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The Estimation of Field Infestation Ratio by Using Infestation Ratio of Blind Bolls of *Pectinophora gossypiella* Saund. and *Earias insulana* Boisd

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Abstract: The study was conducted to calculate field infestation rate by using the infestation rates of blind bolls of Pink Bollworm, PBW (*Pectinophora gossypiella* Saund.) and Spiny Bollworm, SBW (*Earias insulana* Boisd.) in Harran Plain in 2002-2003. At the end of the study, the population of SBW and PBW were found in large areas of Harran Plain and the significant yield reduction was recorded and the infestation ratio of the pests had shown a higher ratio in 2002 (61.02%) than that of in 2003 (58.55%). The average infestation ratio of both years was 59.78%. While the number of PBW's larvae were 6258 and 5935 in the examined 4500 bolls per year in 2002-2003, SBW's larvae were 82 and 68, respectively. A parallelism was detected between the infestation ratio and the number of larvae of these pests. It can be understood from the number of larvae, PBW larvae had a higher infestation ratio than that of SBW in collected bolls. While the highest number of PBW larvae found in a blind boll in 2002-2003 was 4.01±0.25 and 4.86±0.22, the minimum of PBW larvae was 1.00±0.57 and 1.10±0.33, respectively. Field infestation ratios were found as 13.79 and 15.40% in 2002 and 2003, respectively.

Key words: Spiny bollworm, pink bollworm, blind boll, field infestation, infestation ratio

Introduction

Cotton is very important industrial crop that providing the raw material of textile and food in Turkey. It is cultivated in 719, 294 hectares and yield 2,816 kg ha^{-1} (Anonymous, 2000). In our cotton production, it has increased by Southeast Anatolia Project (GAP) since 1995. Sanliurfa is located Southeast Anatolia Region of Turkey and covers 20% of Turkey's total cotton production area (Anonymous, 1998). Harran Plain is located within the borders of Sanliurfa Province in the South East Region of Turkey, which was the place where Mesopotamia civilization flourished, stretches southward from Sanliurfa to Syria border.

Lepidoptera is second among insect orders in number of Species (Carter, 1992). Spiny Bollworm, SBW (*Earias insulana* Boisd.) and Pink Bollworm, PBW (*Pectinophora gossypiella* Saund.) take part in this order and these pests are known to cause serious damage on cotton (Kiray, 1964; Karman, 1960). According to Falcon and Smith (1973) cotton phenology was separated three stages. These pests cause damage in boll stage and mature stage cotton. The means for the transition of the pests from one season to the next and the source of infestation are the blind bolls left in the fields after the harvest. SBW and PBW cause significant damage in cotton fields in GAP region. Various researchers (Uygun *et al.*, 1995; Ünlü *et al.*, 1995; Göven, 1995) reported that SBW has caused damage on cotton in GAP region for long years. Ozpinar *et al.* (1998) reported that PBW has caused harm on cotton in Harran Plain since 1997.

The consequences of infestation are of great importance since SBW and PBW cause a wide spread infestation in the entire Harran Plain. The infestation rates blind bolls for both bollworms were 13.7, 43.1 and 26.6% in 1998-2000, respectively (Ünlü, 2001).

The major aim of this study is to calculate field infestation ratio by using infestation rate of blind bolls cased by SBW and PBW in small scales of fields. In addition, in this study, field infestation ratio is predicted by short sampling time.

Materials and Methods

This study was conducted in Harran Plain during the years of 2002-2003 to determine infestation rate of SBW and PBW in blind bolls. After the harvest, 100 blind bolls from the each of 45 fields, which are in certain distance from each other, were collected each year. The bolls were splited in the laboratory and examined if they were infected with PBW and SBW larvae. The number of total and blossomed bolls were counted and recorded from each of the 20 cotton plants that were randomly selected. According to Ünlü (2004) field infestation ratio was calculated by using infestation rate of blind bolls of pests and number of total and blossomed bolls. This equation was given below.

$$ILF = \frac{NIB \times 100}{NCB(TB - OB)}$$ (1)

ILF : Infected Levels of Field (%) NIB: Number of Infected Bolls (Piece)
NCB : Number of Collected Bolls (Piece) TB : Total Bolls (Piece)
OB: Open Bolls (Piece)

After the calculation of field infestation ratio, infestation ratio for each location in both years (2002-2003) determined and infestation ratio of bolls was determined by using equation 1. The scale of Snedecor and Cochran (1980) was changed and a new scale between 0 and 45% was prepared. This new scale is evaluated such as in below (Table 1).

