Diel Flight Activity and Intra-Plant Distribution of *Megacopta cribraria* (Hemiptera: Plataspidae) Adults in Soybean[1]

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Abstract *Megacopta cribraria* (F.) (Hemiptera: Plataspidae), the kudzu bug, is a soybean pest in the southeastern United States. Accidentally introduced into Georgia in 2009 from Asia, kudzu bug can reduce up to 60% of soybean yield when left uncontrolled. There is limited information on the life history of this invasive pest in soybean. The main goals of this research were to investigate the daily flight activity pattern and intra-plant distribution of kudzu bug adults in soybean. This was accomplished through experiments in two locations in North Carolina during 2013 in which dispersing adult kudzu bugs captured on white sticky cards between 0900–1700 h were counted hourly, and adults on plants were visually sampled between 0900–1200 h from soybean maturity group IV to VII plants. Adult captures on sticky cards were higher from 1300 to 1500 h across sampling dates, suggesting that dispersal or flight activity peaks during this interval. When soybean plants were visually inspected, most of the adults formed aggregations on the main stem, with aggregations most common in the middle section of plants. The number of aggregations per plant, the number of adults per plant, and the male-to-female ratio were not influenced by maturity group. Soybean plant height did not affect adult densities per plant. However, densities varied depending on the date of sampling. Implications of this research on kudzu bug biology are discussed.

Key Words dispersion, soybean maturity group, plant height, adult aggregation, sex ratio

The kudzu bug, *Megacopta cribraria* (F.) (Hemiptera: Plataspidae), is an invasive pest of soybean, *Glycine max* (L.) Merrill, in the United States. Originally from Southeast Asia (Suiter et al. 2010, Hosokawa et al. 2014), this insect was first reported in nine counties of Georgia during 2009 (Suiter et al. 2010), and is currently widespread across most states in the southeastern United States (Gardner 2016). In its invasive range, the kudzu bug prefers feeding on and reproduces not only in soybean, but also in kudzu *Pueraria montana* Loureiro (Merrill) variety *lobata* (Willdenow) (Zhang et al. 2012, Medal et al. 2013, Seiter et al. 2014, Blount et al. 2015, Golec et al. 2015). There is not much agreement on the reproductive success of kudzu bug on alternative hosts. No-choice assays indicated that kudzu bug could potentially develop and reproduce on other legumes such as pigeon pea, *Cajanus cajan*, (Medal et al. 2013, Blount et al. 2015) and on lima bean, *Phaseolus lunatus* (Medal et al. 2013, Golec et al. 2015).

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Kudzu bug is bivoltine in the southeastern United States (Zhang et al. 2012, Seiter et al. 2013). Adults disperse to kudzu or early-planted soybean from overwintering sites during April, where they feed, mate, and then lay eggs (Zhang et al. 2012, Seiter et al. 2013, Del Pozo-Valdivia et al. 2016); however, some F_0 females that mated in the previous fall,can lay eggs immediately following departure from overwintering sites (Golec and Hu 2015). In the southeastern United States, the first generation (F_1) nymphs are observed on soybean during May and June, and adults of the first in-field generation are seen on soybean during July and August (Zhang et al. 2012, Seiter et al. 2013, Del Pozo-Valdivia et al. 2016). A second generation of nymphs and adults can be observed during September and October in kudzu and soybean, respectively (Zhang et al. 2012, Seiter et al. 2013).

Scouting for kudzu bug in soybean is critical for implementing the suggested insecticide action threshold when managing this pest (Seiter et al. 2015). The spatial distribution of the kudzu bug within soybean fields may pose a challenge for accurately sampling populations of this insect. Aggregations of kudzu bug are most commonly found near edges of soybean fields (Seiter et al. 2013). Sampling plans should incorporate this information to avoid sampling bias. Other unknown factors, such as diel flight activity and intra-plant distribution of this insect, might also influence the sampling efficiency.

