Project 25-2020 Using Drones to Sample Insects in Soybeans
Annual Report

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Background and Objectives

Scouting large soybean fields is a time-consuming task. When beans are drilled or when beans get tall and lodge, walking through a soybean field can become virtually impossible. As a result, large soybean fields seldom get sampled properly, with many decisions made based on conditions found on the portion of the field near the access point. Since many insects have a clumped distribution, the density near the access point may not accurately reflect the pest pressure in the entire field, resulting in less than optimal insect management.

Unmanned aerial vehicles (UAV), or drones, are becoming increasingly affordable and easy to use. Attachments can enable drones to do a wide variety of tasks, and applications are being developed in numerous areas of agricultural production. The use of drones for insect sampling is in its infancy. Most drone sampling research has used imagery as the means of sampling, often measuring plant stress rather than counting insects directly. However, to make this monitoring method useful in regions like Mississippi with multiple potential pests causing similar injury, an insect recognition method is needed. For example, management strategies differ for soybean looper, green cloverworm and bean leaf beetle even though they all cause defoliation. Therefore, defoliation imagery is not sufficient for making a management recommendation. While insect identification could theoretically be done with image recognition software, the technology to sample and identify insects in a complex environment like a soybean field using imagery has limitations that will keep it from being adopted in the near future. As an alternative that could be adopted more rapidly, we attached a light sweep net to a drone to facilitate sampling. The drone brings the sweep net to the operator who then manually identifies and counts the insects. This approach enables easy sampling throughout a large field at any growth stage and avoids the issues of automated insect recognition. We have already developed a sweep net prototype, so we have confidence that it can be developed into a reliable sampling technique for many or all insect pests of soybean.

The objectives of this project are to:

1. Develop a drone-powered effective sampling method for insects in soybeans.
2. Correlate the new drone sampling method (Obj. 1) to the manual sweep net sampling method.
3. Conduct an economic comparison of the drone and manual sweep net sampling methods.

Report of Progress/Activity:

Objective 1: Develop a drone-powered effective sampling method for insects in soybeans. This will improve sampling efficiency and the quality of insect management decisions, especially in fields where walking is difficult.

Quarter 1: A second drone was purchased which is the same model as the one we already owned. Adaptations were made to the drone to enable it to sample with a sweep net. Test drone runs have been conducted using new (to us) software so that drone speed, height and sampling distance can be precisely maintained. Minor changes to the proposed speeds and sampling distances to be tested were made based on preliminary observations. Sampling with the drones and comparing them to samples with conventional sweep nets and drop cloths in soybean is scheduled to begin during July.

Quarter 2: After conducting numerous flights using software that pre-programed drone height, speed and all other specifications, it became obvious that this method was not practically feasible for our application because it was time consuming to program and it was not sensitive enough to altitude (one time the drone would be too high and the net would be above the soybeans, and the next time it would be too low and crash into the soybeans without making any change in the program). However, manual control of the drone is sensitive enough to consistently keep the sweep net in the canopy as desired without crashing the drone (assuming the pilot is competent). Therefore, we adopted manual drone control as the method is use for objective 2.

Quarter 3: Parts were purchased and installed to repair one of the drones that had broken down over the summer. We have 2 functional drones modified for sweep net sampling again.

Quarter 4: No work done during this quarter.

Objective 2: Correlate the new drone sampling method (Obj. 1) to the current manual sweep net sampling method. This is necessary so that existing action thresholds can be adapted for data collected using the drone sampling method.

Quarter 1: Nothing was done on this objective except developing a data collection form. Work collecting the data needed for correlation analysis is scheduled to begin during July.

Quarter 2: Sweep net, drop cloth, and drone samples of 25 m and 50 m in length were collected from 51 soybean fields at various growth stages containing a wide range of soybean insect densities. All insect samples were placed in plastic bags and frozen for later enumeration. Insects from most of those samples have been identified and counted. Data is being entered into a spreadsheet for data analysis.

Quarter 3: All insects collected during quarter 2 were counted and the data has been entered into the computer. Preliminary correlations have been made, but analysis is not yet complete.

Quarter 4: Statistical comparisons were made between sampling methods. In all cases there was a positive correlation between manual sweep net sample counts and drone sweep net sample counts. In general, the drone caught fewer insects in 50 m than a sweep net caught in 25 sweeps. Doubling the sweeping distance from 25 m to 50 m increased counts but did not correspond to a doubling of insects captured, suggesting that some insects escaped during drone sampling. No sampled fields were above established manual sweep net thresholds for any insect, so more effort will be made during 2021 to target fields with higher insect populations. Correlation data for all Lepidoptera combined (green cloverworm, soybean looper, velvetbean caterpillar and corn earworm) and all stink bugs combined are shown in Figure 1 at theend of this report. Data were also analyzed for individual species in these complexes plus bean leaf beetle, kudzu bug and threecornered alfalfa hopper. The efficiency of capturing insects with a drone sweep net compared to a manual sweep net was similar for most species. However, it was somewhat poorer for threecornered alfalfa hopper, which is not surprising given how mobile this insect is.

Objective 3: Conduct an economic comparison of the drone and manual sweep net sampling methods. This will allow growers and consultants to decide where and when the drone sampling method makes sense for them.

Quarter 1: Nothing was done on this objective.

Quarter 2: Nothing was done on this objective, but the raw data for this analysis was collected under objective 2.

Quarter 3: No economic analysis has been done yet because the analysis for objective 2 is not yet completed.

