NATURAL ENEMY MOVEMENT BETWEEN ADJACENT SORGHUM AND COTTON FIELDS

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Abstract

Major pests in commercial cotton affect both the quantity and quality of cotton yield. However, existing populations of natural enemies and a variety of chemicals are available to protect the cotton crop. Because neither natural nor chemical controls are acceptable as 'stand-alone' solutions, an integrated approach to pest control in cotton is needed. Using predator conservation as a foundation, better pest control may be realized by using grain sorghum as a source for natural enemies in cotton. There is some evidence to indicate that neighboring cotton fields already receive some benefit from close association with grain sorghum, but the specifics of this relationship are not yet known. Using fluorescent dust markers, we further explored predator movement between cotton and grain sorghum. Results indicate that predators move between cotton and sorghum in both directions throughout cotton maturation, but that cotton receives more immigrant predators from sorghum than it loses by emigration. Further, the strength of predator migration changed with sorghum phenology, with the greatest benefit to cotton coming during the soft dough stage of sorghum growth. Correlating data on predator habitat in both crops with strength of migration indicated that predatory arthropods moved in response to low prey levels and high temperatures. Results indicate that adjacent plantings of grain sorghum can contribute to pest control in cotton, but that predator movement may be sensitive to synchrony of crop phenology and local environmental conditions.

Introduction

With chemical, natural, and biological control options available to them, cotton producers are faced with decisions each year on methods for pest management. While natural control can sometimes be effective, insecticide applications are frequently needed during crucial fruiting stages to ensure yield and quality of the crop. However, regular calendar-based pesticide applications are costly and can decimate natural enemies, contributing to secondary pest outbreaks (Luck and Dahlsten 1975, Van Driesche and Taub 1983). Because neither extreme management tactic seems reliable, an integrated pest management approach (IPM) seems the best approach. Because of the presence and abundance of natural enemies for cotton's indigenous pests, natural enemy conservation is the obvious foundation for an IPM program (Greathead 1994).

Conservation of natural enemies seeks to enhance survival and reproduction of natural enemies relative to their pests and includes many tactics such as selective pesticide use, pesticide-resistant natural enemies, crop residue management, and alteration of crop patterns (Van Driesche and Bellows 1996). Conservation in cotton has been explored before by Corbett et al. (1991) and Wu (1986). Corbett et al. (1991) found that adjacent plantings of alfalfa next to cotton could be used as a source of the predaceous mite *Metaseiulus occidentalis* (Acari: Phytoseiidae) for control of spider mites in cotton. Improved control of the cotton aphid and beet armyworm were realized by interplanting cotton with foodcrops and brassica in China (Wu, 1986).

Fye (1971) suggested that grain sorghum acted as a source for natural enemies in cotton and noted the similarity of the predator fauna in the crops. Robinson (1972a,b) examined predator densities, boll damage, and yields of cotton interplanted with grain sorghum with interesting results. While the interplanted cotton had more square damage than check plots, better yields are higher predator densities also resulted. Most recently, Krauter et al. (1998) used fluorescent dusts to mark predators in sorghum and recapture them in cotton. While these studies all assist in understanding the crops' association, none examine the possibility of predator movement into sorghum, or examine the specific factors that cause predator movement in the system. These two factors may be important because movement of predators out of cotton into grain sorghum could hinder pest control, and knowing the timing and factors influencing predator movement might allow for enhancement of natural enemy impact in this system. During the summer of 1998, we examined the system in order to: (1) quantify bi-directional movement between cotton and grain sorghum, and (2) determine timing and causes of predator migration.

Materials and Methods

Four sites located within twenty miles of Ballinger, TX were used in the summer of 1998. Each site consisted of one cotton field nested between two fields of grain sorghum, with all fields having parallel rows. Each cotton field was split and treated as two similarly sized cotton fields, creating a total of eight pairs of cotton and sorghum fields. Using flags to mark areas within each field, 369 row-meters of each crop were flagged at 5, 20, and 50 meters from the cotton-grain sorghum crop interface.

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Field work was timed to correspond with four late stages of sorghum phenology: halfbloom, soft dough, hard dough, and post-harvest. At the onset of each stage, destructive whole-plant samples were taken in each field to quantify habitat factors (e.g. prey abundance, pollen levels) with 5 plants randomly taken from each flagged row. After collection of the destructive samples, fluorescent dust was applied in two treatments to determine the net movement of predators between cotton and sorghum. In four field pairs, grain sorghum was marked at the specified distances from the interface with three colors of fluorescent dust, each color corresponding to a distance. The other four field pairs received the opposite treatment, with three different colors applied to cotton plants at 5, 20 and 50 meters from the interface. The dust marker was applied using a compressed air gun regulated to 50 PSI.

