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TRAP CROPS FOR LEAFFOOTED BUG MANAGEMENT IN TOMATOES

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ABSTRACT

Leaffooted bugs are a major challenge to vegetable production in the southeastern United States. Crop quality can rapidly deteriorate resulting in major economic loss for farmers. Trap crop is an alternative IPM tactic that was evaluated in Alabama in 2011 and 2012. Perimeter trap crop system incorporating sorghum (NK300) and Peredovik sunflower provided significant reduction in pesticide usage on tomatoes. Inter-plant migration of leaffooted bugs between trap crops extended the effectiveness of the overall system. Insecticide treatment of sorghum at peak leaffooted bug activity provided 78 to 100% control of the pest without the need for treating the main crop.

Introduction

Insect pests are the number one challenge to vegetable production in the southeastern United States. With an increasing number of acres under vegetable production in Alabama, it is very important to educate producers about integrated pest management (IPM) tactics that can increase the sustainability of modern farms. Among various vegetable crops grown in Alabama, tomatoes (open field and high tunnel) stand out as a cash crop that is highly susceptible to many insect pests throughout the production season. At present, there are many available insecticides for the management of caterpillars in tomatoes (Southeastern U.S. Vegetable Crop Handbook, 2012); however, management of sucking insect pests remains a challenge for vegetable producers.

Leaffooted bugs (*Leptoglossus* species, Hemiptera: Coreidae) and stink bugs (*Euschistus* sp., Hemiptera: Pentatomidae) are common sucking insect pests that cause significant fruit quality deterioration in tomatoes even when the insects are present in very low numbers (Sikora and Zehnder, 2000). Leaffooted bugs are ¾ inch long with leafy expansion on hind tibiae. In recent years, leaffooted bugs have acquired a major insect pest status in Alabama. At least three species of leaffooted bugs (*Leptoglossus* sp.) have been commonly recorded on tomato plants (AM, personal observation). Besides tomatoes, leaffooted bugs feed on Satsuma, peaches, beans, peas, and sorghum (Drees and Jackman, 1999). Synthetic pyrethroid insecticides provide moderate control of leaffooted bugs and control costs rise substantially for using the neonicotinoid formulations. However, repeated applications of broad-spectrum insecticides can flare up spider mite outbreak in dry years. Therefore, alternative pest management tactics must be developed for reducing leaffooted bugs in an economical manner that fits current vegetable production practices.

Trap crop is an alternative IPM tactic that has been under investigation in Alabama (this article) and other states (e.g., Boucher and Durgy, 2004, New England; Wszelaki and Broughton, 2010, Tennessee). Trap crops are based on the principle of host preference for insect pests. Trap crops are grown to lure insect pests away from the main crop by providing insects alternative site for feeding and oviposition (Shelton and Badenes-Perez, 2006; Wszelaki and Broughton, 2010). Trap crops can be planted in various ways to provide continuous food for the target insect pests. Trap crops are generally attractive to pests during their reproductive stages; hence, trap crops are planted earlier than the main crops. Benefits of trap crops include reduced cash crop damage, reduction in pesticide dependence, and enhanced biodiversity (Majumdar, 2011). Since there is no single trap crop that can attract all pest species, selection of trap crops depends on the target insect pest while design or layout depends on available field space, insect migration, and grower's preference. In this article, results from recently completed trap crop demonstrations are summarized along with a discussion on implications of this study. Based on our literature review, this is the first article pertaining to the large-scale use of mixed trap crop system for significant leaffooted bug control in tomato production.

Methodology

Trap crop demonstrations were established at the Brewton Agriculture Research Unit (Brewton, AL, 2011 and 2012), Chilton Agricultural Research and Extension Center (Clanton, AL, 2012), and North Alabama Horticultural Research Center (Cullman, AL, 2012). Trap crop varieties included silage sorghum (*Sorghum* spp., Family Poaceae) varieties NK300 and DKB5400, and 'Peredovik type' sunflower (*Helianthus annuus*, Family Asteraceae, 2012). Trap crop seeds were planted using conventional equipment and irrigation was provided to promote quick plant establishment. Trap crops were always planted 2 weeks ahead of the main crop in order to allow early start and good synchronization between plant species. Silage sorghum varieties typically grow vigorously after planting, are drought tolerant, and grow up to 8ft tall under ideal conditions. Peredovik sunflower is a hardy oilseed variety that grows to about 5ft height and forms a large seed head. A mixed trap crop system allowed preliminary investigation regarding the inter-crop migration pattern of leaffooted bugs. At Brewton

(2011 and 2012), two rows of sorghum trap crop were planted as a perimeter in a 50ft x 50ft plot with several rows of tomatoes transplanted in the middle. At Clanton (2012), perimeter trap crops were planted in 300ft long rows surrounding tomatoes with sunflower in the outside rows and sorghum in the inside rows (Figure 1).

