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EFFECT OF TILLAGE SYSTEM AND PLANTING DATE ON SEASONAL ABUNDANCE OF PREDACIOUS GROUND BEETLES IN COTTON

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Abstract

A 2-year field study was conducted near Lamesa, Texas in 2002-2003, to evaluate the effect of tillage system and cotton planting date on the seasonal abundance of predacious ground beetles. The experiment was deployed in a split-plot randomized block design with tillage as the main plot factor and planting date as subplot factor with two levels each. The two tillage systems were conservation and conventional tillage and the two planting dates were timely (early May) and late (early June). Five dominant predacious ground beetles, *Cicindela sexguttata*, *Calosoma scrutator*, *Pasimachus* spp., *Pterostichus* spp., and *Megacephala carolina*, were monitored using pitfall traps (24 oz. plastic drinking cup containing soap water) from June 2002 to October 2003 at 15-day intervals. Highest number of total ground beetles (6/trap) was caught in 9 July 2003 and there were no ground beetle activities from October to December. *C. sexguttata* was the most dominant ground dwelling predacious beetle among the five species. The *Pterostichus* spp., *M. carolina* and *Pasimachus* spp. showed significant differences in their abundance between the two tillage systems. In addition, there was a significant interaction between year and tillage treatments. There was no significant difference between the number of *C. sexguttata* and *Calosoma* spp. from conventional tillage and that from conservation tillage plots in both years. The *Pterostichus* spp. and *M. carolina* numbers were significantly higher in late planted cotton compared with that in timely planted cotton, but the other three species showed no significant difference in their abundance between timely and late planted cotton.

Introduction

Conservation tillage has been defined as a production system in which 30% or more of the soil surface is covered with residue (Reeder 2000, Jasa et al. 2000). The practice of conservation tillage has become commonplace with cotton growers (Birdsong and Mitchell 2002). In Texas, some form of conservation tillage is used on approximately 25% of the cotton acreage. Tillage and other cultural practices have shown to affect arthropod species diversity and density. For example, conservation tillage has resulted in occasional, but severe insect pest problems in the southern region of the United States (Leonard and Emfinger 2002). Nevertheless, cotton production in a conservation tillage system is more profitable compared with that in conventional tillage because of significant yield advantage and substantial resource savings (Parsch et al. 2001, Keeling et al. 1989, Zenter et al. 2002). Conservation tillage practices conserve soil moisture, reduce nitrogen leaching, enhance organic matter in the soil, and reduce soil erosion (Lascano et al. 1994, Bronson et al. 2001). However, conservation tillage poses some crop management problems such as soil compaction and reduced soil aeration, increased weed problems, soil water depletion due to cover crop, reduced soil temperature, and increased activity of some insect pests such as cutworms, thrips, and cotton aphids (Burmester et al. 1995, Bradley 1995, Hill 2000, Nayakatawa and Reddy 2000).

Adoption of conservation tillage has brought changes in crop production practices, which may have a direct or indirect impact on cotton agroecosystems. The cotton plant itself is the key component of the cotton agroecosystem. Changes in farming practices will alter the crop environment and have an affect on the agronomic sustainability. For instance, conservation tillage influences soil properties and microclimate, which consequently affect crop pests, natural enemy dynamics, weed populations, irrigation scheduling, and ultimately the crop growth development and crop yield. The effect of tillage on cotton growth and yield varies with soil type, geographical location, and other management practices. Published research information on the influence of conservation tillage and planting date on predacious ground beetles are commonly not available for the Texas High Plains region.

The overall objective of this study was to determine the species composition and seasonal activity patterns of the predacious ground beetles and also evaluate the effect of conservation tillage and cotton planting date on the abundance of predacious ground beetles in Texas High Plains cotton fields.

Materials and Methods

A 2-year study (2002-2003) was conducted at the Agricultural Complex for Advanced Research and Extension System (AG-CARES) farm, near Lamesa, Texas. The experiment was deployed in a split-plot randomized block design with three replications. The main plot factors were two tillage treatments (conventional and conservation tillage) and subplot factors were two planting dates (timely and late). The conservation tillage system included shredding of cotton stubble, drilling rye seed (55 lb/acre) in winter and chemically terminating rye one month before cotton planting, furrow diking once in mid July and hoeing three times for the control of weed. The conventional tillage system included shredding cotton stubble, breaking (spring-tooth three times), and bedding, pitching out, furrow diking, rod-weeding, hoeing two times and furrow diking three times during the season.

