PINK BOLLWORM DIAPAUSE PATTERNS IN WEST TEXAS

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Abstract

Pink bollworm (PBW) diapause patterns were studied from 1996-1998 in three West Texas cotton production areas. At Pecos, 12.3 and 57.1 percent of larvae collected from bolls tagged as blooms on August 15 were in diapause in 1996 and 1997, respectively. At St. Lawrence, 57.1% were in diapause for the same date in 1996. Very light infestations prevented diapause estimates for El Paso in 1996 and 1998 (in part), St. Lawrence (1997, in part, and 1998) and Pecos in 1998. Estimates of diapausing larvae per acre generated on sample dates were calculated by multiplying (# larvae per boll) x (# susceptible bolls per acre) x (% of the larval population in diapause). Estimates of total diapausing larvae per acre generated through the sample period were made by interpolating values for non-sample dates and summing them. Values ranged from 834 to 215,932 diapausing larvae per acre under different crop and pest conditions.

Introduction

Most studies on the effectiveness of specific fall plow-down practices in reducing overwintering populations of pink bollworms were conducted many years ago, with old technology, and or under artificial test conditions. With new technological advances in farm equipment and capabilities, new questions arise among many producers as to the effect of new equipment and procedures on overwintering populations of pink bollworms. To do this, a method for estimating the size of diapausing populations needs to be developed. However, local information is lacking on the specific diapause behavior of PBW in West Texas. Studies on diapause patterns conducted many years ago and in areas far from West Texas production areas (e.g., Presidio, Texas, Southern California, and Arizona) may not represent local diapause patterns. The objective of this study was to first determine timing of PBW entry into diapause in the St. Lawrence, Pecos, and El Paso areas, and second, to use plant, pest and diapause information to estimate fall populations of diapausing pink bollworms.

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Methods

Two hundred white blooms were tagged weekly from mid-August through crop termination in Pecos, St. Lawrence, and El Paso in 1996 and 1997. In 1998, bloom tagging was initiated at the end of July-early August. Termination of tagging depended on availability of blooms within each field. Tagging was used to estimate susceptible bolls per acre, and to determine the fates of bolls of known age and the PBW larvae attacking them. Bloom tagging was initiated in mid-August in 1996 and 1997, for the portion of the larval population in diapause was expected to be low at that time. The beginning date was moved up to July 31 in 1998 to attempt to better detect the onset of diapause. Twenty-one days after the blooms were tagged, the green bolls were collected. These bolls were held in emergence containers in temperature and light-controlled cabinets for 3 weeks. Temperature cabinets were used in 1997 and 1998 only. Temperature highs and lows in the cabinetss were based on local 10-year averages for the current month. At the end of the 3-week holding period, the emergence containers were opened and inspected and the green bolls were dissected. All larvae, pupae, and or adult moths were collected and recorded. Average numbers of larvae per boll were calculated by totaling all forms of recovered PBW and dividing by the number of bolls for that date. The larvae were then held for an additional 3 weeks to separate the diapausing larvae from the reproducing (non-diapausing) larvae. Percentages of diapausing versus total larvae were calculated for each bloom tag week. Densities of diapausing larvae per acre per tag date were calculated by multiplying the number of bolls per acre by the number of larvae per boll per tag date times the percent diapause. Values between tag dates (e.g., the other six days between tag dates) were estimated by interpolation and summed to estimate total diapausing populations per acre generated through the tagging period.

Results

St. Lawrence

Crop fruiting patterns varied a great deal between seasons for each of the St. Lawrence test fields. The test field matured significantly earlier in 1997 than in 1996, and boll production during the tagging period was much reduced (Table 1). PBW pressure was also very low in 1997 and only few larvae were recovered from three dates (n=2, 15, 30 larvae from tag dates 8/27, 8/30, and 9/6, respectively). In 1998, only 4 total larvae total were recovered and are not reported. Estimates of the percent of the population in diapause from the small samples in 1997 were very similar to the results of 1996, but confidence levels are very low. Estimated numbers of diapausing larvae per acre varied tremendously between 1996 and 1997 (215,932 versus 824) due to the combinations of high infestation and high numbers of susceptible bolls in 1996 and the low numbers of susceptible bolls and low infestation levels in 1997 (Table 1).

