

**COMBOLURETM - IMPROVED PHEROMONE AND INSECTICIDE DELIVERY SYSTEMS FOR USE
IN ACTIVE AND POST ERADICATION PROGRAMS****Timothy Johnson****Plato Industries****Langhorne, PA****Ralph Bagwell****LSU Agcenter****Winnsboro, LA****Ken Pierce****Texarkana, TX****Mark Muegge****Texas Cooperative Extension Service****Fort Stockton, TX****Scott Plato and Tom Plato****Plato Industries, Ltd.****Houston, TX****Abstract**

In three separate replicated field trials, extended-release pheromone dispensers containing various combinations of Grandlure, eugenol, and DDVP (dichlorvos) were compared for efficacy to attract boll weevil (*Anthonomus grandis* Boh.) adults to the Plato Boll Weevil Trap[®]. Dispensers containing Grandlure and eugenol performed better in attracting boll weevils than Grandlure dispensers without eugenol. Dispensers combining Grandlure, eugenol and DDVP into a single dispenser demonstrated performance equivalent to separate Grandlure+eugenol and DDVP dispensers. Extended-release dispensers containing 25-mg of Grandlure captured similar numbers of weevils when changed at either 21-day or 28-day intervals; however, most boll weevil eradication programs will operate on a 21-day interval during post-eradication. The use of dispensers combining Grandlure and DDVP or Grandlure, eugenol, and DDVP are a viable approach to reducing costs associated with active or post-eradication boll weevil eradication programs.

Introduction

The use of monitoring traps is an important component of boll weevil management and is a key component of boll weevil eradication programs (BWEPs). Data obtained from trap captures trigger spray and other management decisions. Boll weevil traps use the synthetic aggregation and sex pheromone, Grandlure, to attract boll weevils into traps for accurate population monitoring and the DDVP insecticide dispensers are used to kill the trapped weevils and prevent them from crawling out of the “trap capture cylinder”. At present and since the early 1980’s, separate dispensers of Grandlure and DDVP are used in eradication programs. The most commonly used dispensers contain either 10-mg of Grandlure or 60 or 90-mg of DDVP. However, in post eradication programs, there are important operational reasons for using a dispenser system that will last longer than two weeks and will have an improved Grandlure liberation rate with equal or superior attraction power for weevils. Currently, a large portion of the Southeast Boll Weevil Eradication Foundation’s program (SEBWEF) is already in a post-eradication status and an extended duration dispenser containing both 25-mg of Grandlure and 30-mg of eugenol is used plus a separate 60 or 90-mg DDVP dispenser. For several years, eugenol has been reported to increase the effectiveness of Grandlure (G. H. McKibben, 2000) in attracting boll weevils.

Much of the mid-south and southwest growing regions will soon be in post-eradication programs and eventually, all of the U.S. will be in such programs. As the boll weevil eradication programs evolve into post-eradication status, researchers are investigating new compounds to improve the effectiveness of Grandlure and program managers are interested in longer lasting dispensers to minimize program labor and operational costs by reducing the frequency of servicing large numbers of deployed traps and reducing the disposal of hazardous wastes.

Plato Industries, Ltd. has developed a series of polyvinyl chloride-based slow-release dispensers, named ComboLuresTM, containing various combinations and amounts of Grandlure, eugenol, and/or DDVP. Field trials

conducted in 2003 with Plato Industry's dispensers demonstrated the viability of combining Grandlure and DDVP in dispensers containing either 10-mg or 25-mg of Grandlure (Johnson et al. 2003). These same field studies were inconclusive on the benefit of including eugenol to increase boll weevil captures. The purpose of these three studies was to continue the evaluation of dispensers combining 25-mg of Grandlure with eugenol and/or DDVP under 21 and 28-day change intervals.

Materials and Methods

Field Study 1

This study was initiated on April 22, 2004 in Red River County of the North Texas Blacklands cotton-growing region. Four dispensers manufactured by Plato Industries containing the following amounts of Grandlure, eugenol and DDVP were evaluated: 1) 25-mg Grandlure only, 2) 25-mg Grandlure and 30-mg eugenol, 3) 25-mg Grandlure and 90-mg DDVP, 4) 25-mg Grandlure, 30-mg eugenol and 90-mg DDVP. A fifth dispenser containing 25-mg Grandlure and 30-mg of eugenol manufactured by Hercon Environmental, Emigsville, PA, was also included. Each dispenser was evaluated at both 21 and 28-day change intervals (a second dispenser added at either 21 or 28 days while the older dispenser remains in the trap during the second period) over a 63-day period. A Plato Industries Insecticide Strip (PI-IS), EPA Reg. No. 65458-5, was included in treatments where DDVP was not included as part of the Grandlure dispenser and was replaced every 28 days. The experimental design was a randomized complete block with factorial arrangement of the treatments. Plato Boll Weevil traps containing the different treatments deployed along the edge of cotton field. The treatments within a replication were arranged in a straight line with 300 feet between traps. A non-data trap loaded with a 10-mg Grandlure dispenser (replaced every 14 days) and a PI-IS was placed at the beginning and end of each trap line. Traps were inspected for weevils weekly. Beginning on the third week, traps were rotated within a replication every seven days.

