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Population Dynamics and Damages on Shoots and Fruits Caused by of *Grapholita molesta* Busck (Lep.: Tortricidae), *Anarsia lineatella* Zell (Lep.: Gelechiidae) and *Ceratitis capitata* (Wied.) (Dip.: Tephritidae) in Some Peach Varieties

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Abstract: The study was conducted to determine population dynamics and damages on shoots and fruits caused by *Anarsia lineatella* Zell, *Grapholita molesta* Busck and *Ceratitis capitata* (Wied.) by using sex pheromone at six peach varieties including Early Red, June Gold, Redhaven, Monreo, Springcrest and Dixired at Research Center of Ministry of Agriculture in 2002 and 2003 in Sultanhisar district, Aydin, Turkey. *A. lineatella* and *G. molesta* were the major pests of peach orchards. However, *C. capitata* was not a problem. Both lepidopteran pests were firstly observed at the last week of March in 2002 and first week of May in 2003 and continued by the first week of November and had four peaks during the two years. They mainly damaged on the shoots and rarely on the fruits at all varieties. The highest damage on the fruits was occurred in late ripining varieties including Monrea and Dixired whereas the lowest damage on the shoots was in the same varieties and it was statistically different from the other peach varieties. The largest infestation on shoots was observed on east side in 2002 and south and east in 2003. The study showed that the use of sex pheromones for *A. lineatella* and *G. molesta* will help the growers to reduce chemical applications, to save management costs and to natural enemies and thus, be useful in IPM.

Key words: *Anarsia lineatella*, *Grapholita molesta*, *Ceratitis capitata*, damage, peach varieties

INTRODUCTION

Turkey with 465.571 ton is the leading peach producer among the Mediterranean countries which accounts for about 3% of world production (Anonymous, 2000). Aydin province is 5th rank peach production with 22.944 ton in our country. *Grapholita molesta* Busck (OFM) and *Anarsia lineatella* Zell (PTB) were the key pests in the peach orchards (Kilinçer and Kovanci, 1986; Günaydin and Efe, 1997; Küden and Küden, 2000). The larvae of two lepidopteran species damage growing shoot tips and fruits of the tree. The protection of fruits of later varieties, which ripen until September was the greatest difficulties. Since they were exposed to damage by populations of PTB and OFM that reach high population in July and August. The larvae of Medfly feed and develop on many deciduous, subtropical and tropical fruits and some vegetables. Although *C. capitata* (MMF) may be major pest of citrus, often it is a more serious pest of some deciduous fruits, such as peach, pear and apple. The larvae feed upon the pulp of host fruits, sometimes tunneling through it and eventually reducing the whole to a juicy inedible mass. The damage caused by the pests varied at different varieties (Frilli and Roversi, 1997). Kilincer and Kovanci (1986) used sex pheromones and they found that the two lepidopteran pests *C. molesta* and *A. lineatella* caused 10.4 and 4% damage on fruits of Hale Haven and Red Globe in Bursa and 2-3 times insecticides used for this pests. In worldwide some agricultural practices were used against those insects in peach orchards. One of the practices in Integrated Pest Management (IPM) is the use of sex pheromones for mating disruption of lepidopteran pests and has become an important component of IPM in peach orchards (Stenava, 1993; Viale and Daita, 1997; Cravedi, 2000).

In the recent years, an increasing attention has been payed to the effect of some practices on human health and the environment. The practice to reduce the use of chemicals in plant protection has received a great help by the application of pheromones which disrupt males from being able to locate unmated females for mating disruption of *C. molesta* and *A. lienatella* in peach orchards (Molinari and Cravedi, 1990; Audemard and Gendrier, 1993; Il'ichev *et al*., 1999; Evenden and McLaughlin, 2004). Rothschild (1979) showed that pheromone could be effective in controlling OFM as insecticides. Also, Vickers *et al.* (1985) reported that pheromone may be more effective than insecticides when all orchards in a district are treated. Pheromone as a major part of IPM is widely used in peach producing countries

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and has proven to be an alternative to conventional pesticide programs for the control of some lepitoperan species in peach orchards (Carde and Minks, 1995). It reduces insecticides application and thus, less residues on the fruit, the environment and conservation of beneficial enemies.

