INFLUENCE OF TEMPERATURE ON THE RATE OF GRANDLURE RELEASED FROM BOLL WEEVIL PHEROMONE LURES

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Abstract

Although pheromone lures dosed with grandlure are effective in attracting boll weevils to traps, ambient temperatures may influence the rate of pheromone released from lures and subsequently affect the detection efficiency of traps. We examined the rate of grandlure released from three commercial lure dispensers (Hercon, Plato, and Scentry) exposed to temperatures representative of those encountered during the early- and mid-cotton production season in South Texas. Pheromone release was measured daily for two weeks under laboratory conditions (70°F and 85°F), and approximated every two days under field conditions. Laboratory and field evaluations revealed that the influence of ambient temperatures on the amount of pheromone released from lures was similar among lure types. In general, the amount of pheromone released from lures, particularly during the first week of aging, increased with increasing temperatures. Overall, Scentry lures released the greatest amount of pheromone over the two-week period, but Hercon and Plato lures released more pheromone than Scentry lures during the second week of aging under warmer temperatures. The total amount of pheromone released during the first week of aging was approximately 3 to 4 times greater than the total released during the second week of aging. Given the subtropical climate of South Texas and northeastern Mexico, our findings suggest the initial grandlure dose of lures used in these areas may need to be increased to ensure that a sufficient amount of grandlure is released during the second week of aging or, alternatively, lures may need to be replaced more frequently.

Introduction

The use and timely replacement of quality pheromone lures are critical to the success of boll weevil eradication programs in the Texas and Mexico. Currently, these two programs use lures dosed with 10 mg of grandlure and replace lures in traps biweekly. Although this trapping regime has resulted in the timely eradication of boll weevils in other U.S. states and throughout most of the cotton production regions in Texas, eradication progress in South Texas has been at a standstill for the past several years. The lack of progress has been largely attributed to the subtropical climate which is favorable for boll weevil reproduction and overwintering survival. This climate may also be responsible for the inconsistent performance of pheromone traps in detecting incipient boll weevil populations in South Texas. The objective of our study was to examine the influence of temperature on the release of grandlure from boll weevil pheromone lures.

Materials and Methods

Laboratory Evaluations

Five to six lures each from three manufacturers (Hercon Environmental Corp., Emigsville, Pennsylvania; Plato Industries, Houston, Texas; and Scentry Biologicals, Billings, Montana) were placed individually inside glass collection vessels. Lures were exposed to a constant temperature (70 ± 2°F or 85 ± 2°F), and pheromone emitted into the headspace of each vessel was collected onto absorbent columns over a 24-h period for 14 d. At the end of each 24-h collection period, pheromone was eluted from the collection columns directly into gas chromatograph (GC) sample vials. Each column was eluted with enough GC grade methylene chloride to result in a 1.0-ml eluant volume. Samples were analyzed on a Shimadzu GC-17A gas chromatograph equipped with dual columns and detectors. Pheromone content from each lure was injected and analyzed on both columns. Estimates from duplicate injections were averaged, and the total pheromone content in each sample was calculated as the sum of the four components. Two trials each were conducted at 70 ± 2°F and 85 ± 2°F.

Field Evaluations

Boll weevil pheromone traps (Technical Precision Plastics, Mebane, North Carolina) were placed on poles in a 10 x 21 array in a field of mowed grass at the USDA-ARS Southern Plains Agricultural Research Center, College Station, Texas. Seventy 10-mg lures from each of the three manufacturers were placed individually in traps. Ten

replicates of each lure type were collected from traps at 2 d, 4 d, 6 d, 8 d, 10 d, 12 d, and 14 d of field aging. Additionally, 10 non-aged (0 d) lures from each manufacturer were used to estimate the initial grandlure content of lures. Pheromone was extracted from lures with hexane, and the residual pheromone contents of lures were analyzed by a Shimadzu 2010 gas chromatograph using gamma-terpinene as an internal standard. The average release of pheromone from field-aged lures was calculated as the average initial content (at 0 d) minus the average residual content of lures for each respective collection date. Evaluations were conducted during four periods to cover a range of temperatures (June 6-20, July 11-25, Sep. 12-26, and Oct. 12-26, 2011), and a Campbell 21XL weather station (Campbell Scientific, Inc., Logan, Utah) was placed near the traps to record hourly weather data during each evaluation period.

