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FIELD EVALUATION OF DIFFERENT BOLL WEEVIL TRAP MODELS FOR USE IN ACTIVE AND POST ERADICATION PROGRAMS

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Abstract

Boll weevil traps baited with Grandlure pheromone dispensers and dichlorvos (DDVP) dispensers are integral in the effort to eradicate the boll weevil from the United States and Latin America. The Plato Boll Weevil Trap, previously known as the S & S Boll Weevil Trap, has been in operational use in U.S. Boll Weevil Eradication Programs for four years. The Plato Trap offered 26 design modifications that were key improvements compared to the USDA model as manufactured by Precision Plastics. Between the 2003 and 2004 seasons several additional design changes were integrated into the design of the Plato Trap. These changes improved the strength of the capture cylinder and improved the locking feet of the trap cylinder. All of the changes and improvements result in time and cost efficiency improvements of the trap when in operational use. In 2004, the Plato Boll Weevil trap was compared to a new plastic trap manufactured by Technical Precision Plastics of Mebane, NC. The data illustrated no differences in trap captures observed. Field tests were conducted in 2003 in Northeast Texas, the Texas Rio Grande Valley and Arkansas to ascertain if an alternative base color would improve weevil captures. The capture results with an experimental yellow base cup were equal to the commercial green (yellow-green) base cup of the Plato Trap; however, trappers reported that the alternate color was more easily seen at distances than the commercial trap. In 2004, an alternative reflective yellow base was evaluated with inconclusive results.

Introduction

The isolation, identification and synthesis of the boll weevil aggregation pheromone, Grandlure, led to the design, development and commercial production of pheromone-baited traps. The boll weevil trap and Grandlure aggregation pheromone are important components in the management of boll weevil infestations and are key components in boll weevil *(Anthonomus grandis Boh.)* eradication programs.

The first commercially produced trap was named the Hardee trap, after its inventor Dr. Dick Hardee. The yellow color of the commercial trap was based upon studies that evaluated height and colors (Hardee et al. 1972 and Cross et al., 1976). Subsequently, a model designed by Dr. Bill Dickerson and patented by the USDA was commercialized by the Southeastern Boll Weevil Eradication Foundation (SEBWEF) and custom manufactured by Technical Precision Plastics of Mebane, NC. The SEBWEF trap became the most widely used trap in the Americas and was a mainstay for detection and spray decisions in U.S. boll weevil eradication programs (BWEPs) in the southeastern U.S. Without traps and Grandlure pheromone to pinpoint infestations, the program to eradicate the boll weevil from the United States probably would not be possible.

In 2001, a boll weevil trap (U. S. patent #6,430,868) was introduced by S & S Trap Company (later renamed Plato Industries, Ltd.) with 26 specific design improvements compared to the USDA modeled SEBWEF trap. The 26 design improvements in the Plato Trap were made after extensive discussions with BWEPs management and cotton entomologists. Key features and improvements included fewer parts and easier assembly, improved design features for easier clean-out, a capture cylinder with slots for holding date marked, pheromone and insecticide dispensers and all parts that are recyclable. As a result of these design improvements, field use studies documented that the Plato Trap requires 15 to 35% less time than the USDA modeled SEBWEF trap for “BWEP trappers” to service and inspects traps in the eradication programs. This efficiency results in considerable savings in labor, parts and replacement costs. During the past four seasons, more than 4,750,000 Plato Traps have been used across the delta and southwestern cotton growing regions in BWEPs. In 2004, Technical Precision Plastics of Mebane, NC introduced a new all-plastic trap designed by the Southeast Boll Weevil Eradication Foundation that is similar in appearance to the Plato Boll Weevil trap. In addition, during 2004, Plato Industries investigated the use of different manufacturing materials that would withstand severe hail impacts that occasionally occur in west Texas.

