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GRAIN SORGHUM AS A TRAP CROP FOR SOUTHERN GREEN STINK BUG IN COTTON

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Abstract

The ability of grain sorghum to serve as a trap crop for the southern green stink bug (SGSB), *Nezara viridula* (L.), in cotton was investigated in Mystic, GA in 2002. Three 150 ft x 12 rows of sorghum (sorghum trap) and cotton (cotton trap) were planted along a single edge of a cotton field adjacent to corn. SGSB populations were monitored in the sorghum trap, in the cotton trap, in field cotton associated with the sorghum trap, and in field cotton associated with the cotton trap. A statistically significant difference in mean number SGSBs per 3 ft. of row occurred between the sorghum and cotton trap for almost every date. SGSBs began moving into Row 1 of field cotton adjacent to each trap crop on 9/6. More SGSBs moved into the cotton field adjacent to the cotton trap than into cotton adjacent to the sorghum trap. Only on this one date were SGSBs at economic threshold in field cotton. No insecticide applications were necessary for control of this pest in the 16-acre cotton field over the whole cotton-growing season, and thus, the trap crop provided a seasonal refuge for natural enemies of the SGSB. Mortality of SGSB eggs by the parasitoid, *T. basilis*, and the two predators, *O. insidiosus* and *G. punctipes* was moderately high (57%) during the 2nd peak in SGSG population in the sorghum trap, and began to fall as the SGSB population began to fall in this trap crop. Parasitization of SGSB nymphs and adults by *T. pennipes* was moderately high (69%) during the first SGSB peak and very high (98%) during the second SGSB peak in the grain sorghum trap crop. These results indicate that the trap crop was effective in conserving and enhancing these natural enemies. Trap cropping for SGSBs in cotton offers the potential to provide an IMP system that could improve sustainability by reducing pesticide and other off-farm inputs and expenses.

Introduction

As use of broad-spectrum insecticides diminish due to successful eradication of the boll weevil, use of transgenic *Bt* cotton, and development of new insecticide chemistries with selective modes of action against lepidopteran pests, stink bugs have emerged as pests of increasing importance (Greene and Turnipseed, 1996; Williams, 2002). In 2001, stink bugs were responsible for an estimated 6.5 million dollars in costs associated with crop loss and insecticide costs across the US (Williams, 2002). The southeast states were the biggest losers to stink bugs. One of the most important stink bug pests in the southeast is the southern green stink bug (SGSB), *Nezara viridula* (L.) (Roach, 1988). Stink bugs feed on developing seeds and lint (Barbour et al., 1990), causing shedding of newly formed bolls, yellowing of lint, and reduction in yields (Roach, 1988; Williams, 2002). Additional strategies for pest insect management are needed to overcome this emerging pest. Encouraging the presence of beneficial insects can be used to achieve this goal.

The spined soldier bug, *Podisus maculiventris* (Say), is a generalist predator, feeding on a variety of insect prey, including nymphs and adults of pest stink bugs (Jones, 1918; Drake, 1920), in a diversity of crop and non-crop ecosystems (McPherson, 1980; McPherson et al., 1982). Ragsdale et al. (1981) tested twenty-seven species for egg and nymphal predation of SGSGs using ELISA (enzyme linked immunosorbent assay). The top egg predator was *Geocoris punctipes* (Say) with *Orius insidiosus* (Say) at 2nd place, and *P. maculiventris* in 5th place. The spider *Oxyopes salticus* Hentz was the top nymphal predator, and *G. punctipes* and *P. maculiventris* were 2nd and 3rd, respectively. The most successful stink bug parasitoids are the scelionid egg parasitoid *Trissolcus basalis* (Wollaston) and the tachinid adult and nymphal parasitoid *Trichopoda pennipes* (Fab.) (Davis,1966; McPherson et al., 1982; Menezes et al., 1985; Orr et al., 1986; Jones, 1988; Awan et al., 1990; Jones et al., 1996).

Agroecosystems limit effectiveness of biological pest control because they often lack adequate food and habitat resources for natural enemies due to practices that repeatedly disturb insect habitats (Landis and Marino, 1999). Conservation biological control is defined as environmental modification to protect and enhance natural enemies (DeBach, 1964). Speight (1983) outlined various ways in which agroecosystems may be manipulated to improve pest control including trap cropping, use of wild plants in and around crops, and intercropping. Trap cropping is used to purposely lure insects into a specific area where they can be controlled (Hokkanen, 1991). Mitchell et al. (2000) encircled cabbage fields with two rows of collards as a trap crop barrier and found that diamondback moth, *Plutella xylostella* (L.), larvae never exceeded the action threshold in the cabbage, although they did in the trap crop (89% of the time) and in nearby control fields (60%). Hunt and Whitfield (1996) planted tomato plots with or without a single row of potatoes in exterior rows for Colorado potato beetle, *Leptinotarsa decemlineata* (Say) control. The trap crop effectively concentrated the beetle population in the potato row and increased crop yield on the unsprayed tomato plots 61 - 87% compared to control plots without the trap crop. In pecan, cowpea, *Vigna unguiculata* (L.), can be planted on the border of the orchard and utilized to attract large populations of stink bugs (Smith, 1996). Feeding damage can be reduced approximately 50% in pecan orchards where trap crops are planted and stink bug populations are moderately high. In broccoli, plantings of mustard and rape can prevent low densities of *Murgantia histrionica* (Hahn) from moving to the main broccoli crop (Ludwig and Kok, 1998). Lygus bugs (*Lygus hesperus* Knight) prefer lushly growing alfalfa over cotton, and strips of this crop interspersed in cotton fields virtually eliminated the need to spray the main crop for Lygus bug control (Stern et al., 1969; Sevacherian and Stern, 1974; Stern, 1981).

