

ARTHROPOD MANAGEMENT & APPLIED ECOLOGY

Identifying Environments in the Mississippi Hills Region that Are Conducive to Threecornered Alfalfa Hopper Damage to Cotton

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ABSTRACT

The threecornered alfalfa hopper (TCAH), *Spissistilus festinus* (Say), is a stem girdling insect pest that has the potential to injure seedling cotton resulting in stunted growth and discoloration. During 2023 and 2024, 120 field surveys were conducted across eight cotton producing counties in the Mississippi Hills region to identify environments favorable for TCAH damage, as well as quantify the amount of damage observed. Field characteristics such as weed presence, tillage practice, and environments bordering the field were recorded along with cotton growth stage. The number of damaged plants out of 100 plants was recorded at 0, 4, 8, 15, 30, and 45 m into the field to determine damage distribution. Higher amounts of TCAH damage were associated with fields that implemented no-tillage cultivation systems and had high populations of weeds along field edges. Damage was more prevalent at 0 m and decreased further into the field; confirming that this is an issue predominantly along field edges. From these results, the implementation of cultural practices such as conventional tillage and minimizing weedy field edges could lessen the effects of TCAH damage on cotton, thus limiting the need for chemical control.

The threecornered alfalfa hopper (TCAH), *Spissistilus festinus* (Say), is an occasional pest in Mississippi row cropping systems. Historically, this species has been found infesting soybeans (*Glycine max* [L.] Merr.) across the state, however, in recent years TCAH has been observed infesting

cotton (*Gossypium hirsutum* L.) in the Hills region of Mississippi (Catchot, 2019). Mississippi can be divided into two agronomically distinct geographical regions: the Hills region and the Delta region. The Hills region has small, cultivated fields with a lower percentage of land devoted to row crop agriculture; therefore, the composition of field edges can be variable, unlike the Mississippi Delta, which predominantly consists of large fields of dedicated monoculture (Pettry, 1977). The variable field characteristics between the Hills and Delta regions can increase the frequency of TCAH damage due to an increase in overwintering sites or host availability.

Threecornered alfalfa hoppers have piercing and sucking mouthparts that extract plant nutrients from the main stem or softer tissue like petioles of seedling cotton (Rice and Drees, 1985). Most often, this pest is known to cause plant girdling. Girdling is a series of horizontal punctures around the circumference of the stem or petiole that often results in disruption of nutrient flow in the phloem. This site can serve as a nutrient sink for continued TCAH feeding (Rice and Drees, 1985). Symptomology of TCAH damage includes stunted growth, dark red veins, or red-to-orange leaves (Stewart, 2012). Necrosis can also result from girdling due to the constriction of plant tissue, and in severe cases, plant death (Rice and Drees, 1985). Previous research determined that heavy infestations of TCAH feeding in cotton did not result in yield reductions (Ewing and McGarr, 1933). Others have observed this pest to be an issue only on field edges and rarely in high enough densities to warrant chemical control (Catchot, 2019). Although there have been reports of TCAH causing damage predominantly on field edges, there is limited research evaluating the distribution of TCAH within fields.

Currently, there are no established economic thresholds in Mississippi for TCAH damage in cotton. Catchot (2019) recommended treating cotton with fewer than six nodes with insecticides when TCAH populations are greater than 10 bugs per 25

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sweeps; and North Carolina State University recommended destroying weedy field edges to limit adult migration into the field (Reisig, 2021). Others do not have clear recommendations. For example, University of Tennessee stated that TCAH damage is generally scattered, and uninjured plants adjacent to damaged ones will often compensate for any yield losses (Stewart, 2012). Due to the limited information of this pest in cotton, the objectives of this research are to determine the damage distribution of TCAH within the field and document environments that are more conducive to pest damage.

MATERIALS AND METHODS

During 2023 and 2024, 120 fields across eight cotton growing counties (Chickasaw, Clay, Lowndes, Monroe, Montgomery, Noxubee, Oktibbeha, and Webster) in the Mississippi Hills region were surveyed to determine factors that could contribute to TCAH infestations in cotton. Cotton fields were selected at random and were sampled during the two- to six-leaf growth stage. Growth stage, county, latitude, longitude, and date were recorded during every survey.