Table 1: The scale of infestation ratio

Infestation Ratio (%)		Scale
0.00	Letter	Clean
00.01-05.00	A	
05.01-10.00	B	Less infested
10.01-15.00	C	
15.01-20.00	D	
20.01-25.00	E	Infested
25.01-30.00	F	
30.01-35.00	G	
35.01-40.00	H	Much infested
40.01-45.00	I	

Results

PBW has caused important damage on cotton in Harran Plain since 1997 and its population increased from year to year, spreaded all over the plain. Although SBW did not cause damage every year, its damage has continued especially in cotton fields that are located nearby Syrian border. Because of the fact that these pests are caused similar damage, infestation ratio of PBW and SBW was evaluated together in this study. According to this, infestation ratio and number of larvae in 2002-2003 years were given in Table 2.

Because the data are given as percentage, ArcSin transformation was applied to the data and then variance analyze table was prepared. At the end of the variance analysis, the difference between the locations was very significant (p<0.01). According to Duncan multiple comparison test by SPSS statistical programmed, the differences between the locations was determined (p<0.01).

Table 2 is examining, infestation ratio of these pest in blind bolls were collected from Harran Plain in 2002-2003 years were found 61.02 and 58.55%, respectively. The mean of each two years was calculated as 59.78%. Infestation ratio of these pests was a little low determined in 2003 than in 2002. We assume that this decrease is due to the normally planted cotton seeds were planted later in 2003.

The number of PBW's larvae was founded 6258 and 5935 pieces in all bolls in 2002-2003, respectively. The number of PBW's larvae was also decreased in 2003 such as infestation ratio (Table 2).

The number of SBW's larvae also provided similar results as did PBW's larvae. The number of SBW's larvae was determined 82 and 68 pieces in all bolls in 2002-2003, respectively.

In 2002, the highest infestation ratio was in Yardimci, Akkus and Koruklu as 96%. The lowest infestation ratio was in Haciekber and Fatmakuyu as 7 and 10, respectively. Infestation ratio of high level in 2003 was found in Kiliçli (97%), Abdurrahmandede (96%) and Asagi Yarimca (95%). Infestation ratio of low level in 2003 was determined in Sultantepe (10%) and Geçittepe (11%). In addition, according to 2002 infestation ratio of these pests was decreased in 25 localities and increased in 20 localities (Table 2).

Table 2: Infestation ratio and number of larvae in blind bolls of pink bollworm and spiny bollworm in Harran plain in 2002-2003

