

Host plant choice experiments of Colorado potato beetle, *Leptinotarsa decemlineata* (Say) in Virginia

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Introduction

Colorado potato beetle, *Leptinotarsa decemlineata* (Say) (CPB), is the most important insect pest of potatoes in the United States and can also damage other solanaceous crops such as eggplant and tomato. Although insecticides have traditionally been used to combat this serious pest, the development of resistance has consistently challenged this method of control. Understanding host plant choice of this pest may provide alternative strategies for the management of CPB. In order to better understand host plant choice of CPB in Virginia, and factors which may contribute to these choices, we conducted field- and laboratory-choice experiments utilizing solanaceous crops available to local CPB populations in the field (potato, eggplant, tomato, and pepper). We also sought to determine if the presence of colonizing male CPB adults feeding on eggplant or potato affected the number of new CPB adults coming to those plants in the field.

Materials & Methods

Olfactory Laboratory Comparison

An open Y-track olfactometer (“Flying T”) apparatus was used for laboratory choice experiments. Humidified hydrocarbon-free air was used to deliver plant volatiles to the apparatus. Beetles were considered to have made a choice after traveling 1 cm up either arm of the “Flying T”. Foliage was replenished after 30 min.

Experiments were conducted in a darkened room at 24°C where the only light source was from the bioassay apparatus. For each assay, 20 adult males and 20 adult females were tested. Beetles were starved for 24 h then dark-adapted for 1 hour prior to testing. The following tests were conducted: potato vs. tomato; potato vs. eggplant; and eggplant vs. tomato. For each of the three plant species tested, single-stems weighing approximately 4.8 g, were removed from the plants and mechanically injured by making approximately 1-cm slits around the perimeter of the leaf. This experiment was conducted three times, once in 2006 and twice in 2007. Data were analyzed by testing the hypothesis that the binomial proportion was significantly different from a probability of 50% using the standard normal approximation.

Field Comparison test 1: tomato versus eggplant versus pepper

Field comparisons were conducted during the summer of 2005 in Painter, VA with the three host plants tomato, eggplant, and pepper. The three crops were transplanted into a single row so that there was a 6-m section of eggplant, a 6-m section of tomato, and a 6-m section of pepper, for a total row length of 18 m. The order of the three crops was randomized for each replicate. There

were three treatments replicated four times and arranged in a randomized complete block design: 1) all plants were treated prior to transplanting with a drench of imidacloprid (255.5 g[AI]/ha); 2) eggplants only were treated with the imidacloprid drench prior to transplanting; and 3) all plants were untreated. Numbers of CPB dead adults within 30 cm of the row, live adults, larvae, and egg masses on each crop in each block were counted twice a week for approximately one month. To meet normality assumptions, all data were transformed using a square root ($x + 0.05$) transformation prior to analysis. Data were subjected to one-way analysis of variance (ANOVA) at $P \leq 0.05$ level of significance. When significant F values were detected by ANOVA, means were separated using Fisher protected least significant difference (LSD) test.

Field Comparison test 2: potato versus eggplant

Field comparisons were conducted during the summer of 2006 and 2007 in Painter, VA to determine if CPB infestations differed between untreated potatoes and eggplants and insecticide-treated potatoes and eggplants. Individual plots consisted of two 1.5-m long rows separated by 0.91-m. One row contained five potted eggplants, while the other row contained five potato plants. In the first experiment, we counted the number of live CPB adults on paired rows of untreated potato and eggplant. In the second experiment, we counted the number of dead CPB adults found on or at the base of plants in paired rows of potato and eggplant treated with imidacloprid (255.5 g[AI]/ha). Both treatments were replicated four times in each experiment. CPB numbers (including dead adults and live adults) in each block were counted every 2-3 days for approximately two weeks.

For all field comparisons, beetle numbers were compared using a paired t -test at the $P \leq 0.05$ significance level. All data were transformed using a square root ($x + 0.05$) transformation prior to analysis.