The aim of the study was to determine the population dynamics of *G. molesta*, *A. lineatella* and *C. capitata* by using the sex pheromone and their infestation on fruits and shoots at different peach varieties in Aydin Province, Turkey.

MATERIALS AND METHODS

The study was conducted to determine population dynamics of MFF, OFM and PTB by using sex pheromones and their infestation on fruits and shoots at six peach varieties during the 2002 and 2003 growing seasons at Research Center of Ministry of Agriculture, Sultanhisar district, Aydin Province, Turkey. In orchards all cultural practices were done and no chemical application were conducted during the two-years studies. The experimental design was randomized plot design with five replicates for each variety.

Population dynamics: Pheromone traps for OFM in 2002, PTB and MFF in 2002-2003 were placed in 1.5-2.0 m above the ground at south-east side of tree. Population in the traps were counted weekly. The base of traps were uniformly coated with a thin layer of an adhesive compound mixture of synthetic hydrocarbon polymers (Kapar Organik Tarim Sanayi, Ankara, Turkey) and changed weekly. The dispensers (Pherocon VI Trap, Trece Inc., Salinas, USA) for OFM, PTB and (Jackson Trap, Trece Inc., Salinas, USA) for MFF in the traps were changed every four weeks and replaced with the new one.

Shoot tip damage assessment: The experiment was carried out to determine the infestation rate on shoots in Early Red, June Gold, Redhaven, Monreo, Springcrest and Dixired peach varieties.

Five trees for each variety were checked for shoot damages caused by OFM and PTB. For the sampling each tree was divided into five parts; east, west, north, south and centre. All shoots were checked and damage on shoots for each week were cumulatively counted in each variety. Both damage of OFM and PTB on the shoots were evaluated together.

Fruit damage assessment: The experiment was carried out to determine the infestation rate on fruits in Early Red, June Gold, Redhaven, Monreo, Springcrest and Dixired peach varieties.

Fruit damage was assessed twice during the seasons when the fruit was harvesting time. At the harvest, a random sample of 10 fruits from each part including north, south, east and west side and totally 200 fruits from five trees on the each variety were evaluated and all fruits were cut to check for the presence of OFM, PTB and MFF. The number of damaged fruits was recorded and the percentage of damaged fruit in each peach variety was calculated. The damages of both OFM and PTB on the fruits were counted together. Also, the damage of MFF were evaluated.

The data were subjected to analysis of variance and means were separated by Duncan's multiple range test ($p<0.05$). Comparisons of data from each year were analyzed separately using SYSTAT version 9.0.1 (SPSS, 1999).

RESULTS

The first adult of PTB caught on March 27 and lasted in November 13 and reached to the highest level with 251 adults per trap on 23 August (Fig. 1). However, in 2003 the first population was observed on May 8 and lasted in November 4. The largest population on the trap captured with 105 per trap on September 17 (Fig. 2). On the other hand, the observation of OFM was not done in 2002. In 2003 the first moth was caught in the trap on May 16 and lasted November 4 and reached to the highest level with 196 adults per trap on August 7 (Fig. 2).

In 2002 the first population of MFF in the trap was observed on August 5 and reached to the highest level with 69 adults per trap on October 9 (Fig. 1). However, in 2003 the first adult was captured on July 31 and reached to the highest level on October 15 with 73 adults per trap (Fig. 2).