Results and Discussion

The ratio of the four grandlure components was similar among lure manufacturers, and remained consistent throughout the 14-d aging period under both laboratory and field conditions (Table 1). Consequently, our findings indicate grandlure remains stable over a wide range of temperature conditions. Our findings also suggest the degradation of grandlure in lures can be ruled out as a contributing factor to the inconsistent performance of traps in detecting incipient weevil populations.

Table 1. Overall composition of boll weevil pheromone (grandlure) in lures produced by three manufacturers held under laboratory (70°F and 85°F) and field conditions for up to 14 d.

Environment	Lure	Comp I	Comp II	Comp III	Comp IV
Laboratory	Hercon	32 ± 1	38 ± 1	15 ± 1	15 ± 1
	Plato	31 ± 1	36 ± 2	17 ± 1	16 ± 1
	Scentry	31 ± 1	37 ± 3	16 ± 2	16 ± 2
Field	Hercon	32 ± 1	41 ± 1	14 ± 1	13 ± 1
	Plato	33 ± 1	40 ± 1	14 ± 1	13 ± 1
	Scentry	32 ± 1	41 ± 2	14 ± 1	13 ± 1

Laboratory evaluations

Lures from all three manufacturers released more pheromone at 85°F than 70°F, particularly during the first week of aging (Table 2). Overall, Scentry lures released considerably more pheromone than Hercon and Plato lures over the 14-d aging period; however, it should be noted that Scentry lures also were initially dosed with 1.2 mg and 2.0 mg more pheromone than Hercon and Plato lures, respectively. Scentry lures released approximately twice as much pheromone daily as Hercon and Plato lures during the first and second week of aging when held at 70°F (Figure 1). However, differences in daily release amounts among lure types were less apparent during the second week of aging (Table 2), particularly when lures were held at 85°F. Hercon lures released as much or more pheromone than Scentry lures during the last four days of aging when lures were held at 85°F (Figure 2). Based on the cumulative total amount of pheromone released during the first and second week of aging, all three lure types released at least two to four times more pheromone during the first week of aging than during the second week of aging (Table 2). The total amount of pheromone released during the first two days of aging was greater than the total released during the entire second week of aging. This initial burst of pheromone release was observed for all three lure types and under both temperature regimes, but was more pronounced at 85°F.

Table 2. Average daily amount (mg) of boll weevil pheromone (grandlure) released from lures produced by three manufacturers held under laboratory (70°F and 85°F) conditions for up to 14 d.

Temperature	Lure (mg)	Week 1	Week 2
70^0F	Hercon (10.1)	0.32	0.14
	Plato (10.1)	0.28	0.11
	Scentry (12.1)	0.59	0.22
85^0F	Hercon (10.5)	0.52	0.20
	Plato (9.7)	0.46	0.16
	Scentry (11.7)	0.85	0.21