| No. | Location | 2002 | | | 2003 | | | Average (%) | * |
		Infestation ratio (%)	SBW	PBW	Infestation ratio (%)	SBW	PBW		
1	Akkuş	96.0	1	280	92.0	1	262	94.0	a
2	Koruklu	96.0	5	256	90.0	5	250	93.0	ab
3	Kılıçlı	88.0	2	320	97.0	0	297	92.5	ab
4	Aşağı Yarımca	88.0	0	246	95.0	4	287	91.5	ab
5	Abdurrahmandede	79.0	0	188	96.0	0	467	87.5	abc
6	Açmalı	85.0	1	186	91.0	0	268	88.0	abc
7	Yardımcı	96.0	3	325	75.0	0	131	85.5	abc
8	Yakacık	87.0	2	325	85.0	2	272	86.0	abcd
9	Hancağız	87.0	1	244	79.0	0	191	83.0	abcde
10	Parapara	87.0	0	207	74.0	0	157	80.5	abcde
11	Tozluca	57.0	2	114	93.0	4	275	75.0	abcde
12	Ovabeyli	84.0	0	260	69.0	3	156	76.5	abcdef
13	Aklar	91.0	2	232	52.0	0	70	71.5	abcdefg
14	Ziyaret	79.0	0	147	67.0	0	147	73.0	abcdefg
15	Akkeçi	81.0	7	155	64.0	0	125	72.5	abcdefg
16	Sütlüce	47.0	7	50	92.0	1	278	69.5	abcdefg
17	Tahılalan	73.0	2	253	68.0	0	144	70.5	abcdefg
18	Ambartepe	83.0	1	211	55.0	0	110	69.0	abcdefg
19	Balgat	70.0	3	215	69.0	3	157	69.5	abcdefg
20	Akçamescit	57.0	0	93	79.0	1	170	68.0	abcdefg
21	Nusretiye	68.0	8	133	64.0	0	106	66.0	abcdefg
22	Güneş	72.0	0	130	49.0	0	69	60.5	abcdefg
23	Ozanlar	42.0	2	51	78.0	4	166	60.0	abcdefg
24	Gelincik	72.0	1	127	47.0	0	82	59.5	abcdefg
25	Köprülük	59.0	3	98	60.0	2	102	59.5	abcdefg
26	Kökenli	55.0	0	86	60.0	0	144	57.5	abcdefg
27	Mesudiye	59.0	5	89	52.0	0	66	55.5	abcdefg
28	Uğurlu	87.0	1	288	18.0	0	15	52.5	abcdefg
29	Çavdarlı	38.0	0	39	68.0	0	140	53.0	abcdefg
30	Çatalhurma	56.0	0	95	49.0	7	68	52.5	abcdefg
31	Yamaçaltı	62.0	0	116	40.0	0	74	51.0	abcdefg
32	Sultantepe	90.0	1	223	10.0	0	11	50.0	abcdefg
33	Külünçe	63.0	0	105	30.0	0	44	46.5	abcdefg
34	Yeşerti	30.0	1	34	61.0	11	101	45.5	abcdefg
35	Büyücek	29.0	1	42	58.0	3	108	43.5	abcdefg
36	Öncüler	29.0	2	28	47.0	3	76	38.0	abcdefg
37	Çamurluk	24.0	1	32	48.0	0	68	36.0	bcdefg
38	Zeynep	55.0	2	73	18.0	0	25	36.5	bcdefg
39	Bolatlar	24.0	3	30	47.0	3	67	35.5	bcdefg
40	Kapköy	29.0	1	37	31.0	0	46	30.0	cdefg
41	Ulucanlar	25.0	3	37	32.0	0	38	28.5	cdefg
42	Turluk	34.0	1	37	14.0	0	13	24.0	defg
43	Fatmakuyu	10.0	2	3	38.0	9	52	24.0	efg
44	Haciekber	7.0	1	4	23.0	1	29	15.0	fg
45	Geçittepe	16.0	4	14	11.0	1	11	13.5	g
Totality		61.02	82	6258	58.55	68	5935	59.78	

* Mean value followed by the different letters are significant at the 0.01 level

The field infestation ratios belonging to localities in 2002 (Table 3) and 2003 (Table 4) years were given in below, respectively.

In Harran Plain in 2002, the calculation by using blind bolls the lowest infestation ratio of fields was determined in Haciekber as 1.75%, the highest infestation ratio of fields was determined in Akkeci as 40.50%. The mean of infestation ratio of fields of all locations was calculated as 13.79%. Infestation ratio of these pests showed differences among the locations: out of the 45 locations, four locations had infestation 0.1 to 5% (A), ten of them 5.1-10% (B), fifteen of them 10.1-15% (C), seven of them 15.1-20% (D), eighth of them 20.1-25% (E) and one of them 40.1-45% (I). According to these results, infestation percentage of forty locations was ranged from 5-25% (Table 2). Nowhere was found clean in 2002.

