EVALUATION OF POTENTIAL RELAY STRIP CROPS FOR PREDATOR ENHANCEMENT IN COTTON

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Abstract

This article reports the second year of evaluating the potential of relay strip crops for predator enhancement in cotton. Predator abundances were quantified in 6 cover crops to examine their potential as relay strip crops for predator enhancement in cotton in 1996-97 at Munday, TX. Strip crop treatments included 3 fall planted crops [fall canola, vetch, and wheat], 3 spring planted crops [spring canola, forage sorghum, and grain sorghum], and a relay system comprising canola planted in the fall and grain sorghum planted in the spring. Cotton planted adjacent to cotton served as a check. Potential of each strip crop for enhancing predator abundance in cotton was evaluated by quantifying predator numbers in cotton adjacent to each strip crop treatment. Also, the efficacy of each strip crop in suppressing pest populations in cotton was assessed by quantifying the abundances of cotton aphids and bollworms in cotton planted adjacent to each strip crop. Among fall crops, vetch had higher predator numbers than canola or wheat. Among spring crops, forage sorghum supported fewer predators than spring canola and grain sorghum. Predator abundance in cotton was significantly affected by strip crops, with higher predator numbers in all cotton plots adjacent to strip crops compared with the check plot. Predator species composition varied significantly among strip crops, but it did not vary significantly in cotton plots adjacent to strip crops. Aphid numbers did not reach to the economic threshold of 50 aphids/leaf for 3 wk in cotton plots adjacent to any of the strip crops examined, but aphid numbers exceeded the economic threshold in check plots. Strip crops did not significantly impact bollworm abundance in cotton.

Introduction

Strip intercropping has been shown to benefit insect predators through habitat diversification (Burleigh et al. 1973, Andow 1991, Bugg et al. 1991, Tonhasca 1993, Alderweireldt 1994,). Parajulee et al. (1997) indicated a potential role of strip crops for enhancing predator abundance and reducing aphid numbers in cotton. Theunissen (1994) documented the role of intercropping in vegetable crop pest management through agroecosystem diversification. However, the selection of an appropriate strip crop for a given situation should be made with caution to avoid some potential limitations of using strip crops. Strip intercropping would be counter productive if strip crops would become more attractive than the primary crop itself and act as a sink for predators (Corbett and Plant 1993), or a poor choice of strip crops may relay pests to the primary crop together with the predators (Tonhasca and Stinner 1991). An efficient strategy for relaying predators from strip crops to the primary crop without relaying pests requires that the intercrops be colonized by natural enemies before the primary crop is most susceptible to pest damage (Corbett and Plant 1993). Growing two or more crops simultaneously during part of the life cycle of each, termed as relay intercropping (Vandermeer 1989), can have advantages over simple strip intercropping. For example, there is less competition for water and nutrients between the crops in the relay system (Fukai and Trenbath 1993), and relay crops provide a predator reservoir that is in place before the arrival of key pests of the primary crop. Depending on the crops chosen, the location, and the maturity timing of the crops, they may relay insect predators, without relaying pests, from one crop to another as each crop matures and senesces. The objective of this study was to evaluate the efficacy of different cover crops as potential relay strip crops for predator enhancement and pest suppression in cotton. Specific objectives were to (1) compare seasonal abundances of predators in selected strip intercrops and in cotton planted adjacent to each strip crop, and (2) compare cotton aphid and bollworm abundances in cotton, as affected by strip crops.

Materials and Methods

The study was conducted at the Texas Agricultural Experiment Station at Munday, TX during the 1996-97 crop season. Each treatment consisted of 4 rows of strip crop on both sides of an 8-row x 75-ft cotton plot (Fig. 1). Strip crop treatments included three fall crops [fall canola, vetch, and wheat], three spring crops [spring canola, forage sorghum, and grain sorghum], a relay crop system comprising canola planted in the fall (2 outer rows) and grain sorghum in the spring (2 inner rows) [hereafter referred to as C/S-relay], and cotton as a check. Treatments were deployed in a randomized complete block design, with three replications as blocks. Treatment plots were separated from each other by a 25-ft strip of fallow land. Irrigation was applied as needed.