Effect of colonizing male CPB adults feeding on eggplant and potato

Field studies were conducted with 'Superior' potatoes and 36 6-leaf stage eggplants in pots at the ESAREC in Painter, VA in 2006 and 2007. Test plants used in the study were either eggplant or potato treated with an imidacloprid drench (Admire 2F 0.20 lb ai/A). Test plants were either paired with an eggplant or potato plant that was covered in mesh bag that contained two newly emerged CPB males that had been collected from nearby potatoes. There were six treatments which consisted of the following pairs of plants: potato (treated) + potato (CPB); potato (treated) + eggplant (CPB); potato (treated) + potato (no CPB); eggplant (treated) + potato (CPB); eggplant (treated) + eggplant (CPB); and eggplant (treated) + eggplant (no CPB). Numbers of live and dead CPB adults on/or within a 30 cm radius of each test plant were recorded at 24, 48, 72, and 96 h. For each evaluation, all beetles found on a test plant were removed to avoid recounting for the following evaluation. Data were analyzed by analysis of variance (ANOVA) at $P \leq 0.05$ level of significance. When significant F values were detected by ANOVA, means were separated using Fisher protected least significant difference (LSD) test.

Results

Olfactory Laboratory Comparison

Significantly more CPB adults oriented to the odorous blend emitted from mechanically-damaged potato foliage compared to volatiles of mechanically-damaged eggplant foliage ($P \leq 0.01$) or mechanically-damaged tomato foliage ($P \leq 0.01$). In addition, volatiles arising from mechanically-damaged eggplant foliage were preferred by CPB over volatiles from mechanically-damaged tomato foliage ($P \leq 0.01$) (Table 1).

Field Comparison test 1: tomato versus eggplant versus pepper

Bell pepper plants tested in the study had no CPB adults, larvae, or egg masses for all sample dates, and were therefore omitted from analysis. On untreated plots (no insecticides), more CPB adults ($F = 18.5$; $df = 1, 82$; $P < 0.0001$), larvae ($F = 11.6$; $df = 1, 82$; $P = 0.0010$), and egg masses ($F = 10.6$; $df = 1, 82$; $P = 0.0016$) were noted on eggplants than on tomatoes. In imidacloprid treated plots, more dead CPB adults ($F = 8.55$; $df = 1, 82$; $P = 0.0045$) were found in eggplant plots than tomato plots.

Field Comparison test 2: potato versus eggplant

In 2006, more live CPB adults were found on untreated eggplant than on untreated potato for one sample date, 16 May ($t = 5.09$; $df = 3$; $P = 0.0147$). There were no significant treatment effects for the number of adults on untreated eggplant and untreated potato for the remainder of the sampling dates for both 2006 and 2007.

For the imidacloprid-treated plants, there were no significant differences in the numbers of dead CPB adults found on treated eggplant and treated potato in 2006 and 2007 for all sample dates.

Effect of colonizing male CPB adults feeding on eggplant and potato

There was a significant difference in the total number of CPB adults found coming to the test plants over time in 2006 ($F = 2.76$; $df = 5, 25$; $P = 0.0406$) and 2007 ($F = 3.12$; $df = 5, 25$; $P = 0.0252$), with the eggplant (treated) + eggplant (CPB) treatment having significantly more beetles than all other treatments (Figs. 1A and 1B).

