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The Effect of Different Tillage Systems on Cotton Pests and Predators in Cotton Fields

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Abstract: The experiment was conducted in cotton fields at Adnan Menderes University, Research Center of Agricultural Faculty, located in Aydin, Province, Turkey in 2000 and 2001. The effect of four tillage systems, conventional, strip, precision and ridge tillage methods, were studied on cotton pests and their predators. *Aphis gossypii* Glov., *Thrips tabaci* Lind. and *Frankliniella* spp. were not affected from the tillage systems in either years. However, *Bemisia tabaci* Genn. populations in 2001 and *Empoasca* spp. in both 2000 and 2001 were affected and the two pests were not reached economic injury level. The highest amount of seasonal average means of *B. tabaci* was in the conventional and strip tillage than in precision and ridge tillage systems. The *Empoasca* spp. population was higher in conventional and precision than in ridge system. The predator populations were also not affected from the tillage systems. As a result, the important predators were *Orius minutus* (L.), *Geocoris ater* (F.), *Cammpylomma diversicornis* Rt. in Heteroptera Order, *Chrysoperla carnea* Steph. in Neuroptera and *Adonia variegata* (Goeze), *Coccinella spetmepunctata* L., *Symnus* spp. and *Stetherus* spp. in Coleoptera. Tillage systems have no adverse effect on the cotton pests and their predators. Thus, the lowest cost tillage system can be applied into the cotton fields to reduce the management cost in Turkey.

Key words: Cotton pests, predators, tillage systems

INTRODUCTION

Cotton insects, if not managed or if poorly managed, can cause significant damage from the cotyledon through boll maturity stages. Additionally insect pests can cause yield losses and lint quality directly or indirectly by feeding. However, producers can keep insect damage to a minimum by applying some agricultural practices which have been used for a long time in cotton fields. One of the practices is conservation tillage system that has a significant impact on cotton pests. It has recently been widely accepted in some countries and greatly improves the microenvironment for insect and natural enemy populations associated with the soil by the increasing host plant density and enhances in soil physical and chemical properties, mediating soil moisture and temperature extremes. Conservation tillage system is becoming widely adopted in all of the cotton growing season in the US. It means that a number of strategies and techniques for establishing crops in the previous crop's residues which are purposely left on the soil surface.

Some information is available concerning the effects of tillage systems on insect populations in cotton. Some studies conducted in the US showed that conservation tillage was applied to manage the insect populations. In some studies insects were not affected by the tillage systems. Despain *et al.*[1] reported that conservation tillage showed no effect on thrips numbers in cotton. Despain *et al.*[1-4] also mentioned that it did not increase the severity of insect populations compared with conventional tillage. On the other hand, some researchers indicated insect population was lower in conservation tillage system[2,5,6] or more severe[7,8] in the cotton fields.

Conservation tillage increased predator populations[9]. However, some researches reported that conservation tillage system did not affect natural enemy populations between conservation and conventional tillage fields[4,6,10,.11].

Conservation tillage system is new and some studies were done about implementation of tillage systems in wheat and cotton in Turkey[12-14]. On the other hand, conventional tillage was mainly used in cotton fields of Turkey and was not economically practices[15].

The adoption of the conservation tillage system in cotton is new and little data are available to describe the effect of these systems on cotton insects and predators. However, there is not any research on it in Turkey. The purpose of the work reported here was to evaluate the effects of different tillage systems on some cotton pests and predators in cotton fields of Turkey.

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MATERIALS AND METHODS

This experiment was conducted during the 2000 and 2001 cotton growing seasons in cotton fields at Adnan Menderes University, Agricultural Faculty Research Center, located in Aydin Province, Turkey. The soil consisted of 12% clay, 23% silt, 65% sand with a loamy sand structure. The cotton variety was "Nazilli-84", which is well adapted to the local environment. The experimental design was Randomized Block Design with three replicates. Each block consists of four tillage systems, conventional, strip, precision and ridge tillage systems. Plots were 8 rows wide (70 cm row spacing) by 25 m long within 3 m plot space left to reduce the edge effects.

In winter depth tillage was done in 10 inches with mouldboard plough in all tillage systems on February 3, 2000 and January 26, 2001. In precision tillage plot, the ridge with 8 inches in height was prepared on February 13, 2000 and February 26, 2001 and left from winter season to the spring. In spring the soil was cultivated with chisel at 8 inches deep in conventional, strip and ridge system on May 3, 2000 and April 26, 2001. Other tillage practices in the spring were followed as:

Conventional tillage system: the soil had been tillage 6 times with disc harrow at depths of 6 inches on May 3, 2000 and April 26, 2001. At the same date the fertilization and herbicide application were done with Broadcaster and Field sprayer before planting and then the soil was mixed with disc harrow at depths of 6 inches. After scrubbing seed was planted with pneumatic spacing drill on May 5, 2000 and April 26, 2001 then the soil was pressed with scrubber on May 6, 2000 and April 27, 2001.