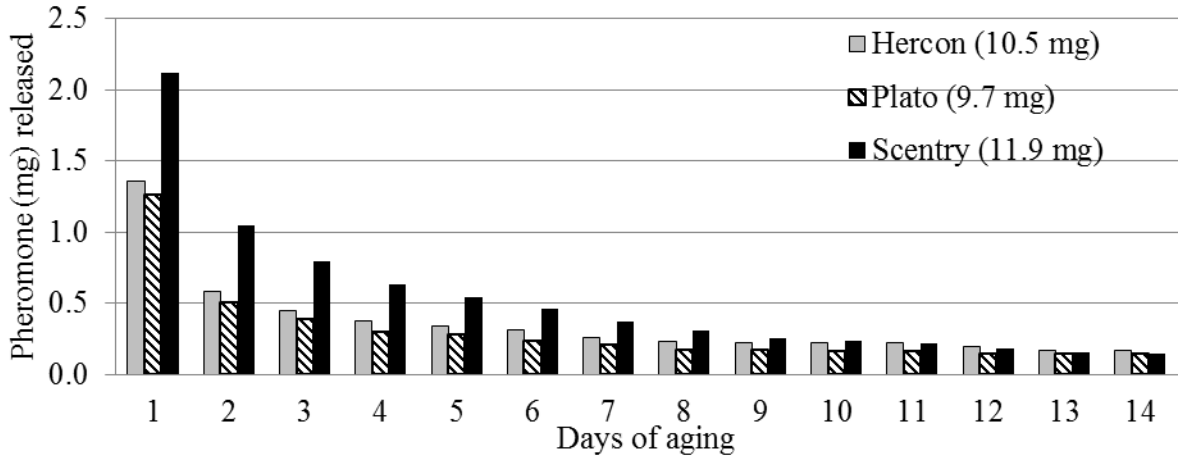

Figure 1. Daily release of pheromone from lures produced by three manufacturers held under laboratory (70°F) conditions for up to 14 d.

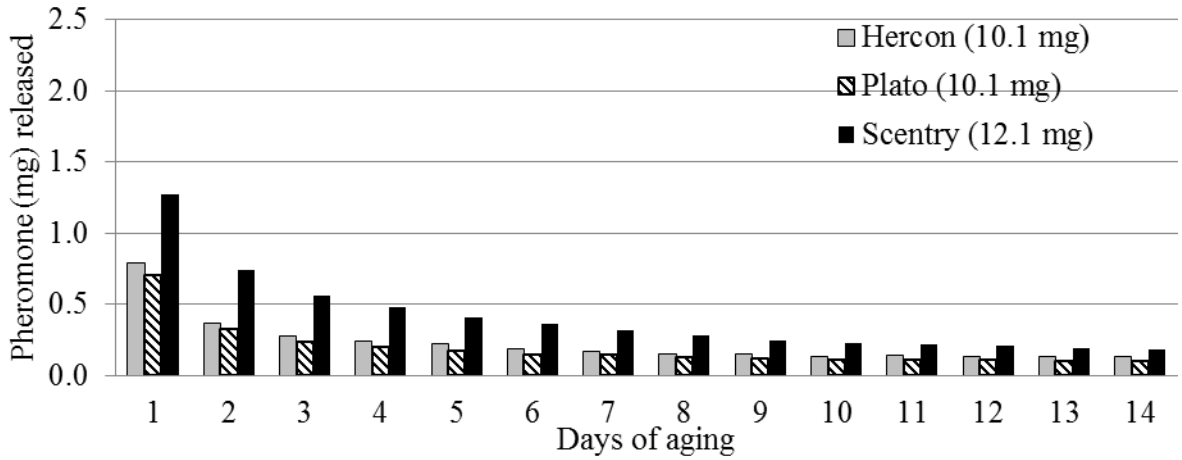

Figure 2. Daily release of pheromone from lures produced by three manufacturers held under laboratory (85°F) conditions for up to 14 d.

Field evaluations

Several of the trends and differences observed in the laboratory evaluations were similarly observed in the field evaluations. On average, Scentry lures released the most pheromone (11.4 mg), followed by Hercon (7.8 mg) and Plato lures (5.8 mg) over the four 14-d evaluation periods. However, as noted in the laboratory evaluations, Scentry lures contained a higher dose of pheromone. After adjusting for the initial pheromone content of lures, Scentry, Hercon, and Plato lures released 96%, 75%, and 59% of the respective initial pheromone content, and Hercon and Plato lures released as much or more pheromone than Scentry lures during the second week of aging under the two warmest evaluation periods. All three lure types released considerably more pheromone during the first week of aging than during the second week of aging (Table 3, Figures 3-6). Under the coolest evaluation period (Oct. 12-26), Scentry, Hercon, and Plato lures respectively dispensed 86%, 58%, and 43% of the initial pheromone content overall after aging for 14 d.