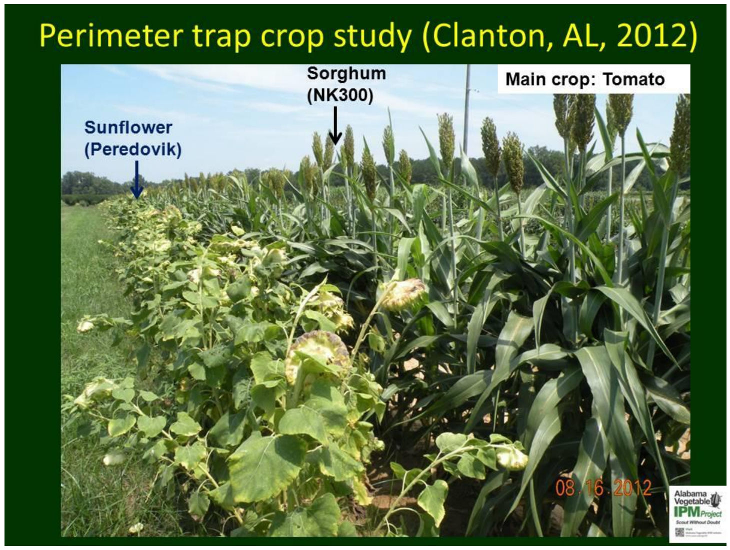

Figure 1. Perimeter trap crop design with sunflowers planted behind sorghum NK300, Clanton, AL (2012). Tomatoes were planted on the other side of sorghum.

At Cullman (2012), sorghum and sunflower trap crops (300ft) were planted in an end-to-end fashion on both sides of tomato plants (Figure 2).

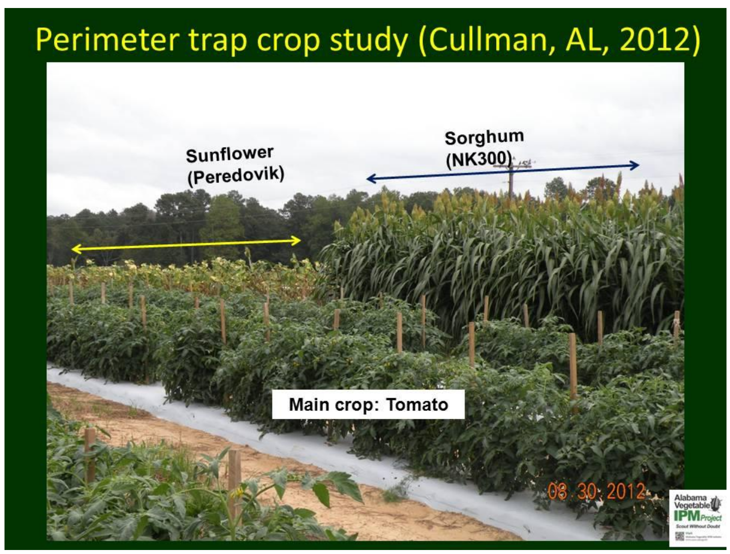

Figure 2. Perimeter trap crop design with sunflower and sorghum planted end-to-end, Cullman, AL (2012). Tomatoes were transplanted two weeks after planting trap crops.

Tomato varieties included in the study were Mountain Fresh, Bella Rosa, and Amelia. Our calculations suggest that trap crops occupied about 12% of the total production area (goal is to minimize area under trap crops without sacrificing insect control). About 20 or 40 plants of sorghum, sunflower, and tomato were randomly checked for leaffooted bugs on each observation date. Insecticides were applied to sorghum trap crop at all locations during the peak insect activity using back pack sprayers with extended booms. Tomatoes were not treated with insecticides for controlling leaffooted bugs. Only selective insecticides were used on tomatoes to control caterpillars during the season.