Pecos

At Pecos, crop maturity and fruit production were very much delayed in 1997 compared to 1996. As a result, boll production continued much longer during the test period and many more susceptible bolls were present during the study (Table 2). The PBW infestation was much lower in 1997 than 1996, and even lower in 1998. 1998 figures are not reported. Diapause patterns in 1997 differed from 1996, in that much higher proportions of the population entered diapause earlier than 1996 for the same calender dates (e.g., 12.3% and 57.1% from 8/15 in 1996 and 1997, respectively; Table 2). The cause for this is unknown. The induction of diapause in PBW populations is a very complex phenomenon influenced by external factors such as temperature, moisture, food quality, etc, as well as introduced experimental factors such as sample size and variability, sample handling, etc. Precipitation during the sample period, especially August and September was much higher in 1996 than 1997 (6.3" versus 2.3"), and temperatures and Heat Unit accumulation were lower also (1,244HU versus 1,389HU). Interestingly, although all-round test conditions differed greatly between 1996 and 1997, the estimates for diapausing populations were remarkably close (60,764 versus 61,380). In 1996, the numbers of susceptible bolls and percent diapause were low, but PBW infestation was very high. In 1997, increased boll production and earlier induction of diapause were offset by the significant reduction in PBW infestation.

El Paso

Pink bollworm infestations at test fields in El Paso were very low in 1996 and 1998 (in part). 1997 data were not available for analysis due to contamination of larval samples. Table 3 shows crop and PBW figures for the 1998 test. The number of larvae per boll remained very low until late September - early October. Estimates of percent of larvae in diapause were based on very few larvae from tag dates 7/31 through 8/21 (n=2-11 larvae), and results from them are low in confidence. The diapause estimates from the 8/29 (n=38) and 9/4 (n=52) tag dates are probably somewhat more reliable. If the difference in diapause percentages between tag dates is real, the cause of the drop in percentages in diapause from 84% to 54% is unknown. The estimated number of diapausing larvae per acre in this case was very low (7,531).

Discussion

Pink Bollworm diapause patterns carry strong implications to the importance of crop and pest management practices and their relationship to overwintering PBW populations. At Pecos, 12.3%-57.1% diapausing larvae were observed in bolls from mid-August blooms (1996, 1997, respectively), with rapid increases from that point on. This means that September appears to be the most significant period of transition from reproductive to diapausing populations. In West Texas, growers typically apply their last irrigation from early to late September to finish out their crop. Unfortunately this also keeps bolls susceptible to PBW from mid-September to well into October, when PBW moth populations are usually highest and diapause is near or at 100%. Although diapause patterns may vary between seasons and sites for a number of reasons, high PBW pressure combined with a late crop is a worst case scenario and is to be avoided (e.g., Table 1, St. Lawrence, 1996). On the other end of the spectrum, low PBW pressure with an early crop is the most desirable condition (e.g., Table 1, St. Lawrence, 1997). Low numbers of bolls per acre in the presence of high PBW pressure can still produce relatively high numbers of diapausing larvae (e.g., Table 2, Pecos, 1996), which shows the importance of in-season management of PBW to keep numbers of larvae per boll low.

Basically, the three factors involved in the “diapause equation” (i.e., #susceptible bolls / acre, #larvae / boll, and % larvae in diapause) are dynamic and interact with each other to influence the final outcome of numbers of diapausing larvae that come about. The grower has much control of the first two and no control over the third. Growers therefore need to focus their attention on the former two through choice of planting dates, irrigation scheduling, and crop termination, and chemical control (in-season) and residue destruction (post-season for next year, i.e. plowdown). Various post-harvest farming practices reduce overwintering populations (e.g., plowdown, winter irrigations, etc.) but the prevention of their initial buildup is arguably the best measure to avoid a large spring emergence because induced mortality through plowdown and other practices are never 100%, no matter what the practice is.

