Sampling Soybean Insects using DINSS, 49-2023
Annual Report

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Background and Objectives:

Insect scouting in soybean is needed throughout the season, but it is a time-consuming task, and when beans are tall, soils are wet, or beans are planted in narrow rows, walking through these fields can be nearly impossible. The development of inexpensive unmanned aerial vehicles (drones) presents an opportunity for scouting insects under all conditions more rapidly than currently done. Research initiated during 2019 led to a 12" diameter sweep net hung below a drone on a spring-loaded arm as our selected sampling tool which we have called the Drone Insect Net Sampling System (DINSS). Based on our experiences, we believe that some modifications of the tool may increase the insect catch rate without sacrificing drone stability. If so, these modifications should reduce the number of samples required to make a management decision, thereby improving the efficiency of DINSS. Previous comparisons of DINSS to manual sweep net sampling methods showed that DINSS captured fewer insects per sample than manually making 25 sweeps, but there were strong correlations among sampling methods for all four groups of pests monitored (threecornered alfalfa hopper, kudzu bug, Lepidoptera larvae, and stink bugs). While the data suggest that DINSS can be used to monitor all soybean pests, all the data were collected with a single drone flown by a single pilot. Furthermore, all the sampled fields were planted in wide rows. Before recommending DINSS to consultants and farmers, data from a broader array of drones, pilots, and fields need to be collected to establish thresholds so they can be used with confidence for all drones and pilots under a broad range of field conditions. In addition to confirming previous research over a wider range of conditions, we plan to explore modifications of DINSS to see if efficiency can be increased. Lastly, we plan to incorporate defoliation imagery captured by the drone into DINSS to make a complete insect management recommendation and compare these decisions with manually generated decisions. With the rapid adoption of drone technology currently happening in agriculture, we anticipate that DINSS will be rapidly adopted by consultants and larger growers throughout the state and region, particularly when traditional manual scouting is difficult.

Objective 1: Test modifications of the current DINSS to increase insect counts per sample.
Objective 2: Validate DINSS with multiple drones and drone pilots in a wide variety of field situations.
Objective 3: Compare cost and time required to make management decisions using drone-collected defoliation images plus DINSS data versus manual estimates of defoliation plus conventional sweep net data.

Report of Progress/Activity

Objective 1: Test modifications of the current DINSS to increase insect counts per sample

Two modifications to DINSS were tested during 2023. The first was using a 15-inch diameter sweep net vs. the 12-inch net used previously. The second modification was the addition of a second spring attachment that provided more tension on the attachment so that the net would remain more vertical when being pulled through soybeans. We also purchased a larger drone (DJI Matrice 350 RTK) and compared it to our existing drone (DJI Matrice 100). The DJI Matrice 100 was not stable with the 15-inch net, so the larger DJI Matrice 350 RTK was used exclusively to compare the modifications to DINSS. Insect data were collected using the following versions of DINSS:

1. D1-12: Drone with a 12-inch sweep net and a single-spring tension apparatus (original DINSS)
2. D1-15: Drone with a 15-inch sweep net and a single-spring tension apparatus
3. D2-12: Drone with a 12-inch sweep net and a double-spring tension apparatus
4. D2-15: Drone with a 15-inch sweep net and a double-spring tension apparatus
5. Control: Manual sweep net

Nineteen soybean fields were sampled by all 5 methods with 4 samples collected by each method in each field. Each DINSS sample was done with the DJI Matrice 350 RTK drone flown 50-meters across rows at a constant speed of 4-meters per second. A control sample consisted of 25 sweeps with a manual sweep net. Each sample was collected from a different part of the field to minimize any impact of one sample on other samples. The contents of each sample were placed in a plastic bag and frozen. Insects were later identified and counted in the lab. Data were analyzed by making correlations between the 4 DINSS methods and the manual sampling method.

Contrary to expectations, the larger sweep net and the additional tension did not increase the number of threecornered alfalfa hoppers (Fig. 1) or stink bugs (Fig. 2) captured by DINSS in the range relevant for different thresholds. Lepidopteran pressure was not high during 2023, so no fields were sampled that were near a treatment threshold. While the D2-15 treatment had a numerical trend somewhat higher than the other DINSS configurations (Fig. 3), it is not known if this trend would continue at higher densities of Lepidoptera and result in a different action threshold.

