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The invasive "kudzu bug," Megacopta cribraria (Hemiptera: Plataspidae) as an agricultural and nuisance pest

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Introduction

- *Megacopta cribraria*, also known as the kudzu bug or bean plataspid, was first found in the southeastern United States in the fall of 2009 in northern Georgia. A native of Asia, this species has spread throughout Georgia and South Carolina and into parts of Alabama, North Carolina, Tennessee, Virginia, Florida, and Mississippi.
- Adults and nymphs feed on the stems of soybeans, *Glycine max* (L.) Merr., kudzu, *Puereria montana* (Lour.) Merr. variety *lobata* (Willd.), and several other legumes. Heavy feeding causes the formation of brown-black necrotic lesions on the stems of plants. However, because these insects do not feed directly on seeds, any yield loss that occurs is due to stress on the plant, and may not be visually apparent.

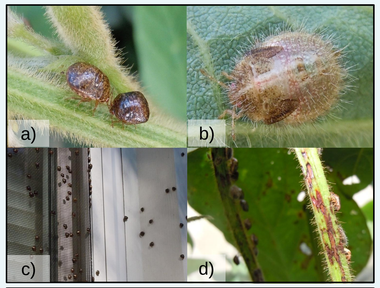


Figure 1. *Megacopta cribraria* adults (a), fifth-instar nymph (b), adults overwintering on a window pane (c), and damage to soybeans from a large aggregation of adults and nymphs (d).

- In addition to its potential agronomic importance, *M. cribraria* can be a nuisance pest in the fall when it seeks to overwinter in homes and other structures.
- We performed two experiments examining these aspects of *M. cribraria* pest management. The objective of the first study was to determine the effects of *M. cribraria* feeding and development on soybean yield and components. The objective of the second study was to evaluate the efficacy of insecticides that may be used to manage this insect as a nuisance invader of structures.

Materials and Methods

Experiment 1: effects of *M. cribraria* feeding on soybean yield and components.

- This experiment was set up as a completely randomized design with four replicates and three *M. cribraria* infestation-level treatments. Small plots (2 rows × 1.07 m) of soybeans were enclosed by 1.5 m high mesh cages in 2011 and 2012. During the late vegetative stages of development, caged plots were infested with zero, five, or 25 *M. cribraria* adults per plant. These adults and their offspring were confined within the caged plots until the soybeans were ready for harvest (stage R8).
- Population development of *M. cribraria* in 2011 was not measured, but was much greater than anticipated. Therefore, in 2012 biweekly population estimates from the time of infestation to full soybean pod development (stage R6) were made by counting the adults and nymphs per plant on three to five plants per cage.
- When soybeans reached stage R8 (18 November 2011 and 23 October 2012), all plots were harvested and shelled by hand. The number of pods per plant, total number of seeds, total seed weight per plot, and grain moisture were measured, and total yield at 13% moisture, seeds per pod, and average individual seed weight were calculated.
- Regression analyses were performed using the simple linear model $y = ax + b$, where y = the dependent variable, x = infestation level, a = the parameter estimate for the relationship between infestation level and the dependent variable, and b = the parameter estimate of the y-intercept. Soybean yield at 13% moisture content, pods per plant, seeds per pod, and individual seed weight were analyzed as dependent variables.

Experiment 2: efficacy of insecticides for management of *M. cribraria* as a nuisance invader.

- This experiment was set up as a randomized complete block design with four replicates and a three × five × eight full factorial treatment arrangement, with three residual exposure periods (one, 16, or 30 days), five exterior building material surfaces (vinyl soffit, painted wood, unpainted wood, metal, and brick), and eight spray applications (seven insecticides + untreated control; Table 1).
- Insecticides were applied to 10 cm × 10 cm surfaces (“panels”) of five common structural materials on 31 Oct 2012 at the Clemson University Cherry Farm Insectary using a handheld pressurized sprayer at 25 PSI and a walking speed of 1.5 feet per second. Panels assigned to a 16 or 30 day residual treatment were held for the duration of the exposure period under a plastic tarp suspended over a metal frame to create a semi-exposed condition.
- Insect mortality evaluations were begun on 1 Nov (1 day residual), 15 Nov (16 day residual), and 29 Nov 2012 (30 day residual). *Megacopta cribraria* adults were confined to each panel in groups of five using an upturned mason jar. The rim of each mason jar was greased with a thin layer of petroleum jelly to prevent the insects from climbing the side of the jar. Insect mortality was evaluated at 24 h post-infestation; each insect was classified as alive (responsive to stimulus), dead (unresponsive), or stunned (responsive, but in uncoordinated twitchy movements).