A total of 100 plants were examined for TCAH damage at 0, 4, 8, 15, 30, and 45 m into the field to determine the damage distribution throughout the field. Damage was recorded when stem girdling was observed or cotyledons had signs of red or orange coloring. Environments surrounding and within the field were characterized as: fields bordered by weeds, bordered by a road, bordered by a pond, or bordered by trees; tillage practice; presence of a cover crop; and field weediness. For the border to be classified as weeds, a large area of weeds needed to be present on the edge of the field (minimum of 8 m wide). Environments classified by road had a road directly bordering the field (within 8 m from field edge), whereas environments bordered by a pond indicated the presence of a pond next to the point of survey within the field (within 8 m from field edge). Lastly, bordered by trees corresponded to the field survey being conducted next to a tree line.

Although Mississippi cotton is predominantly grown using conventional tillage, other tillage practices were observed; therefore, tillage practice was broken down into three categories: no-tillage, minimum tillage, and conventional tillage. No-tillage is the practice of disturbing the soil as little as possible: soil disturbance only occurs at the time of planting to

open the seed bed, place seed, and close the seed furrow (Ozlu, 2023c). Minimum tillage was identified as cultivation that does not invert the soil, causing minimal soil disturbance, and maintaining at least 70% of field residue (Ozlu, 2023b). Conventional tillage involves inversion of the soil with the use of a primary tillage tool followed by secondary tillage resulting in 80 to 90% of crop residue being buried in the soil (Ozlu, 2023a).

Because several plant species can serve as hosts for TCAH, weed control across the field was classified using a scale of 0 to 3. A completely weed-free environment was rated 0, minimal weeds was rated 1, moderate weeds was rated 2, and a rating of 3 was characterized as a field with a high population of weeds with limited-to-no weed control.

Statistical Analysis. Data were analyzed using Proc Glimmix in SAS 9.4 (SAS Institute, Cary, NC) with a log transformation of damage plus one. Distance, cultivation, weeds, environment, and year, were considered fixed effects in the model. County was considered a random effect. Means were separated using Fisher's Protected LSD procedure at an alpha level of 0.05.

RESULTS

When comparing the distribution of damage within the field from 0 to 45 m, the greatest amount of damage was associated with ratings at the field edges ($F = 4.28$; $df = 5, 579.2$, $p < 0.01$) (Fig. 1). The 0-m sample site had more damaged plants than all other distances. Cotton plants at the 0-m distance on the field edge showed approximately 4.5 damaged plants observed per 100 compared to all other dis-

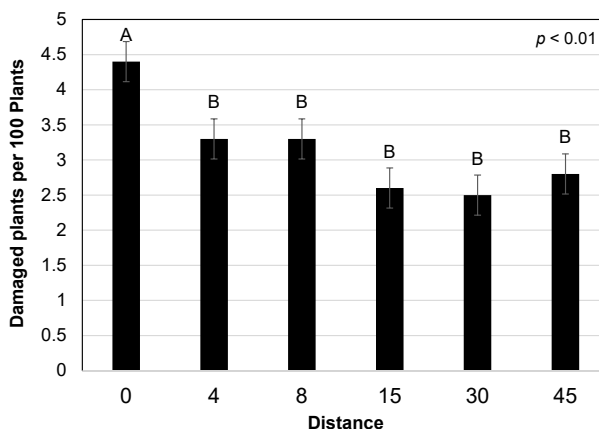


Figure 1. Mean number of TCAH damaged plants per 100 plants at each distance into the field in meters, starting at the field edge.

tances, which averaged 2.5 to 3.5 damaged plants. No differences were observed among all other distances. With the highest amount of damage observed at the 0-m distance and no differences further into the field, this data showed that pests clumped in a narrow edge, causing the greatest impact on a very small portion of the field.