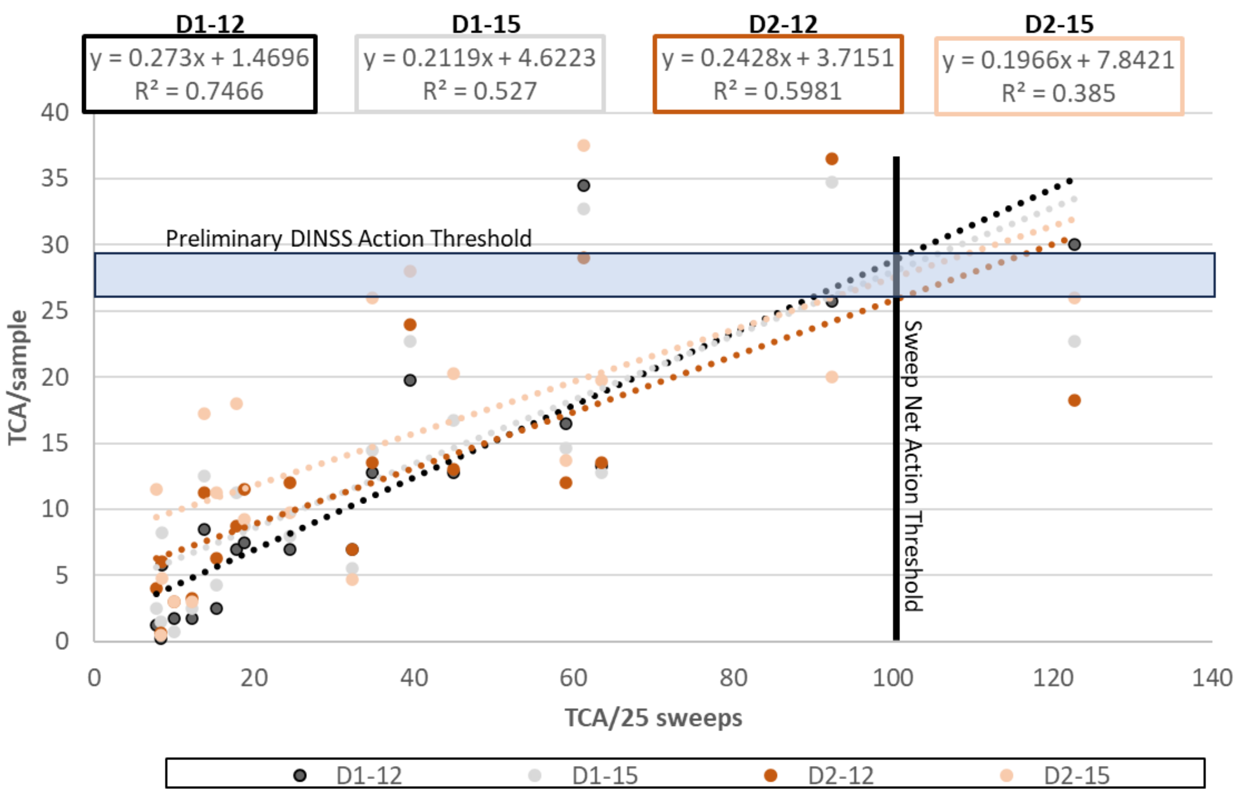

Figure 1. Correlations of threecornered alfalfa hopper adults caught between 4 DINSS methods and a manual sweep net from 19 Mississippi soybean fields during 2023. The vertical line at 100 TCA/25 sweeps is the current sweep net action threshold, so the blue shaded area (between 26 and 29 TCA/sample) is the preliminary corresponding threshold for all versions of DINSS.