It is well documented that some hemipterans have aggregated intra-plant distributions, reflecting their preference for certain tissues on their host plants. In alfalfa, *Medicago sativa* L., *Acyrthosiphon kondoi* Shinji and Kondo (Hemiptera: Aphididae) is mostly found on stems and leaves along the mid-portion of the canopy (Zarrabi et al. 2005). The spatial distribution can change as the hemipteran or plant develops. For instance, adults of the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) (Hemiptera: Miridae) are mostly found on vegetative structures (mainly leaves) of cotton, *Gossypium hirsutum* L., compared with nymphs that are found in fruiting structures (squares, bolls, and blooms) (Snodgrass 1998). On the other hand, apterous and alate aphids, *Aphis gossypii* Glover (Hemiptera: Aphididae) are uniformly distributed over the cotton plant during the early growth stages, with apterous aphids more common in the bottom and middle sections of the cotton plant as cotton develops (Fernandes et al. 2012).

In soybean, there are some records of how insect densities vary within the plant canopy. For example, the soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), has higher growth rates at the upper nodes of plants, compared with the lower section of the plant (McCornack et al. 2008, Costamagna 2013). Stink bugs (Hemiptera: Pentatomidae) are commonly found in the upper portion of plants. However, when density-dependent effects are exerted, high infestation levels of conspecifics force the bugs to feed in the lower portion of plants (Russin et al. 1987). This has been corroborated in southeastern U.S. soybean, where approximately 80% of green, *Acrosternum hilaris* Say (Hemiptera: Pentatomidae), and brown, *Euchistus* spp. (Hemiptera: Pentatomidae), stink bugs are found within the upper portion of the soybean canopy in Virginia (Owens et al. 2013). Additionally, another southeastern U.S., non-hemipteran pest, the corn earworm, *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae), prefers to oviposit on terminals of trifoliates that are located in the lower and upper sections of the soybean canopy (Terry et al. 1987). The hypothesis is that a closed canopy, especially at the middle section of the plant, may inhibit moth flight or obscure visual cues, resulting in fewer eggs at the middle of the plant (Terry et al. 1987).

Diel flight activity also varies among hemipterans in the field, even among species in the same family. For example, the mealybug *Planococcus citri* Risso (Hemiptera: Coccidae) and *Planococcus ficus* Signoret (Hemiptera: Coccidae) are more active fliers during early in the morning ~0700 h (Levi-Zada et al. 2014). Furthermore, the rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), is more active on ornamental greenhouse plants between 0600 and 1000 h (Taravati et al. 2014). In contrast, more sweetpotato whiteflies, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), are caught towards midday in experimental field plots of cotton, watermelons, and cantaloupe (Bellows et al. 1988). Other hemipterans are generally active during later hours of the day. Adults of the stink bug *Bagrada hilaris* (Burmeister) (Hemiptera: Pentatomidae) are more active and abundant during the afternoon, specifically between 1300 and 1800 h, in desert cole crops (Huang et al. 2013). Finally, other stink bugs, such as *Euchistus conspersus* Uhler (Hemiptera: Pentatomidae), are highly active during the night, with a peak of abundance and mating ~2100 h (Krupke et al. 2006).

Literature on the life history of kudzu bug is still incomplete. Since its introduction, no information about diurnal activities of this insect in soybean fields has been reported. The objectives of this study were to identify periods when during the day adult flight activity peaked in soybean fields, and to investigate the distribution of adults within soybean plants of different maturity groups during the morning. Maturity group is defined as the categorization of the number of days until soybean flowers under specific photoperiod conditions (Pedersen 2009). Plant phenology was modified in these experiments, because different maturity groups within a given experiment were planted the same date. We hypothesized that adult *M. cribraria* flight activity would differ at specific times of the day in soybean fields and that intra-plant distribution may be influenced by maturity group. Additionally, we were interested in testing if plant height, which we expected to change through time and among maturity groups, may also influence kudzu bug adult densities. Ultimately, understanding flight activity and intra-plant distribution of adults might lead to improved scouting procedures and optimized insecticide application timing.