The standard boll weevil trap uses a yellow-green base cup. In 2003, Plato Industries manufactured a number of boll weevil traps with a yellow base cup similar in color to the original Hardee trap. Field evaluations were conducted in the Rio Grande Valley and North Texas Blacklands of Texas plus in Mississippi County, Arkansas where the yellow trap was compared to the commercial yellow-green Plato boll weevil trap. Both traps captured an equal number of boll weevils (Johnson et al. 2003). Some trappers remarked that the yellow trap was easier to see at a distance. As eradication programs enter a post-eradication phase, fewer traps are used, traps are visited less frequently, and finding traps that are surrounded by vegetation may become more difficult. Therefore, we decided to continue to investigate the development of a yellow and more easily seen trap color.

Design improvements to the Plato Boll Weevil Trap

After three seasons of use, BWEPs, conventional customers and BWEP trappers were surveyed about their experiences with the Plato Trap and possible ideas for improvement. Based upon this feedback the following changes were implemented into the design of the Plato Trap:

Capture Cylinder

1. Increased wall and roof thickness and change manufacturing material to improve cylinder resistance to hail and “trapper” handling damage.
2. Increased locking foot strength to reduce likelihood of breakage during assembly and disassembly.
3. Reduced length of internal slots for holding pheromone and insecticide dispensers in the cylinder, to aid in their removal during trap servicing
4. Elimination of “snuggle pockets” for easier cleaning in the capture area

Cone

1. Improved design of the feet by which the cone locks onto the trap base cup. The objective is to allow for easier disassembly when needed for removing non-target insects, spiders, and their webs.
2. Mold design modifications to improve the consistency of the orifice and screen openings.

Trap Color Field Studies

Two field studies were conducted in Red River County, Texas in the Northern Blacklands Cotton growing region. Standard commercial Plato boll weevil traps were compared to an experimental Plato boll weevil trap (Plato 3M Trap) where the base cups were coated with a fluorescent yellow green reflective coating (3M™ Diamond Grade™ Series 3983 Fluorescent Yellow Green VIP Reflective Sheeting). The 3M reflective sheeting is used on highway signs for maximum visibility near school crossing zones. The two traps are illustrated in Figure 1.

The first study was implemented on April 22, 2004 along field edges of newly emerging cotton where boll weevils were moving from over-wintering habitat into cotton fields. Treatments were the commercial Plato Boll Weevil trap with and without a 10-mg Grandlure dispenser and the experimental Plato 3M Trap with and without a 10-mg Grandlure dispenser. Grandlure dispensers where changed every 14 days and all traps included the Plato Industries Insecticide Strip (PI-IS), EPA Reg. No. 65458-5, replaced every 28 days. The experimental design was a randomized complete block with ten replications. Traps were spaced at 300-foot intervals with a 10-mg Grandlure baited non-data trap at the end of each trap line. The traps were in the field for 63 days with weevil captures recorded every 7 days.

The second study was initiated on September 1, 2004 and included the commercial Plato boll weevil trap, the Plato 3M trap and a new plastic trap manufactured by Technical Precision Plastics (TPP) of Mebane, NC (Figure 1). The TPP trap looks virtually identical to the commercial Plato trap with minor differences in design details such as the number of pheromone release holes in the capture cylinder and the amount of entry space from the base cup into the cone. The base cup of the TPP trap is a slightly different shade of yellow-green than the commercial Plato trap. Each trap was baited with a 10-mg Grandlure dispenser, changed every 14 days, and a 90-mg Plato Industries

Insecticide Strip was changed every 28-days. The experimental design was a randomized complete block with ten replications. Traps were located at 100-foot intervals along cotton fields where good over-wintering habitat was visible with a 10-mg Grandlure baited non-data trap at the end of each trap line. Weevil populations were leaving maturing cotton fields during the experiment and searching for over-wintering habitat. Each trap was rotated within a replication every seven days when weevil captures were noted. The experiment continued for five weeks.