Conclusions

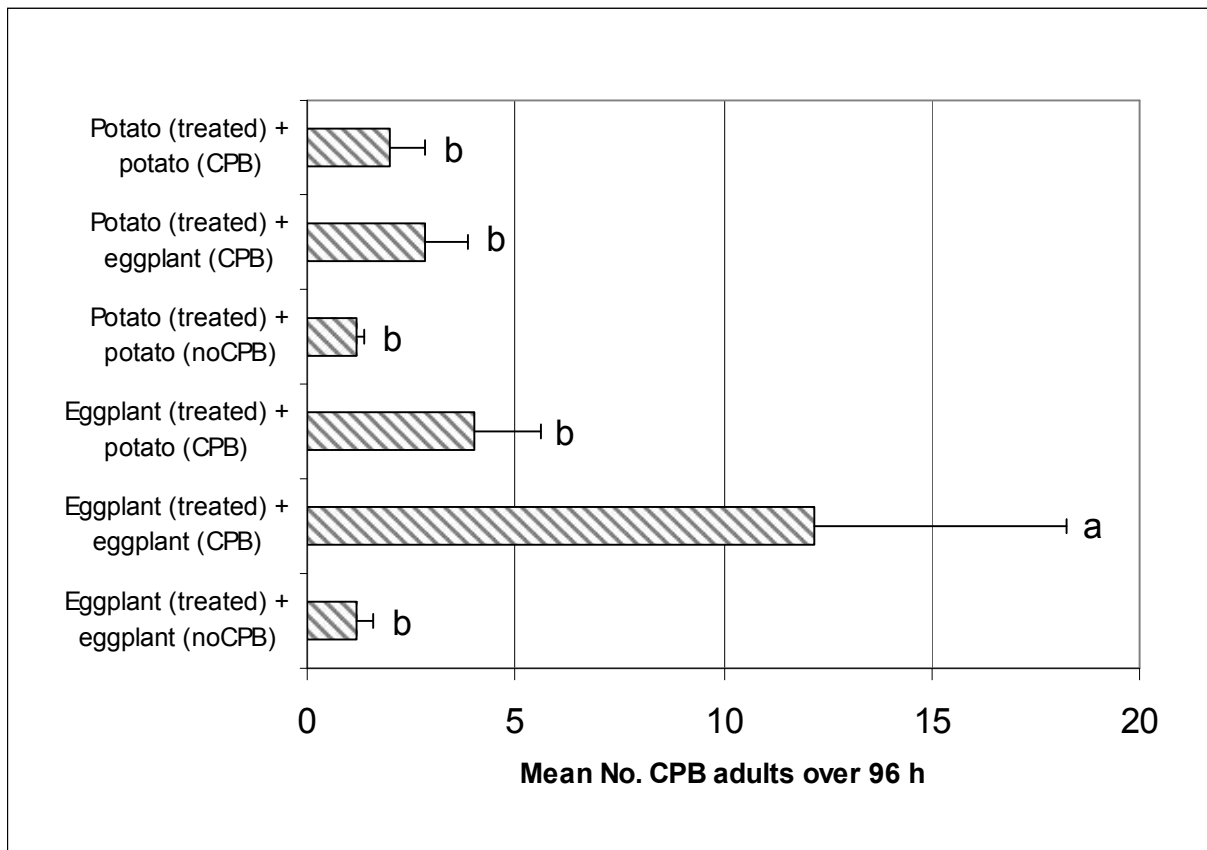
Our field test results indicate that, in the field, CPB prefer eggplant to potato plants; however, when the plants were treated with a systemic insecticide, there was no difference in numbers of dead beetles observed in the area of either host plant. This explains why CPB oriented to potato foliage over eggplant foliage in the lab, but not in the field.

Recently a male-produced aggregation pheromone was identified for CPB, and may potentially play a role in host plant selection. In field experiments, it appears beetles were able to feed on untreated eggplants and potatoes, and likely released their aggregation pheromone while feeding. Insect mortality on imidacloprid-treated plants made pheromone release unlikely. The effect of newly-emerged male CPB feeding on host plants further supports this observation with a clear orientation to the eggplant (treated) paired with eggplant (CPB) combination, indicating that host plant choice in the Colorado potato beetle involves both plant volatiles and a male-produced aggregation pheromone.