Fall strip crop treatments of wheat, canola, and vetch and canola of the C/S-relay were planted on 2 October 1996. Fall crops were irrigated on 16 October 1996, 24 January 1997, and 18 March 1997. Spring canola was planted on 6 March 1997. Spring strip crop treatments of forage sorghum and grain sorghum and grain sorghum of the C/S-relay were planted on 18 April 1997. Cotton var. 'Sphinx' was planted on 26 May, with a postplanting fertilization of 50-25-0 (N-P-K) lbs/ac on 16 June. Cotton plots received one irrigation on 24 July.

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Predator abundance in strip crops and cotton was monitored weekly throughout the crop season by taking a 15-second D-Vac sample from each treatment plot. Samples were sorted for each predator species, and numbers were recorded. Predator abundance in fall strip crops was monitored from 5 March through 25 June, whereas the spring strip crops were sampled from 1 May through 20 August. Predator abundance in cotton was monitored from 1 July through 10 September. Aphid abundance in cotton was monitored from 13 August through 9 September by counting the number of aphids on 10 upper and 10 lower leaves within each treatment plot. A leaf was picked every 2-3 steps along a row, and top- and bottom-half leaves were sampled in different rows. Bollworm abundance was estimated by counting the number of larvae present in 6.5 row-ft of cotton at two locations (13 row-ft total) in each plot from 23 July through 13 August. Separate repeated measures analyses of variance (ANOVA) were performed for the predator abundances in fall crops, spring crops, and cotton and for aphid and bollworm abundances in cotton, with sample weeks as repeated measures (SAS Institute 1995).

Results and Discussion

The most common predators collected in all strip crops and cotton included hemipterans (big-eyed bugs, damsel bugs, minute pirate bugs, stilt bugs, and assassin bugs), lady beetles, other predatory beetles (soft-winged flower beetles and hooded beetles), lacewings, and various species of spiders (Fig. 2). Overall, fall strip crops supported higher predator abundance compared with the spring strip crops (Fig. 3). Among the fall crops, vetch supported significantly higher numbers of total predators compared with canola and wheat. Among the spring crops, spring canola supported significantly higher predator numbers followed by grain sorghum and forage sorghum (Fig. 3).

Predator abundance in cotton was significantly affected by the adjacent strip crop, but this effect dissipated as the season progressed (Fig. 4). During the first three weeks of the sampling period (i.e., before mid-July), all strip crops, except vetch and spring canola, enhanced predator numbers in adjacent cotton plots. Although vetch and spring canola were the best strip crops among fall and spring strip crops, respectively, in terms of the total predator abundance supported, predator abundance in cotton adjacent to these strip crops were not enhanced significantly. The highest (90%) and second highest (49%) percentage of hemipterans occurred in vetch and spring canola (Fig. 2). It may be possible that hemipteran predators did not move efficiently to adjacent cotton plots, or the hemipterans may have dispersed to all cotton plots. All fall strip crops matured before cotton was ready to support the dispersing predators. Spring strip crops overlapped temporally with cotton which provided continuity for relaying predators from strip crops to cotton. However, the predator abundances in spring strip crops were lower than the fall strip crops. Predator abundance in cotton during the second 8 weeks of the sampling period was not affected by the strip crops (Fig. 4).

The pattern of predator movement into cotton from adjacent crops early in the season (before mid-July) appeared to suppress aphid populations in cotton. Although statistically not significant, aphid numbers were highest in the check plot and the lowest in cotton plots adjacent to spring canola (Fig. 5). Aphid numbers did not attain the economic threshold of 50 aphids per leaf for 3 consecutive weeks (Fuchs and Minzenmayer 1995) in cotton plots adjacent to any of the strip crops evaluated, but it exceeded the economic threshold in check plots, suggesting the suppression of aphid population in cotton by the adjacent strip crops. Because bollworm larval abundance remained very low throughout the sampling period (seasonal average: 500 larvae/acre), the assessment of the influence of strip crops on this pest was not conclusive (Fig. 6). Cotton yield ranged from 807 lbs/acre in cotton plots adjacent to vetch to 1,021 lbs/acre in cotton plots adjacent to fall canola, with an average of 880 lbs/acre. There was no significant difference in yield among 8 treatments.