Materials and Methods

Plot information. Field sites were located in the North Carolina State University Sandhills Research Station, near Jackson Springs in Montgomery Co., NC (N 35°11′06.5″ W 79°40′15.8″) and in a commercial soybean field near Gibson, Scotland Co., NC (N 34°44′42.8″ W 79°35′15.8″) during 2013. The east (Sandhills) and south (commercial field) sides of experimental sites were ~40 m away from the wood line, composed mainly of broad-leaf tree species. Experiments were set up as a randomized complete block design in conventionally disc-tilled fields, with four replications and a single factor, maturity group. For both locations, soybean seed was Roundup Ready (Asgrow, Monsanto Company, St. Louis, MO) and maturity groups were IV (variety AG4531), V (AG5503), VI (AG6132), and VII (AG7502). Experimental plots were four rows wide and 12.2 m long at both locations. At the

Sandhills Research Station, soybean was planted on 16 April 2013, with 0.97 m row-spacing using a four-row cone planter (John Deere model 1750, Deere and Co., Moline, IL) and a seeding rate of 29 seeds per row meter. At the commercial field near Gibson, soybean was planted on 18 April 2013, with 0.91 m row-spacing using a two-row disc planter (White model 6700, AGCO Corporation, Duluth, GA) and the same seeding rate (29 seeds per row meter).

Adult flight activity monitoring. Two 20 $\times$ 25-cm white sticky traps (replacement liner for Pherocon IV trap, Trécé Inc., Adair, OK) were fastened at 0.75 m and another at 1.5 m above the ground level, respectively, to 4-cm diameter wooden poles; one located at each corner of the two fields. Two additional poles were placed in the middle of the northern and southern side of each field. The sticky surface of each trap faced into the experimental field. Trap heights were selected to approximate mid-canopy and above the maximum canopy height of mature plants (1.0 m). White sticky cards were used because more kudzu bugs are captured on light-colored sticky cards (Horn and Hanula 2011). The kudzu bug adults were counted and removed from each sticky card hourly from 0900 to 1700 h. This experiment was conducted on 11 June 2013 and 6 August 2013 at the Sandhills Research Station, and on 13 June 2013 and 13 August 2013 at the commercial field. New sticky cards were placed on each date and at each location before beginning adult monitoring, and cards were removed after 1700 h.

Adult intra-plant distribution. Whole-plant visual inspections were conducted to record the number of adult aggregations per plant, number of adults per aggregation, number of adults per plant, plant height (cm), location of aggregations within a plant's canopy, and number of males and females in the middle section of soybean plants. An adult aggregation was defined as two or more adults adjacent to each other with no clear separation between or among them. Based on preliminary observations indicating that adults were on the soybean main stem during the morning, visual inspections were performed from 0900 to 1200 h. Three plants were randomly selected from the middle section of the third row in each experimental plot. By using a 1-m ruler, plant height was recorded from the soil surface at the base of the plant to the apex of the main stem. After measuring plant height, the canopy was divided into thirds, representing the upper, middle, and lower sections of the canopy. The number of aggregations per plant within each section was recorded as were the number of adults per aggregation and the total number of adults per plant. To document the number of males and females on soybean plants, a sub-sample of the counted adults was collected from the middle section of the plant and placed in a 50-ml clear plastic centrifuge tube with a lid (Corning Inc., Corning, NY). Adults were sexed in the field while they were contained inside the centrifuge tube, by using morphological characters on the last abdominal sternite (Zhang et al. 2012). Adult monitoring using sticky cards and plant visual inspections were performed during June in soybean that came from the first in-field generation. Monitoring adults from the beginning of the second in-field generation in soybean was conducted during August. Plant inspections were conducted on 20 June 2013 (commercial field only) and on 14 August 2013 (Sandhills Research Station only).

