CONTRIBUTIONS OF GRAIN SORGHUM TO NATURAL ENEMY POPULATIONS IN COTTON

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Abstract

Grain sorghum and cotton are grown in close association in most regions of Texas, and share a number of predators which can provide natural control of cotton bollworm and tobacco budworm in mid-late season cotton. The focus of this study was to determine the role of grain sorghum as a source of predators in cotton in the Southern Rolling Plains of Texas by identifying and quantifying important predators in grain sorghum and cotton through direct counts and collection, and quantifying the movement of predators from grain sorghum to cotton by self-marking of predators with fluorescent dust in sorghum and recovery of marked predators in adjacent cotton. Results show many of the common predators increase in both grain sorghum and cotton from early bloom of sorghum to hard dough stage, and continue to increase in cotton after sorghum harvest. Recovery of marked predators in cotton provide further evidence that grain sorghum is an important source of predators in cotton at a time when cotton is at risk from bollworm and budworm infestations.

Introduction

Control by indigenous natural enemies is the dominant form of cost-effective biological control available to IPM practitioners in all cotton growing regions in Texas. Although many studies indicate natural control of the cotton bollworm/ tobacco budworm complex is possible, it remains the second most common target of insecticide applications in Texas cotton production, responsible for an estimated 48.5 million dollars in costs associated with crop loss and insecticide costs in 1995 Texas cotton (Williams 1996). Early-season insecticide applications intended to protect and promote early fruiting can decimate natural enemy populations in cotton which could otherwise increase and provide control of late-season pests such as the bollworm and budworm. Cotton, however, is not isolated in the environment but is commonly grown in close association with grain sorghum, a crop which shares many of the same predators believed important in the control of mid-late season cotton pests (Fye 1971; Lopez and Teetes 1976).

A number of studies have attempted to explain the origin and movement of predators from surrounding vegetation into particular crops. While some studies observed the movement of predators from adjacent vegetation into crops (van Steenwyk et al., 1978; Seber 1982; Thomas et al., 1992), others found adjacent vegetation can act as both a source and a sink for predators (McMurtry et al., 1978), or distant sources of natural enemies may be more important than adjacent vegetation in determining natural enemy abundance (Kareiva 1982). In order to move toward biologically-based integrated pest management of the bollworm/budworm complex in Texas cotton, the pest regulatory influences exerted by indigenous natural enemies must be determined and utilized efficiently. This requires quantitative data regarding the spatial dynamics of the pests and their associated natural enemies to assure cotton producers and consulting entomologists that alternate methods of control are effective and insecticide dependence can be reduced or eliminated without undue risk to the cotton crop.

The objectives of this project were to determine the role of grain sorghum as a source of predators in cotton in the Southern Rolling Plains of Texas by (1) identifying and quantifying important predators in grain sorghum and cotton, and (2) determining the rates and distances natural enemies spread into cotton fields from adjacent grain sorghum.

Methods

Six sites were established within fifty miles of San Angelo, TX, with each site consisting of adjacent cotton and grain sorghum fields with parallel rows. Within the cotton and sorghum fields, 8 plots 100 row-meters in length were established and flagged at each of three distances (5, 20, and 50 meters) from the cotton-sorghum crop interface . Plots were located at least 25 meters from the end of the rows with 25 meter spacing between plots and divided into 2, 4-plot blocks at opposite ends of the field with several hundred meters between blocks. Sampling was conducted on four dates corresponding to preselected phenological stages of grain sorghum determined at mid-panicle: 50% anthesis, milk stage, hard dough, and post-harvest.

On each sample date, beat-bucket counts of all adult predators were taken from 10 sorghum plants per plot for a total of 240 plants per field to quantify the number and species composition of predators present in the grain sorghum. Immediately following the bucket samples, the entire plots were dusted with fluorescent dust using a compressed-air sandblast gun regulated at 50 psi. Six different colors were used to distinguish the plots according

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to distance and field-end block. Twenty four hours after dust application, all adult predators were collected and placed individually into glass vials from 10 cotton plants per plot for a total of 240 plants per field. These collections were intended to provide comparative quantitative data on predator numbers and species composition in the cotton and to measure movement of predators from grain sorghum into cotton by recovery of dust-marked individuals.

Predators collected from cotton were taken to the lab for identification and screened under a dissecting microscope for the presence of fluorescent dust. The number of predators by species per plot in both sorghum and cotton were compiled and analyzed using PROC GLM (SAS Institute) to determine significant differences between dates and distance from crop interface. Numbers of marked individuals were tabulated according to sample date as well as origin (as indicated by dust color) and rate and distance of movement (as indicated by minimum possible distance in meters from origin to collection divided by 24 hours).