Paymaster (PM) 2326RR cotton cultivar was planted on 8 May in 2002 and 9 May in 2003. These dates reflect the optimal cotton-planting window for the Texas High Plains. In both years, cotton was planted in 40-inch rows with a plant density of 62,100 plants per acre (15 lb/acre). Plot size was 16 rows x 125 feet. The crop was irrigated (13.9 inches in 2002, 8.2 inches in 2003) by center pivot system equipped with LEPA (low energy precision application) nozzles.

Ground beetles were monitored by using pitfall traps inspected every other week throughout the year. Plastic drinking cups (24 oz.) were used for trapping. Two traps were set for each plot. Fresh water with dishwashing soap was used to kill the beetles inside the cups. Dead beetles were collected after 48 hours of trapping and were washed, dried and identified in the laboratory.

Data Analysis

Data for all species were analyzed using analysis of variance (ANOVA), with year, tillage system, and their interaction as sources of variability (PROC GLM, SAS Institute 2002). Mean separation of treatment effects was performed using protected least significant difference (LSD) at α=0.10 level. The two-year data were combined and analyzed using a single model and effect of year was analyzed by assigning year as main plot random source of variation (McIntosh 1983). For any response variable, if year x tillage or year x planting date interaction was significant, data were analyzed separately for each year.

Results and Discussion

Species Composition and Seasonal Activity

The analysis of data from 540 traps inspected (both years) revealed that *C. sexguttata* was the most dominant (53%) ground dwelling predacious beetle among the five species followed by *M. carolina* (32%), *Pasimachus* spp. (7%), *Pterostichus* spp. (5%), and *C. scrutator* (3%) (Fig. 1). When the data were analyzed separately for the two tillage systems, the species compositions were different. In conventional tillage plots, the percentage of *C. sexguttata* (42%) was low compared to that in conservation tillage (63%). But in the case of *M. carolina,* it was high in conventional tillage (42%) plots compare to that in conservation tillage (24%).

Following a freeze, ground beetle activity was not detected during October, November and December, but some activity was recorded from February. Highest ground beetle activity was found in the period of July to August. The abundance of all species of ground beetles was significantly low in 2002 compared to 2003, but species activity patterns were similar in both years. In conservation tillage plots, the first ground beetle population peak was observed in February when the rye (cover crop) was blooming. At this same time, a very low number of beetles were recorded from the uncovered soils in the conventional tillage system. As the cotton crop developed, the abundance of ground beetles increased with peak populations observed in September and October when the cotton was still blooming (Figs. 2 and 3). Population development in conservation tillage plots was faster than that in conventional tillage so the peak population was observed about one month later in conventional tillage plots. Though the number of total ground beetles was lower in conventional tillage plots, beetle abundance patterns were similar in both tillage systems during the cotton growing season.

Effect of Tillage Practice

Megacephala carolina numbers were found significantly higher in 2003 (1.25/trap) than in 2002 (0.78/trap), but *Pterostichus* spp. numbers were significantly higher in 2002 (0.18/trap) than in 2003 (0.03/trap). For the other three species, the numbers in both years were not significantly different. Total predacious beetle abundance in conventional and conservation tillage systems did not differ significantly in both years (Fig. 4), but when species specific data were analysed separately, *Pterostichus* spp. (df=1,4; F=37.31; P= 0.0036), *M. carolina* (df=1,4;

F=22.68; *P*= 0.0089) and *Pasimachus* spp. (df=1,4; *F*=13.93; *P*= 0.020) showed significant differences in their abundance between the two tillage systems. *Pterostichus* spp., *M. carolina* and *Pasimachus* spp. had significant interaction between year and tillage treatments, therefore the data were analyzed separately for two years to determine the effect of tillage practice on their abundance in cotton. Significantly higher numbers of *Pterostichus* spp. were recorded from conventional plots (0.28/ trap) compared with that from conservation tillage plots (0.05/trap) in 2002, but in 2003 the difference was not significant. Significantly higher numbers of *M. carolina* were recorded from conventional plots (1.85/ trap) compared with that from conservation tillage (0.62/trap) in 2003, but in 2002 the difference was not significant. Significantly higher numbers of *Pasimachus* spp. were recorded from conservation tillage plots (0.34/ trap) compared with that from conventional tillage plots (0.03/trap) in 2003, but in 2002 the difference was not significant. There was no significant difference between the number of *C. sexguttata* and *Calosoma* spp. beetles from conventional tillage and that from conservation tillage plots in both years.