Data analysis. Numbers of insects captured on sticky cards were pooled across locations ($n = 2$) and sampling dates ($n = 2$) to form a single data set. Adult captures were averaged between height of the sticky cards on each pole ($n = 2$) to provide adults per card for each position of the pole ($n = 6$). Adults per card were $\log_{10}$-

transformed ($\log_{10}[X+1]$) to comply with the assumptions of the analysis of variance (ANOVA). This data set was analyzed using a mixed linear model ANOVA (PROC MIXED, SAS version 9.3, SAS Institute 2010, Cary, NC). The response variable for this analysis was $\log_{10}$-transformed adults per card; the fixed effects were sampling date ($n = 4$), time of the day ($n = 8$), and their interactions. Random effects were location and position of the pole nested with location. The effect of time of day on random effects was modeled using repeated measures. The total number of experimental units was calculated by multiplying dates by locations and by the position of the pole. Because sticky cards evaluations were performed every hour, the covariance structure to account for the repeated measures was selected as compound symmetry. To further analyze the interaction between sampling date and time of the day, least square means were partitioned by the single effects of time of the day for each level of sampling date, by using the SLICE option in the LSMEANS statement.

For the second part of this study, separate mixed linear models (PROC MIXED, SAS Institute 2010) were performed using number of aggregations found in each plant section ($n=3$), aggregations per plant, adults per aggregation, male-to-female ratio, adults per plant, and plant height as response variables. All response variables except male-to-female ratio and plant height were $\log_{10}$-transformed ($\log_{10}[X+1]$) to comply with the assumptions of the ANOVA. In our first mixed linear model, the response variable was $\log_{10}$-transformed number of aggregations, and the fixed effects were sampling date ($n=2$), maturity group ($n=4$), plant section ($n=3$) nested within plant ($n=3$), plant sampled per plot ($n=3$), and their interactions. For the second, third, and fourth mixed linear models, the response variables were $\log_{10}$-transformed number of aggregations, $\log_{10}$-transformed number of adults per aggregation, and male-to-female ratio, respectively, and sampling date ($n = 2$), maturity group, and their interaction were fixed effects. For the last mixed linear model, $\log_{10}$-transformed number of adults was the response variable, and sampling date, maturity group, plant height nested with maturity group, and their interactions were fixed effects. Replication nested with location was the only random effect included in all mixed linear models.

Degrees of freedom for all ANOVA tests were calculated using the procedure of Kenward and Roger (1997). When a two-way interaction was significant, least square means were partitioned by the single effects of maturity group for each level of sampling date by using the SLICE option in the LSMEANS statement. Post hoc mean separation of the transformed data, male-to-female ratio, and plant height was performed using the Tukey's test at $\alpha \leq 0.05$. Means and standard errors are reported from back-transformed data.

Results

Adult flight activity. A total of 132 kudzu bug adults were captured on white sticky cards at the two fields. Adult captures were influenced by the interaction of sampling date and time of the day ($F = 4.72$; df $= 21, 140$; $P < 0.0001$) (Fig. 1). When controlling for the sampling date effect, adult captures on sticky cards were significantly different from 1100–1200 h ($F = 6.64$; df $= 3, 134$; $P = 0.0003$) and from 1300–1600 h ([1300–1400 h: $F = 10.32$; df $= 3, 134$; $P < 0.0001$] [1400–1500 h: $F =$

