Title: Alternative management tactics for green June beetles in grape

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Objectives

The overall objective is to develop a management tactic that prevents green June beetles from damaging fruit. The specific objectives are:

1) To compare the attractiveness of different odor mixtures for mass trapping green June beetles outside grape plantings; and
2) To evaluate efficacy of insecticides and biopesticides against the green June beetle for potential use in an attract-and-kill formulation.

Justification

The green June beetle (GJB), *Cotinis nitida* (L.) causes significant damage to ripening small fruits and tree fruits in the southeastern US. The GJB is native to the southeastern US from Kansas to Connecticut and south to Texas and northern Florida. Over the past 60 years, the size of the poultry and livestock industry in this region increased, resulting in more acreage receiving applications of manure which decomposes into nutrients that support GJB grubs. I conducted an E-Mail survey of research, extension personnel and growers in the SE region that asked questions about the pest status of GJB. A majority of the 29 respondents (72%) in 11 states observed GJB damage every year: 1000 A of turf and 3000 A of fruit in AL; 1000 A of grapes and peaches in AR; 4000 A of peaches in GA; pasture and turf in MS; 2025 A of grapes in MO; peaches in NJ; 1000 A of turf in NC; 750 A of grapes and peaches in OK; 6000 A of peaches in SC; 300 A of grapes in TN, and 7000 A of grapes in TX. Growers indicated they applied insecticide to prevent GJB damage to: grapes in 7 of 10 states, especially 'Vignoles', 'Seyval', 'Niagara', and Muscadine; peaches in 6 of 10 states; and thornless blackberries in 3 of 10 states. One respondent in TX said, "…these little devils can destroy an entire harvest (of grapes) all by themselves." At least 34,870 A of fruit and turf in the SE Region were damaged yearly by GJB feeding with yield losses and/or spray costs exceeding $3.6 million or $105 per acre. The respondents emphasized setting a goal to develop an alternative tactic to insecticide control of GJB on ripening fruit (Johnson et al 2009).

Methodologies

Objective 1: By July 3 or 4, 2008, Xpando Japanese beetle yellow funnel trap ($4.50 ea) were wired to a 5 cm dia. hole in cover of a 10+ liter capture box ($5 ea) and held 1 m above the ground on a bent rebar of 0.9 cm dia. (3/8") ($1 each). Twelve traps were spaced 30 m apart in a line parallel to and 20 m outside both the west and south perimeters of a 'Seyval' vineyard in Purdy, MO. Another 12 traps were similarly placed north of a 'Venus' vineyard in Altus, AR. Each trap line was arranged in a randomized complete block design with 6 replicates of two baits: 1) a plastic 250 ml bottle dispensing 200 ml/wk of 91% isopropanol from 2 cotton wicks through a 1.75 cm diameter opening; or 2) Trécé floral lure cup dispensing 3.5 ml/wk of the five component TRE-8607 blend (phenylacetaldehyde + phenethyl alcohol + methyl-2-methoxybenzoate + limonene + methyl salicylate) (provided by Trécé Incorporated, Adair, OK). In 2008, Great Lakes IPM, Inc. (Vestaburg, MI) started selling a season long lure for GJB called TR-GJB (Trécé Incorporated, Adair, OK) for $7.35/lure. The 91% isopropanol bait costs $3.50-$4/trap/season. Weekly from 3 July to 14 August, trap baits were recharged and the volume of GJBs captured per trap was converted into an estimate of the number of GJBs per trap, where 125 GJB adults displaced 300 ml.

Objective 2: The objective of these laboratory tests were to compare the efficacy against GJB of several synthetic insecticides and biopesticides (OMRI approved for organic farm production), given that only carbaryl is registered against GJB. On 24 July, live GJB were collected from fruit on apple trees and caged. Plastic window screen measuring 12" x 6" was folded on itself to form a 6" x 6" pocket screen cage, the two sides were stapled closed, then ten live GJB and an apple slice were placed inside the cage and the top edge stapled closed. Each treatment cage with GJBs and an apple slice was dipped in one of the treatment solutions (5 replicates) and hung on a wire inside the insectary. At 24, 48 and 72 hrs after being dipped, records were made of the percentage GJB adults per cage that were live (able to walk), morbid (probing elicits slight leg movement, but no walking) or dead.

