CONTROL OF IMMATURE AND ADULT GLASSY-WINGED SHARPSHOOTERS:EVALUATION OF BIORATIONAL AND CONVENTIONAL INSECTICIDES

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INTRODUCTION
Pierce's disease, caused by *Xylella fastidiosa* has become an increasingly important factor in grape production in California since 1996. The glassy-winged sharpshooter (GWSS) is a primary *X. fastidiosa* vector. Serious grape and vine losses have increased as GWSS numbers have increased in southern California (Blua et al. 1999). Purcell et al. (1999) suggested that diseases caused by *X. fastidiosa* are likely to become more prevalent with increased numbers and spread of GWSS. Management methods are urgently needed for GWSS that are economically, ecologically and socially acceptable. Cultural and biological components of developing integrated pest management (IPM) strategies need to be melded with efficacious GWSS chemical control and insecticide resistance management (IRM), and integrated crop management (ICM) inputs. In 2000, we studied GWSS adulticides in grapes (Akey et al., 2001a). Our objectives in the two-year trials (2001-2002) were to identify selective, conventional and biorational insecticides that were efficacious for control of immature and adult GWSS in citrus.

OBJECTIVES
1. Identify selective, conventional and biorational insecticides that were efficacious for control of immature and adult GWSS in citrus.

RESULTS AND CONCLUSIONS
Experiments were conducted with naturally occurring GWSS populations during egg to nymph to adult development during a 4-mo.period (April-July), on 6-7 foot tall orange trees. The experimental designs were two - 3 replicate randomized complete blocks at University of California, Agricultural Operations, Riverside, CA. Plots were 0.114ac in size; 25 by 22ft, 3 trees per plot with guard rows on each side (except for Surround® that had plots 3 times larger). GWSS counts were made weekly following applications of treatments (table 1) made with a windmill blast-type sprayer (John Bean Div., FMC) (compliant with Good Lab Practices, GLP). Spray delivery was at 200 psi at 300 gal/ac with 5 swivel-nozzle bodies (Tee Jet) on one side. There were 10 nozzles, each had a core 23, disc 6, and slotted strainer. An adjuvant, Silwet® L 77, (Loveland Ind.) was used in all applications (except Surround®). Spray penetration was studied previously (Akey et al. 2001a,b). LSD mean separation tests were made if there were significant F values by analyses of variance. Data were transformed by $\sqrt{(x + ½)}$ to adjust zeros in data sets.

Efficacies of materials evaluated for control are shown in table 2. The pyrethroids, Baythroid®, Capture® and Danitol® and the neonicotinoids, Provado® and Assail® were highly effective against GWSS. Also, the insect growth regulator (IGR), Applaud® (1 application 0.9333 lb AI/ac), was highly effective against GWSS nymphs. That Applaud® rate was ca. half-label and unlikely to affect beneficial insects (study needed). Neem products (5 applications) were efficacious against development of GWSS to large nymphs (neem products had no efficacy or repellency on GWSS adults on grapes; unpublished data, summer/fall 2000). GWSS nymphal control in 2002 (Table 2) with Applaud®, Agroneem® and Neemix®, and Baythroid® confirmed our first-year results (Table 2, Akey et al. 2001b). Novaluron® (benzoylphenylurea group), a chitin blocker, was more effective against nymphs than Micromite® (also a chitin blocker), diflubenzuron (1 application of each). Sucrose octanoate had minimal efficacy (3 applications). The repellant, Surround®, significantly decreased numbers of immature and adult GWSS (3 applications).

In summary, Applaud® is a prime candidate for IPM programs on GWSS. Pyrethroids are effective conventional agents against GWSS. Neem products may have a place as one tool, combined with others, in organic programs against GWSS. The biorational agents evaluated here will probably be more efficacious in area-wide programs.

Table 1. Trade names, chemistry classes, formulations and rates per acre of foliar insecticides evaluated for immature and adult glassy-wing sharpshooter control in citrus, Riverside, CA, 2001 and 2002.