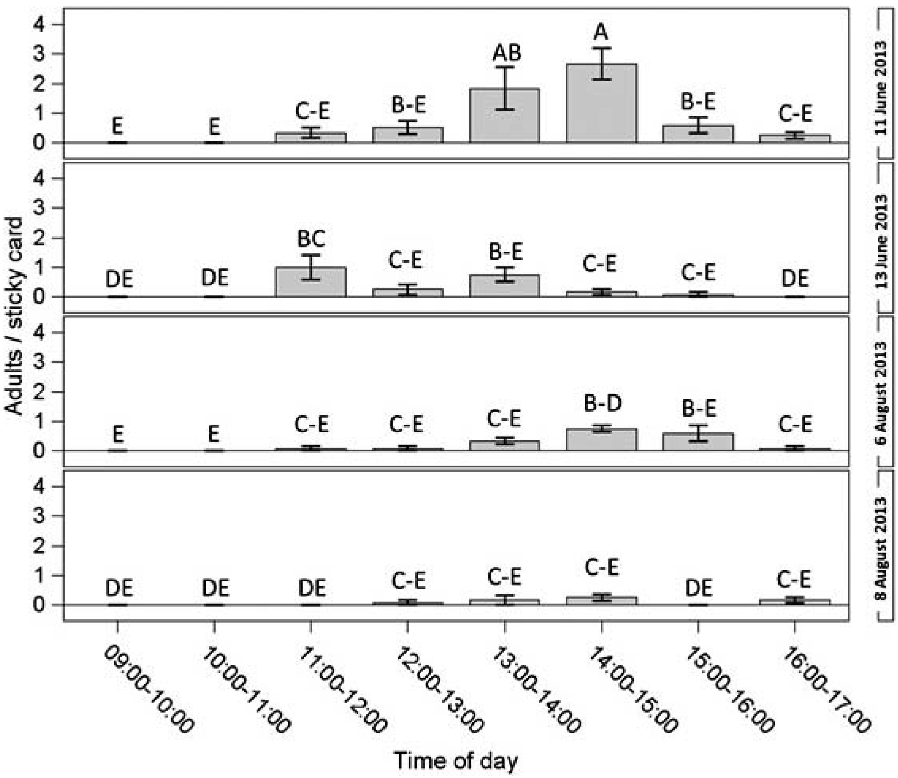

Fig. 1. Hourly captures of *Megacopta cribraria* on white sticky cards placed around experimental fields at the Sandhills Research Station and a commercial soybean field near Gibson, NC, during 2013. Monitoring was conducted twice during June and August (horizontal panels) at both locations. Means sharing the same letter are not statistically significant (α >0.05).

22.21; df = 3, 134; $P < 0.0001$] [1500–1600 h: $F = 3.35$; df = 3, 134; $P = 0.0209$]), when monitoring was conducted from 0900 to 1700 h. Generally, and across sampling dates, higher adult captures were recorded during 1300–1500 (1300–1400: 0.77 ± 0.23 adults per card; 1400–1500: 0.95 ± 0.25 adults percard), compared with captures recorded from 0900–1100 h (no captures) and from 1600–1700 h (0.12 ± 0.05 adults per card).

Adult intra-plant distribution. There were 1039 adults on 76 plants over the course of this experiment. The location of adult aggregations throughout the main stem of soybean plants was not influenced by sampling date ($F = 0.03$; df = 1, 4.99; $P = 0.8756$), maturity group ($F = 1.79$; df = 3, 142; $P = 0.1511$), plant inspected ($F = 0.28$; df = 2, 139; $P = 0.7536$), or any interaction among treatments (sampling date x maturity group: $F = 1.61$; df = 3, 142; $P = 0.1906$, maturity group x plant inspected: $F = 0.21$; df = 6, 139; $P = 0.9741$, sampling date x maturity group x plant inspected: $F = 0.64$; df = 6, 139; $P = 0.7003$). The total number of aggregations differed among