Analysis The trap data were analyzed using the general linear model procedure and Tukey's Studentized Range Test (HSD), whereas percentage mortality data were transformed by arcsine square root (proportion), analyzed with ANOVA and means separated by the Waller-Duncan k-ratio t-test, k-ratio = 100 (SAS Institute 2003).

Results

Objective 1: The 2008 season total catches of GJB adults was 324,007 in 36 baited traps, where the 12 traps each in Altus, AR and the south and west trap lines in Purdy, MO captured 7,428; 166,634; and 149,945 GJBs, respectively. In Altus, AR, the baits of 91% isopropanol and the TRE-8607 blend captured similar numbers of green June beetles (Fig. 1 A). In Purdy, MO, the traps in both the west and south trap lines baited with 91% isopropanol had significantly more GJB adults per trap from 17 July through the 14 August than did traps baited with TRE-8607, but equal captures earlier on 10 and 17 July (Fig. 1 B, C). The GJBs captured in traps by the 'Venus' vineyard in Altus was 20-fold less than in Purdy, MO. Grape damage was low because grower insisted on spraying the 'Venus' block with insecticide. The 'Seyval' grapes did not ripen during the GJB flight period so no damage estimates could be made.

Objective 2: At 72 h after treatment on 24 July, the caged GJBs dipped in treatment solutions of NAI 2302 and Alverde killed > 87 % of the GJB adults which was similar to that for Ecotrol (71%) but significantly greater than Aza-Direct, MOI 201, Botanigard, QRD-416 or the water check (all < 41%) (Table 2). Actara, Admire, Altacor, Battalion, Baythroid, Clutch, Danitol, and Sevin killed 100% of the GJB by 72 h after application on 25 July. These treatments caused significantly more GJB mortality than the < 51% killed by Ecotrol, Botanigard, Delegate and the water check (Table 3). Treatments of QRD-416, Aza-Direct and the water check applied on 30 July all caused similarly low mortality ($\leq$ 30%) (Table 4).

Conclusions

Both the 91% isopropanol and the TRE-8607 blend used as individual baits in Xpando Japanese beetle traps elicited very strong feeding aggregation behavior in GJB adults resulting in very large trap captures (324,007 beetles from 36 traps) outside two vineyards. It appears that growers could use Xpando traps baited with either lure and spaced 30 m apart around vineyards in place of traps baited with fermenting fruit to help reduce the local population of GJBs. The yearly cost would be < \$25/hectare/yr (< \$10/acre/yr) for new baits. The cost of Xpando traps (\$10.50 ea) can be depreciated over several years of use. Further studies are planned to determine the minimum trap density and optimum placement of traps around the perimeter that maintain fruit damage at an acceptable level (< 2%).

In a companion study, several registered insecticides registered on fruit but not on GJB were found to cause > 87% GJB adult mortality including: Alverde, Actara, Admire, Altacor, Battalion, Baythroid, Clutch, Danitol, NAI 2302, and Sevin. The two biopesticides, Ecotrol and Aza-Direct, had moderate activity (% mortality) against GJB adults. In future experiments, the bait could be used to attract GJB adults to a perimeter trap crop sprayed with a sugar + insecticide as an attract-and-kill tactic for GJBs. There is still a need to identify the sex pheromone of GJBs which could be used in traps to capture GJB males during early mating portion of the season and to add the fermentation odor lure later to catch both sexes during the fruit feeding period in July and August.

Impact Statement

We expect the results of these trapping and efficacy studies to eventually be integrated into an attract-and-kill tactic against GJB that can be adapted for any fruit or turf production area in the southeastern US. The trapping cost is expected to be < \$20/acre the first year and < \$10/acre/yr thereafter for purchase of new baits. This cost would be similar to or even less per acre than making two or more full vineyard applications of Sevin or other insecticides. The efficacy data for those insecticides that caused > 87% GJB mortality will be forwarded through the IR-4 Minor Use Program to request that EPA add GJB to the respective labels for all fruits. This will give growers several insecticides with different modes of action in addition to Sevin for use against GJB adults.

Citation(s) for publications arising from the project

Johnson, D.T., and B.A. Lewis. 2009. Efficacy of insecticides against green June beetle, 2008. ESA Arthropod Management Tests 34: C (Submitted)

Johnson, D.T., B.A. Lewis, R.J. Bryant, R. Liyanage, J.O. Lay, and M.A. Pszczolkowski. 2009. Attractants for the green June beetle, *Cotinis nitida* (Coleoptera: Scarabaeidae). J. Econ. Entomol. (Submitted).