Effect of Planting Date

There was no significant difference in total predacious beetle abundance between timely planted and late planted plots in 2003, but total beetle numbers were significantly higher in late planted cotton compared with that from timely planted cotton in 2002 (Fig. 5). When species specific data were analyzed separately, there were no significant interactions between planting date and year. Only *Pterostichus* spp. and *M. carolina* showed significant differences in abundance between the two planting dates. Both *Pterostichus* spp. (0.14 and 0.09 per trap in late and timely planted plots, respectively) and *M. carolina* (1.33 and 0.71 per trap in late and timely planted plots, respectively) counts were significantly higher in late planted cotton compared with that in timely planted cotton.

Summary

Differences in the species composition and the abundance patterns of ground beetles between conventional and conservation tillage systems might be due to the multidimensional effect of soil cover and tillage operation. The winter rye crop might harbor some arthropods serving as a food source for ground beetles and in addition, provide a protective shelter and warmer micro-environment. Therefore, most beetle numbers started to increase earlier and faster in the conservation tillage plots. On the other hand, the frequent tillage practices such as sand-fighting might have disturbed the habitat of the ground dwelling adult beetles and their immatures. However this was not true for some species. They were captured in higher number from the conventional tillage plots compared to conservation tillage in the cotton growing season. This might be due to the difference in prey availability or other factors that affect their behavior and survival. Therefore, the relationship between ground beetle behavior and biology and other factors such as soil moisture, pest population, soil temperature, etc. should be examined to understand species-specific population dynamics in different cotton agroecosystems.

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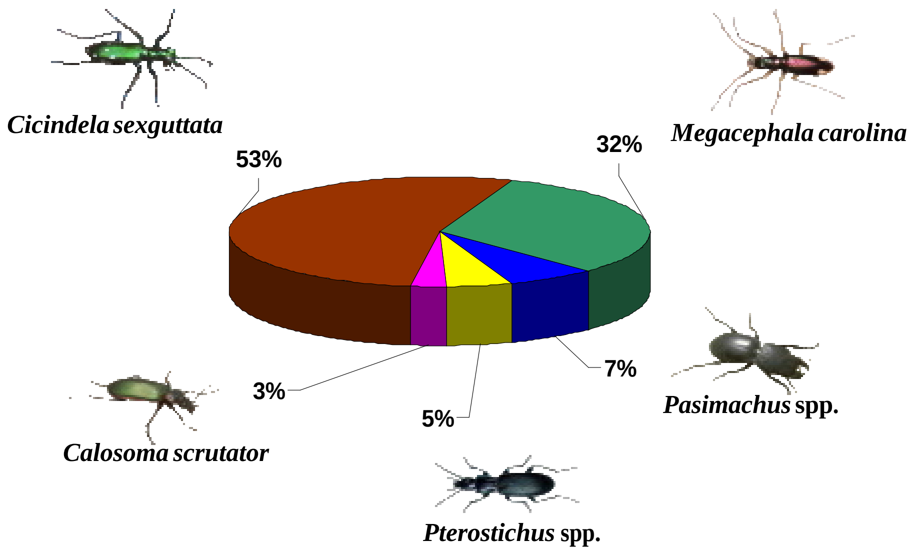

Fig. 1. Predacious ground beetles composition in cotton field at Lamesa, Texas, 2002-2003