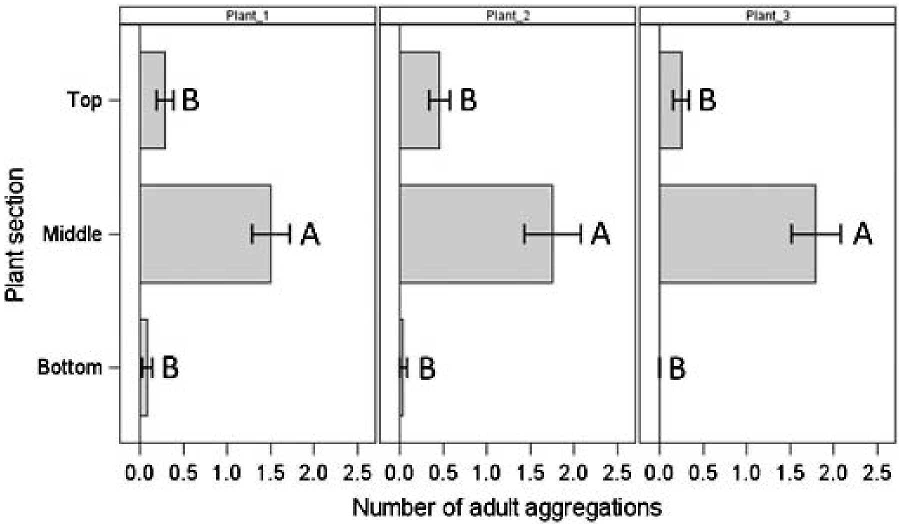

Fig. 2. Intra-plant distribution of adult aggregations of *Megacopta cribraria* in soybean. Visual inspections of plants were conducted once during June at a commercial soybean field near Gibson, NC; and once during August at the Sandhills Research Station. Plant canopy was divided vertically into upper, middle, and lower thirds. Adult aggregations were defined as two or more adults grouped together with no clear space separation between or among them. Means sharing the same letter are not statistically significant (α >0.05).

canopy sections within soybean plants ($F = 28.80$; df = 6, 139; $P < 0.0001$). More aggregations were observed in the middle section of the main stem of plants, compared to both the upper and the lower sections (Fig. 2).

There were 148 adult aggregations on 76 soybean plants, and the number of aggregations ranged from 0 to 8 per plant; the average number of aggregations per plant was 1.95 ± 0.17. From those aggregations, the range of number of adults per aggregation was 2–18 and the average number of adults per aggregation was 5.16 ± 0.32. The number of adults per aggregation was not influenced by either sampling date ($F = 1.01$; df = 1, 16.1; $P = 0.3292$), maturity group ($F = 0.08$; df = 3, 16.1; $P = 0.9713$), or their interaction ($F = 0.32$; df = 3, 16.1; $P = 0.8121$). Furthermore, 74% ± 3.29 of adults occurred in aggregations rather than individually on soybean plants, where most of the aggregations (98% ± 1.20) were found on main stems. The number of adult aggregations per plant was influenced by the interaction between sampling date and maturity group ($F = 3.86$; df = 3, 63.5; $P = 0.0133$). When controlling for the sampling date effect, the number of aggregations per plant was not affected by maturity group (IV: $F = 1.01$; df = 1, 8.54; $P = 0.3434$, V: $F = 0.50$; df = 1, 9.33; $P = 0.4984$, VI: $F = 2.37$; df = 1, 7.74; $P = 0.1637$, VII: $F = 0.57$; df = 1, 7.74; $P = 0.4724$).

There were 359 males and 234 females collected from adult subsampling. The male-to-female ratio was not affected by sampling date ($F = 0.39$; df = 1, 4.75; $P = 0.5632$), maturity group ($F = 0.35$; df = 3, 61.6; $P = 0.7888$), or the interaction