Materials and Methods

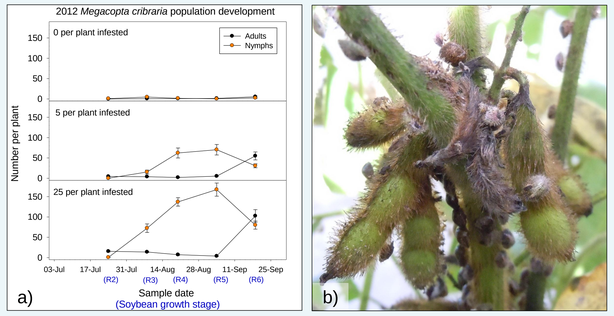
Experiment 2 (Continued)

- Data were analyzed using a mixed model ANOVA. The response variable was the proportion of insects killed or knocked down (“morbidity”), transformed by taking the arcsine of the square root. Residual exposure time, surface, chemical, and all interactions were considered fixed effects, and the replicate was considered a random effect.

Results

Effects of *M. cribraria* feeding on soybean yield and components

- Soybean yield was reduced as *M. cribraria* infestation level increased in both 2011 (F = 49.41; df = 1, 10; P < 0.001) and 2012 (F = 31.77; df = 1, 10; P < 0.001) at α = 0.05. Pods per plant was not affected by *M. cribraria* infestation level in either year (2011: F = 3.85; df = 1, 10; P = 0.078; 2012: F = 0.45; df = 1, 10; P = 0.519). Seeds per pod (2011: F = 31.95; df = 1, 10; P < 0.001; 2012: F = 36.74; df = 1, 10; P < 0.001) and individual seed weight (2011: F = 69.98; df = 1, 10; P < 0.001; 2012: F = 36.11; df = 1, 10; P < 0.001) were reduced as *M. cribraria* infestation level increased in both years.



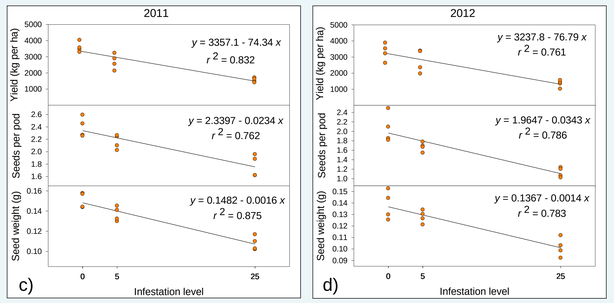


Figure 2. Impact of *Megacopta cribraria* feeding and development on soybeans. Adults confined to small soybean plots reproduced, and their offspring completed a generation within the caged plots (a). Feeding in the highest density cages resulted in visibly reduced soybean pod fill and seed size (b). Soybean yield, seeds per pod, and individual seed weight were reduced in both 2011 (c) and 2012 (d).

Conclusions

Effects of *M. cribraria* feeding on soybean yield and components

- At sufficient densities, *M. cribraria* feeding can cause severe yield reductions in soybeans.
- Feeding by *M. cribraria* puts stress on the soybean plant. Reduction of seeds per pod and weight per seed indicates that heavy plant stress occurred during the pod fill stages of soybean development when populations of late instar nymphs were high in the caged plots.
- Further study of the physiological and behavioral mechanisms of *M. cribraria* feeding may provide additional insights as to the categories of stress (nutritional, drought, etc.) that are the main contributors to soybean yield reduction.

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Table 1. Chemical treatments and rates used in Experiment 2.