Results

Although some genera of predators were represented by more than one species, predator data was condensed into generic classes since individual species dominated within genera. Of all spiders collected, the majority were crab spiders, the vast majority of Orius were tristicolor (minute pirate bugs), and Hippodamia convergens accounted for almost all ladybugs. These three predator classes accounted for 80.6% of the total predators counted in grain sorghum, with spiders accounting for 35.2%, pirate bugs for 29.6%, and ladybugs 15.8% (Table 1). The same three classes also comprised 76.8% of the total predators collected in adjacent cotton fields, where ladybugs accounted for 27.6%, pirate bugs 25.5%, and spiders 23.6% of the total (Table 2). Although there were 11 classes represented in sorghum counts and 13 in cotton collections, numbers of predators beyond the first six and seven predator classes, respectively, were comparatively insignificant.

Comparisons of individual predator classes according to phenological sample date reveal significantly different population trends between cotton and grain sorghum. Although the mean number of ladybugs are significantly higher in grain sorghum at 50% anthesis, they drop rapidly and almost exactly match those in cotton at milk and hard dough stage, and continue to increase in cotton after sorghum harvest in cotton (Table 3). Pirate bugs, however, show a significant increase from 50% anthesis to milk stage and then drop again at hard dough stage with a concurrent increase in cotton (Table 4). After sorghum harvest, however, numbers of pirate bugs in cotton decrease rather than increase. The trend in numbers of spiders in grain sorghum mimics that of pirate bugs, but is almost flat in cotton from 50% anthesis through hard dough (Table 5). Damsel bugs and Scymnus ladybugs in cotton were collected in increasing numbers from milk stage to post harvest of sorghum, while lacewings and assassin bugs increased in cotton from 50% anthesis to post harvest of sorghum (Tables 6-9). While population trends of damsel bugs and Scymnus ladybugs in sorghum were mixed from 50% anthesis to hard dough stage, numbers of lacewings and assassin bugs were consistently positive during the same time period.

The highest number of marked individuals recovered from cotton occurred at hard dough stage, with the second highest at post harvest of the sorghum (Table 10). Since the most common fluorescent dust-marked predator class recovered was pirate bugs, it is not surprising that recovery of marked predators closely coincides with numbers of pirate bugs collected in cotton across sample dates (Table 4).

Counts of total predators in grain sorghum reveal decreasing numbers from plots 5 meters from cotton to plots 50 meters from the crop interface (Table 11). This is not unusual and has been referred to as the "edge effect". However, while a majority of the dust-marked predators collected in cotton originated in the 5 meter sorghum plots, the second largest number originated from the 50 meter rather than the 20 meter plots as would be expected (Table 12). Recovery of marked predators in cotton consistently decreased from the 5 meter to the 50 meter plots. Although too few marked predators were recovered to model dispersion rates, simple rates of movement were calculated for recovered predators in terms of mean number of meters traveled per 24 hours (Table 13). These rates are conservative estimates since distances were calculated as straight lines perpendicular to the rows from origin to collection, when in fact some of the predators originated in plots at one end of the field yet were collected from plots at the opposite end. Since the total dimensions of the fields are unknown, it is impossible to calculate more accurate estimates of the total distance traversed by the recovered predators.

Summary

Results of this study concur with those of Fye (1971) and Lopez and Teetes (1976) in the mutual occurrence of many predators in cotton and grain sorghum. Also, this study demonstrates movement of these predators from grain sorghum to adjacent cotton does take place prior to and after sorghum is harvested. This time period coincides with the flowering period of cotton, which is when cotton is at greatest risk from damaging bollworm/ tobacco budworm populations. Current studies by other researchers are focusing on which predators are most important in controlling bollworm and budworm in cotton, and together with increasing knowledge of the spatial and temporal dynamics of the pests and their natural enemies in the environment, it is hoped that integrated pest management in cotton can move toward a foundation of biological rather than chemical control.

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Table 1. Total numbers of predators by class counted in grain sorghum.

Predator class	Total counted
Spiders	1263
Pirate Bugs	1065
Ladybugs	569
Scymnus ladybugs	221
Lacewings 208	
Big-eyed Bugs	144
Damsel Bugs	59
Assassin Bugs	33
Syrphids	22
Red cross beetles	7
Brown lacewing	1

Table .2 Total numbers of predators collected in cotton.