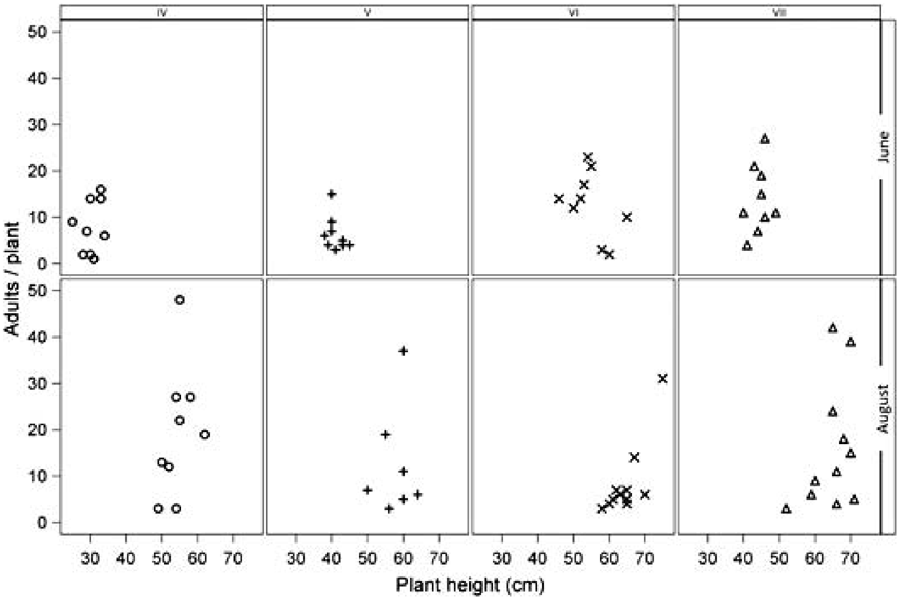

Fig. 3. Scatter plot showing the relationship between plant height (cm) of soybean (X-axis), planted during April using four different maturity group (MG) varieties (labeled "IV", "V", "VI", and "VII" on the vertical panels), and densities of adults per plant (Y-axis) recorded on 20 June 2013 (labeled "June" on the horizontal panels) and on 14 August 2013 (labeled "August" on the horizontal panels). This type of plot was chosen to show all data point, including the outliers.

between these factors ($F = 2.66$; df $= 3$, 61.6; $P = 0.0561$). Numerically, there was a male-bias ratio across all plant inspections, with more males (4.72 $\pm$ 0.34) present per plant in the middle section than females (3.08 $\pm$ 0.23).

The average number of adults per plant across the two sampling dates was 13.67 $\pm$ 1.98. Adult density per plant was not influenced by sampling date ($F = 2.83$; df $= 1$, 59.7; $P = 0.0977$), maturity group ($F = 0.22$; df $= 3$, 56.4; $P = 0.8812$), plant height ($F = 1.04$; df $= 4$, 56.5; $P = 0.3967$), or any interaction (sampling date x height: $F = 0.61$; df $= 4$, 56.5; $P = 0.6591$, sampling date x maturity group: $F = 0.07$; df $= 3$, 56.4; $P = 0.9772$). Taller soybean plants were generally recorded from maturity groups VI (60.43 $\pm$ 1.53) and VII (56.23 $\pm$ 2.51), compared to maturity groups V (48.38 $\pm$ 2.31) and IV (42.33 $\pm$ 3.02). More adults were usually observed on moderate-height soybean plants in maturity groups V and VI during June, and maturity groups IV and V during August, compared to either relatively shorter or taller plants (Fig. 3). There were few instances where taller maturity group VI and VII soybean plants had more kudzu bug adults than the moderate-height plants within those maturity groups during August (Fig. 3). Additionally, numerically more adults were on the main stem of soybean plants during August (16.76 $\pm$ 3.59), compared to June (10.25 $\pm$ 1.12) in 2013.

Discussion

The flight activity pattern of kudzu bug in soybean changes throughout the day. More kudzu bug adults were caught on sticky cards during 1300–1500 h, indicating that this period was when the most flight and dispersion activities occurred in soybean during the dates we sampled. Adult densities per plant did not vary when different soybean phenologies were present at the same time. However, kudzu bug adult densities varied in their vertical distribution on soybean main stems. Most adults (74%) were observed in aggregations, rather than singly, and at the middle section of the main stem of soybean plants, rather than at the top or bottom. These visual plant inspections were taken during the morning (0900–1200 h), because most kudzu bug adults were not flying at this time.

Ideally, additional sticky cards would have been placed inside the experimental soybean plots to record potential adults flying towards or away from these fields. Because sticky cards were placed at the perimeter of experimental fields, they might have been exposed to stronger wind gust and lower relative humidity conditions than those within experimental plots or the interior of commercial fields. However, this is the first effort to document at what time of the day kudzu bug adults are flying and dispersing in soybean fields. Results from this study could be complemented with future experiments in which sticky cards are placed inside experimental soybean fields to document if adult flight activity patterns at the canopy level and above the canopy differ. Additional research might also investigate how adult flight activity correlates with kudzu bug distribution within soybean plants during and after the peak of flight activity in the field.