Results & Discussion

Trap crops (NK300 sorghum and Peredovik sunflower) consistently provided excellent control of leaffooted bugs - the predominant sucking insect pest at all study locations. *L. phyllopus* was the most abundant species found in the trap crops. A few brown stink bugs (*Euschistus servus*) were also recorded in the sorghum trap crop. Tomatoes grown with a perimeter trap crop had minor damage from leaffooted bug feeding without the use of insecticides. Results suggest that insecticide treatments at peak activity prevent migration of leaffooted bugs from trap crops to the main crop. These field demonstrations indicate the tremendous potential of trap crops like sorghum NK300 for leaffooted bug management with applications in both conventional and organic vegetable production systems. Figures 1 and 2 show the layout of the perimeter trap crops on research farms. Figures 3 and 4 provide a graphical summary of the seasonal migration pattern of leaffooted bugs between the trap crops.

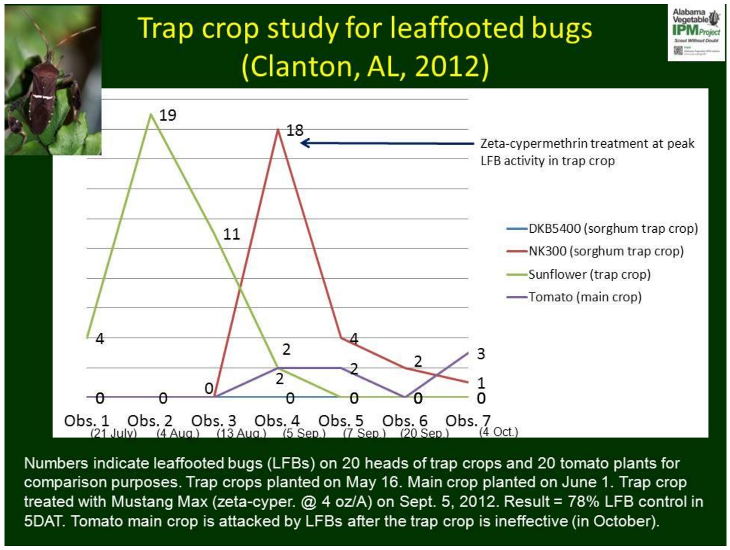

Figure 3. Leaffooted bug migration in a trap crop system with sunflower and sorghum planted one behind the other, Clanton, AL (2012). Crisscrossing red and green lines indicate seasonal migratory pattern of the target insect pest.

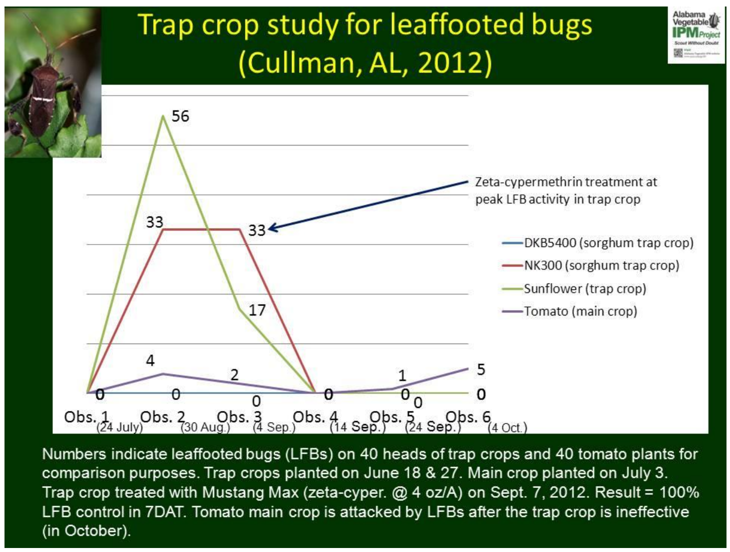

Figure 4. Sunflower and sorghum trap crops (planted end-to-end) are effective in keeping leaffooted bugs away from tomatoes, Cullman, AL (2012). Migration pattern of the leaffooted bugs is indicated by the crisscrossing green and red lines.

