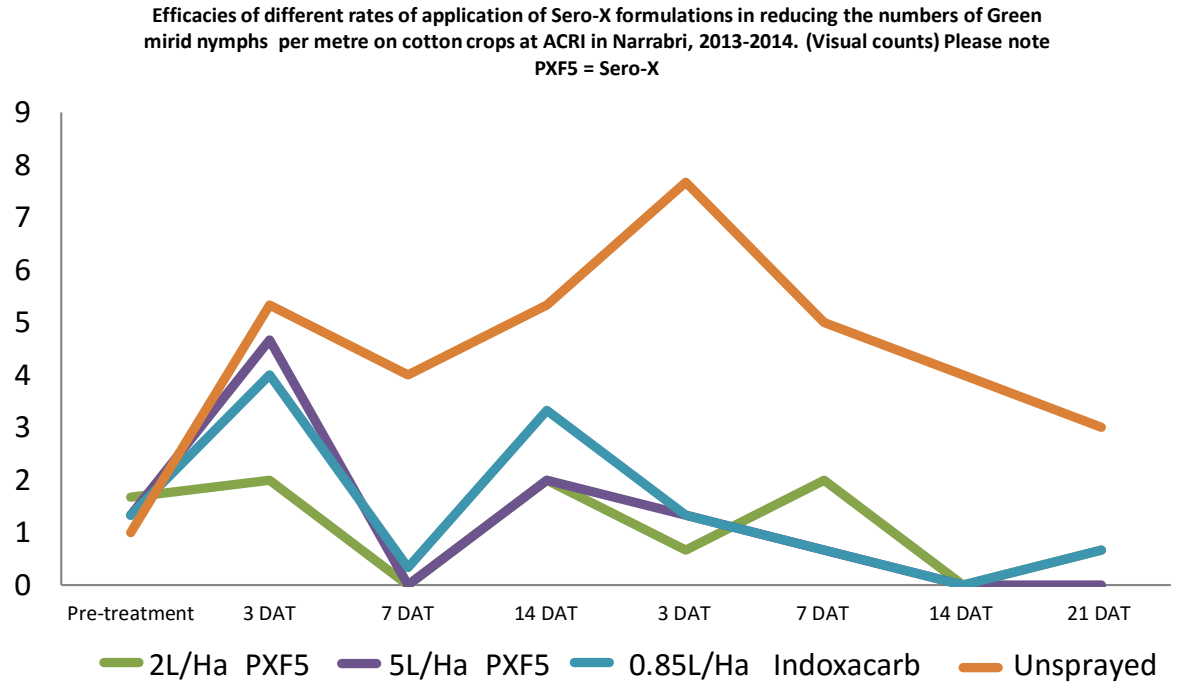
The one instance of incompatibility noted to date is when the product is mixed with paraffinic or "white" oils. Do not mix Sero-X with these products.

Efficacy summary

Current registered label claims

Helicoverpa spp. - Good as a feeding and oviposition deterrent. High level direct toxicity. 2lt per Ha in 100lt of water applications should be timed to coincide with egg hatch and when small larvae up to 5mm are present. A second application at 7-10 days may be required if conditions favour pest development.

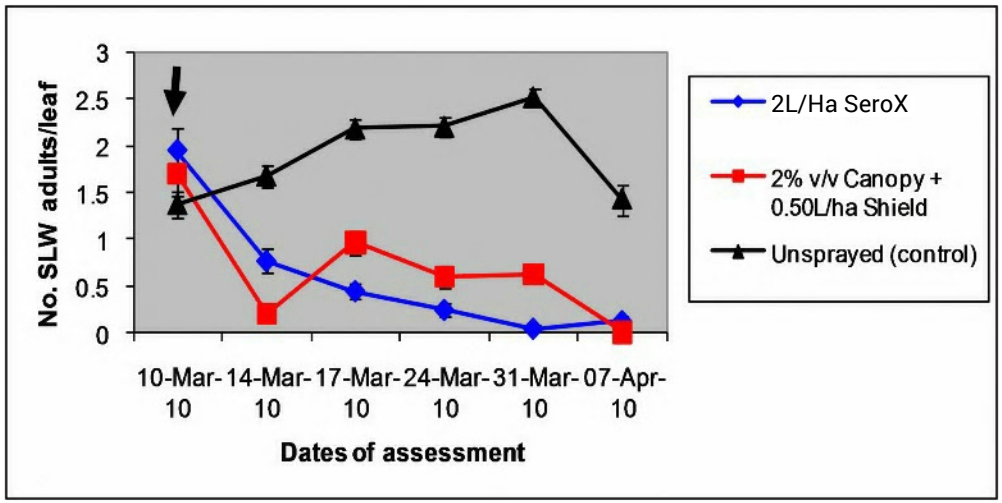
Green Mirids – Excellent both anti-feedant and direct mortality. Apply at recommended threshold levels as indicated by field checks. A repeat application may be required at 14 - 20 days if conditions favour pest development.



Efficacy summary

Current registered label claims - cont'

Silver Leaf Whitefly – Suppressant of populations, may not handle large populations. As good as expensive commercial standards in most conditions. Apply at recommended threshold levels as indicated by field checks. A repeat application may be required at 14 -20 days if conditions favour pest development.



Efficacy of Sero-X against SLW adults on conventional cotton crops at Norwood near Moree.

*Canopy is a registered trademark of Caltex Australia Petroleum Pty Ltd and Shield is a trademark of Sumitomo

Other pest efficacy - not registered

Green Vegetable Bugs – As per Mirids

Seed Treatments – Great early indications of Wireworm control and Thrip suppression

Mites, Thrips, Fruit Fly and various other pests - Bioassay screening and in field replicated trials against a number of Mite and Thrip species indicate excellent control and label claims in various crops expected in the future.

Ongoing trial work both in Australia and internationally will see Sero-X registered across a broad range of crops and pests in the coming seasons.