Table 1: The seasonal mean numbers of shoot damage caused by the lepidopteran pests at peach varieties in 2002 and 2003

	Years	
Varieties	2002	2003
Redhaven	9.5±1.4abA	10.3±0.8cA
Dixired	10.3±1.5aA	13.5±1.1abA
Early Red	7.5±1.3cB	14.9±1.4aA
Monreo	7.3±1.2cB	13.2±1.2abA
Springcrest	10.3±1.3aA	13.1±1.3abA
Junegold	10.4±1.3aA	12.4±0.9abA

Capital letters show the significant differences between varieties within years ($p<0.05$), Lower case letters show the significant differences between years within varieties ($p<0.05$)

Table 2: The seasonal mean numbers of shoot damage caused by the lepidopteran pests on different sides of peach varieties in 2002 and 2003

	Years	
Sides	2002	2003
North	1.96±0.1ab	2.31±0.1b
South	2.08±0.1ab	3.0±0.1a
East	2.31±0.2a	2.94±0.1a
West	1.81±0.1b	1.97±0.1c
Center	1.10±0.1c	2.71±0.1a

Lower case letters show the significant differences between years within varieties ($p<0.05$)

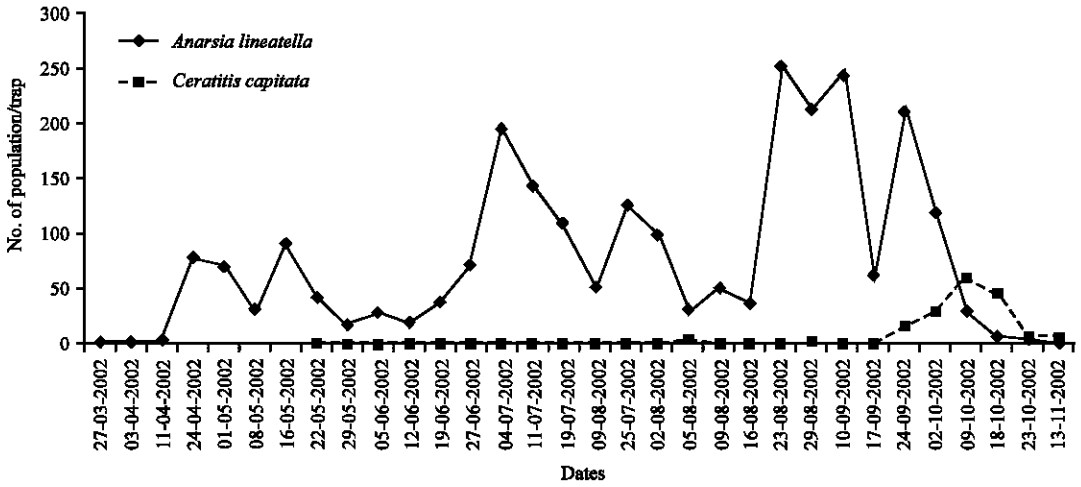

Fig. 1: Population fluctuation of *Anarsia lineatella* and *Ceratitis capitata* per trap, 2002