Trap Component Field Study. An experiment was conducted in Red River County, Texas in the Northern Blacklands cotton-growing region to investigate trapping efficiency for two boll weevil traps and traps with alternative trap components. The experimental design was a randomized complete block design with six different treatments each with ten replications. The six treatments were: 1) the commercial Plato Boll Weevil Trap, 2) the commercial Plato Boll Weevil Trap with the fill chimney removed from near the trap cone orifice (Figure 2), 3) the Plato Boll Weevil Trap with an experimental "hail-proof" polycarbonate capture cylinder, 4) the new TPP Boll Weevil Trap, 5) the Plato base cup with a TPP cone and capture cylinder and 6) the TPP base cup with a Plato Boll Weevil Trap cone and capture cylinder. Treatment 2 was designed to determine whether the presence of the "fill chimney" aided in weevils escaping form the capture cylinder prior to succumbing from the DDVP dispenser. Treatments 4 and 5 were designed to determine whether the slight color difference in base cups might impact trap captures. Because the TPP trap does not have slots for holding pheromone and DDVP dispensers, slots in Plato capture cylinders were not used. Traps were located at 100-foot intervals along cotton fields where good over-wintering habitat was visible with a 10-mg Grandlure baited non-data trap at the end of each trap line. Weevil populations were leaving maturing cotton fields during the experiment and searching for over-wintering habitat. Each trap was rotated within a replication every seven days when weevil captures were noted. The experiment began on October 6, 2004 and continued for seven weeks.

Figure 1. (L to R) Technical Precision Plastics trap, Plato 3M trap, Plato Boll Weevil Trap

