Project title: Evaluation of Grain Sorghum as a Predator Source for Biological Pest Control in Texas Agroecosystems

Primary Agency Affiliation: Texas A&M University

Primary Location: Area surrounding San Angelo, Texas

Contact Information: Kevin M. Heinz
Texas A&M University
Department of Entomology
College Station, TX 77843-2475
email: KMHeinz@tamu.edu
phone: 979-862-3408
fax: 979-845-7977

Report, Section 1: The unifying goals of this project are to determine the usefulness of grain sorghum as a supplier of beneficial predators to nearby cotton plots, and to explore ways that benefits of this association may be enhanced. Previous studies have suggested the potential benefits of grain sorghum as a supplier of predators to cotton producers, but little direct study of this relationship has been made. It is also yet unknown what factors influence the movement of predators in this system, how predators and their offspring function in pest control, and how the overall arrangement of grain sorghum within a diversified agricultural landscape.

To address these issues, four separate experiments have been planned for two years of study each. First, we plan to use a chemical mark (a trace element, rubidium, which is similar to potassium) to mark large numbers of predators in both cotton and grain sorghum, and to recollect these predators at three stages of sorghum growth (half bloom, soft dough, and hard dough). After examining predators for the mark, we will be able to determine the type and number of predators moving at each of these stages. Data will also be collected on various factors at each location (such as wind, temperature, pest densities) to suggest possible causes of detected predator movement. Second, we plan to use 3x3x2 meter field cages to test some factors that are likely causes of predator movement. Two supposed causes, pest levels and plant growth (phenology) will be experimentally altered in a controlled environment to determine if either or both of the factors determine predator habitat preference. The results of the first two objectives should show the normal patterns of predator movement in our area, and suggest causes of this movement. Depending on the factors found to be important, some of these factors may be changed to increase the benefits of grain sorghum plantings.

The third objective is to determine how predators impact pest species. Because predators feeding on cotton and grain sorghum accumulate different isotopes of the common elements carbon and nitrogen (due to differences in how the plants conduct photosynthesis), we can collect and measure these levels in predators and their eggs to determine where the adults have been feeding and where the nutrition from eggs deposited in cotton is derived from. From these results, we expect to determine whether the initial colonizing predators are dependent on sorghum nutritionally, and whether these initial colonists and their offspring are more important than additional predators leaving grain sorghum late in the season. Combined information from this objective and the first two could have effects on pesticide treatment decisions in both crops so that natural control by predators is maximized.

The final objective is an area-wide analysis of agricultural practices in both grain sorghum and cotton. Data on field size, pest and predator levels, insecticide use, field locations, and other factors will be collected for at least 30 different locations. A complex data analysis

tool, principle components analysis, will be used to determine the effects of these various factors on yields. Briefly, the results of this objective should indicate which factors are most valuable in crop production, and may suggest possible changes to planting dates or crop arrangement that could benefit producers of grain sorghum and cotton in our area of study.

The overall benefit to producers of this project should be twofold. First, results should give a clear picture of the value of grain sorghum to crop production outside of grain sorghum fields. Second, the results may also indicate ways to improve the natural benefits of grain sorghum with reduced chemical use in the agroecosystem.

While severe drought has limited our abilities to conduct population level studies in the field, we have made great progress on two of the four objectives. We have perfected the use of the rubidium marking technique and collected some data on predator movement between these crops. Additionally, samples for objective three have been collected and are currently being analyzed. In the event that weather problems are similar next year, a decision will be made on an alternate study site to complete the project objectives.

Report, Section 2:

This project is a regional research project designed to validate grain sorghum as a source for predators that provide pest control services in nearby cotton fields. The four central objectives are:

(1) To measure arthropod movements among plantings
(2) To identify factors that influence movement between adjacent plantings
(3) Assess how immigrant predators impact pest populations
(4) Analyze the area-wide agricultural practices to improve benefits of grain sorghum production

Objective (1) will use a trace element, rubidium, to mark varied predator species in large plots of cotton and sorghum. Three replicates of marking predators in grain sorghum and collecting them in cotton will be used to determine the flow of predators into cotton. Another three replicates will mark predators in grain sorghum and recollect them in cotton to determine the flow of predator in the opposite direction. These experiments will be repeated three times during the season at distinct stages of sorghum phenology (half bloom, soft dough, hard dough) to determine how predator movement changes over time. By measuring movement in both directions, an estimate of the net gain or loss for each crop over time can be determined.