Field Study 2

This study was initiated on October 6, 2004 in Red River County of the North Texas Blacklands cotton region. The study included seven treatments and lasted for 77 days. Two ComboLures manufactured by Plato Industries containing 25-mg of Grandlure and 30-mg of eugenol or 25-mg Grandlure, 30-mg eugenol and 90-mg of DDVP were evaluated at 21 and 28-day change intervals (a second dispenser added at either 21 or 28 days while the older dispenser remains in the trap during the second period). Other treatments included a dispenser containing 25-mg of Grandlure and 30-mg of eugenol manufactured by Hercon Environmental, Emigsville, PA, changed at 21 and 28-day change intervals (a second dispenser added at either 21 or 28 days while the older dispenser remains in the trap during the second period). A standard treatment of a 10-mg Grandlure dispenser changed every 14 days was included for comparison. A Plato Industries Insecticide Strip (PI-IS), EPA Reg. No. 65458-5, was included in treatments where DDVP was not included in the Grandlure dispenser and was replaced every 28 days. Each treatment was replicated 10 times in a randomized complete block design. Traps were deployed along a cotton field edge with 100 feet separating each trap. A non-data trap loaded with a 10-mg Grandlure dispenser (replaced every 14 days) plus a PI-IS was placed at the ends of each trap line. Traps were inspected for weevils every seven days and traps were rotated weekly within each replication.

Field Study 3

This study was initiated on May 4, 2004 in Glasscock County in western Texas. The study protocol included the ten treatments in Field Study 1 plus the standard 10-mg Grandlure dispenser presently used in eradication programs managed by the Texas Boll Weevil Eradication Foundation. Weevil populations were very low and only 25 weevils were captured in the first 35 days of the trial. At that time the study was ended. In addition to the weevil capture component of the trial, the time necessary to service the different dispenser combination at each trap was measured to determine whether lures combining Grandlure and DDVP required less time to service than traps using separate dispensers.

Results

Field Study 1

Weevil captures were analyzed by analysis of variance (Table 1). In general, weevil populations were low as is typical of spring populations coming out of hibernation sites, with trap captures averaging about 5 weevils per trap per week. There were no differences in weevil captures when dispensers were changed on a 28-day interval versus a 21-day interval. Traps baited with the Plato ComboLures containing Grandlure and eugenol or Grandlure, eugenol

and DDVP captured significantly ($P=0.05$) more weevils overall than traps containing a Plato Industries dispenser with only 25-mg Grandlure. Numerically, traps baited with the Plato ComboLures containing eugenol and eugenol plus DDVP captured more weevils than did traps baited with the Hercon dispenser loaded with 25-mg of Grandlure and 30-mg of eugenol but this difference was not statistically significant at $P=0.05$.

Table. 1. Analysis of Variance for mean boll weevil captures over all dates

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F	Prob(F)	LSD (.05)
Total	69	251.70				
Rep	6	31.35	5.23	1.77	0.123	1.5
A - 21 day versus 28-day	1	0.025	0.025	0.009	0.926	0.8
B - Dispenser	4	46.13	11.53	3.908	0.007	1.3
A*B	4	14.80	3.70	1.25	0.300	1.8
ERROR	54	159.38	2.95			

Boll weevil captures reported as weevils per trap per week

	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42	Day 49	Day 56	Day 63	Mean
TABLE OF A MEANS										
Change every 21 days	12.3	3.9	0.9	2.7	0.4	0.8	0.7	1.7	1.1	2.7
Change every 28 days	11.6	2.9	1.4	0.8	1.3	2.5	0.1	2.7	1.3	2.7
	NS	NS	NS	LSD=1.6	LSD=0.6	LSD=1.0	NS	NS	NS	NS
TABLE OF B MEANS										
Plato 25/90	8.1	1.3	0.1	1.9	0.4	0.3	0.2	0.8	0.4	1.5
Plato 25/30	13.4	4.6	3.1	1.8	1.1	2.2	0	2.6	1.5	3.4
Plato 25/30/90	11.4	3.7	0.5	3.9	1.4	2.4	0.1	3.9	1.7	3.2
Plato 25	10.2	2.7	0.1	0.3	0.6	1.1	0.2	2.0	0.9	2
Hercon 25/30	16.5	4.5	1.8	1	0.7	2.1	1.6	1.7	1.6	3.5
	NS	LSD=2.1	LSD=2.0	NS	NS	LSD=1.5	LSD=1.1	LSD=1.9	NS	LSD=1.3
TABLE OF AB MEANS										
Plato 25/90 - 21 days	7.4	1.1	0.1	3.7	0.4	0.3	0.4	0.4	0.1	1.6
Plato 25/90 - 28 days	8.9	1.4	0.1	0	0.3	0.3	0	1.1	0.6	1.4
Plato 25/30 - 21 days	13.6	5.1	1.6	2.4	0.7	0.9	0	2.4	1.4	3.1
Plato 25/30 - 28 days	13.1	4.1	4.6	1.1	1.6	3.6	0	2.9	1.6	3.6
Plato 25/30/90 - 21 days	10.9	4.0	0.4	5.7	0.3	1.7	0.1	2.4	1.0	3.0
Plato 25/30/90 - 28 days	12.0	3.4	0.6	2.0	2.6	3.0	0	5.3	2.4	3.5
Plato 25 - 21 days	7.4	2.7	0.1	0.4	0.1	0.1	0.4	1.6	0.7	1.5
Plato 25 - 28 days	13.0	2.7	0.1	0.1	1.0	2.1	0	2.4	1.0	2.5
Hercon 25/30 - 21 days	22.0	6.4	2.0	1.1	0.4	1.0	2.4	1.4	2.1	4.3
Hercon 25/30 - 28 days	11.0	2.6	1.6	0.9	1.0	3.3	0.7	2.0	1.1	2.7

