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IMPROVEMENTS IN THE PLATO BOLL WEEVIL TRAP FOR USE IN ACTIVE AND POST ERADICATION PROGRAMS

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Abstract

The Plato Boll Weevil Trap (Plato Trap), previously known as the S & S Boll Weevil Trap, has been in operational use in U.S. Boll Weevil Eradication Programs for three years. The Plato Trap offered 26 design modifications that were key improvements compared to the USDA model as manufactured by Precision Plastics. During 2003, several additional design changes have been integrated into the design of the Plato Trap. These changes improve the strength of the capture cylinder, improve the locking feet of the trap cylinder, and improve the method whereby the trap base is attached to either a bamboo stake or wooden stake. All of the changes and improvements result in time and cost efficiency improvements of the trap when in operational use. In addition, 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.

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 Precision Plastics. 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 U.S. BWEPs 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 inspect traps in the eradication programs. This efficiency results in considerable savings in labor, parts and replacement costs. During the past three seasons, more than 4,500,000 Plato Traps have been used across the delta and southwestern cotton growing regions in BWEPs.

Trap Improvements

After three seasons of use, BWEP Foundations, 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 – Figure 1

1. Increased wall and roof thickness to provide 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 clean out and a stronger capture cylinder.

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.

Base – Figure 2

1. A new flexible flap with an "X" opening to be used with bamboo stakes will allow placement of the trap on a bamboo stake without use of a zip tie.
2. A larger flexible "X" on the top of the base for users who place the trap on wooden stakes using a roof shingle nail.

Methods and Materials

Trap Color Spectral Analysis

The original work on the capture of boll weevils by traps of different colors was conducted by Hardee et al. (1972) and Cross et al. (1976). These researchers concluded that the 500-525 nm region of the visible light spectrum has the greatest attraction and that traps coated with highly reflective daylight fluorescent pigments with this spectral characteristic captured the greatest number of boll weevils. The present trap base cup is best characterized as yellow-green but will be referred to in this paper as the green trap. A new base cup in yellow was constructed for comparative field trials (Figure 3).

Hemispherical spectral reflectance measurements were performed in accordance with ASTM Standard Test Method E903-88. The measurements were performed with a Beckman 5240 Spectrophotometer utilizing an integrating sphere. Total reflectance measurements were obtained in the solar spectrum from 2500 nm to 250 nm at an incident angle of 15^{o}. The measurements employ a detector-baffled, wall-mounted integrating sphere that precludes the necessity of employing a reference standard except to define the instrument's 100% line. The measurements are properly denoted as being "hemispherical spectral reflectance".

The spectral data were integrated against Air Mass 1.5 global spectrum utilizing 105 weighted ordinates. The UV region of the spectral data (300 to 400 nm) was integrated using 15 weighted ordinates from Air Mass 1.5 global spectrum. The visible region of the spectral data (410 to 722 nm) was integrated using 25 weighted ordinates from Air Mass 1.5 global spectrum. The NIR region of the spectral data (724 to 2500 nm) was integrated using 66 weighted ordinates from the Air Mass 1.5 global spectrum. The reflectance values are also provided every 5 nm from 500 nm to 525 nm. All spectral data submitted herewith in the original.

Trap Color Field Studies

Five field studies were conducted outside of active eradication zones to compare Plato Boll Weevil Traps having different colored bases (Figure 3). Studies were conducted in the Rio Grande Valley under the supervision of Dr. John Norman, Texas A&M University, in northeast Texas under the supervision of Ken Pierce, USDA-APHIS, and in Mississippi County, Arkansas under the supervision of Dr. Glen Studebaker, University of Arkansas.

Rio Grande Valley Study

Ten traps of each colored base (yellow and green) were arranged in a randomized pattern to form ten replicates. Each trap was set 100 feet apart along the western side of a sugarcane field on the Texas Agricultural Experimental Station "Hiler" Annex farm north of Weslaco. The traps were arranged along an east to west line in a new randomized configuration within each replicate during each of the four weeks the traps were tested. A dummy trap was placed on the each end of the trap line. All traps were baited with a 10-mg Grandlure dispenser that was replaced weekly and a dichlorvos insecticide tab that was replaced biweekly. The traps were examined weekly from August 7 through August 28, 2003. All weevils from each trap, except the dummy traps, were placed in numbered plastic zip lock bags, returned to the research station and then counted. All data were analyzed with ANOVA using a SAS program.