Overall, comparing the results of 1996-97 season with that of 1995-96 season, the trends were similar both years with regard to all the parameters evaluated. Fall strip crops supported higher predator numbers than the spring strip crops, but the fall crops matured before the cotton plots were able to support the dispersing predators from the adjacent strip crops. Nevertheless, there was an apparent impact of all strip crops, especially during mid-June to mid-July, in enhancing predator numbers in adjacent cotton plots. Consequently, the predator enhancement in cotton significantly reduced aphid abundance in cotton, as evidenced by highest aphid numbers in check plots in both years and aphid numbers exceeded the economic threshold only in check plots in 1996-97. A significant impact of strip cropping on bollworm abundance in cotton was not detected either year. Despite an apparent impact of strip cropping in enhancing predator numbers in cotton and consequently reducing aphid numbers, average cotton yield (lint/acre) did not significantly vary among treatments in either year. Results of this study indicate that relay strip cropping is a promising strategy for enhancement of biological control of cotton aphids in agroecosystems that do not employ insecticides for insect control.

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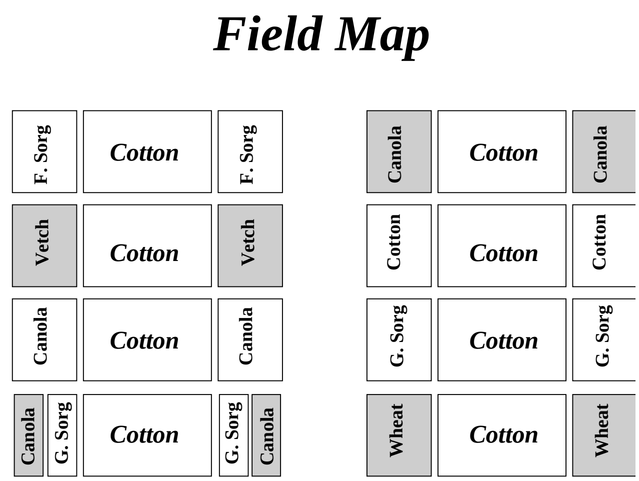


Figure 1. Field map showing the deployment of eight strip crop treatments adjacent to cotton plots in one of the replications, Munday, TX, 1996-97. Shaded blocks represent the fall planted strip crops.

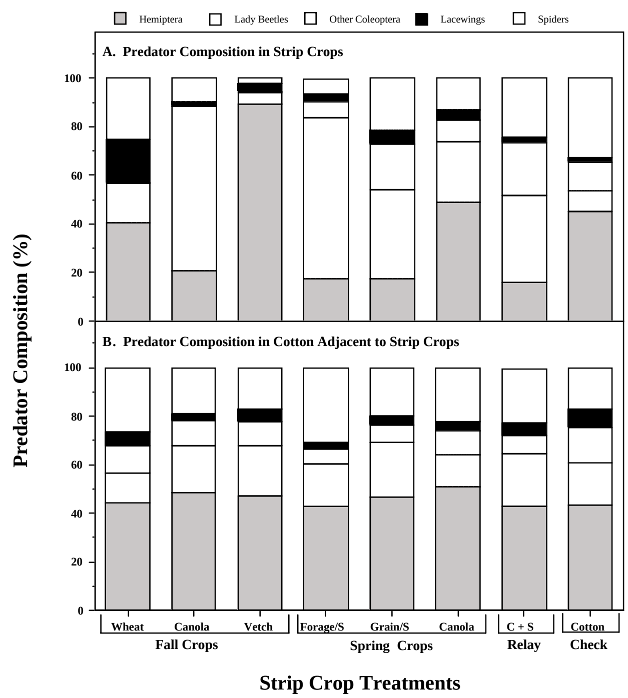


Figure 2. Predator composition in strip crops versus cotton plots adjacent to the corresponding strip crops, Munday, TX, 1996-97. Species categories in each bar follow the order of the legend.