*Leaffooted bugs on sunflower (2012 study):*Leaffooted bugs were first detected in July and peak activity occurred in August to September. Early in the season, sunflower was a preferred host plant for leaffooted bugs. Leaffooted bugs were attracted to the maturing seed head consisting of brown to black seeds. Insects actively mated on the seed head and nymph clusters were visible in August. During peak activity, the average number of insects on Peredovik sunflower varied from 0.9 to 1.4 per head at various locations indicating strong attraction to this trap crop variety (Table 1). On one sunflower head examined at Cullman, the highest insect numbers recorded was 14 bugs (7 mating pairs). As the sunflower plants desiccated, the number of leaffooted bug gradually reduced as shown in Figures 3 and 4. Sunflowers are very attractive to a variety of pollinators during bloom, so they were not treated with insecticides. Overall, sunflower trap crop was easy to establish and required minimum maintenance even in drought year (e.g., 2011).

LFBs per plant during peak insect activity (2011 & 2012)

			Sorghum (trap crop)		Sunflower (trap crop)	Tomato (main crop)
	Trap crop design	Trap crop planting date	NK300	DKB5400	Peredovik	Mt. Fresh, Amelia, Bella Rosa
Brewton	Perimeter (2 rows)	May 23, 2011	3.2	-	-	0.3
Brewton	Perimeter (2 rows)	May 11, 2012	3.4	0	-	0
Clanton	Perimeter (2 rows)	May 16, 2012	0.9	0	0.9	0.1
Cullman	Perimeter (2	June 18 & 27,	0.8	0	1.4	0

rows) 2012

Table 1. Average number of leaffooted bugs on trap crops in the vicinity of tomatoes during peak insect activity (2011 & 2012). Dash indicates absence of a trap crop at that location.

*Leaffooted bugs on sorghum (2011 & 2012 study):*Sorghum NK300 panicles were strongly attractive to leaffooted bug adults from the soft dough stage until maturity (purple panicle); tomato main crop planted in the vicinity remained practically unaffected by these sucking pests. We have also observed such strong host preference in small cage experiments (data not shown). Leaffooted bug numbers on sorghum head varied according to the location (Table 1), for example, NK300 trap crop at Brewton had an average of 3.4 bugs per head (September 12, 2012) whereas the numbers were 0.9 bug per head at Clanton (September 5, 2012) and 0.8 bugs per head at Cullman (September 4, 2012). This indicated the unusually high pest pressure at Brewton (AL) and the success of sorghum trap crop under various environmental conditions. At Brewton, we have recorded up to 23 bugs (11 mating pairs) on one panicle of NK300 sorghum. Dense growth of sorghum also sheltered some beneficial organisms such as spiders, syrphid flies, and lady beetles, but no formal evaluations were conducted on those insects.

*Insecticidal treatment of sorghum trap crop:*Sunflower is very attractive to many beneficial insects and it was maintained pesticide-free in this study. However, it is very important to control leaffooted bugs when they accumulate on sorghum trap crop to prevent buildup and migration to the main crop (Figures 3 and 4). Unlike sunflower, the sorghum trap crop retains leaffooted bugs for a prolonged period of time lasting several weeks. At peak insect activity, sorghum trap crop was treated with one to two applications of insecticides (zeta-cypermethrin and lambda-cyhalothrin) which killed 78% to 100% leaffooted bugs within 7 days after treatment. Insecticides used in this study were labeled for use on both trap crop and main crop in order to reduce the concern for drift. Tomatoes were not treated for leaffooted bugs since there was no considerable pest pressure in the presence of trap crops. Thus, mixed trap crops can reduce overdependence on synthetic insecticides for sucking insect pest control.

*Migratory behavior of leaffooted bugs:*Trap crops significantly moderated the behavior of leaffooted bugs. In a preliminary study at Brewton (2011), we observed migration of leaffooted bugs from tomato to sorghum NK300 after 95% panicle emergence (soft dough stage). In Cullman (2012), leaffooted bugs appeared to migrate from a mature tomato patch several hundred feet away to the sunflower trap crop. As the sunflower plants desiccated (late August), leaffooted bugs migrated to sorghum and remained there. Once all the trap crops are past their prime condition, leaffooted bugs migrated to the tomato plants if not controlled. This inter-crop movement of leaffooted bugs between sorghum, sunflower, and tomato is a significant finding because it shows the benefit of a mixed trap crop system for effective crop protection.

