TARGETING THE POWER OF NATURE



THRIPS, WHITEFLIES*, AND SPIDER MITES* CONTROL *EPA APPROVAL PENDING

Power of synthetics, safety of biologicals.

Spear[™]-T is Vestaron's new biopesticide for control of thrips in vegetables and ornamentals in greenhouses. Field trials of Spear-T demonstrate results equivalent or superior to conventional control chemicals. Two novel modes-of-action make Spear-T ideal in a resistance management program.

www.vestaron.com

©2016 Vestaron Corporation. All Rights Reserved. Always Read and Follow Label Directions. 4717 Campus Drive, Kalamazoo, Michigan 49008 • 269-372-3108





For the control of Thrips, Whitefly and Spider Mites in Glasshouses

Vestaron's first product launch will be SPEAR™-T in the greenhouse market. It will be the only single ingredient product in the market for the simultaneous control of thrips, whiteflies and spider mites. It also exhibits suppression of aphids.





eld trials of Spear-T demonstrate results equivalent o











SPEAR[™]-T works by contact with these insects under low volume or fogging conditions. The product is compatible with use of beneficial insects such as lady beetles lacewings and parasitic wasps. It is EPA approved for 4 hr reentry and 0 day PHI

Dist. Prof. of Entomology **UC** Riverside

"VST06330 tested on the two spotted spider mite (Tetranychus urticae) provided excellent control.





Active Ingredient: GS-omega/kappa-Hxtx-Hv1a	.20%
Other Ingredients:	80%
Total	100%

Net Contents: EPA Registration Number: 88847-E Batch (Lot) Number: **EPA Establishment No.:**

CAUTION Keep out of reach of children Read safety directions before opening or using





Cystine knot peptides: a rich source of traits for the protection of plants

> Exceed the Seed Chicago December 6th, 2016

Robert M. Kennedy, PhD CSO, Vestaron Corp

New Protein Traits for GMO Crops

Houston, we have a problem..







- New Bt proteins
- Bigger stacks
- RNAi

Is there a plan B?

Introducing: Vestaron's GMO Technology

• Leveraged off a credible biopesticide

- Controls insects in real world
- Synergizes with Bt
- Benign Toxicology
- Regulatory path
- Expression in plants
- Business model

Bt-resistance rescue trait for corn rootworm





Specialists in using the safe components of naturally occurring venoms for insect control



Vestaron's Concept for Insecticides



- Thousands of naturally occurring insecticidal peptides exist in nature
- Identify and isolate those that are non-toxic, synthesize the genes for them
- Express those genes in yeast- a Bioinsecticide
- Express those same genes in plant a Plant Incorporated Insecticide
- Analyze their active site, screen for synthetic structures that mimic them a Synthetic Mimic

Driven by design – not screening

Manufacture of SPEARTM



GMO Yeast



Fermentation



Filtration and concentration



Formulation and spray drying

Vestaron's First Registered Biological: SPEAR™



- Effective
 - Two novel modes of action of a.i. excellent insect resistance management
 - The first biological insecticide effective as traditional synthetics in field trials
 - Fits well in a 7 day rotation
- Broad Spectrum
 - Lepidoptera, Diptera, some Coleoptera, Tetranychus, many Hempitera
- Safe
 - Non-toxic to mammals, birds, fish, honeybees, some beneficial insects
 - No toxic residues (MRLs), no noxious odors
 - Certified sustainable
 - No phytotoxicity
- Easy to Use
 - Spray through normal equipment, dissolves easily in water
 - No refrigeration required, stable to pH extremes, stable in sunlight
 - 4 hour REI, 0 days PHI for maximum flexibility at harvest



Bioavailability: the Central Challenge

Two routes of entry:

- Contact for existing insects at the time of spray (through spiracles/surface to volume ratio)
- Oral ingestion for insects that appear postspray (synergistically enhanced by Bt)







Synergy with Bt





10

Combination

SPEAR[™]-C Extends Duration of Protection 2nd Instar H. Zea



11

SPEAR[™]-C Extends Spectrum 4th Instar BAW



SPEAR[™]-C on Celery



Arizona Grower Trial

Three consecutive sprays with Spear-C or industry standards at label rates followed by harvest and evaluation of marketable heads. Primary pest – Beet Armyworm.

Cool! Now just express it in plants..

- Small peptides express at low levels
- Increase the gene copy number and the plant recognizes as a virus repression
- Folding of cysteine rich peptides is non-trivial
- Bioavailability in insects

"Pearls on a Chain" Expression Strategy & Activation



- Coomassie stained protein gel of a repeat Al with cleavable linker.
- Digest is stopped at partial completion to show stepwise breakdown.



Mean levels of peptide in stems and leaves for Vestaron vs. an industry PIP example

	<u>Mean levels</u>	In stems and leaves
	GS-omega/kappa-HxTx-Hv1a peptide	138 µg/g (FW)
A Contraction	modified Cry3Bb1 in MON88017 ⁽¹⁾	27 µg/g (FW)

1. Safety Assessment of Genetically Modified Food, Maize line MON88017 tolerant to the herbicide glyphosate and resistant to coleopteran pests, October 2005

What does the EPA think about putting spider genes in plants?



- Biopesticide -> PIP model love it!
- Bt-resistance rescue trait for Corn Rootworm Yes please!
- Experimental Use Permit they suggested it
- Data package use the biopesticide
- Allergenicity looked at that already but will revisit
- Anything else? maybe some environmental fate work

Where are we?



Phase	Description	Vestaron PIP Progress
Discovery Gene/Trait Identification	Screen genetic resources for target genes. Most promising target genes move to Phase 1.	GS-omega/kappa-HxTx-Hv1a peptide
Phase 1 Proof of Concept	Test genetic constructs in plants to screen for desired performance. Determine most promising leads for application to crops of interest.	
Phase 2 Early Development	Conduct laboratory, greenhouse, and initial field trials of traits in plants to select potential commercial product candidates.	
Phase 3 Advanced Development	Demonstrate efficacy of traits in commercial quality events through additional field trials. Begin development of regulatory data as appropriate.	Collaborative work
Phase 4 Regulatory/Pre- Launch	Complete regulatory process as needed. Develop plans and other requirements for commercial launch.	Licensing
Phase 5 Commercial	On-market.	

A Pipeline of Al's



- First Biopesticide that is as efficacious as synthetics
- Leads seamlessly to insecticidal traits
- Toxicology risk upfront no late stage attrition

Where's Vestaron Going with this?



- SPEAR[™]-T for greenhouse control of thrips, whiteflies and spider mites in late 2017 – distribution nearly negotiated
- SPEAR[™]-C for lepidopteran control in row crops
- SPEAR[™]-P for beetle control on potatoes
- GMO Project Maturing
 - Patents filed for expression technology
 - Levels and constructs nearing point ready for cross with Bt expressing crops
- Relationships with Strategic Partners advanced
 on Biopesticide products but not on GMO





The power of synthetics – The safety of biologicals

Bob Kennedy CSO, Vestaron rmkennedy@vestaron.com 734-255-1946