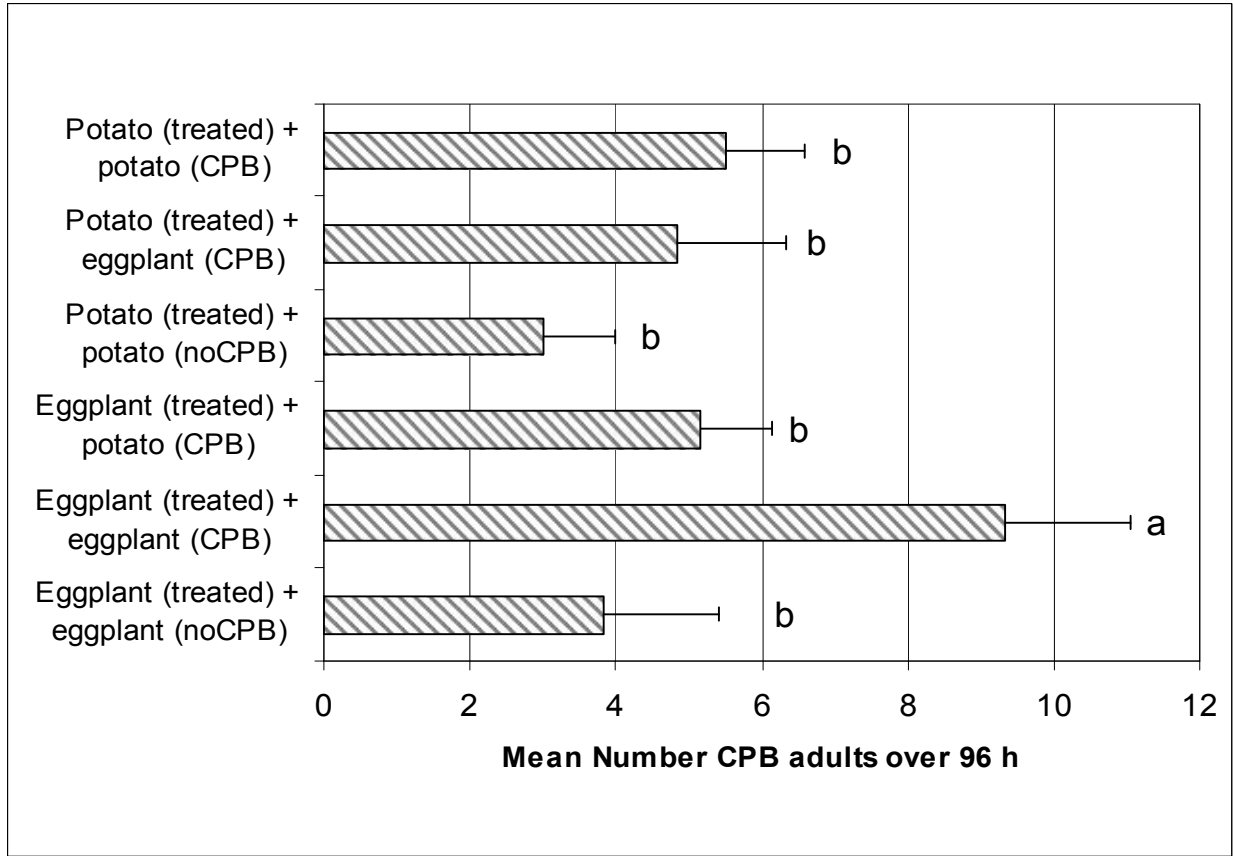
Table 1. Behavioral response of *L. decemlineata* adults to volatiles emitted by mechanically-damaged foliage from solanaceous plants in a laboratory olfactometer for three combined experiments, 2006-2007, Painter, VA.

Orientation of <i>L. decemlineata</i>	Mechanically damaged plants		
	A. Potato vs. B. Tomato	A. Potato vs. B. Eggplant	A. Eggplant vs. B. Tomato
Combined experiments 2006 & 2007	76:44	80:40	76:44
% response to A	63.3*	66.7*	63.3*

* Responses differed for paired treatments ($P < 0.01$) by testing the hypothesis that the binomial proportion is significantly different from $P = 50\%$ using the standard normal approximation.



(A) 2006



(B) 2007

Figure 1. Mean \pm SE cumulative numbers of *L. decemlineata* adults coming to combinations of paired eggplant and potato plants (*L. decemlineata* = 2 males per plant) over 96 h in 2006 (A) and 2007 (B) in Painter, VA. Bars surmounted by different letters are significantly different as determined by ANOVA ($P \leq 0.05$) and Fisher protected LSD.