Table 3: According to localities, calculation of the field infestation ratios in 2002 in Harran

No	Location	No. of bolls	Infestation ratio (%)	Field infestation ratio (%)	Letter
1	Yamaçaltı	100	62.0	15.50	D
2	Kapköy	100	29.0	4.14	A
3	Ulucanlar	100	25.0	5.00	A
4	Kılıçlı	100	88.0	22.00	E
5	Turluk	100	34.0	5.66	B
6	Ambartepe	100	83.0	11.86	C
7	Yardımcı	100	96.0	24.00	E
8	A. Yarimca	100	88.0	22.00	E
9	Çamurluk	100	24.0	6.00	B
10	Ovabeyli	100	84.0	21.00	E
11	Kökenli	100	55.0	13.75	C
12	Hancağız	100	87.0	14.50	C
13	Külünçe	100	63.0	9.00	B
14	Sultantepe	100	90.0	22.50	E
15	Akçamescit	100	57.0	11.40	C
16	Ozanlar	100	42.0	8.40	B
17	Köprülük	100	59.0	14.75	C
18	Parapara	100	87.0	14.50	C
19	Gelincik	100	72.0	18.00	D
20	Uğurlu	100	87.0	12.43	C
21	Zeynep	100	55.0	13.75	C
22	Ziyaret	100	79.0	15.80	D
23	Çavdarlı	100	38.0	7.60	B
24	Ab.dede	100	79.0	15.80	D
25	Açmalı	100	85.0	17.00	D
26	Akkuþ	100	96.0	24.00	E
27	Fatmakuyu	100	10.0	2.00	A
28	Sütlüce	100	47.0	11.75	C
29	Öncüler	100	29.0	9.66	B
30	Tahılalan	100	73.0	12.16	C
31	Geçittepe	100	16.0	5.33	B
32	Tozluca	100	57.0	11.40	C
33	Çatalhurma	100	56.0	11.20	C
34	Mesudiye	100	59.0	19.66	D
35	Güneş	100	72.0	14.40	C
36	Hacıekber	100	7.0	1.75	A
37	Balgat	100	70.0	11.66	C
38	Büyücek	100	29.0	7.25	B
39	Yeşerti	100	30.0	6.00	B
40	Yakacık	100	87.0	21.75	E
41	Bolatlar	100	24.0	8.00	B
42	Aklar	100	91.0	18.20	D
43	Akkeçi	100	81.0	40.50	I
44	Nusretiye	100	68.0	13.60	C
45	Koruklu	100	96.0	24.00	E

Table 4: According to localities, calculation of the field infestation ratios in 2003 in Harran

No	Location	No. of bolls	Infestation ratio (%)	Field infestation ratio (%)	Letter
1	Yamaçaltı	100	40.0	6.67	B
2	Kapköy	100	31.0	6.20	B
3	Ulucanlar	100	32.0	6.40	B
4	Kılıçlı	100	97.0	24.25	E
5	Turluk	100	14.0	2.80	A
6	Ambartepe	100	55.0	18.33	D
7	Yardımcı	100	75.0	15.00	C
8	A. Yarımca	100	95.0	23.75	E
9	Çamurluk	100	48.0	12.00	C
10	Ovabeyli	100	69.0	23.00	E
11	Kökenli	100	60.0	20.00	D
12	Hancağız	100	79.0	13.17	C
13	Külünçe	100	30.0	7.50	B
14	Sultantepe	100	10.0	2.50	A
15	Akçamescit	100	79.0	13.17	C
16	Ozanlar	100	78.0	19.50	D
17	Köprülük	100	60.0	12.00	C
18	Parapara	100	74.0	14.80	C
19	Gelincik	100	47.0	11.75	B
20	Ugurlu	100	18.0	9.00	B
21	Zeynep	100	18.0	3.00	A
22	Ziyaret	100	67.0	11.17	B
23	Çavdarlı	100	68.0	22.67	E
24	A.dede	100	96.0	32.00	G
25	Açmalı	100	91.0	15.17	D
26	Akkuþ	100	92.0	30.67	F
27	Fatmakuyu	100	38.0	9.50	B
28	Sütlüce	100	92.0	23.00	E
29	Öncüler	100	47.0	11.75	C
30	Tahılalan	100	68.0	22.67	E
31	Geçittepe	100	11.0	3.67	A
32	Tozluca	100	93.0	18.60	D
33	Çatalhurma	100	49.0	12.25	C
34	Mesudiye	100	52.0	10.40	B
35	Güneþ	100	49.0	12.25	C
36	Hacıekber	100	23.0	7.67	B
37	Balgat	100	69.0	17.25	D
38	Büyücek	100	58.0	19.33	D
39	Yeserti	100	61.0	12.20	C
40	Yakacık	100	85.0	42.50	I
41	Bolatlar	100	47.0	9.40	B
42	Aklar	100	52.0	10.40	B
43	Akkeçi	100	64.0	16.00	D
44	Nusretiye	100	64.0	12.80	C
45	Koruklu	100	90.0	45.00	I