For three days after dust marking, daily predator collections were taken in the fields opposite the dust marked sections. Predators were collected by visual inspection (see Pyke et al. 1980) every 7.4 meters of each 369 meter section, for 150 plants sampled per unmarked field, per day. All adult predators were individually placed in 1/4-dram shell vials to prevent cross-contamination of the dust mark.

After collection, whole plants and adult predators were returned to the lab for examination. Destructive plant samples were examined and abundances of predators, prey, and pollen were transcribed. Along with abiotic environmental factors, these biotic factors were totaled for each field by date. Testing for influence on predator movement was conducted by Spearman's Rank Correlation (Jandel Scientific 1995) of all habitat factors with total movement (sum of distances moved by all collected migrants). Adult predators were examined for identification and presence of fluorescent dust under a dissecting microscope and results were tabulated according to field number, stage of sorghum phenology, taxon and mark presence. Analyses of predator densities were conducted using Analysis of Variance (ANOVA), and means were separated using Tukey's Test (Jandel Scientific 1995). Comparison of overall predator densities and immigrant species was also conducted using Spearman's Rank Correlation.

Results and Discussion

Net Movement Between Crops

A total of 3,233 adult predators were collected in fields adjacent to marked plots, 32 of which scored positive for a fluorescent dust marker. Of the total, 1,626 were collected in cotton, and 1,607 collected in sorghum. Of predators scoring positive for a mark, 21 were captured in cotton and 11 collected in sorghum. Essentially, these data tend to confirm the hypothesis that grain sorghum acts as a predator donor to neighboring cotton, since roughly twice as many predators moved into cotton as compared to sorghum.

Which Predators Migrate?

A comparison of the composition of predator taxa in the two crops shows (see Table 1) their composition to be similar, as reported in other studies (Fye 1971, Fye and Carranza 1972, Krauter et al. 1998). Ladybeetles, spiders and pirate bugs were the most common predators, and we hypothesized that these would be the most common migrants based upon their abundances. The 32 immigrants were composed of 13 *Hippodamia convergens* Guérin-Méneville (the convergent lady beetle), 8 *Orius tristicolor* (White) (minute pirate bug), 7 spiders, 2 *Scymnus loewii* Mulsant beetles, 1 *Collops* sp. beetle, and one *Geocoris* sp. (big eyed bug). A Spearman's Rank Correlation between the overall abundance and frequency of marked capture by taxon yielded a non-significant result (r_s=0.812, *P*=0.058). The test was only carried out for groups with one or more marked capture, but a non-significant result suggests that the most common predators are not necessarily the most common migrants. While such a result is not conceptually surprising, we view it with some skepticism due to the sensitivity of the test.

Timing of Movement and Habitat Factors

Results show a peak of movement into cotton at the soft dough stage followed by a peak of predators moving into sorghum at the hard dough stage (Figure 1). These data clearly indicate non-uniform movement over the stages of phenology examined. Additionally, density data (Table 2) show the same patterns as the recapture data with regard to predator levels in cotton, indicating that random effects on recaptures were not responsible for results. Although the movement into cotton at sorghum's soft dough stage was strong, the predators left cotton during its early flowering and boll development, which corresponded with the hard dough phase in sorghum. The effect of predators leaving cotton during early boll formation is unknown, but the post-harvest return of insects from sorghum may work to suppress any elevated pest levels that developed during the interim.

While predator movement did change with sorghum phenology, this may be an oversimplification. Because other factors (pollen levels, wind direction) may or may not vary with phenology, biotic and abiotic factors were evaluated individually. Again using Spearman's Rank Correlation, we found local prey availability (r_s= -0.515, *P*=0.012) and temperature (r_s=0.439, *P*=0.032) to be significant correlates to overall predator movement. This suggests that predators are moving in response to prey scarcity or hunger, and increased temperature.

Summary

While this study confirms results of previous studies showing movement from grain sorghum into cotton, it also shows that predators move in the opposite direction, and at times this movement can exceed the beneficial movement into cotton. The period when migration out of cotton was highest coincided with the flowering and early onset of bolls in cotton, a critical period. However, over the course of a season, cotton appears to receive a net benefit from an association with sorghum. Predator migration varies over the course of sorghum phenology, but movement appears to be a response to changing temperatures and prey availability. Therefore, it appears that this conservation tactic may be a viable management tool for pest control.