Summary

This study provided information on diapause patterns in West Texas and documented the transition period in the late season. The study also demonstrated the effect of crop and pest factors on the potential number of diapausing larvae generated within a field. From the farmer’s standpoint, he can only affect the crop maturity and pest infestation levels, and not diapause patterns. His options include reducing the late season boll load by choice of planting date and in-season crop management practices, and reduce pink bollworm infestation severity by spraying during the season, and through fall and winter cultural practices after harvest-- the pink bollworm diapause pattern is primarily light, temperature and moisture-driven and therefore out of his control. By knowing the approximate local pink bollworm diapause patterns and how factors interact to affect diapausing populations, we can make better recommendations to significantly reduce the numbers of larvae going into diapause and delay or eliminate the development of damaging populations the following season.

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Table 1. Comparison of per acre estimates of bolls and diapausing PBW larvae by bloom tag dates; St. Lawrence, TX; 1996,1997.

Bloom Tag Date	Yr	Bolls / Ac	Larv. / Boll	% Diap.	Diap. Larv. / Ac
8/15	1996	4,312	0.58	57.1	1,428
	1997	4,940	0.00	0.0	0
8/22	1996	9,540	1.07	74.2	7,574
	1997	2,483	0.03	0.0	0
8/29	1996	6,142	1.86	78.5	8,968
	1997	693	0.17	76.9	0
9/5	1996	6,011	1.25	76.9	5,778
	1997	439	0.29	90.0	115
9/12	1996	2,352	1.77	94.0	3,914
	1997	---	---	---	---
9/19	1996	3,267	1.73	97.4	5,505
	1997	---	---	---	---
9/26	1996	523	0.71	100.0	371
	1997	---	---	---	---
10/4	1996	4,051	—	—	—
	1997	---	---	---	---
Total	1996	36,198			33,538
	1997	8,555			206
Interpolated Totals through tag period				1996	215,932
				1997	824

Table 2. Comparison of per acre estimates of bolls and diapausing PBW larvae by bloom tag dates; Pecos, TX; 1996,1997.

Bloom Tag Date	Yr	Bolls / Ac	Larv. / Boll	% Diap.	Diap. / Larv. / Ac
8/15	1996	7,339	1.30	12.3	1,173
	1997	16,449	0.27	53.0	2,354
8/22	1996	3,515	2.50	35.8	3,143
	1997	15,161	0.19	82.0	2,362
8/29	1996	659	2.50	51.9	855
	1997	9,172	0.28	96.0	2,466
9/5	1996	366	3.60	73.6	969
	1997	4,863	0.28	80.0	1,089
9/12	1996	510	2.50	82.1	1047
	1997	1,907	0.32	100.0	610
9/19	1996	653	1.40	90.5	828
	1997	1,035	0.84	100.0	869
9/26	1996	1,623	1.40	91.4	2,076
	1997	149	0.32	100.0	48
Total	1996	14,663			10,091
	1997	48,736			9,798
Interpolated Totals through tag periods				1996	60,764
				1997	61,380

Table 3. Comparison of per acre estimates of bolls and diapausing PBW larvae by bloom tag dates; El Paso, TX; 1997, 1998.

Bloom Tag Date	Yr	Bolls / Ac	Larv. / Boll	% Diap.	Diap. / Larv. / Ac
7/31	1998	3,116	0.02	50.0	26.5
8/7	1998	3,455	0.00	–	--
8/15	1998	4,773	0.02	100.0	105.0
8/22	1998	1,886	0.13	82.0	207.2
8/29	1998	2,183	0.37	84.0	680.3
9/5	1998	261	0.73	54.8	104.5
Total	1998	15,674			1,123.5
Interpolated Total through tag period					7,531