Table 1. Mean number ± SEM (N = 6) of green June beetle (GJB) adults in Xpando Japanese beetle traps baited with different baits near vineyards in Purdy, MO and Altus, AR in 2008

Location and bait	# GJB captured / trap [a]	F	df	*P*
West edge, Purdy, MO		13.27	1, 5	0.015
TRE	10,821 ± 978.5b			
91% isopropyl alcohol	14,169 ± 1,403.4a			
South edge, Purdy, MO		9.73	1,5	0.026
TRE	12,205.8 ± 574.8b			
91% isopropyl alcohol	15,566.5 ± 1,607.2a			
North edge, Altus, AR		2.71	1,5	0.16
TRE	747.5 ± 151.8a			
91% isopropyl alcohol	490.5 ± 143.7a			

[a] TRE = TRE-8607 blend = phenylacetaldehyde, phenethanol, methyl-2-methoxybenzoate, methyl salicylate and limonene

Mean values by location and date followed by the same letter are not significantly different (Tukey's Studentized Range Test (HSD); $P > 0.05$)

Table 2. Percent dead green June beetle adults 72 hrs after being dipped in treatment insecticide solution on 24 July 2008

Treatment or formulation	Active ingredient(s)	per 100 gal sol./A	% dead after 72 hrs
NAI 2302 15 EC	Tolfenpyrad	27 fl oz	100.0a
Alverde BAS 320 I	metaflumizone + 0.5% MSO v/v	16 fl oz	87.33ab
Ecotrol EC	10% rosemary oil + 2% peppermint oil	96 fl oz (3 qts)	70.9a-c
Aza-Direct 1.2%	azadirachtin	32 fl oz (2 pts)	50.8b-d
MOI 201	1:500 dilution extract of Chinese medicinal plants	25.6 fl oz	40.9c-e
QRD-416 25%	plant oil of *Chenopodium ambrosioides*	96 fl oz (3 qts)	9.1de
Water check	water	--	5.0e
Botanigard ES	*Beauveria bassiana*	64 fl oz (2 qts)	0.0e

Means not followed by the same letter are significantly different (Waller-Duncan k-ratio t-test, k-ratio = 100). Data transformed by arcsine square root (proportion)

Table 3. Percent dead green June beetle adults 72 hrs after being dipped in treatment insecticide solution on 25 July 2008

Treatment or formulation	Active ingredient(s)	per 100 gal sol./A	% dead after 72 hrs
Actara 25%	thiamethoxam	3.5 oz	100.0a
Admire 2F	imidacloprid	32 fl oz	100.0a
Altacor 35% ai	rynaxypur	4.5 oz	100.0a
Battalion 0.2 EC	deltamethrin	14.1 fl oz	100.0a
Baythroid 12.7%	cyfluthrin	3.2 fl oz	100.0a
Clutch 50 WDG	clothianidin	3 oz	100.0a
Danitol 2.4 EC	fenpropathrin	10.677 fl oz	100.0a
Sevin 4F	carbaryl	64 fl oz (2 qts)	100.0a
Ecotrol EC	10% rosemary oil + 2% peppermint oil	96 fl oz (3 qts)	50.0b
Water check	water	--	12.0c
Botanigard 22 WP	*Beauveria bassiana*	32 oz (2 lbs)	4.0d
Delegate 25 WG	spinetoram	5 oz	2.0d

Means not followed by the same letter are significantly different (Waller-Duncan k-ratio t-test, k-ratio = 100). Data transformed by arcsine square root (proportion)

Table 4. Percent dead green June beetle adults 72 hrs after being dipped in treatment insecticide solution on 30 July 2008

Treatment or formulation	Active ingredient(s)	per 100 gal sol./A	% dead after 72 hrs
QRD-416 25%	plant oil of *Chenopodium ambrosioides*	96 fl oz (3 qts)	30.0 a
Aza-Direct 1.2%	azadirachtin	32 fl oz (2 pts)	0.00 a
Water check	water	--	0.00 a

Means not followed by the same letter are significantly different (Waller-Duncan k-ratio t-test, k-ratio = 100). Data transformed by arcsine square root (proportion)