References

Corbett, A., T. F. Leigh, and L. T. Wilson. 1991. Interplanting alfalfa as a source of *Metaseiulus occidentalis* (Acari: Phytoseiidae) for managing spider mites in cotton. Biol. Cont. 1: 188-196.

Fye, R. E. 1971. Grain Sorghum: A source of insect predation for insects on cotton. Progr. Agri. Ariz. 23: 12-13.

Fye, R. E. & R. L. Carranza. 1972. Movement of insect predators from grain sorghum to cotton. Environ. Entomol. 6: 790-791.

Greathead, D. J. 1994. *In* "Insect pests of cotton" (G. A. Matthews and J. P. Tunstall, Eds.), pp 463-475. CAB International, Wallingford, UK.

Jandel Scientific. 1995. "SigmaStat User's Manual, Version 2.0 for Windows." Jandel Scientific Corporation, San Rafael, CA.

Krauter, P. K., K. M. Heinz, C. G. Sansone, A. England. 1998. Contributions of grain sorghum to natural enemy populations in cotton. *In* Proc. Beltwide Cotton Conf., pp. 1102-1104. Nat. Cotton Council Amer., Memphis, TN.

Luck, R. F. and D. L. Dahlsten. 1975. Natural decline of a pine needle scale (*Chionaspis pinifoliae* [Fitch]), outbreak at South Lake Tahoe, California following chionaspis cessation of adult mosquito control with malathion. Ecology 56: 893-904.

Pyke, B., W. Sterling, and A. Hartstack. 1980. Beat and shake bucket sampling of cotton terminals for cotton fleahoppers, other pests and predators. Environ. Entomol. 9: 572-576.

Robinson, R. R., J. H. Young, and R. D. Morrison. 1972a. Strip-cropping effects on abundance of *Heliothis*-damaged cotton squares, boll placement, and yields in Oklahoma. Environ. Entomol. 1: 140-145.

Robinson, R. R., J. H. Young, and R. D. Morrison. 1972b. Strip-cropping effects on abundance of predatory and harmful cotton insects in Oklahoma. Environ. Entomol. 1: 145-149.

Wu, Q. 1986. Investigation on the fluctuations of dominant natural enemy populations in different cotton habitats and integrated application with biological agents to control cotton pests (in Chinese: English summary). Natural Enemies of Insects 8: 29-34.

Van Driesche, R. G. and G. Taub. 1983. Impact of parasitoids on *Phyllonoycter* leafminers infesting apple in Massachusetts, USA. Protection Ecology 5: 303-317.

Van Driesche, R. G. and T. S. Bellows, Jr. 1996. *In* "Biological Control", pp. 105-127. Chapman and Hall, New York.

Table 1: Composition of predatory arthropods in cotton and grain sorghum by visual inspection, 1998.

Predator Class	Percent of Predators in Crop	
	Cotton	Sorghum
Ladybeetles	45	36
Spiders	27	38
Pirate bugs	4	13
Scymnus ladybeetles	16	5
Collops beetles	5	2
Other predators	3	6

Table 2: Number of predators per plant (x10) ± standard error, indexed by stage of sorghum phenology

Phenology	Cotton	Sorghum
Halfbloom	1.72 ± .34 a A	4.44 ± .26 a B
Soft Dough	4.70 ± .47 b A	3.85 ± .54 ab A
Hard Dough	3.17 ± .38 a A	2.93 ± .26 b A
Post-Harvest	2.93 ± .22 a	--------------------

[1]Different lowercase letters denote statistical significance in column values at *P*=.05.
[2]Different capital letters denote statistical significance in row values at *P*=.05.

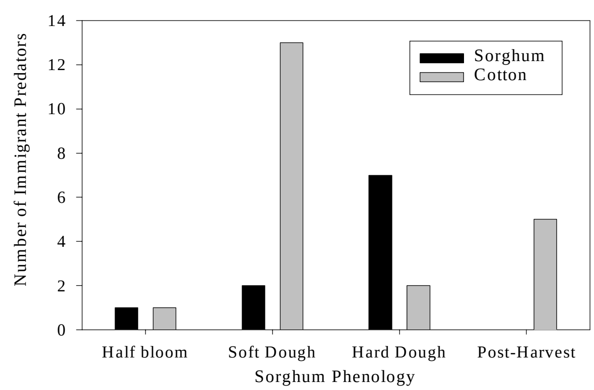

Figure 1: Number of immigrants captured over stages of sorghum phenology. Crop type indicates location captured.