SGSB phenology is closely bound to crop phenology and seasonal succession of host plants, making trap cropping a suitable strategy for control. Previous work in South Georgia found that small areas of early-planted soybean (*Glycine max* (L.) Merr.) could trap stink bugs in soybean fields (Newsom and Herzog, 1977; McPherson and Newsom, 1984; Todd and Schumann, 1988). Building on this work, an on-farm research project was conducted to increase the effectiveness of natural enemies to control stink bugs in cotton (*Gossypium hirsutum* L.) by establishing grain sorghum (*Sorghum bicolor* (L.) Moench) as a trap crop for stink bugs next to the main crop. This approach to ecologically based pest management relies on a refuge to conserve and enhance natural enemies to optimize their efficacy.

Materials and Methods

The ability of grain sorghum to serve as a trap crop for the SGSB in cotton was investigated in Mystic, GA in 2002. A complete randomized experimental design was used. Three 150 ft x 12 rows of sorghum (sorghum trap) and cotton (cotton trap) were planted along a single edge of a cotton field adjacent to corn. SGSB populations were monitored in the sorghum trap, in the cotton trap, in field cotton associated with the sorghum trap, and in field cotton associated with the cotton trap. Data were analyzed using t-tests to 1) ascertain the attractiveness of the sorghum trap crop by comparing the mean number of SGSBs in the sorghum trap crop and the cotton trap crop and comparing the mean number of SGSBs in the sorghum/cotton trap crops and the field cotton associated with each trap crop, and 2) determine if and where SGSBs dispersed throughout cotton through time by comparing the mean number of SGSBs in each field cotton row sampled over time.

Results and Discussion

A statistically significant difference in mean number SGSBs per 3 ft. of row occurred between the sorghum and cotton trap for almost every date (Table 1). The initial appearance of SGSBs occurred on 7/19. Presumably these SGSBs migrated from corn since they began to appear in grain sorghum when corn was being harvested in the area. SGSBs began moving into Row 1 field cotton adjacent to each trap crop on 9/6. More SGSBs moved into the cotton field adjacent to the cotton trap than into cotton adjacent to the sorghum trap (Table 2). Only on this one date were SGSBs at economic threshold (1 stink bug per 6 ft. of row; Greene et al., 2001) in field cotton. SGSBs in Row 1 field cotton adjacent to the cotton trap crop eventually moved into the cotton trap crop so that on 9/17 there was no difference in numbers of SGSB between the trap crops. SGSBs only gradually moved into Row 1 of field cotton adjacent to the sorghum trap and never reached economic threshold indicating that SGSBs were much more attracted to sorghum than to field cotton. SGSBs moved to Row 50 and 100 of field cotton adjacent to the sorghum trap and cotton trap, respectively. These results indicate that SGSBs were more attracted to sorghum than cotton, and thus this plant could be an effective trap crop for this pest in cotton.

Due to the effectiveness of the grain sorghum in trapping SGSBs, no insecticide applications were necessary for control of this pest in the 16-acre cotton field over the whole cotton-growing season. Thus, the trap crop provided a seasonal refuge for natural enemies of the SGSB. Mortality of SGSB eggs (laboratory-reared egg masses hung in grain sorghum heads) by the parasitoid, *T. basilis*, and the two predators, *O. insidiosus* and *G. punctipes* was moderately high (57%) during the 2nd peak in SGSG population in the sorghum trap, and began to fall as the pest population began to fall in this trap crop. Parasitization of SGSB nymphs and adults by *T. pennipes* was moderately high (69%) during the first SGSB peak and very high (98%) during the second SGSB peak in the grain sorghum trap crop. These results indicate that the trap crop was effective in conserving and enhancing these natural enemies. Trap cropping for SGSBs in cotton offers the potential to provide an IMP system that could improve sustainability by reducing pesticide and other off-farm inputs and expenses.

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Table 1. Comparison of mean number of southern green stink bugs (SGSB) in grain sorghum and cotton trap in a cotton field in Mystic, Georgia for each date in 2002.

	Mean no. SGSB/3 ft. of row		**Comparison**
Date	**Grain Sorghum Trap**	**Cotton Trap**	***t*-value**
7/29	0.38	0	0.96 NS
8/5	1.13	0	1.51 NS
8/8	10.39	0	24.67**
8/13	6.62	0.03	15.71**
8/15	0.99	0.01	2.93**
8/19	0.98	0	2.95**
8/22	0.65	0	1.93NS
8/27	1.44	0	4.06**
9/3	3.27	0.03	7.31**
9/6	0.93	0	2.92**
9/17	1.14	0.69	1.34NS
9/20	1.07	0.08	3.19**
9/27	0.61	0.14	1.69NS
Overall	1.43	0.06	18.13**

** significant at the 0.01 level

Table 2. Comparison of mean number of southern green stink bugs (SGSB) on row 1 in cotton field associated with grain sorghum and cotton trap in a cotton field in Mystic, Georgia in 2002.

	Mean no. SGSB/3 ft. of row		
Date	**Cotton Field: Grain Sorghum Trap**	**Cotton Field: Cotton Trap**	**Comparison *t*-value**
9/3	0	0	0
9/6	0.17	0.81	11.19**
9/17	0.19	0.14	0.97
9/20	0.06	0.19	2.43**
9/27	0.25	0.19	.97
Overall	0.02	0.08	2.02**

** significant at the 0.01 level