Kudzu bug adult densities on soybean plants were not influenced by maturity group. This finding is consistent with other studies showing the same trend (Blount et al. 2016, Del Pozo-Valdivia et al. 2016). The experiment detailed in this study included soybeans ranging from maturity group IV to VII. This range of maturity groups represented a range of plant phenology and plant architecture at two time points in the season. The presence or absence of reproductive tissue did not affect population dynamics of kudzu bug in soybean, consistent with previous findings (Blount et al. 2016, Del Pozo-Valdivia et al. 2016). In contrast, it is possible that plant architecture plays an important role in how kudzu bugs are distributed within plants. For example, the middle section of the plant might favor the presence of more kudzu bug adult aggregations because the main stem is wider compared to the upper portion of the plant, thereby providing more space and plant tissue on which adults can aggregate. Additionally, the micro-climate in the middle section of the plant could be beneficial for the kudzu bugs. By comparison, the lower portion of soybean canopy is cooler and more humid, compared with the upper portion of the canopy, which is an average of 2.2°C warmer and 10.6% dryer (Owen et al. 2013). Furthermore, kudzu bugs may avoid predators or parasites in this section of the plant.

This study included different maturity groups, with different plant heights in the same field, and neither maturity group nor plant height influence kudzu bug density. Although plant height is one factor that characterizes plant canopy, it is possible that other characteristics besides plant height were confounded with maturity group and may have affected the attractiveness of soybean to the kudzu bug. For instance, angle of insertion of leaves or pubescent levels may have changed potential visual cues for the kudzu bug to find a suitable soybean host plant.

Male-to-female ratio was not affected by maturity group. Because adult densities (number of males and females) were not directly influenced by maturity group, and the male-to-female ratio was not influenced either, it is expected that sex ratio would be mediated by either semiochemical cues, such as an aggregation pheromone, or by a density-dependent factor, such as crowdedness of males on the host. In this study, there was a male-bias ratio in the adult population of kudzu bugs found on the middle section of soybean plants. This finding is consistent with Hibino and Itô (1983), who showed that there were more males than females in adult aggregations of *Megacopta punctatissima* (Montandon) (Hemiptera: Plataspidae), the kudzu bug's sibling species, in *Lespedeza cyrtobotrya* (Fabales) in Japan. In this study, the majority of kudzu bug adults were found in aggregations, but the activity of the kudzu bugs in aggregations was not measured. It is more likely that kudzu bug adults, recorded in our visual inspections, were either feeding or mating during the morning while aggregating than simply resting on plants. *Megacopta punctatissima* mainly forms aggregations to facilitate mating (Hibino 1986). For example, more females of this species engage in mating behavior when more than two males are present in an aggregation (Hibino 1986). It is also possible that the kudzu bug may engage in aggregation to benefit mating. Future research on kudzu bug behavior may complement these observations and confirm when feeding, mating, and resting behaviors occur on soybean plants.

In conclusion, this study showed that kudzu bug adult flight activity varies from0900 to 1700 h, and most of the adults are found forming aggregations in the middle section of the main stem of soybean plants between 0900 and 1200 h. From these data, we can speculate that flight and dispersion activity of the kudzu bug may be reduced from 0900 to 1200 h in soybean fields, because adults form aggregations on soybean plants during that period of time. It is more likely that higher adult captures between 1300 and 1500 h may represent the highest peak of flight activity of the kudzu bug. It is also possible that adults may not be forming aggregations on soybean plants while dispersing during this time. Additional observations are needed to confirm intra-plant soybean adult distribution during the afternoon to complement the flight activity experiment in this study, and to understand the intra-plant distribution of the kudzu bug throughout the day.

Acknowledgments

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