	Name		Chemistry		Per Acre		
Year	Trade	Generic	Class	Formulation	Product	lb AI	Company
			Conventional Insecticides				
2001	Capture®	bifenthrin	pyrethroid	2 EC	6.4 fl oz	0.50	FMC
2002	Danitol®	fenpropathrin	pyrethroid	2.4 EC	21.0 fl oz	0.40	Valent USA
2001	Baythroid®	cyfluthrin	pyrethroid	2 E	1.6 fl oz	0.010	Bayer Crop Sc
2001, 02	Baythroid®	cyfluthrin	pyrethroid	2 E	3.2 fl oz	0.020	Bayer Crop Sc
2001	Fujimite®	fenpyroximate	oxime	5 EC	4.0 pt	0.0933	Nichino Amer
2001	Assail®	acetamiprid	neonicotinoids	70 WP	1.2 oz	0.0233	Bayer Crop Sc
2001	Provado®	imidacloprid	neonicotinoids	75 WP	10.0 oz	0.2147	Bayer Crop Sc
			Biorational Insecticides and Repellants				
2002	Surround®	Kaolin clay	surface film	100 WP	50.0 lb	50.0	Engelhard
2002	Aza-Direct®	azadirachtin	neem IGR	1.2% wt	1.3 qt	0.0324	Gowan
2001, 02	Agroneem®	neem extract & azadirachtin	neem IGR	15.0 % 0.15%	4.0 qt 4.0 qt	1.100 0.110	Agro Logistics
2002	Neemix®	azadirachtin	neem IGR	4.5 %	1.0 qt	0.46	Certis USA
2001	Trilogy®	neem without azadirachtin	neem IGR	70 %	5 gal	12.74	Certis USA
2002	Applaud®	buprofezin	chitin inhibitor	70 WP	0.2 lb	0.1633	Nichino Amer
2002	Applaud®	buprofezin	chitin inhibitor	70 WP	1.0 lb	0.7000	Nichino Amer
2001, 02	Applaud®	buprofezin	chitin inhibitor	70 WP	1.3 lb	0.9333	Nichino Amer
2001	Esteem®	pyriproxyfen	JH analog	0.86 EC	0.5 qt	0.03	
2002	AVAChem Sucrose Octanoate	sucrose octanoate	bio-soap	40 %	0.8%v/v	7.9 lb	Ava Chemical Ventures
2002	AVAChem Sucrose Octanoate	sucrose octanoate	bio-soap	4 %	1.2% v/v	11.9 lb	Ava Chemical Ventures
2002	Micromite®	diflubenzuron	chitin inhibitor	80 WG	6.3 fl oz	0.3125	Uniroyal Chem
2002	Novaluron®	benzoylphenyl urea group	chitin inhibitor	2.4 EC	4.2 lb	0.3125	Uniroyal Chem

Table 2. Mean numbers (± SE) and insecticidal efficacy percentages following applications of selected chemicals for glassy-wing sharpshooter control in citrus at Riverside, CA , 2001 and 2002.

2001 Treatments[1,2]	Small nymphs		Large nymphs		Adults	
	$\bar{x}$ [3]	%[4]	$\bar{x}$	%	$\bar{x}$	%
Baythroid 1	0.1 ± 0.1	99 d[5]	0.3 ± 0.1	95 e	4.3 ± 1.2	67 efg
Baythroid 2	0.1 ± 0.1	99 d	0.0 ± 0.0	100 e	2.7 ± 0.9	79 g
Capture	0.0 ± 0.0	100 d	0.0 ± 0.0	100 e	2.5 ± 0.9	81 g
Provado	0.2 ± 0.1	96 d	0.2 ± 0.1	97 e	3.4 ± 1.1	74 fg
Assail	0.1 ± 0.1	99 d	0.1 ± 0.1	99 e	2.8 ± 0.8	79 g
Fujimite	3.6 ± 1.0	45 bc	2.3 ± 0.6	68 d	4.7 ± 1.3	64 def
Applaud[6]	0.7 ± 0.5	90 d	0.0 ± 0.0	100 e	5.9 ± 2.3	55 cde
Esteem	6.7 ± 2.0	a	4.9 ± 1.3	31 bc	5.4 ± 1.4	59 cde
Agroneem	6.8 ± 1.8	a	5.3 ± 1.9	26 b	7.1 ± 1.9	39 bc
Neemix	5.6 ± 1.8	15 ab	3.0 ± 0.8	58 d	6.3 ± 1.4	52 bcd
Trilogy	2.3 ± 0.7	65 cd	3.4 ± 1.2	52 cd	7.9 ± 1.9	39 b
Control	6.6 ± 1.9	-- a	7.1 ± 1.7	-- a	13.1 ± 3.4	-- a