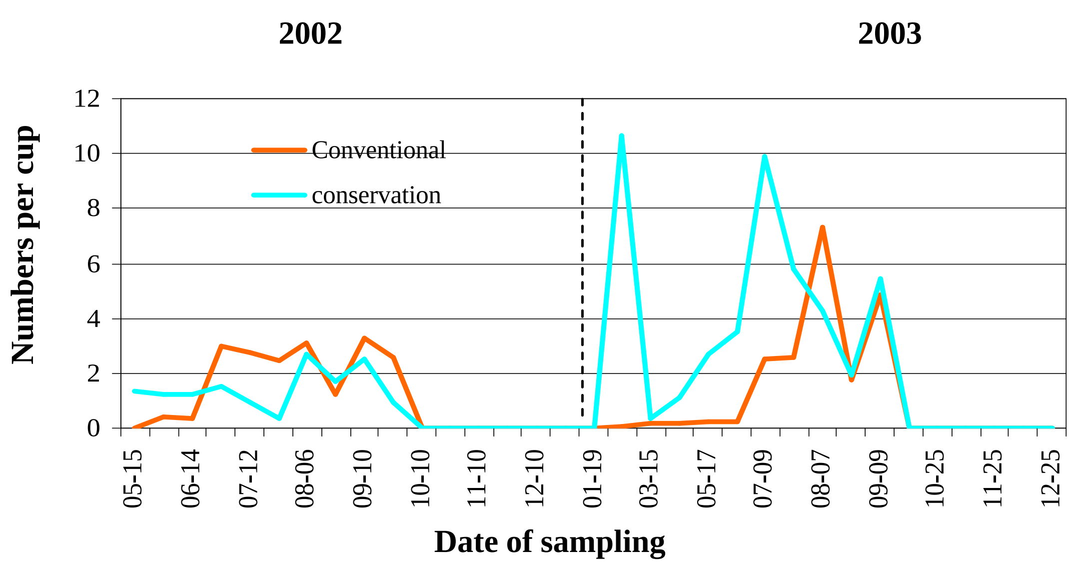

Fig. 2. Seasonal abundance patterns of total predacious ground beetles in cotton grown under two tillage systems. Lamesa, Texas, 2002-2003.