No A*B interactions were significant at Prob(F)=0.05 on any date.

Field Study 2

Weevil captures were analyzed by analysis of variance (Table 2). Populations of weevils leaving maturing cotton fields were high and averaged more than 100 weevils per trap per week. Overall weevil captures were very similar among treatments over the duration of the trial with no statistically significant differences (Table 2). Traps containing 25-mg Grandlure and 30-mg eugenol manufactured by Plato Industries and Hercon Environmental performed almost identically as measured by weevil captures. As in Field Study 1, there was no difference in weevil captures when 25-mg Grandlure dispensers were changed every 28-days versus every 21-days.

Table 2. Boll weevil captures by sample date and over all sample dates. Weevil captures reported as weevils per trap per week.

	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42	Day 49	Day 56	Day 63	Day 70	Mean
TREATMENT											
Plato 25/30 - 21 days	254	150	222	283	103	31	64	39	24	20ab	119
Plato 25/30 - 28 days	172	213	300	169	179	30	66	22	17	28ab	120
Plato 25/30/90 - 21 days	226	177	200	313	135	43	24	37	18	9 b	118
Plato 25/30/90 - 28 days	237	198	269	198	164	57	40	31	34	14ab	124
Hercon 25/30 - 21 days	187	210	312	217	152	24	51	25	34	32a	125
Hercon 25/30 - 28 days	170	134	274	180	152	37	22	27	18	8 b	101
Hercon 10 mg - 14 days	151	171	267	174	114	36	39	33	10	8 b	100
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	14.3	NS

Means followed by the same letter do not significantly differ (P=0.05), Student-Newman-Keuls).

Field Study 3

As reported in the Methods and Materials section, only 25 weevils were captured during the 35 days of the trial, insufficient to draw any biological conclusions. Traps baited with a single dispenser containing both the grandlure and DDVP components required less time to replace than did traps containing separate grandlure and DDVP dispensers. On average, servicing a trap with a single Plato Industries ComboLure (Grandlure and DDVP or Grandlure, eugenol and DDVP) required significantly less time at 114 seconds ($P > F = 0.026$) than servicing a trap with separate Plato Industries pheromone and DDVP lures that required an average of 130 seconds for a mean difference of 16 seconds. Traps containing the Hercon Grandlure/eugenol dispenser and a DDVP dispenser required an average of 127 seconds to service.

Discussion and Conclusions

Trap Captures

Initial field studies in 2003 indicated excellent potential to develop a combination dispenser or "ComboLure" that combines Grandlure and DDVP to significantly reduce labor requirements and the disposal of wastes in BWEPS. Field studies conducted in 2004 confirm the 2003 results and demonstrated greater weevil captures with the addition of eugenol. The improved performance observed with eugenol in 2004 contradicts observations from 2003 but are in agreement with similar results reported by McKibben (2001). The Plato ComboLure containing 25-mg of Grandlure and 30-mg eugenol was statistically equal to the Hercon "Superlure" containing similar ingredients in attracting boll weevils in two field studies where measurable numbers of boll weevils occurred. There was no difference in boll weevil captures when dispensers containing 25-mg Grandlure were changed on a 28-day interval versus a 21-day interval; however, most BWEPS are expected to use a 21-day schedule to be able to detect weevils before an infestation can occur and disperse to other fields.

Excellent boll weevil captures were observed in traps baited with the Plato Industries ComboLure containing 25-mg Grandlure, 30-mg eugenol and 90-mg DDVP relative to other tested lures. Boll Weevil traps baited with lures containing both Grandlure and DDVP in a single dispenser required less time to service than did traps using separate dispensers. ComboLures with 25-mg Grandlure, 30-mg eugenol and 90-mg DDVP would significantly reduce the

costs to BWEPS by reducing the labor involved with preparing, labeling, dating and loading traps with dispensers. Complete “time and motion” studies have not been done, but at 16 seconds per trap, there is a projected “loading” labor savings of 4,445 hours per cycle per one million traps in using a ComboLure containing Grandlure and DDVP versus the use of separate lures. In addition, the cost of disposing depleted dispensers would be reduced by one-half. Plato Industries, Ltd. has applied for EPA registration of this product and anticipates registration in 2005.

References

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