Table 3. Average daily release of pheromone from lures produced by three manufacturers that were exposed in traps at College Station, Texas.

Temperature	Lure (mg)	Week 1 (0-6 d)	Week 2 (8-14 d)
June 6-20, 2011	Hercon (9.3)	0.80	0.28
Avg. 87°F	Plato (9.8)	0.75	0.28
	Scentry (11.9)	1.60	0.17
July 11-25, 2011	Hercon (10.9)	1.07	0.25
Avg. 89°F	Plato (10.4)	0.70	0.32
	Scentry (12.2)	1.68	0.20
Sep. 12-26, 2011	Hercon (10.5)	0.95	0.28
Avg. 82°F	Plato (9.7)	0.62	0.33
	Scentry (11.7)	1.53	0.30
Oct. 12-26, 2011	Hercon (10.8)	0.68	0.27
Avg. 71°F	Plato (9.8)	0.53	0.17
	Scentry (12.0)	1.32	0.32

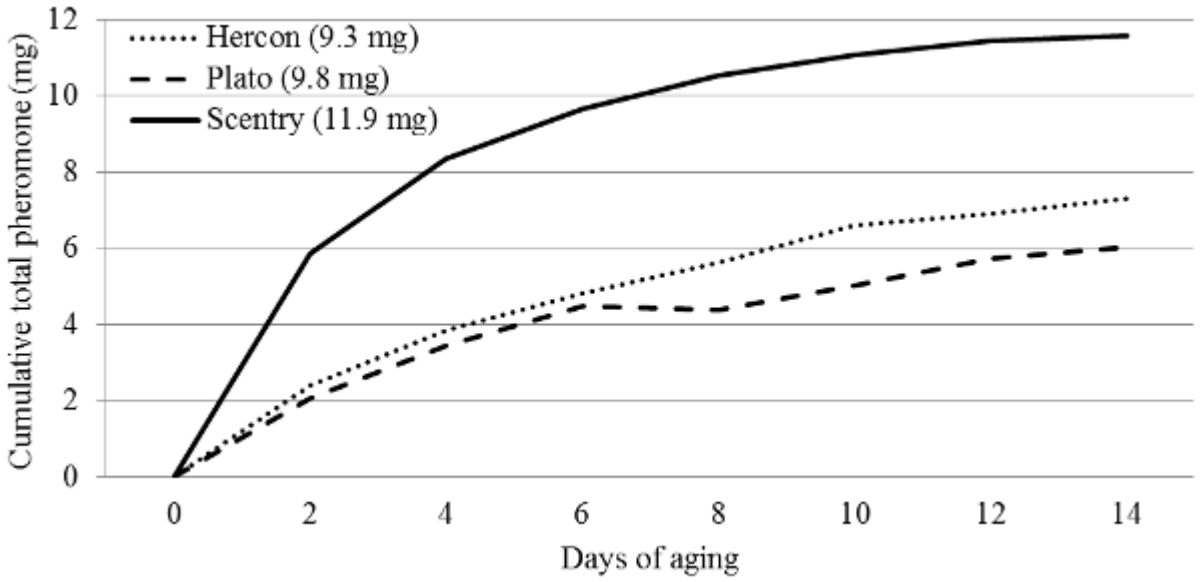

Figure 3. Cumulative release of pheromone from lures produced by three manufacturers that were exposed in pheromone traps at College Station, Texas, on June 6-20, 2011. Average daily mean, minimum, and maximum air temperature values were 87°F, 74°F, and 101°F, respectively.