Predator class	Total Collected
Pirate Bugs	432
Spiders	399
Damsel Bugs	112
Scymnus ladybugs	94
Lacewings 72	
Assassin Bugs	66
Big-eyed Bugs	29
Red cross beetles	9
Syrphids	3
Brown lacewing	2
Berytids	2
Hooded Beetle	1

Table 3. Mean no. Ladybugs/ 10 plants by sample date in sorghum and cotton.

Sample Date	Sorghum	Cotton
50% anthesis	2.70 ± .20 a	0.56±.10 b
Milk stage	0.56 ± .10 b	0.51 ± .08 a
Hard dough	1.19 ± .23 c	1.20 ± .15 b
Post Harvest	--	1.93 ± .13 b

Different letters after denote statistical significance at .05 level.

Table 4. Mean no. Pirate bugs/10 plants by sample date in sorghum and cotton.

Sample Date	Sorghum	Cotton
50% anthesis	1.89 ± .24 b	0.16 ±.04 a
Milk stage	5.35 ± .38 a	0.61 ± .09 ab
Hard dough	1.18 ± .16 b	2.75 ± .26 c
Post Harvest	--	0.85 ± .13 b

Different letters after means denote statistical significance at .05 level.

Table 5. Mean no. Spiders/10 plants by sample date in sorghum and cotton.

Sample Date	Sorghum	Cotton
50% anthesis	1.66 ± .15c	1.10 ±.12 a
Milk stage	5.00 ± .32 a	1.02 ± .13 a
Hard dough	2.57 ± .20 b	1.01 ± .12 a

Different letters after means denote statistical significance at .05 level.

Table 6. Mean no. Damsel bugs/10 plants by sample date in sorghum and cotton.

Sample Date	Sorghum	Cotton
50% anthesis	0.07 ± .03 a	0.10 ±. .03 b
Milk stage	0.19 ± .05 a	0.08 ± .03 b
Hard dough	0.14 ± .05 a	0.40 ± .09 a
Post Harvest	--	0.45 ± .10 a

Different letters after means denote statistical significance at .05 level.

Table 7. Mean no. Scymnus/10 plants by sample date in sorghum and cotton.

Sample Date	Sorghum	Cotton
50% anthesis	0.18 ± .06 b	0.11 ± .04 b
Milk stage	0.20 ± .06 b	0.04 ± .03 b
Hard dough	1.23 ± .29 a	0.29 ± .09 ab
Post Harvest	--	0.50 ± .12 a

Different letters after means denote statistical significance at .05 level.

Table 8. Mean no. Lacewings/10 plants by sample date in sorghum and cotton.

Sample Date	Sorghum	Cotton
50% anthesis	0.05 ± .03 b	0.00 ±.00 b
Milk stage	0.29 ± .07 ab	0.04 ± .02 b
Hard dough	0.54 ± .16 a	0.17 ± .06 a
Post Harvest	--	0.16 ± .04 a

Different letters after means denote statistical significance at .05 level.

Table 9. Mean no. Assassin bugs/10 plants by sample date in sorghum and cotton.

Sample Date	Sorghum	Cotton
50% anthesis	0.00 ± .00 b	0.00 ± .00 b
Milk stage	0.09 ± .03 b	0.03 ± .02 b
Hard dough	0.20 ± .05 a	0.06 ± .02 b
Post Harvest	--	0.20 ± .05 a

Different letters after means denote statistical significance at .05 level.

Table 10. Recoveries of marked predators by sample date.

Sample Date	Pirate Bugs only	All Predators
50% anthesis	0	0
Milk stage	0	2
Hard dough	11	16
Post Harvest	5	6
Total	16	24

Table 11. Mean number of predators/10 plants in grain sorghum and cotton at 3 different distances from the crop interface.

Distance (m)	Sorghum	Cotton
5	7.00 ± 0.47	3.30 ± 0.33
20	5.65 ± 0.51	3.02 ± 0.29
50	4.58 ± 0.32	2.38 ± 0.23

Table 12. Total number of recovered marked predators from origin in sorghum to collection in cotton from the crop interface.

Distance (m)	Sorghum	Cotton
5	16	18
20	1	5
50	7	1

Table 13. Rates of movement by predators assuming straight line movement from sorghum to cotton.

Predator	n	Meters/24 hours
Pirate Bugs	16	32.5 ± 5.6
Ladybugs	3	10.0 ± 0.0
Scymnus	2	32.5 ± 15.9
Big-eyed Bugs	1	25.0
Damsel Bugs	1	40.0
Assassin Bugs	1	10.0