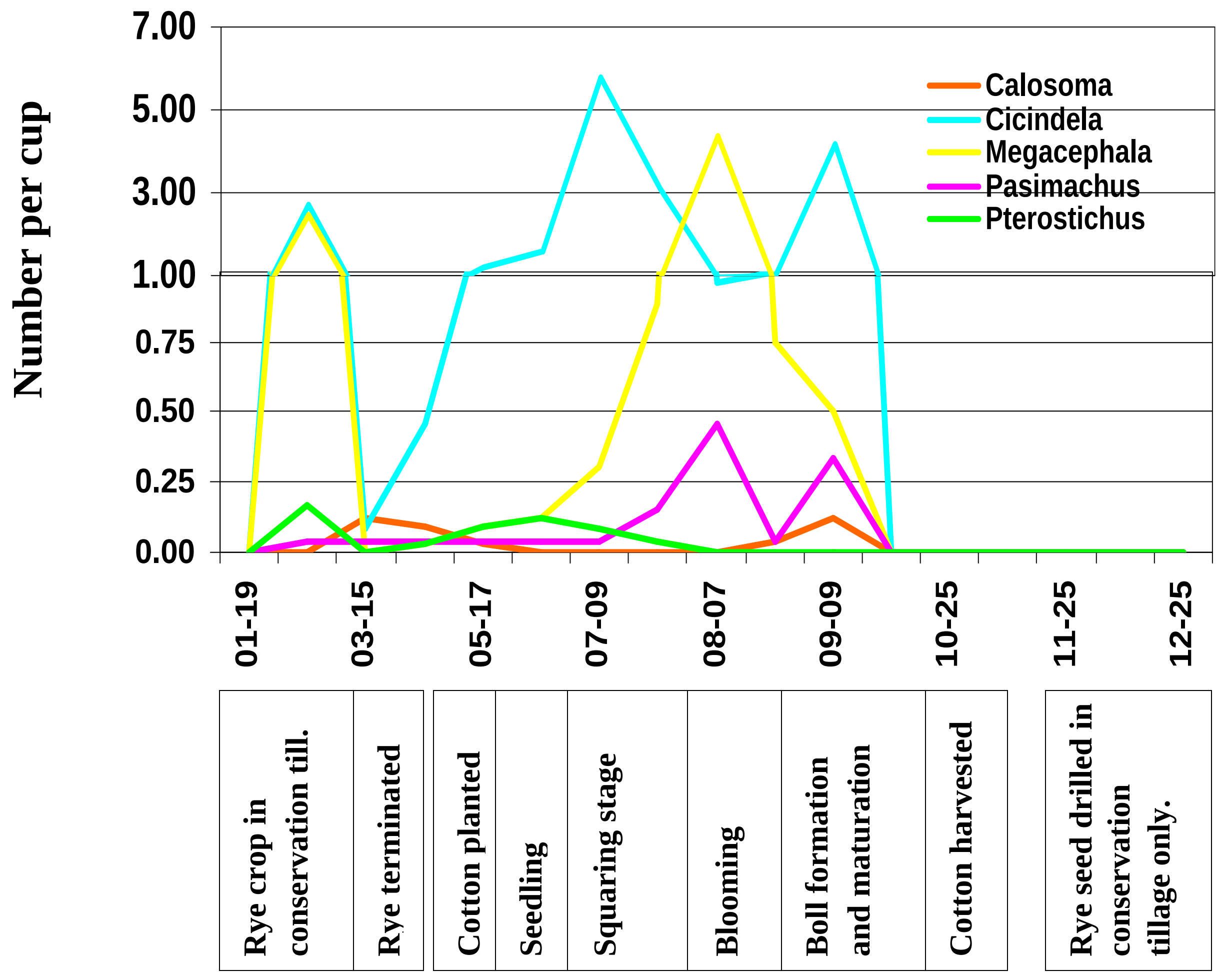

Fig. 3. Ground beetle abundance patterns and cotton phenology in 2003, Lamesa, Texas.

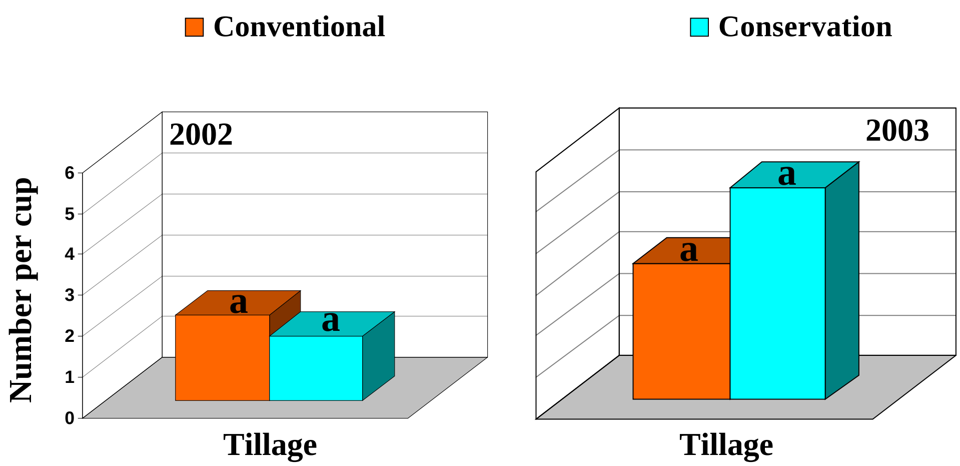

Fig. 4. Total predacious ground beetle abundance as affected by tillage practice, Lamesa, Texas, 2002-2003.

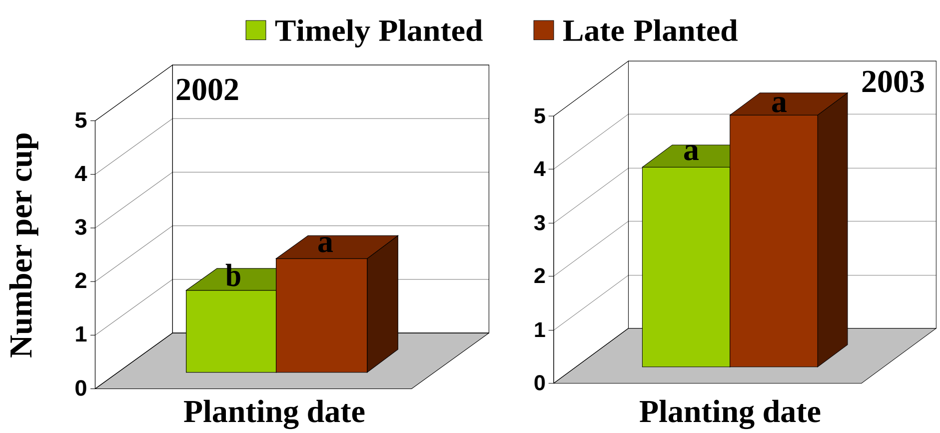

Fig. 5. Total predacious ground beetle abundance as affected by cotton planting date, Lamesa, Texas, 2002-2003.