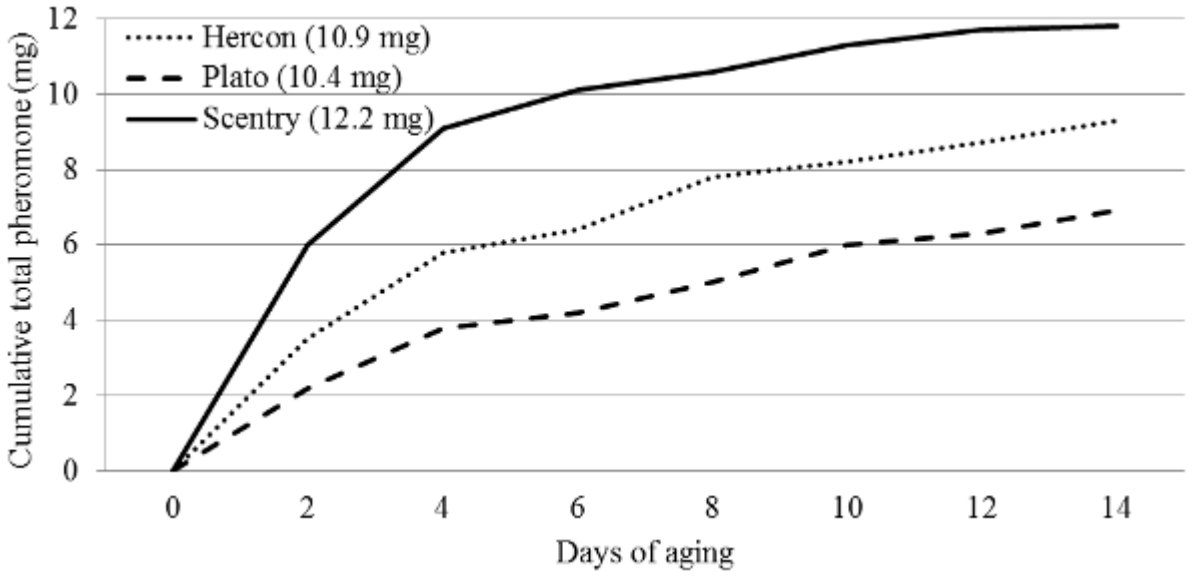

Figure 4. Cumulative release of pheromone from lures produced by three manufacturers that were exposed in pheromone traps at College Station, Texas, on July 11-25, 2011. Average daily mean, minimum, and maximum air temperature values were 89°F, 77°F, and 101°F, respectively.