When evaluating tillage practice and environment, there was an interaction between tillage type and the environment bordering the field for the number of damaged plants ($F = 5.73$ $df = 6,583.9$; $p < 0.01$) (Fig. 2). No-tillage fields with weedy field edges had the highest amount of damage compared to

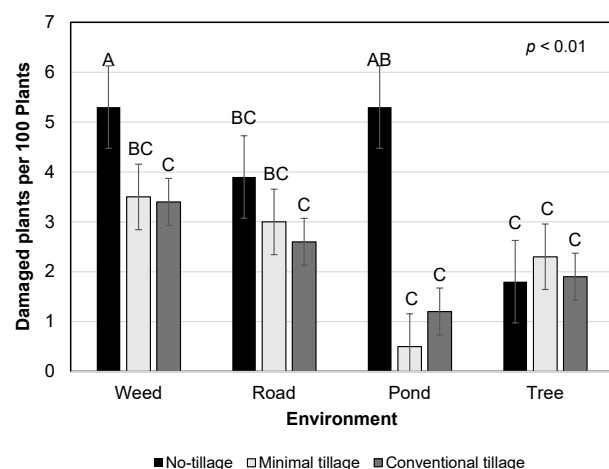


Figure 2. Mean number of TCAH damaged plants per 100 plants sampled for each tillage practice used and each field border environment.

all other environments, except no-tillage fields bordering a pond. No-tillage fields bordered by a pond had 77 to 90% higher amounts of associated damage than fields bordering a pond with conventional and minimum tillage systems. The lowest amount of plant damage was observed in all conventional tillage fields, all field practices bordering a tree line, and minimum tillage fields near a pond. Out of all fields surveyed in the Hills region, 50% were conventionally tilled, 35% had no tillage, and 15% had minimum tillage. Although the number of damaged plants varied between bordering environments, the highest amounts of damage were associated with no-tillage systems suggesting that tillage practice impacts the amount of TCAH damage.

Additionally, an interaction was observed between environments that bordered field edges and year ($F = 5.56$; $df = 3,577.2$; $p < 0.01$) (Fig. 3). Overall, there was an 8 to 63% increase in damage associated with each environment in 2024 compared to 2023. In 2023 and 2024, fields with weedy field

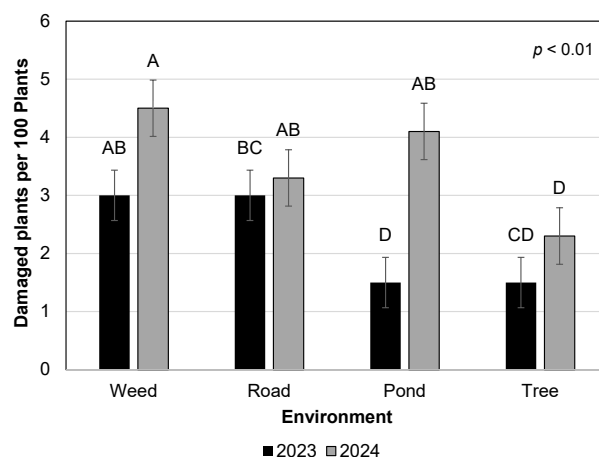


Figure 3. Mean number of TCAH damaged plants per 100 plants sampled by field border environment in 2023 and 2024.

edges had a higher amount of damage than 2023 fields with a road or pond as the border, as well as 2023 and 2024 fields near a tree line. However, fields located next to a road or pond during 2024 had similar levels of damage with weedy field edges during 2023 or 2024. The lowest amount of damage was found in fields from both years near a tree line or in 2023 fields bordering a pond. Yearly fluctuation in insect populations could be attributed to overwintering temperatures, geographical distribution, or invasive predatory pests (Porter et al., 1991).

Weed densities within the field did not impact the number of TCAH damaged plants ($F = 2.42$; $df = 6,580.4$; $p = 0.06$) (Fig. 4). The mean number of damaged plants ranged from 2.5 to 3.8 plants per 100. No differences were observed in number of plants damaged regardless of weed pressure ratings indicating that lack of weed control does not greatly contribute to TCAH damage in cotton.