After the marks are applied to crops, three separate collections of predators will be taken and analyzed for the mark using atomic absorption spectrometry, a proven analytical technique. After the movement of different insect groups are tabulated, data may be analyzed to determine if there is a pattern to insect movement based upon crop phenology and consideration (along with results from other objectives) will be given to ways to improve this beneficial result.

Objective (2) will be conducted concurrently with the previous objective, but will use a confined, controlled field environment to determine the effects of crop phenology and pest levels on predator habitat preference. We will use three replicates of a 3x3 experimental design (for a total of 27 units) to test these factors. Three prey levels on each of the two crops give nine possible combinations of prey levels to be artificially created in field cages (3x3x2 m). Predator species will be released in the cages and allowed to settle for one day. Afterwards, predators will be collected and the number found in each crop will be recored. The difference found in recoveries in the two crops will be defined at crop preference and an analysis of variance

ANOVA) will be conducted to determine whether effects of phenology, cotton prey levels, sorghum prey levels, or a combination of factors, are responsible for predator habitat preference.

Objective (3) will determine how feeding and reproduction behavior by a common predator, the lady beetle *Hippodamia convergens*, impact pest densities in nearby cotton fields. Predators and their eggs will be collected on a weekly basis from four field pairs and at four different distances from the grain sorghum – cotton crop interface in each pair. The isotope analysis of these predator will show how much feeding predators have done in cotton and grain sorghum prior to their capture, and this will be an indicator of each crop's importance to the production and maintenance of predator populations. This is possible because the two crops of interest produce energy in different chemical pathways that are reflected in both the pests of the crops and the predators of those pests. By comparing the contributions of grain sorghum to adult beetles and to beetle eggs over time, we can also determine whether grain sorghum is more valuable for providing initial colonists or if it is essential as a predator source for the entire overlap period between the two crops.

Objective (4) will use a massive information database created by an area-wide scouting program for crops Runnels and Tom Green counties to determine how sorghum planting date relative to cotton, sorghum field location, pest and predator levels, and other environmental factors, such as pesticide use, effect the production of cotton in the area. Because some type of data collected will show similar patterns, the redundancy of the data will be reduced (and interpretive ability increased) by a method known as principle components analysis. After the data are reduced to these principle components, a regression will be used to determine how important each factor is in the overall production scenario. Collection of data from 60 or more fields will be used to overcome variation that is common in this type of field study. It is hoped that some of the factors shown to be important are those that can be manipulated, and that a set of recommendations can be developed for growers to improve the benefits of cropping grain sorghum and cotton in close association.

As mentioned in section 1, the results of this project were hindered by extreme drought in the proposed study area; therefore, progress on only two of the objectives was made. For Objective (1) we have perfected and validated the proposed marking technique and obtained some data on predator movement between cotton and grain sorghum. These data suggest that movement between these crops occurs in both directions throughout the coincident period of cotton and sorghum growth, but that there are some possible differences between groups of predators and how they colonize crops. We are currently reviewing one publication generated from this work and preparing to submit it for review. As for Objective (3), one complete season of collection was conducted in an alternate study area where cotton, grain sorghum and corn dominate the landscape. The results for this work are not yet available since samples are currently being analyzed.

Technology transfer will be achieved through publication of results in scholarly journals, as well as presentations at grower, extension, and academic conferences. Presentations are planned or scheduled this year for the Beltwide Cotton Conference, Entomological Society of America (ESA) national and branch meetings, and the Entomological Science Conference. There are also possibilities for other outlets of information dissemination, but possibly the most important one is the contact with state extension and IPM agents in this project. Two local and one area-wide extension workers have been involved with this project in different locations and they will serve as additional outlets of information to producers and the public. The contribution to student education is evident for the student participant in this project, who is helping conduct

research and analysis in partial completion of his PhD. Degree. In addition, results derived from this project have provided the baseline information necessary to be competitive for additional grants on the subject. In Spring, 2000, a grant was obtained from the USDA-National Biological Control Institute to fund work on the landscape ecology of the sorghum-cotton ecosystem.