Quarter 4: Time (effort) to collect samples was compared for the drone and manual sampling methods. The time required to collect four samples with a drone going 25 m, a drone going 50 m, using a manual sweep net, or using a manual drop cloth was about 10 minutes per field for each method. This involved flying the drone or walking out a maximum of 30 m into the field to collect samples. Furthermore, all fields sampled had wide rows and most samples were collected in good walking conditions. If samples were collected further from the edge or if conditions were not conducive to walking through the soybeans, it is expected that the time required to sample manually would be longer, but drone sampling times would not be impacted much, possibly making the drone sampling method more efficient. What has not been determined yet is the number of samples required to make a management decision with equivalent precision using the various methods. This analysis will not be conducted until after a second year of sampling is completed to provide a larger data set and to potentially identify field or environmental conditions that impact sampling efficiency (wind speed, crop height, crop maturity, row spacing, etc.).

Impacts and Benefits to Mississippi Soybean Producers

Approximately 90% of soybean acres are currently scouted for insects on a routine basis. If drone sampling proves to be a cost-effective method of sampling insects in soybean, we expect that most consultants would adopt this sampling method within 5-8 years under at least some conditions (when soybeans are hard to walk through). This will impact growers and consultants by reducing the cost (time) for scouting and/or improving the quality of the scouting, which will impact growers by improving their insecticide management.

End Products–Completed or Forthcoming

No outputs have resulted from this research to date. However, it is expected that one or more presentations will be given during the next year, and a MS thesis and one or more scientific publications will be written.

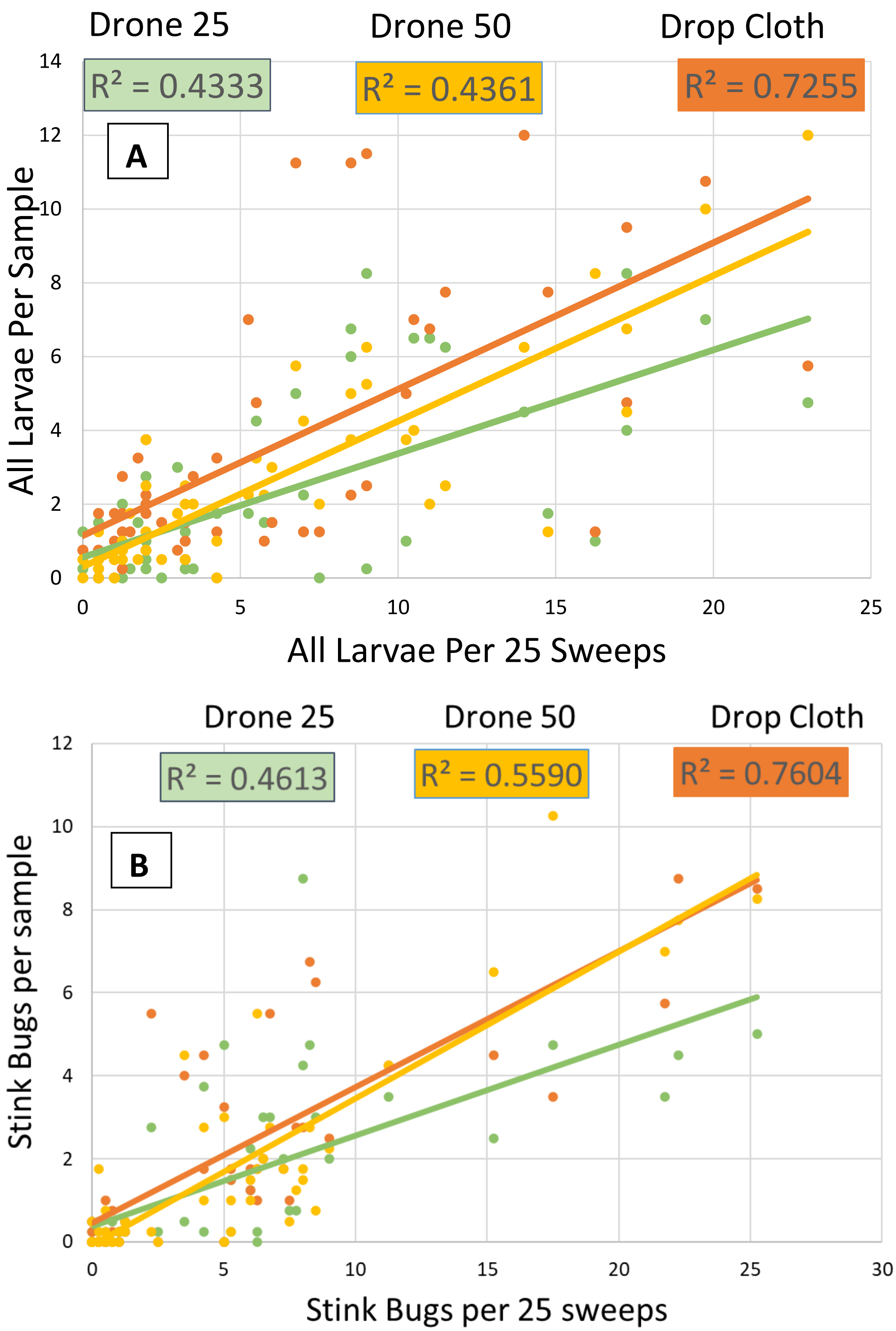

Figure 1. Correlations of manual sweep net counts (x-axis) with drone powered sweep net counts covering 25 m (Drone 25), 50 m (Drone 50), and manual drop cloth samples (Drop Cloth). Part A is for all lepidopteran larvae and part B is for all stink bug species. Individual points are the average of 4 samples collected from one field on one day.