2002 Treatments	Small nymphs			Large nymphs			Adults		
	n[2]	$\bar{x}$	%	n	$\bar{x}$	%	n	$\bar{x}$	%
Baythroid	12	0.1 ± 0.1	99 b[5]	18	0.1 ± 0.1	99 b	21	1.8 ± 0.7	71 b
Danitol	12	0.0 ± 0.0	100 b	18	0.0 ± 0.0	100 b	21	1.0 ± 0.4	85 b
Control	12	7.3 ± 3.8	-- a	18	15.2 ± 4.2	-- a	21	6.1 ± 1.6	-- a
Novaluron	12	6.8 ±2.3	56 b	18	2.1 ± 0.6	86 c	18	5.4 ± 1.7	22 a
Micromite	12	12.3 ± 1.8	20 a	18	5.6 ± 0.8	63 b	18	7.5 ± 1.6	-- a
Control	12	15.3 ± 3.2	-- a	18	15.2 ± 4.2	-- a	18	7.0 ± 1.8	-- a
Applaud[7]	21	6.3 ± 1.2	60 b	18	3.7 ± 1.0	78 b	18	2.1 ± 0.7	49 b
Applaud	21	5.4 ± 1.6	66 bc	18	2.4 ± 0.8	85 bc	18	0.8 ± 0.3	81 c
Applaud	21	2.3 ± 1.2	86 c	18	0.0 ± 0.0	100 c	18	1.2 ± 0.4	71 bc
Control	21	15.8 ± 2.6	-- a	18	16.8 ± 4.8	-- a	18	4.2 ± 1.3	-- a
Sucrose[8]	21	20.7 ± 3.6	-- a	15	10.0 ± 2.1	44 a	12	4.5 ± 1.7	-- a
Sucrose	21	8.2 ± 1.3	26 a	15	3.5 ± 0.7	80 b	12	2.1 ± 0.7	48 a
Control	21	11.2 ± 2.5	-- a	15	18.0 ± 4.7	-- a	12	4.0 ± 1.6	-- a
Surround	9	5.3 ± 1.4	65 b	9	2.1 ± 0.6	89 b	9	19.4 ± 5.9	-- a
Control	9	15.0 ± 4.0	-- a	9	19.4 ± 5.9	-- a	9	2.0 ± 0.9	-- a
Agroneem	12	12.0 ± 2.8	33 a	12	8.8 ± 2.8	68 b	12	20.3 ± 3.9	16 ab
Aza-Direct	12	9.3 ± 2.0	48 a	12	7.6 ± 2.1	72 b	12	15.3 ± 2.8	37 bc
Neemix	12	17.2 ± 5.7	41 a	12	10.3 ± 3.2	62 a	12	12.2 ± 2.4	50 c
Control	12	18.0 ± 4.7	-- a	12	27.2 ± 6.8	-- a	12	24.2 ± 5.4	-- a

[1] Number of applications applied were: one for Baythroid, Capture, Danitol, Assail, Provado, Applaud, Novaluron, and Micromite; two for Fujimite, three for AVA Chem, Sucrose Octanoate, Surround; Agroneem Neemix, and Trilogy, 2001, five for Agroneem, Aza-Direct and Neemix, 2002.
[2] n = 3 replicates of each treatment times number of analyzed dates in which the life stage was present post application(s); n 2001 was 21.
[3] Means of 3 replicates of each treatment.
[4] % efficacy = percent reduction from control.
[5] Means in columns by group(s) with different letters, are significantly different by ANOVA and LSD at $P \leq 0.05$, analyses were based on transformed data, $\sqrt{(x + ½)}$ to adjust zeros in data sets.
[6] 2001, 0.93 lb AI/ac
[7] 2002, 0.16, 0.70 and 0.93 lb AI/ac, respectively.
[8] 0.8 and 1.2%, respectively.

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