Strip tillage system: In spring the soil was cultivated with chisel at the depths of 8 inches on May 3, 2000 and April 26, 2001 and after a day both fertilizing and herbicide application were done with broadcaster and field sprayer and the soil was mixed with disc harrow at depths of 6 inches. The strip was cultivated with rotary row tiller on May 5, 2000 and April 26, 2001 and the seed was planted with pneumatic spacing drill and then the strip was pressed with scrubber one day later.

Precision tillage system: The ridge with 8 inches in height was prepared on February 13, 2000 and February 26, 2001 and left from winter to the spring. In spring the ridger was used for the broken ridge to repair on May 4, 2000 and April 26, 2001 and at that time fertilizing and herbicide application were done with broadcaster and field sprayer and then the soil was mixed with ridger at the depths of 8 inches. The ridge was pressed with ridge scrubber on May 4, 2000 and April 26, 2001 and after a day the seed was planted with pneumatic spacing drill on the ridge and the planted ridge was pressed with ridge scrubber.

Ridge tillage system: In spring the ridge at depths of 8 inches was made with ridger on May 3, 2000 and April 26, 2001. However, the ridge was made in winter in precision tillage on February 13, 2000 and February 26, 2001. After fertilizing and herbicide application with broadcaster and field sprayer the soil was mixed with ridger at depths of 8 inches and the seed was planted with pneumatic spacing drill on the ridge on May 5, 2000 and April 26, 2001. One day later the planted ridge was pressed with ridge scrubber.

The cotton was planted on May 5, 2000 and April 26, 2001 using a steyr 768 brand tractor with a pneumatic spacing drill. The same seeding rate, fertilization, irrigation and other production factors were used for all tillage systems.

The samplings were initiated when the plants had 2-4 true leaves for thrips, aphids, whiteflies and cicdellids and at blooming stage for flower thrips and conducted weekly until the season was over. A plant washing technique was used for thrips and aphids sampling[16]. Fifteen randomly selected seedlings from the center of each tillage system were removed from the soil and placed into a cup filled with 70% alcohol. After a few seconds of shaking, the plants were removed from the cup and samples of the pests in the alcohol were taken to the laboratory for examination under a stereomicroscope. Both nymphs and adults of both pest species were counted. To estimate levels of 3rd and 4th *B. tabaci* instar nymph populations, the leaves were randomly chosen as they contained pupae and 3rd instars on the six infested leaves collected from 5th main stem node to the plant apex of each plant[17]. We collected 30 leaves from randomly selected 5 plants from each replicate near the center of each plot. A total of 90 leaves from 15 plants per each tillage system were checked for the whitefly and cicdellids within each tillage method. Whitefly Nymphs were counted on whole leaf. Since infestation was very low[18,19]. Populations of *Frankliniella* spp. (*F. intonsa* and *F. occidentalis*) were sampled from flower and two leaves at the top of each plant. Total 30 leaves and 15 flowers per 15 plants for tillage method with three replicates were sampled weekly.

The amounts of predators were sampled from 5 plants within each replicate and total 90 leaves and all squares on cotton in each tillage system were visually checked per each week. In sampling, the larvae and adults for Coleoptera, nymphs and adults for Heteroptera and Thysanoptera, eggs, larvae and adults for Neuroptera and adults for Aranea species were counted and the samples obtained were taken into laboratory and sent to the specialist for identification.

Data of the pests and predators were transformed by applying logarithmic transformation and log-transformed data points were analyzed running MIXED procedure using SAS statistical computer program[20] including repeated statement with compound symmetry covariance structure which defines the relationship between observations coming from same replicate within each block. Comparisons among least square means were made using contrast when significant (P<0.05).

RESULTS

The effect of different tillage systems on cotton pests and their predators was conducted in the study. *A. gossypii*, *T. tabaci, Empoasca* spp. and *B. tabaci* were recorded as the economically important pests in Aydin province. The other Lepidoptera species and *Tetranychus* spp. were not recorded during the experimental years. *F. occidentalis* and *F. intonsa* were recorded as Flower thrips species and *Empoasca decipiens* and *Asymmerasca decedens* were also recorded as a leafhoopers. The each species of two flower thrips and cicadellids were counted together.