*Perimeter trap crop versus strip trap crop design:*Perimeter trap crop design has been shown very effective IPM strategy in many vegetable crops (e.g., Boucher and Durgy, 2004). Our results support past observations and perimeter trap crop is a good option for medium- to small-scale farming operation. Due to logistical challenges to a four-side perimeter trap crop system, we recommend trap crops limited to two sides if pest migration pattern is known. A strip trap crop system, where a wide patch of trap crops are planted after several rows of the main crop, may be feasible in large field settings. Insecticidal treatment with large field equipment is feasible for strip trap crops.

*Cost-effectiveness of trap crops:*As indicated earlier, trap crops for leaffooted bug management resulted in a major reduction of insecticide usage against leaffooted bugs (assuming area under trap crops is 15% or less). In this study, two insecticide applications per season were directed at the sorghum trap crop during peak insect activity; this was under $30 per acre expense. Trap crop seeds are approximately $60 per bag (50 lb) that is adequate for many crop production seasons. No other specialized equipment is needed to plant or to maintain the trap crops. Thus, the cost of trap crops is estimated to be under $40 per acre over the season. In the absence of trap crops, producers have to use a neonicotinoid insecticide, e.g., dinotefuran, which costs about $40 per acre x two sprays = $80 per acre minimum for leaffooted bug/stink bug control. If two synthetic pyrethroid insecticides are added to this for chemical rotation, then the cost of a conventional insect control approach rises sharply to over $110 per acre, excluding labor charges. Thus, growers can save at least $80 per acre or more by using trap crops to concentrate the insect pests. Apart from the financial advantage, reduced use of insecticides allows the buildup of natural enemies (predators and parasitoids) that provides environmental sustainability.

*Improvement in quality of produce:*There was over 90% reduction in fruit damage due to leaffooted bugs and stink bugs as long as the trap crops were in good condition. This was due to significant reduction in the leaffooted bug numbers during peak activity on the main crop. This improvement in fruit quality was consistent at all study locations and relates well with a previous report on advantages of trap crops (Boucher and Durgy, 2004).

Technique demonstration to producers

During 2011 and 2012, nine IPM field days were conducted at various locations in Alabama to create awareness about trap crops and correct use of insecticides. During these events, producers were asked to scout the trap crops and the main crop to compare pest pressures; over 90% audience were highly satisfied with the demonstration plots and requested continuation of the trap crop research in 2013. In-service 'Train-the-Trainer' events were also organized by the lead author to provide hands-on IPM training to the Regional Extension Agents. Currently, efforts are underway to develop vegetable IPM recommendations using trap crops as a key strategy for leaffooted bug control.

Future scope

Trap crops provide multiple benefits in a conventional vegetable production system. In organic farming systems, it is hypothesized that staggered planting of sunflower and sorghum may deter leaffooted bugs throughout the season. In this paper we have provided preliminary evidence for insect migration between perimeter trap crops; future research will focus on evaluating other designs, varieties, and staggered planting dates for optimizing trap crop recommendations for organic crop producers. Effectiveness of approved insecticides on trap crops in an organic system also needs to be evaluated.

Conclusions

Trap crops can significantly reduce direct fruit damage in tomatoes by deterring leaffooted bug feeding injury. However, trap crop is not a silver bullet solution to all insect pest issues. Vegetable producers have to carefully design the trap crops as part of an IPM approach. Most important advantage is the reduction in pesticide usage and improvement in fruit quality. Only 12 to 15% production area under trap crops can be adequate for significant pest management; this characteristic makes sorghum and sunflower mixed trap crop system very economical. New vegetable producers can use trap crops on a small area to gain more experience and then develop an intensive IPM plan. Unmanaged trap crops can be disastrous since insect pests will accumulate and migrate to the main crop. Treating trap crops with insecticides at peak activity is an effective strategy to reduce pest populations. Organic producers can stagger trap crops and use mechanical insect removal tactics. Producers should consult the Extension personnel in their state before using trap crops and develop an IPM strategy that is environmentally friendly and financially rewarding.

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