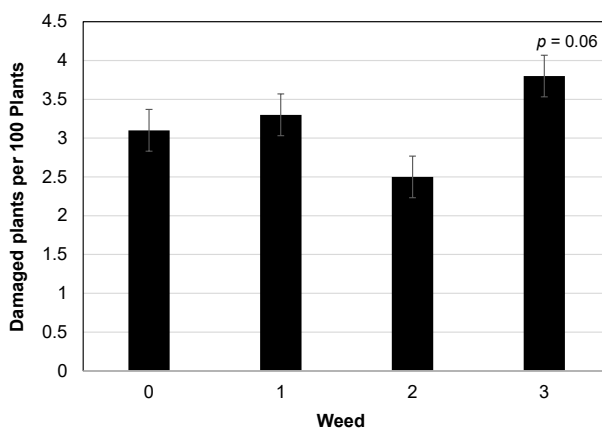


Figure 4. Mean number of TCAH damaged plants per 100 plants sampled by in-field weed pressure.

DISCUSSION

The results from this survey indicate that most cotton fields in the Mississippi Hills region are at risk of TCAH girdling injury. Like many insects, populations and associated damage can vary across years. Despite minimal amounts of damage sustained in various environments, implementation of cultural practices can aid in reducing the impact of this pest. However, the level of TCAH injury observed during this study suggest that TCAH is less of an economic risk compared to other insect pests found in Mississippi cotton production systems.

Unlike previous field distribution studies, the greatest amount of girdling was found near field edges and decreased slightly further into the field. Other studies concluded that sampling distances away from the field border did not affect injury levels in peanut (*Arachis hypogaea* L.) (Rahman et al., 2007). Additionally, Sparks and Boethel (1987) determined that populations were not localized within the field after the first generation. A field distribution study conducted in Mississippi comparing damage at 0, 20, and 50 m into the field reported no differences in observed damage, and the amount of identified damage to cotton was minimal (Ramsey, 2015).

This survey suggests that the implementation of conventional tillage has the potential to reduce TCAH damage compared to conservation tillage practices. Although implementing conventional tillage can reduce the number of TCAH damaged plants, it can be impractical for many areas of Mississippi. However, other studies have found that tillage practice and damage were independent of one another (Minton et al., 1991; Rahman et al., 2007). Troxclair and Boethel (1984) found that alternating cultivation practices, tillage, and/or row spacing, did not effectively control this pest. Although no differences were observed season long in the populations found in no-tillage compared to conventional tillage, populations were higher in the early season in the no-tillage system (Troxclair and Boethel, 1984). Conventionally tilled systems likely have the potential to minimize overwintering opportunities by removal of the previous crop residue.

Lastly, the survey determined that the level of weed presence did not impact the total amount of girdling damage sustained, likely due to the presence of other weedy hosts. Some of the most common and problematic weed species found in Mississippi cotton include Palmer amaranth (*Amaranthus palmeri* S.

Wats.), morning glory species (*Ipomoea* spp.), and Italian ryegrass (*Lolium perenne* L. spp. multiflorum (Lam.) Husnot.) (Riar et al., 2013). TCAH has many hosts, but its preferred hosts are members of the Fabaceae family (Muller and Dumas, 1987). The most prevalent fabaceous plants in the region are soybeans and peanuts (Beyer et al., 2017; Mitchell and Newsom, 1984; Wildermuth, 1915). TCAH host species preference is not limited to Fabaceae; other host species include Johnsongrass (*Sorghum halepense* [L.] Pers.), marehail (*Erigeron canadensis* L.), and cocklebur (*Xanthium strumarium* L.), among others (Wildermuth, 1915). Therefore, it is possible that the weed host species matters more than presence or absence of weeds.

The results from this survey suggest that some environmental and cultural practices are more favorable to TCAH damage. The most severe damage found during this survey was minimal when compared to major economically damaging insect pests. Based on previous research, TCAH damage can be sporadic across the field and generally not uniform. If a field had an estimated damage of 5% that was uniformly distributed, which was the highest amount of damage observed in this survey, the impacts would not be economically significant to warrant management efforts. McGinty et al., (2019) determined that an 18% stand reduction had no significant reduction of yield in dryland cotton. Even with the increases in TCAH presence in the Hills region of Mississippi, this pest remains of minimal importance in cotton arthropod pest management. This pest does not typically occur in high enough populations to justify management decisions. Therefore, an economic threshold in the Mississippi insect control guide is not currently needed for TCAH management in cotton. In rare cases that TCAH damage is severe enough to consider an application, the threshold suggested by Catchot (2019) could be followed.

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