In 2000 seasonal average means of *A. gossypii*, *T. tabaci* and *Frankliniella* spp. were not affected from the tillage systems. However, *B. tabaci* and *Empoasca* spp. populations were affected (Table 1). The seasonal average means of *A. gossypii* was higher in strip and conventional tillage systems than in precision and ridge system. However, there was not any significant differences (F=1.018, df=3, 28, P>0.05). The population was higher at the first sampling date (May, 24) and then decreased. It was not observed in late season. The seasonal average means of *T. tabaci* was higher in precision and ridge tillage systems than in conventional and strip tillage system. However, there were not any significant differences among tillage system (df: 3, F=0.553, P>0.05). *T. tabaci* increased after first sampling week and reached to the highest level at the second week and then decreased. The seasonal average of *B. tabaci* was higher in conventional and strip tillage systems than in precision and ridge tillage systems. However, there were significant differences observed (F=7.010, df=3, 127, P<0.001). The population was initially observed at the second week of June and reached to the highest level between on August 9 and August 15 and then decreased. The seasonal average of means of *Empoasca* spp. was affected from tillage systems and there were significant differences (F=3.826, df=3, 204, P<0.01). The population means were higher in conventional and precision systems than in strip and ridge tillage systems. The population started increasing from the first sampling week and reached to the highest level on June 6 and around September, 20. The seasonal average means of *Frankliniella* spp. was higher in strip tillage system than in the others. However, there were not significant differences (F=1.561, df=3, 39, P>0.05). The population was initially observed at late June and the first week of August.

In 2001 the seasonal average means of all economically important pest except *Empoasca* spp. were not affected from the tillage system (Table 2). The seasonal average means of *A. gossypii* was higher in conventional and strip tillage systems. However, there was not significant differences (F=0.892, df=3, 30, P>0.05). The population is higher at the first sampling date (May 11) and then decreased in all systems. It was rarely found in late season. The seasonal average means of *T. tabaci* was not affected from the tillage systems. There was not significant differences (df:3, 63, F=2.128, P>0.05). The population reached to the highest level at the second week (May 18) and then decreased and observed until June 19. The seasonal average means of *B. tabaci* was higher in precision and strip tillage systems than in

Table 1: Seasonal average means of cotton pests in the different tillage systems, 2000

Tillage systems	*Aphis gossypii*	*Thrips tabaci*	*Bemisia tabaci*	*Empoasca* spp.	*Frankliniella* spp.
Conventional	2.2±1.03ns	5.77±1.75ns	8.72±1.28a	33.66±7.44a	7.5±1.08ns
Precision	1.33±0.81ns	7.88±1.95ns	6.5±0.97b	35.35±8.23a	10.08±1.8ns
Strip	3.66±2.06ns	6.16±2.0ns	7.88±1.2a	29.1±6.27ab	12.66±2.73ns
Ridge	1.88±1.48ns	7.27±2.42ns	6.55±1.07b	25.05±5.35b	10.16±1.65ns

Table 2: Seasonal average means of cotton pests in the different tillage systems, 2001

Tillage sytems	*Aphis gossypii*	*Thrips tabaci*	*Bemisia tabaci*	*Empoasca* spp.	*Frankliniella* spp.
Conventional	5.0±3.09ns	12.16±4.88ns	5.61±0.91ns	8.41±1.5b	7.66±1.05ns
Precision	1.77±0.75ns	13.55±4.32ns	6.28±1.1ns	10.2±1.93a	8.41±1.76ns
Strip	4.44±2.5ns	12.83±5.47ns	6.48±1.04ns	8.21±1.4b	11.25±2.26ns
Ridge	1.33±1.11ns	14.83±8.54ns	5.94±0.91ns	8.48±1.49b	9.58±1.61ns

Means within a column followed by the same letter are not significantly different (P<0.05), ns: no significance

Table 3: Seasonal average means of predators in the different tillage systems, 2000

Tillage systems	Thysanoptera	Neuroptera	Heteroptera	Coleoptera	Aranea
Conventional	0.05±0.02ns	0.43±0.1ns	0.60±0.21ns	0.15±0.04ns	0.40±0.11ns
Precision	0.10±0.04ns	0.35±0.09ns	0.60±0.20ns	0.16±0.06ns	0.38±0.10ns
Ridge	0.10±0.04ns	0.33±0.07ns	0.68±0.26ns	0.10±0.04ns	0.41±0.10ns
Strip	0.03±0.02ns	0.35±0.08ns	0.66±0.26ns	0.10±0.05ns	0.25±0.10ns

Table 4: Seasonal average means of predators in the different tillage systems, 2001