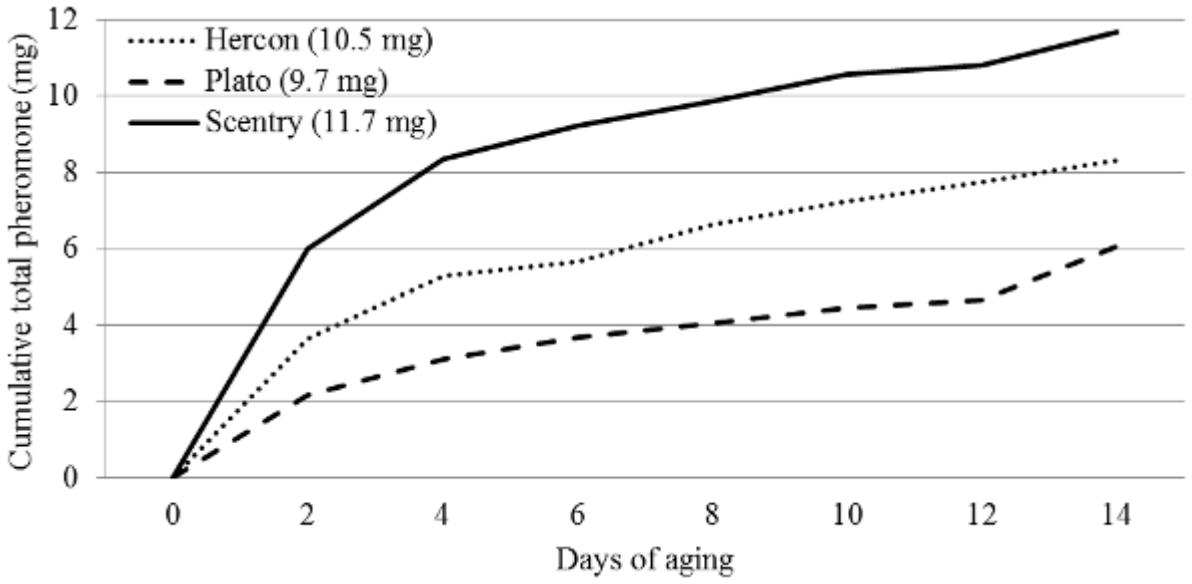

Figure 5. Cumulative release of pheromone from lures produced by three manufacturers that were exposed in pheromone traps at College Station, Texas, on Sep. 12-26, 2011. Average daily mean, minimum, and maximum air temperature values were 82°F, 70°F, and 96°F, respectively.

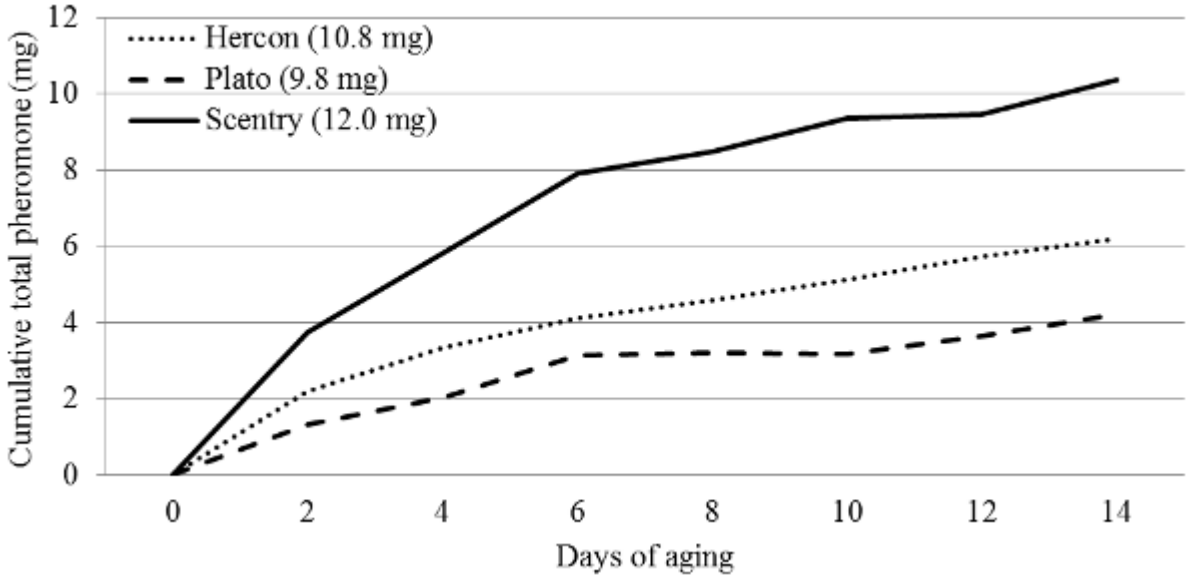

Figure 6. Cumulative release of pheromone from lures produced by three manufacturers that were exposed in pheromone traps at College Station, Texas, on Oct. 12-26, 2011. Average daily mean, minimum, and maximum air temperature values were 71°F, 58°F, and 85°F, respectively.

Conclusions

Although the total amount of pheromone released differed substantially among lure types, air temperature had a similar effect on the pattern of pheromone released from lures. In general, 70% to 80% of the total pheromone released from lures was emitted during the first week of aging. Consequently, the reduced amount of pheromone released during the second week may limit the detection efficiency of traps. In order to maximize detection of weevils with traps in southern Texas and northeastern Mexico, our findings suggest the dose of grandlure should be increased in lures to ensure a sufficient amount of pheromone is released during the second week or, alternatively, lures need to be replaced more frequently.

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