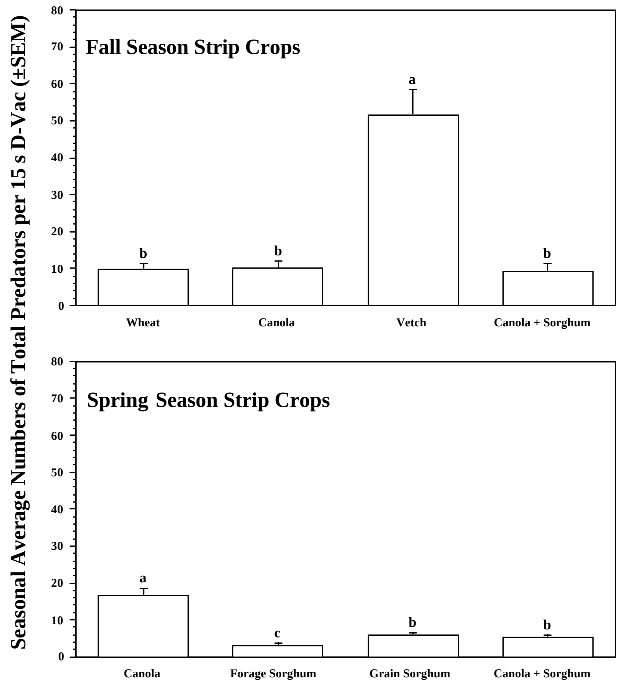
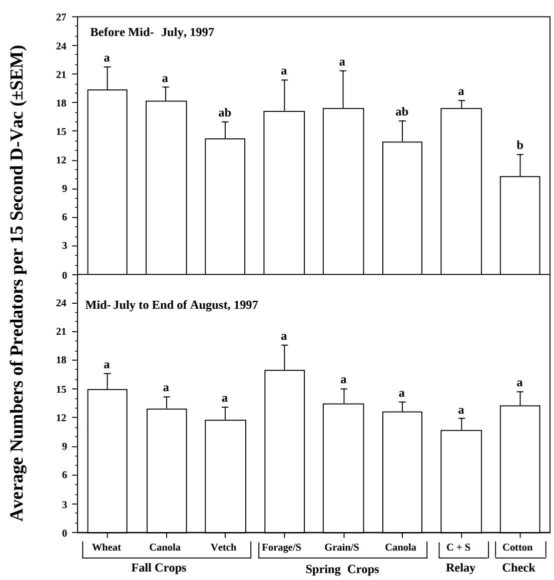
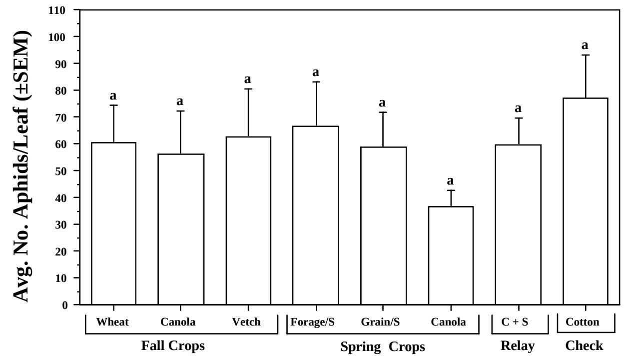


Figure 3. Predator abundances in fall and spring strip crops, Munday, TX, 1996-97.



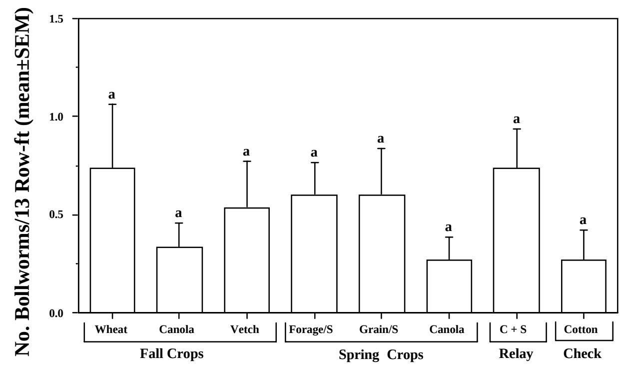
Strip Crops Planted Adjacent to Cotton

Figure 4.Predator abundances in cotton, as affected by strip crops during the first three weeks and the second eight weeks of the sampling season, Munday, TX, 1996-97.



Strip Crops Planted Adjacent to Cotton

Figure 5. Aphid abundance in cotton, as affected by strip crops, Munday, TX, 1996-97.



Strip Crops Planted Adjacent to Cotton

Figure 6. Bollworm abundance in cotton, as affected by strip crops, Munday, TX, 1996-97.