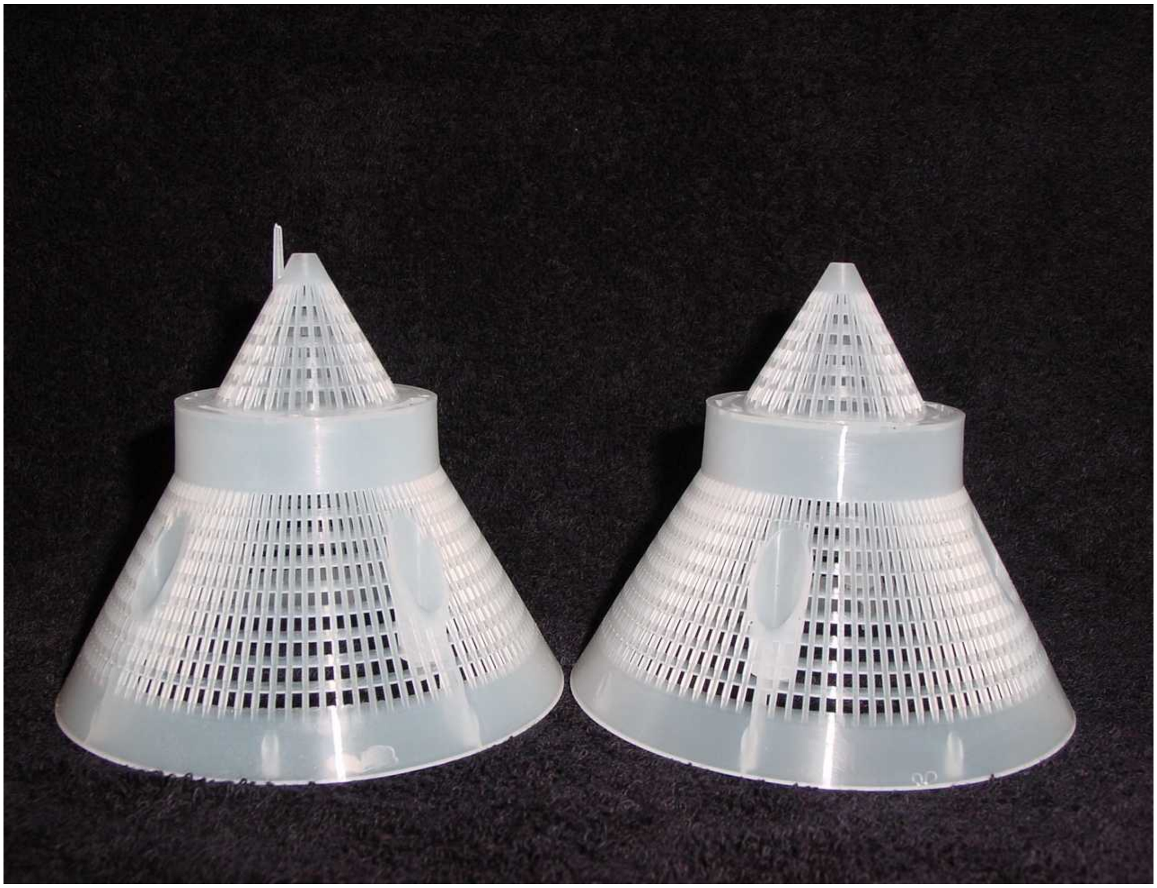

Figure 2. (L) Commercial cone. (R) Experimental cone with fill chimney removed.

Results

April 2004 study

Boll weevil populations in the April 2004 study were low and trap captures in baited Plato Boll Weevil Traps averaged 2.7 weevils per trap per week. Weevil numbers were highest at the beginning of the experiment. Treatment differences were statistically significant according to AOV at P=0.05 (Table 1). When weevil numbers were highest, traps with pheromone lures captured significantly more weevils than did traps without pheromone lures. When weevil captures were low treatment differences were minimal. The Plato 3M trap without a pheromone lure consistently captured more weevils than did the Plato trap without a pheromone lure but the difference was not significant. When baited with pheromone lures the Plato 3M trap and the Plato Boll Weevil Trap captured similar numbers of weevils. The Plato 3M traps were highly visible in the field from long distances.

Table 1. Boll weevil trap captures in Plato Boll Weevil traps and experimental 3M traps in spring 2004

	Weevils per trap per week on indicated day									
Treatment	7	14	21	28	35	42	49	56	63	Avg.
Plato BWT plus grandlure	0b	0b	0.4a	0.8	0.2	1.6a	1.9	2.9	0.7	0.9b
Plato BWT minus grandlure	11.4a	0.9b	2.4a	0.7	1.3	3.0a	1.6	2.5	0.6	2.7a
Plato 3M trap plus grandlure	0b	0b	0.7a	3.6	1.7	2.8a	2.3	4.2	0.8	1.8ab
Plato 3M trap minus grandlure	11.7a	1.8a	1.8a	2.1	0.3	7.4a	1.6	1.4	0.4	3.1a
Trt. Prob(F)	0.001	0.001	0.05	0.099	0.14	0.05	0.88	0.32	0.84	0.005
LSD (P=0.05)	5.69	0.86	1.58	2.6	1.54	4.33	2.28	3.03	0.94	1.25

Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls.
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

<u>September 2004 study</u>

Boll weevil populations in the September 1, 2004 study were much higher than in the spring as weevils began to move from maturing cotton fields to over-wintering sites. Weevil captures in the commercial traps were approximately 140 weevils per trap per week or 20 per trap per day. Over the five-week duration of the trial, the Plato Boll Weevil Trap and the Technical Precision Plastics trap caught similar numbers of weevils. Inexplicably, the Plato 3M experimental trap consistently caught far fewer weevils than the other traps (Table 2).

Table 2. Boll weevil trap captures in two commercial and one experimental trap in fall 2004

	Weevils per trap per week on indicated day					
Treatment	7	14	21	28	35	Avg.
Plato BWT-commercial	133ab	88.9a	70.7a	309.7a	121.5a	145a
Tech. Prec. Plastics Trap	248.5a	119a	71a	243.3a	83.4a	155a
Plato 3M trap	35b	25.9b	26b	188.2a	11.8b	60b
Trt. Prob(F)	0.007	0.003	0.027	0.335	0.001	0.003

Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls).
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