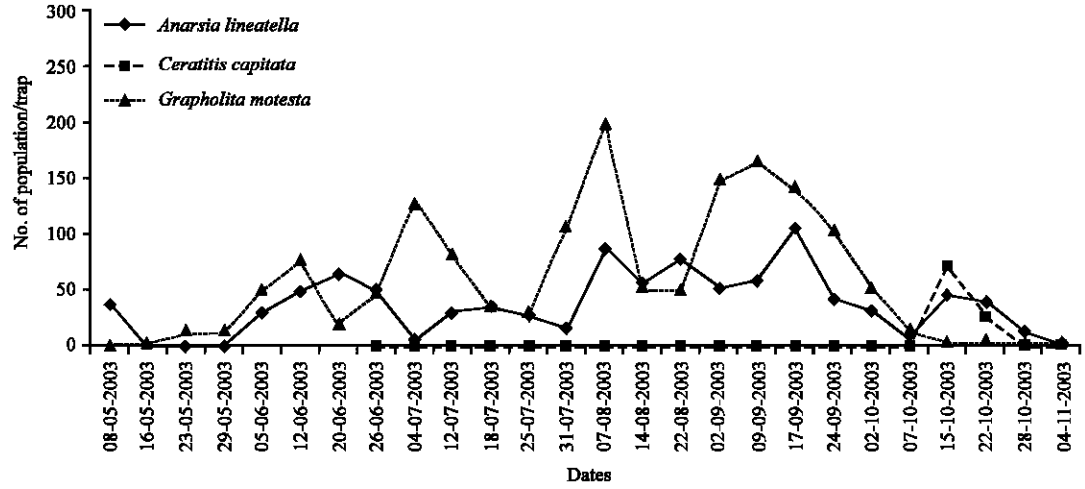

Fig. 2: Population fluctuations of *A. lineatella*, *G. molesta* and *C. capitata* per trap, 2003

Shoot damage: Table 1 shows that the infestation rate of shoot damage on Early Red and Monreo in 2002 were two times higher than that of 2003 with 14.9±1.4 and 13.2±1.2.

In 2002 the lowest damage on the shoots were in Early Red with 7.5±1.3 and Monreo variety with 7.3±1.2 and statistically different than Redhaven, Dixired, Springcrest and June Gold varieties. However, the highest infestation in 2003 were observed in Early Red (14.9±1.4) whereas the lowest one was in Redhaven (10.3±0.8) and statistically different than the other varieties.

The seasonal mean numbers of shoot damage on different sides of peach varieties in 2002 and 2003 was shown in Table 2. In 2002 the seasonal mean numbers of highest infestation shoot were observed with 2.31±0.2 on the east side and statistically important than north, south, west and center sides. However, in 2003 the highest infestation were observed in south, east and center sides with 3.0±0.1, 2.94±0.1 and 2.7±0.1.

The Table 3 shows that the highest infestation were observed in south sides of Redhaven and Early Red, east and west in Monreo, north, south and east sides of Dixired, Springcrest and June Gold and the lowest one were observed in center of all varieties. However, In 2003 the largest infestation was observed on south in Redhaven, east in Dixired, south and east in Early Red, south in Monreo, south and center in Springcrest and south in June Gold (Table 4).

In 2002 the highest damage was found with 5.1% in Monreo. However, there were not any damaged fruit in Dixired, Early Red and June Gold. In 2003 the highest damage was observed with 5.5 and 5.0% in Redhaven and Monreo and not in Springcrest and June Gold (Table 5). The damage of MFF on the fruits at all varieties were not observed.

Table 3: The seasonal mean numbers of shoot damage caused by the lepidopteran pests on the different sides of each peach variety in 2002

	Varieties					
Sides	Redhaven	Dixired	Early red	Monreo	Springcrest	June gold
North	2.03±0.3ab	2.31±0.4a	1.40±0.3abc	1.20±0.2ab	2.31±0.4a	2.41±0.4a
South	1.85±0.3ab	2.44±0.4a	1.93±0.3a	1.33±0.2ab	2.50±0.4a	2.40±0.3a
East	2.38±0.5a	2.62±0.4a	1.80±0.3ab	1.87±0.3a	2.58±0.4a	2.60±0.4a
West	1.89±0.3ab	1.86±0.3ab	1.32±0.3bc	1.90±0.4a	1.91±0.3ab	1.88±0.3ab
Center	1.36±0.3c	1.05±0.2b	1.17±0.2c	0.86±0.2b	1.00±0.2c	1.12±0.2b

Lower case letters show the significant differences between years within varieties ($p<0.05$)

Table 4: The seasonal mean numbers of shoot damage caused by the lepidopteran pests on the different sides of each peach variety in 2003