In Harran Plain in 2003, the calculation by using blind bolls the lowest infestation ratio of fields was determined in Sultantepe as 2.50%, the highest infestation ratio of fields was determined in Koruklu as 45.00%. The mean of infestation ratio of fields of all the location was calculated as 15.40%. Infestation percent of these pests showed differences among the locations: out of the 45 locations, four locations had infestation 0.1 to 5% (A), twelve of them 5.1-10% (B), eleven of them 10.1-15% (C), eight of them 15.1-20% (D), six of them 20.1-25% (E) one of them 25.1- 30 (F) one of them 30.1-35 (G) and two of them 40.1-45% (I). According to these results, thirty seven locations were ranged from 5 to 25% (Table 4). Nowhere was also found clean in 2003.

Discussions

At the end of the study, PBW and SBW were found and spread almost everywhere in Harran Plain and were determined to cause economical damage. In addition, the pests were shown higher

infestation ratios in collected bolls in 2002 (61.02%), than 2003 (58.55%). The infestation ratio in 2003 was a little lower than the previous year. The mean of boll infestation ratio of two years was materialized such as 59.78%. The field's infestation ratios were calculated by using boll infestation ratio and plant phenology in 2002 and 2003 years such as 13.79 and 15.40%, respectively.

The field's infestation ratios were determined to especially increasing in 2003 year. Singh and Sandy (1993), Purohit and Deshpande (1994) reported that, if infestation ratio of PBW and SBW is higher than 5%, damage of pests will have economic level and local producers have to apply insecticides. The results shown that, the field's infestation ratio is also higher than economic threshold and pests have economic importance in this study. It is important to notice that, a 1% increase in infestation ratio of bolls would reduce about 2.5-6% of cotton yield (Unlu and Bilgic, 2004). So, farmers should give an attention to these pests.

The number of PBW's larvae was determined as 6,258 and 5,935 pieces in 2002-2003 years, respectively. Similarly, the number of SBW's larvae was found as 82 and 68 pieces in same years, respectively. A parallelism was determined between infestation ratio of these pests and the number of larvae.

The number of larvae indicated that, maximum infestation in collected bolls was caused by PBW's larvae. While the maximum of PBW larvae occurred from a blind boll in 2002-2003 was 4.01±0.25 and 4.86±0.22, the minimum of PBW larvae was 1.00±0.57 and 1.10±0.33, respectively.

Results show that, infestation ratio caused by late planting cotton seeds (delayed planting time) in 2003 was decreased. Despite the decrease in the number of larvae, larvae density in a boll was high.

The higher infestation ratio of collected bolls was determined in the study. The means for the transition of the pests from one season to the next and the source of infestation are the blind bolls left in the fields after the harvest. So, the importance of these bolls will have existed in.
Ultimately in study, PBW was spreaded to the large areas of Harran Plain and continues to cause damage every cotton season. Although SBW's population in general area of Harran Plain was relatively low, but still damaging with higher populations in some areas (such as Fatmakuyu, Nusretiye and Yeserti) where cotton intensively produced near the Syrian border.

In addition, estimate of field infestation ratio by using the infestation ratio of blind bolls of these pests in estimation of field infestation ratio of these pests, because of the fact that used method in research that is more effective, easier and existing in short time than the other sampling techniques have more sampling time and manpower was determined.

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