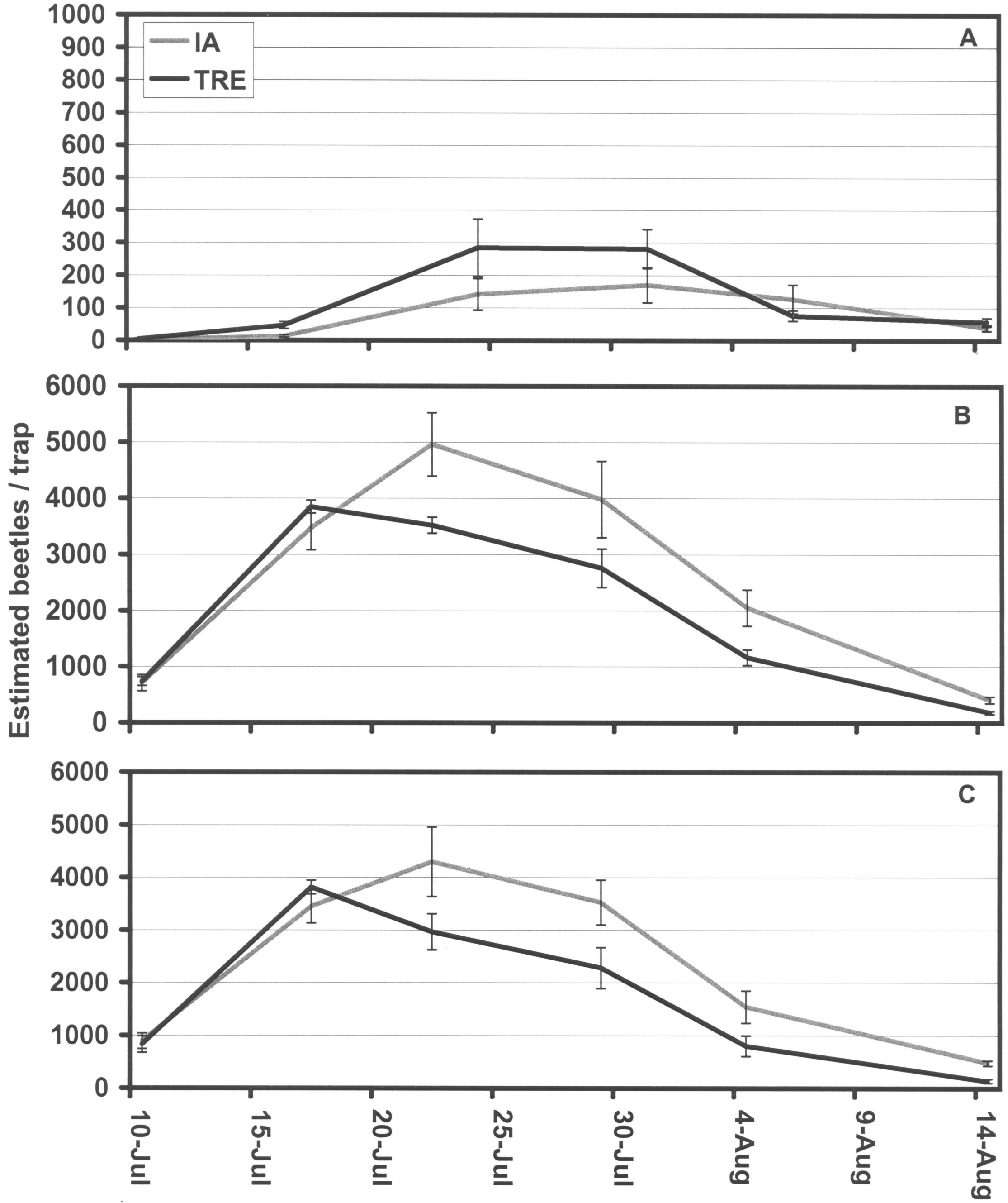

Figure 1. Number of green June beetle (GJB) adults in yellow funnel traps baited with TRE-8607 blend (TRE) or 91% isopropanol (IA) set in line parallel to but 10 m outside grape vineyards along A) north perimeter in Altus, AR; B) south perimeter in Purdy, MO; and C) west perimeter in Purdy, MO in 2008, where mean values by graph for a given date with overlapping ± SEM bars are not significantly different, Tukey's Studentized Range (HSD) Test, $P > 0.05$