Trade name	Active ingredient (stock concentration)	Spray soln. concentration	Spray vol. (gal/1000ft²)	Manufacturer
Arilon	Indoxacarb (20%)	0.05%	1	DuPont
Arilon	Indoxacarb (20%)	0.1%	2	DuPont
Alpine WSG	Dinotefuran (40%)	0.3%	1	BASF
Tandem	Thiamethoxam (11.6%) *Lamda*-cyhalothrin (3.5%)	0.13%	1	Syngenta
Talstar Pro	Bifenthrin (7.9%)	0.062%	1	FMC
Transport Mikron	Acetamiprid (5%) Bifenthrin (6%)	0.11%	1	FMC
Temprid	Imidacloprid (21%) Cyfluthrin (10.5%)	0.15%	1	Bayer
Water (deionized)	N/A	N/A	1	N/A

Results

Efficacy of insecticides for management of *M. cribraria* as a nuisance invader

- Residual exposure time (F = 33.20; df = 2; P < 0.001), surface material (F = 24.22; df = 4; P < 0.001), and chemical (F = 404.86; df = 7; P < 0.001) all significantly affected insect morbidity. All interaction terms were significant at α = 0.05, including: surface × residual (F = 6.04; df = 8; P < 0.001), chemical × residual (F = 3.75; df = 28; P < 0.001), surface × chemical (F = 12.21; df = 28; P < 0.001) and surface × residual × chemical (F = 2.11; df = 56; P < 0.001).

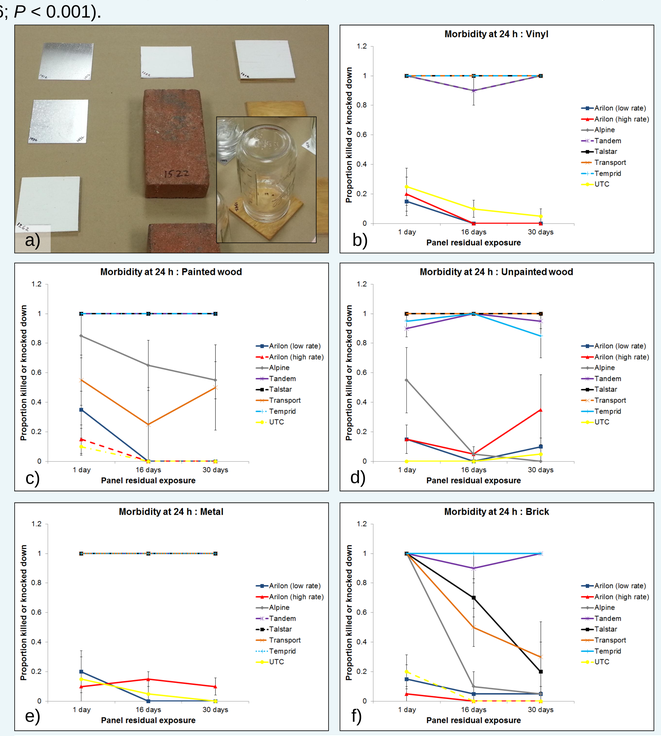

Figure 3. Experimental setup prior to infestation of *Megacopta cribraria* adults, with inset showing confined insects post-infestation (a). Morbidity evaluated after insects were exposed to treated surfaces for 24 h on vinyl soffit (b), painted wood (c), unpainted wood (d), metal (e), and brick (f).

Conclusions

Efficacy of insecticides for management of *M. cribraria* as a nuisance invader

- Several insecticides showed high initial efficacy and residual activity against *M. cribraria* adults, even at 30 days post-application. Materials containing pyrethroid insecticides (*lamda*-cyhalothrin, bifenthrin, cyfluthrin) were particularly effective.
- A decline in residual insecticide efficacy of some materials was especially pronounced on brick, a highly porous surface. Metal and vinyl, which are non-absorbent, showed little to no decline in activity at up to 30 days post-application.
- As all chemicals evaluated here are registered for professional use only, further studies should include chemicals that are registered for general purchase and use by homeowners.