Soil Technologies Corp.
Research and Development Department

Research Report

Title: Toxicity of Botanical Formulations to Nursery-Infesting White Grubs

Location: Wooster, Ohio

Principal Investigators: Christopher M. Ranger
Michael E. Reding
Jason B. Oliver
James J. Moyseenko
Nadeer N. Youssef

Published: Horticultural Entomology
Vol. 102 no. 1
Page 304-309

Date: 2009

Preamble:
This study was conducted by independent researchers as a service to the USDA efforts to identify materials that would best control larvae in potted plants, prior to such potted plants being transported across state lines in the USA. To conduct this test, pots of soil were allowed to be drenched or saturated with a solution of the tested materials. The commercial use of these materials in an agronomic setting, relevant to this research, would involve drenching potted plants with commercially marketed plants in the pots, prior to shipment of said plants. Another use of the materials would be to drench the soils in the pots prior to transplant and establishment of the commercial plants in the pots. This application is considered of value for any potted plant, including but not limited to, ornamentals, citrus, fruit trees, flowering plants, etc.

Abstract:
The toxicity of six botanically based biopesticides was evaluated against third instars of the scarab larvae (Coleoptera: Scarabaeidae) *Popillia japonica*, *Rhizotrogus majalis*, *Anomala orientalis*, and *Cyclocephala borealis*. Soil dip bioassays were used to obtain concentration-mortality data seven days after treatment of larvae, leading to the calculation of LC_{50} and LC_{90}

values were exhibited among the formulations. The product Armorex[1] was one of the most active formulations against *P. japonica* (LC_{50}=0.42 ml/L), *R. majalis* (LC_{50}=0.48 ml/L), *A. orientalis* (LC_{50}= -.39 ml/L), and *C. borealis* (LC_{50}=0.49 ml/L). The product Azatin[2], composed of 3% azadirachtin, also exhibited high toxicity to *P. japonica* (LC_{50}=1.13 ml/L), *R. majalis* (LC_{50}=0.81 ml/L), and *A. orientalis* (LC_{50}=43.76 ml/L), and *C. borealis* (LC_{50}=50.24 ml/L). These results document the potential for botanical formulations to control white grubs, but blending extracts from diverse botanical sources does not ensure enhanced biological activity.

Methods:

Six commercially available biopesticides were obtained for bioassays. Stock formulations were diluted with deionized water (ml/L) to obtain concentration-mortality measurements and LC_{50} and LC_{90} calculations.

Toxicity of botanical formulations was measured using an in vitro soil dip bioassay. Third instar *P. japonica, A. orientalis, R. majalis*, and *C. borealis* were collected and placed in cell tray sections. Azatin was not tested on *C. borealis* due to lack of test insects. Cell tray sections containing the white grubs were immersed in the formulations for one minute (n=4 grubs per rep, n=6 reps per dose). Control treatments were dipped in deionized water. The mortality of each white grub was subsequently evaluated seven days after treatment.

Results:

Table 1. Contact toxicity 7 DAT of botanical formulations to third instar larvae of the Japanese beetle (*P. japonica*)

Product	*n*	Slope ± SE	LC_{50}	Concentration (ml/L)		95% CI
				95% CI	LC_{90}	
Armorex	6	1.22 ± 0.39	0.42a	(0.25-0.66)	1.20a	(0.74-7.30)
Azatin	6	1.22 ± 0.24	1.13b	(0.87-1.47)	3.23a	(2.26-6.59)
Ecotrol[3]	6	1.66 ± 0.38	1.62b	(1.13-2.03)	3.52a	(2.76-5.77)
Triact 70[4]	6	1.13 ± 0.44	1.74bc	(1.10-2.80)	5.38ab	(3.61-18.18)
Cinnacure[5]	6	1.92 ± 0.31	2.57c	(2.13-3.11)	4.99a	(3.96-7.33)
Veggie Pharm[6]	6	1.61 ± 0.31	35.19e	(26.21-43.56)	77.83c	(61.02-119.71)

LC_{50} and LC_{90} values followed by a common letter are not significantly different (P=0.05) as based on nonoverlap of the 95% Cl.

[1]Armorex is an OMRI Listed, minimum risk pesticide manufactured by Soil Technologies Corp. in Fairfield, Iowa

[2]Azatin is a biological pesticide EPA Registration No. 7-51-9-59807

[3]Ecotrol is an OMRI listed biological insecticide manufactured by KeyPlex

[4]Triact 70 is a biological pesticide CAS No. 947173-77-5

[5]Cinnacure is a biological pesticide CAS No. 104-55-2

[6]Veggie Pharm is a biological pesticide manufactured by Pharm Solutions

Table 2. Contact toxicity 7 DAT of botanical formulations to third instar larvae of the European chafer (*R. majalis*)

Product	***n***	**Slope ± SE**	**LC_{50}**	**Concentration (ml/L)**		**95% CI**
				95% CI	**LC_{90}**	
Armorex	6	1.04 ± 0.42	0.48ab	(0.76-1.64)	1.64ab	(1.08-12.48)
Azatin	6	0.88 ± 0.23	0.81a	(0.49-1.13)	3.46ab	(2.10-13.58)
Ecotrol	6	1.61 ± 0.55	1.15ab	(0.40-1.54)	2.55a	(1.95-5.49)
Cinnacure	6	1.92 ± 0.31	2.57c	(2.13-3.11)	4.99a	(3.96-7.33)
Triact 70	6	0.67 ± 0.21	3.87bc	(1.22-6.18)	25.95c	(13.64-27.37)
Veggie Pharm	6	1.94 ± 0.33	62.10d	(50.40-75.28)	120.14d	(95.91-175.22)

LC_{50} and LC_{90} values followed by a common letter are not significantly different (P=0.05) as based on nonoverlap of the 95% CI.