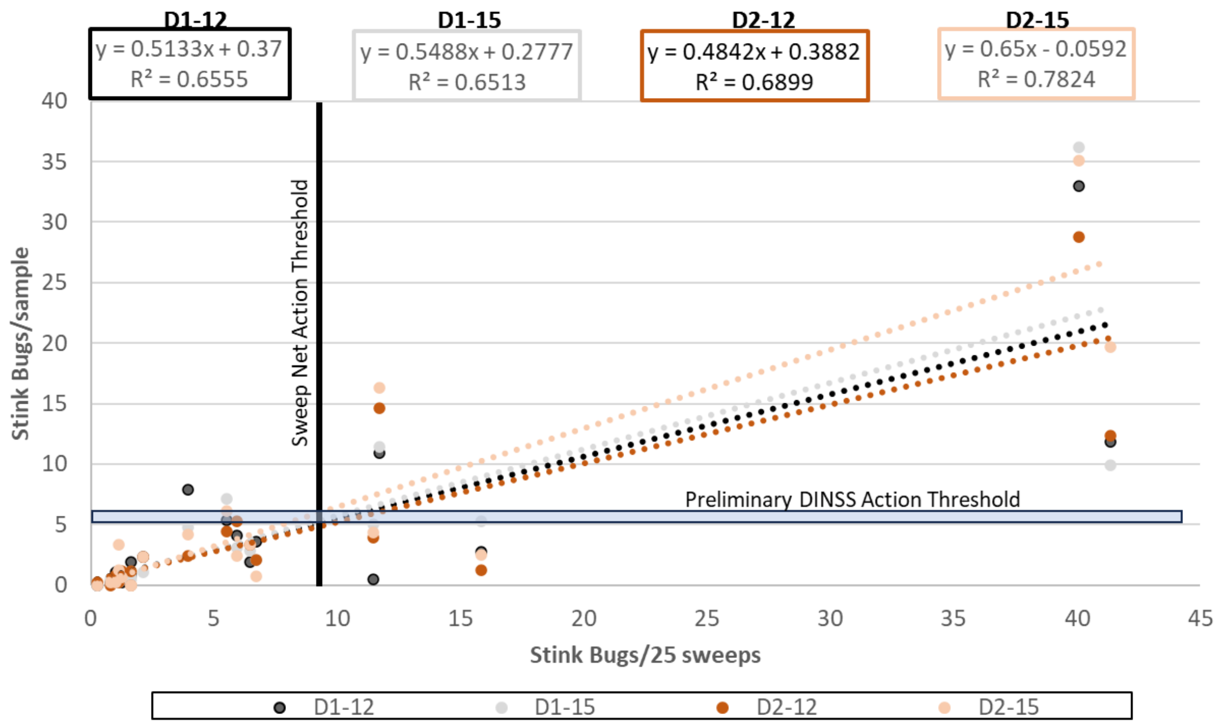

Figure 2. Correlations of stink bugs (all species and stages) caught between 4 DINSS methods and a manual sweep net from 19 Mississippi soybean fields during 2023. The vertical line at 9 Stink bugs/25 sweeps is the current sweep net action threshold, so the blue shaded area (between 5 and 6 stink bugs/sample) is the preliminary corresponding threshold for all versions of DINSS.