<u>October 2004 study</u>

Boll weevil populations in the October 1, 2004 study began at high levels with trap captures ranging from 50 to 120 weevils per trap per week (Table 3). Populations gradually dropped as weevils moved to over-wintering sites and dropped precipitously after 35 days as daytime temperatures dropped below the threshold necessary for boll weevil activity. Over the duration of the trial, the Plato Boll Weevil trap and the Technical Precision Plastics trap captured similar numbers of weevils (45.7 weevils/trap/week versus 47.6 weevils/trap/week). Analysis of variance of the data detected significant treatment differences at P=0.05 for weevil counts on day 14, day 35 and for average counts. Student-Newman-Keuls means separations test only indicated significant differences on day 35.

Table 3. Boll weevil trap captures with various commercial and experimental traps.

	Weevils per trap per week on indicated day					
Treatment	7	14	21	28	35	Avg.
Plato BWT-commercial	80.6	64.4a	39.3	23.5	20.5b	45.7a
Tech. Prec. Plastics Trap	116.8	40.5a	31.3	34.9	14.3b	47.6a
Plato Base/TPP cone	98.5	51.5a	25.1	43.7	32.2a	50.2a
TPP Base/Plato cone	65.7	22a	27.2	35.2	8.3a	31.7a
Plato BWT- experimental cone	69.1	66.2a	21.8	16.8	17.7b	38.3a
Plato BWT-polycarbonate cylinder	52.2	23.6a	34.5	18.3	8.9a	27.5a
Trt. Prob(F)	0.22	0.015	0.7	0.24	0.0001	0.023
LSD (P=0.05)	53.4	29.5	21	28.9	9.04	15.74

Means followed by the same letter do not differ significantly (P=0.05, Student-Newman-Keuls.
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Discussion and Conclusions

In 2003, the commercial Plato Boll Weevil trap and an experimental trap with a yellow base cup performed similarly in several research trials and in operational use at different locations in Texas, Arkansas and Louisiana. In 2004, two trials with an experimental reflective coating resulted in different results between spring and fall trials. In the spring trial the Plato 3M trap with the reflective coating and no pheromone lure consistently captured more weevils than the Plato Boll Weevil trap with no pheromone lure. When a pheromone lure was added there was little difference between the two traps, but in the fall trial the Plato 3M trap with a pheromone lure caught significantly fewer weevils than the standard Plato Boll Weevil Trap. Is this seasonal difference the result of boll weevil biology? Are boll weevils emerging from over-wintering habitat in search of host plants more color oriented than late season weevils looking for over-wintering habitat? Whatever the case may be it appears that the 3M reflective coating is not suitable for a trap designed to be used season long.

Several design improvements were made to the Plato Boll Weevil Trap between the 2003 and 2004 growing seasons. These improvements resulted in a more durable trap that will reduce replacement costs to Boll Weevil Eradication Programs by reducing breakage during assembly and due to hail. The improvements will also reduce labor costs associated with servicing traps in the field. In two replicated field trials where both the commercial Plato Boll Weevil Trap and the Technical Precision Plastics boll weevil trap were included there was little numerical (less than 6%) and no statistical difference in boll weevil captures. In a fall trial with both commercial traps and several experimental treatments were included there were no statistical differences among treatments over the duration of the trial despite a 58% difference in weevil captures between the top and bottom treatments. The lack of a statistical difference in a trial with 10 replications and weekly trap rotation is indicative of the difficulty in determining true treatment differences in studies of pheromone traps. When evaluated on the basis of numerical differences, Plato Boll Weevil traps where the fill chimney had been removed from the cone captured slightly fewer weevils indicating that the presence of the chimney did not aid in the ability of weevils to escape the capture cylinder. The Plato Boll Weevil trap with an experimental capture cylinder made of polycarbonate consistently captured fewer weevils than the commercial Plato trap. Although this material is extremely durable, polycarbonate should not be used for commercial trap production unless further study determines this numerical reduction in trap captures is due to random variation and is not a true biological difference.

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