	Varieties					
	Redhaven	Dixired	Early red	Monreo	Sprincrest	June gold
North	1.90±0.2ab	2.32±0.23bc	2.71±0.3ab	2.55±0.3ab	1.88±0.2c	2.48±0.2b
South	2.42±0.2a	2.96±0.3ab	3.35±0.3a	3.10±0.3a	3.02±0.3a	3.18±0.3a
East	2.14±0.2ab	3.47±0.4a	3.72±0.4a	2.77±0.3ab	2.86±0.4ab	2.70±0.3ab
West	1.73±0.2c	1.88±0.2c	1.93±0.2b	2.42±0.3b	2.11±0.2bc	1.77±0.2c
Center	2.13±0.2ab	2.92±0.3ab	3.21±0.4a	2.40±0.3b	3.32±0.4a	2.30±0.2bc

Lower case letters show the significant differences between years within varieties ($p<0.05$)

Table 5: Total amount of fruit damaged by the lepidopteran species on each variety (%)

	Varieties					
Years	Redhaven	Dixired	Early red	Monreo	Springcrest	June gold
2002	0.1	0	0	5.1	3	0
2003	5.5	0.5	1.5	5.0	0	0

DISCUSSION

The results showed that OFM and PTB were key pests of peach orchards in Aydin province as also other places of Turkey (Günaydin and Efe, 1997; Kilinçer and Kovanci, 1986; Kuden and Küden, 2000). It was reported that OFM and PTB were key pests in Spain, France, Italy, Australia, Bulgaria, New Zealand, Ukraine, Brasil and USA (Molinari and Cravedi, 1990; Weakley *et al*., 1990, Stenava, 1993; Lo *et al*., 1995; Omelyatu and Chernishov, 1997, Il'ichev *et al*., 1999; Souza *et al*., 2000).

The overwintering larvae of OFM and PTB enter the buds, then 2-3 cm of the shoots, thereby killing and withering the shoot. The first flights of two lepidopteran pests and infested shoots with their larvae were observed late-March in 2002 and early-May in 2003. The flights finished early-November for two pests in both years. The two pests had four generations per year in the study and supported by Omelyatu and Chernishev (1997) and Günaydin and Efe (1997). Molinari and Cravedi (1990) reported that the flights of 2 pests were between early-April and later-December in Italy. According to Weakley *et al.* (1990), PTB females prefer to lay eggs on the most matured fruits in the orchards. Also, fruit damage was the greatest on the tops of trees where fruit matures earliest. In this study, it was, however, determined that the damage on fruit was lower than shoots. No correlation between the damage on shoots and fruit found in this study. This result wasn't harmony by Molinari and Cravedi (1990). Most of the damages on the shoots were observed on the south and east sides of trees, respectively. According to Weakley *et al.* (1990), fruit damages was greatest on southern edge of trees and likely to be more mature than on the other edges. It thought that more sunlight was exposed to the this edges.

In this study, the levels of damaged fruit were quite low in early and late matured varieties. Cravedi and Jörg (1996) reported that the later cultivars are particularly at risk and their defense requires numerous insecticide interventions. However, Rice (1992) mentioned that the levels of infestation on the first fruits harvested were relatively low, but it was generally increased into the harvest progressed in June. In the region, 57-59% of the growers in the district used some chemicals against the two lepidopteran pests even they were not economical important in peach orchards (Erol *et al*., 1997). The data showed that the application of chemicals was not necessary in the region. Since most of the damage was observed on the shoots, not fruit.

C. capitata was not a major problem species for research orchard and Aydin/Turkey. The damaged fruit with *C. capitata* larvae was not recorded in peach orchard in 2002 and 2003. However, some peach growers reported its damage in some years in local orchards. Matioli *et al*., 1989; Cinti *et al*., 1993; Cravedi and Molinari, 1995; Rossi *et al*., 1988; Mustafa and Abdel-Jabbar (1996) reported that it has economical importance in peach orchards of Brasil, Jordan and Italy and damaged in late ripining varieties.

In conclusion, the study will help the growers to monitor the flying period of the pests for management programs and reduced the chemical applications in peach orchards and this result will be key stone of Integrated Pest Management in the region. Also, further researches

should be done on degree-days models, biology and natural enemies of the two lepidopteran pests.

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