Tillage systems	Thysanoptera	Neuroptera	Heteroptera	Coleoptera	Aranea
Conventional	0.07±0.03ns	0.1±0.04ns	0.80±0.22ns	0.10±0.03ns	0.38±0.11ns
Precision	0.03±0.02ns	0.20±0.06ns	0.66±0.2ns	0.08±0.04ns	0.20±0.05ns
Ridge	0.02±0.01ns	0.16±0.05ns	0.76±0.21ns	0.18±0.06ns	0.20±0.08ns
Strip	0.08±0.04ns	0.1±0.03ns	0.60±0.15ns	0.25±0.03ns	0.33±0.08ns

ns: no significance

conventional and ridge systems. However, there was not significant difference ($F=1.189$, $df=3, 138$, $P>0.05$). The population was observed at the end of June and reached to the highest level on August 28 in all systems and then decreased. The seasonal average means of *Empoasca* spp. were affected from the tillage systems. There were significant differences among tillage systems ($F=2.963$, $df=3, 215$, $P<0.05$). The highest population means were observed in precision tillage and higher than in the others. The population was initially observed at the first sampling date (May 24) and reached to the highest level on September 20 in all systems. The amount was around 3 times less compared with that of 2000. The seasonal average means of *Frankliniella* spp. were not affected from the tillage system. There were not significant differences among the tillage systems ($F=1.062$, $df=3, 39$, $P>0.05$).

The seasonal average means of predators in different tillage systems were seen in Table 3 and 4. *Aeolothrips* spp., *A. intermedius* Bagnall, *Adonia variegata* (Goeze), *Campylomma diversicornis* Rt., *Chrysoperla carnea* Steph., *Coccinella septempunctata* (L.), *C. undecimpunctata* (L.), *Geocoris ater* (F.), *Hyperaspis quadrimaculata* Redtenbacher, *Nabis ferus* (L.), *Orius minutus* (L.), *Paederus fuscipes* Curt., *Propylaea quatuordecimpunctata* (L.) *Psyllobora virgintiduopunctata* (L.), *Scymnus pallipediformis* Günther, *S. rubromaculatus* (Goeze) and *Stetherus gilvifrons* were recorded as predators in the study.

In 2000 the tillage systems did not affect predator populations. The highest amount was observed in Heteroptera order and followed by the Aranea species in both years. On the other hand, the lowest one was in Thysanoptera and Coleoptera orders. *O. minutus*, *G. ater* and *C. diversicornis* were the most species in Heteroptera and observed mainly in blooming and boll season. In Aranea the species are not classified in taxa and seen in all seasons. In Thysanoptera *A. intermedius* and *Aeolothrips* spp. were rarely found in all seasons.

DISCUSSION

Population densities of *A. gossypii*, *T. tabaci* and *Frankliniella* spp. were not affected from the four tillage systems during two-cotton growing seasons. Leonard *et al.*[2,3] and Despain *et al.*[1] did not observed any significant differences in thrips populations. Leonard[2] found that conservation tillage system did not affect the severity of *Frankliniella* spp. in Louisiana. Also, Ruberson *et al.*[4] found that aphid population were similar among tillage system during early June. In our study the population was mainly observed in the early season. *Empoasca* spp. in both years and *B. tabaci* populations in 2001 were affected from the tillage systems. However, both pests were not reached economic injury level. Smart *et al.*[21] reported that *B. tabaci* populations were not different for the conventional, reduced and presowing no-tillage systems. All literature supported this study. However, *Empoasca* spp. and *B. tabaci* were affected from tillage systems. It was thought that crop residues or environmental factors among tillage systems affected those pest populations. Thus, crop residues did not necessary in the cotton field. Since it increased the population dynamics of the cotton pests[7,8].

The populations of predators were not affected from the tillage systems in both years. Stapel *et al.*[11] reported that there was no difference in abundance of plant-dwelling beneficial insects between conservation and conventional tillaged fields in the season. Ruberson *et al.*[4] also found that natural enemy populations were similar among tillage systems. McCutcheon[9] found that the population density of lady beetles was similar in early season in tillage system. However, bigeyed bugs, lady beetles and imported fire ants were the most predators in conservation tillage plots[10] and Ruberson *et al.*[4,6] reported that no differences were observed among tillage systems on the big eyed bug *Geocoris punctips*, *Orius insidiosus* and spider populations. In this study there were not any significant differences on predators among tillage systems. The reason is that there is not any cover crop in the study. Blumberg and Crossley[22] and McPherson *et al.*[23] reported that natural enemy populations can be dramatically enhanced using cover crops that provide alternate prey or host for development of natural enemy populations.

As a result at least tillage systems applied in to cotton fields had no adverse affects on cotton pests and predators. Therefore, the producer can apply the lowest cost of tillage system in the cotton field.

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