Table 3. Contact toxicity 7 DAT of botanical formulations to third instar of the Oriental beetle (*A. orientalis*)

Product	***n***	**Slope ± SE**	**LC_{50}**	**Concentration (ml/L)**		**95% CI**
				95% CI	**LC_{90}**	
Armorex	6	1.54 ± 0.34	0.48ab	(0.76-1.64)	0.89a	(0.62-2.07)
Azatin	6	1.19 ± 0.28	0.81a	(0.49-1.13)	5.47bc	(3.39-18.29)
Ecotrol	6	1.25 ± 0.30	1.15ab	(0.40-1.54)	6.09bc	(4.28-13.36)
Cinnacure	6	2.84 ± 0.55	2.48b	(1.34-3.23)	6.26b	(5.24-8.73)
Triact 70	6	0.93 ± 0.21	5.91c	(4.97-7.92)	33.47cd	(19.82-113.43)
Veggie Pharm	6	1.24 ± 0.26	62.10d	(50.40-75.28)	123.03d	(88.31-241.10)

LC_{50} and LC_{90} values followed by a common letter are not significantly different (P=0.05) as based on nonoverlap of the 95% CI.

Table 4. Contact toxicity 7 DAT of botanical formulations to third instar of the northern masked chafer (*C. borealis*)

Product	***n***	**Slope ± SE**	**LC_{50}**	**Concentration (ml/L)**		**95% CI**
				95% CI	**LC_{90}**	
Armorex	6	1.78 ± 0.72	0.49a	(0.08-0.67)	1.02a	(0.76-3.27)
Ecotrol	6	2.38 ± 0.55	2.44b	(1.95-3.05)	4.18b	(3.29-7.07)
Cinnacure	6	1.45 ± 0.35	5.12c	(4.01-7.63)	12.37c	(8.10-37.10)
Triact 70	6	0.68 ± 0.22	19.1d1	(11.83-78.70)	124.35d	(42.88-95.78)
Veggie Pharm	6	0.97 ± 0.22	50.24d	(34.66-66.84)	188.32e	(132.72-486.52)

LC_{50} and LC_{90} values followed by a common letter are not significantly different (P=0.05) as based on nonoverlap of the 95% CI.

Conclusions:

These results demonstrate that botanically based biopesticides may be useful as dip or drench treatments for controlling white grub species that infest nursery stock.

Japanese beetle (*P. japonica*)

Results from this assay demonstrate that Armorex required the lowest concentration out of all treatments to achieve a 50% mortality rate in Japanese beetle larvae with a rate of 0.42 ml/L. A 50% mortality rate was also seen using Azatin at 1.13 ml/L, Ecotrol at 1.62 ml/L, Triact 70 at 1.74 ml/L, Cinnacure at 2.57 ml/L, and Veggie Pharm at 35.19 ml/L. For a mortality rate of 90% the following treatments were used: Armorex at 1.20 ml/L, Azatin at 3.23 ml/L, Ecotrol at 3.52 ml/L, Cinnacure at 4.99 ml/L, Triact 70 at 7.38 ml/L, and Veggie Pharm at 77.83 ml/L.

European chafer (*R. majalis*)

Results from this assay demonstrate that Armorex required the lowest concentration out of all treatments to achieve a 50% mortality rate in European chafer larvae with a rate of 0.48 ml/L. A 50% mortality rate was also seen using Azatin at 0.81 ml/L, Ecotrol at 1.15 ml/L, Triact 70 at 2.57 ml/L, Cinnacure at 3.87 ml/L, and Veggie Pharm at 62.10 ml/L. For mortality rate of 90%, the following treatments were found effective: Armorex at 1.54 ml/L, Ecotrol at 2.55 ml/L, Azatin at 3.46 ml/L, Cinnacure at 4.99 ml/L, Triact 70 at 25.95 ml/L, and Veggie Pharm at 120.14 ml/L.

Oriental beetle (*A. orientalis*)

Results from this assay demonstrate that Armorex required the lowest concentration out of all treatments to achieve a 50% mortality rate in Oriental beetle larvae with a rate of 0.48 ml/L. A 50% mortality rate was also seen using Azatin (0.81 ml/L), Ecotrol (1.15 ml/L), Cinnacure (2.48 ml/L), Triact 70 (5.19 ml/L), and Veggie Pharm (62.10 ml/L). For a 90% mortality rate, the following treatments were found effective: Armorex at 0.89 ml/L, Azatin at 5.47 ml/L, Ecotrol at 6.09 ml/L, Cinnacure at 6.26 ml/L, Triact 70 at 33.47 ml/L, and Veggie Pharm at 123.03 ml/L.

Northern masked chafer (*C. borealis*)

Results from this assay demonstrate that Armorex required the lowest concentration out of all treatments to achieve a 50% mortality rate in northern masked chafer larvae with a rate of 0.49 ml/L. A 50% mortality rate was also seen using Ecotrol (2.44 ml/L), Cinnacure (5.12 ml/L), Triact 70 (5.19 ml/L), and Veggie Pharm (62.10 ml/L). For a 90% mortality rate, the following treatments were found effective: Armorex at 1.02 ml/L, Ecotrol 4.18 ml/L, Cinnacure 12.37 ml/L, Triact 70 at 124.35 ml/L, and Veggie Pharm at 188.32 ml/L.