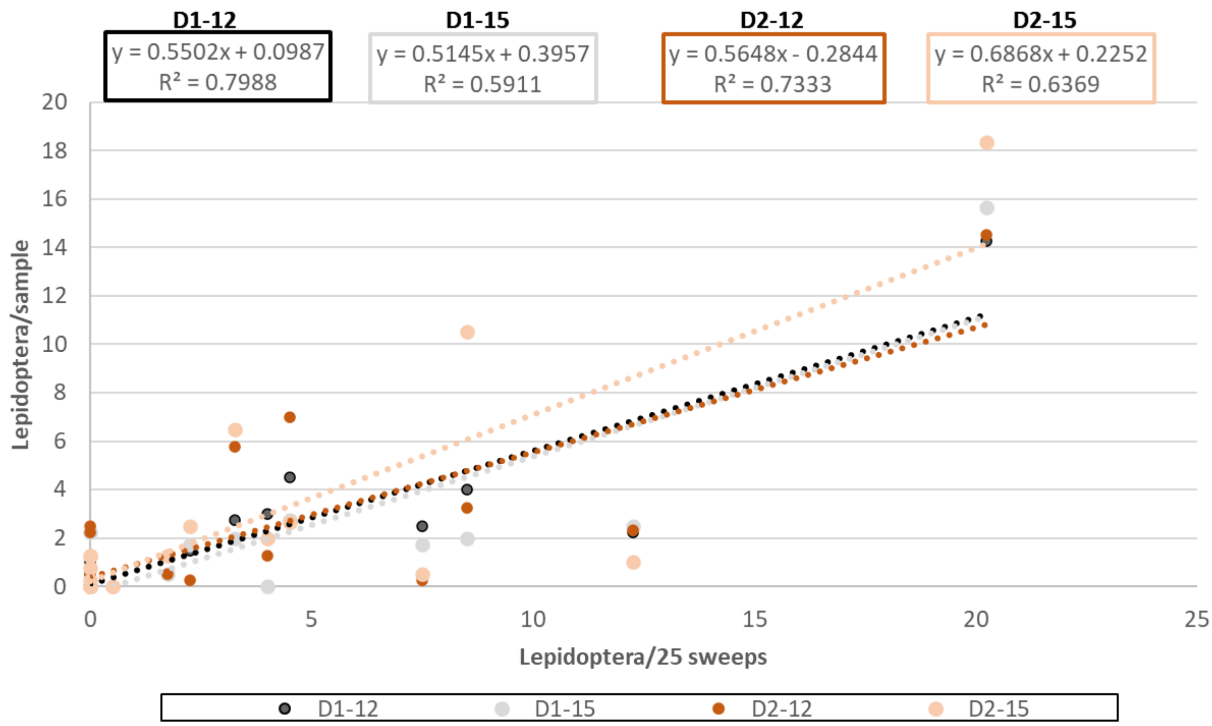

Figure 3. Correlations of Lepidopteran larvae (all species) caught between 4 DINSS methods and a manual sweep net from 19 Mississippi soybean fields during 2023. Sweep net action threshold of 38 larvae/25 sweeps much higher than any sampled fields, so corresponding DINSS action threshold not estimated.

Objective 2: Validate DINSS with multiple drones and drone pilots in a wide variety of field situations.

No work was planned or completed on this objective during 2023. This will be a major focus of research during 2024.

Objective 3: Compare cost and time required to make management decisions using drone-collected defoliation images plus DINSS data versus manual estimates of defoliation plus conventional sweep net data.

The time to collect samples for each method was compared. As expected, there were no differences among the various DINSS methods. However, there was a difference between the DINSS methods and the manual sweep net method. Collection times include sampling time plus walking or transport time between samples. While the drone needed to return to the field edge between each sample to empty the sweep net, all samples could be collected with the manual sweep net method in a single pass through the field. No fields were sampled during 2023 that had poor walking conditions (such as tall, lodged soybeans, muddy conditions, or drilled fields), so the situations where drone sampling would be expected to be most advantageous were not encountered. Under the good walking conditions encountered during 2023, the manual sweep net sampling time was quicker than the DINSS sampling time (4:05 minutes vs 5:50 minutes). No work was completed using defoliation imagery as defoliation was not a substantial problem during 2023. This will be addressed during 2024.

Impacts and Benefits to Mississippi Soybean Producers

Nearly all soybeans in MS are sampled for insects sometime during the season, with many fields being sampled weekly. This research will provide guidance to producers and their crop consultants on a potential new insect sampling method that may improve efficiency, thereby reducing production costs or improving decision-making during certain times of the year.

End Products

Oral Presentations

Musser, F. Unmanned aerial systems to sample insects in soybean. Agro-Based Engineering Seminar, Brawijaya University, Malang, Indonesia, July 4, 2023.

Lockhart, C., M. Merkl, J. Whittenton, and F. Musser. Utilizing unmanned aerial systems to sample in sects in soybean. MS Assn. Entomol. Nematol. Plant Pathol. annual meeting, Mississippi State, MS. Oct. 30, 2023.

Lockhart, W., M. Merkl, B. Whittenton, and F. Musser. Taking flight: unleashing drones to sample pest insect populations in soybeans. S1080 Multistate Soybean Entomology Group annual meeting, Augusta, GA, Mar. 17, 2024.

Lockhart, W., M. Merkl, B. Whittenton, and F. Musser. Taking flight: unleashing drones to sample pest insect populations in soybeans. SEB- Entomol. Soc. Amer. meeting, Augusta, GA, Mar. 18, 2024.

Poster Presentations

Lockhart, C., F. Musser, T. Towles, B. Whittenton, and G. Merkl. Utilizing unmanned aerial systems to sample insects in soybean. MS Ag. Consortium, Miss. State, MS, Mar 6, 2024.

In addition to the completed outputs listed above, further expected outputs by the completion of this project are expected to include: more presentations, a MS thesis, at least one refereed journal publication, an extension-type publication describing DINSS and the thresholds developed, and additions or changes to soybean section of the MSU Insect Control Guide to address DINSS sampling.