Northeast Texas Studies

Three separate field studies were conducted near Deport, TX. Studies1 (initiated on May 1) and 2 (initiated on July 16) consisted of 20 traps of each color alternated with 20 traps of the other color at 100-foot intervals along the edge of a cotton field. A dummy trap was placed at each end of the trap line. All traps were baited with 10-mg Grandlure (replaced every 14 days) and 90-mg DDVP dispensers (replaced every 28 days). Captured weevils were recorded on a weekly basis.

Study 3 consisted of 20 pairs of traps, one of each base color, placed one foot from each other. Each pair of traps was placed at 100-foot intervals along a cotton field. Traps were baited with 10-mg Grandlure (replaced every 14 days) and 90-mg DDVP (replaced every 28 days) dispensers. The study was initiated on September 9 and captured weevils were recorded weekly.

Mississippi County, Arkansas Study

A single study was conducted from May 11 – September 11, 2003. Twelve traps of each color were randomly placed at 100-foot intervals along a cotton field. Each trap was baited with 10-mg Grandlure (replaced every 14 days) and 90-mg DDVP (replaced every 28 days) dispensers. Traps were re-randomized each week when captured weevils were counted and removed.

Results

Spectral Analysis

Between 440-nm and 520-nm the spectral reflectance of the yellow base was 30-40 nm higher in the spectrum than the yellow-green base (Figure 3). In the 500 – 525 nm range, the % reflectance of the standard green trap was considerably higher than with the yellow base (Table 1). The total % reflectance of the yellow base was higher than the yellow-green base in the UV and visible spectra, lower in the NIR spectra and near equal in the solar range (Table 4). The entire spectral analysis is reported in Figure 3.

Field Trap Captures

Rio Grande Valley Study. Boll weevil traps with yellow bases caught slightly fewer (12%) weevils than traps with the traditional green (sometime referred to as yellow-green) base (Table 3). The difference was not statistically significant (Table 4).

Northeast Texas and Arkansas Studies. Northeast TX Study 1 continued for 56 days during a period of low boll weevil numbers. At the conclusion of the trial, the commercial green trap had captured a total of 290 boll weevils (0.259 weevils/trap/day) and the experimental yellow trap had captured a total of 285 weevils (0.254 weevils/trap/day).

Northeast TX Study 2 continued for 32 days during a period of higher boll weevil numbers. At the conclusion of the trial, the experimental yellow trap had captured slightly more weevils (4680 weevils or 7.31 weevils/trap/day) than the commercial green trap (4509 weevils or 7.05 weevils/trap/day).

Northeast TX Study 3 was conducted near the end of the crop season during very high weevil populations. Trap captures were determined by volumetrically measuring the weevils caught and estimating the equivalent number. The study was conducted for 14 days and the numbers of weevils captured were essentially equivalent at 72 weevils/trap/day for the commercial green trap and the experimental yellow trap.

Arkansas Study 1 was conducted in Mississippi County. Trap captures were highest in spring and fall averaging approximately 1.7 weevils per trap per day over the duration of the test. Traps with the experimental yellow base cup captured, on average, 11% more weevils (1.81 weevils/trap/day vs. 1.63 weevils/trap/day) than did traps with the commercial green base (Table 5). The difference was not statistically significant.

Conclusions and Discussion

Several design improvements have been made to the Plato Boll Weevil Trap. These improvements are being integrated into production and will generally be available during the 2004 crop season. These improvements will result in a more durable trap that will reduce replacement costs to Boll Weevil Eradication Programs by reducing breakage due to hail and assembly and the improvements will also reduce labor costs associated with servicing traps in the field.

Overall, traps with the experimental yellow base cup performed equal to traps with the commercial green (yellow-green) base cup in the capture of boll weevils in five separate field studies. Trappers servicing the field studies reported that the experimental yellow trap was easier to see at a distance than the commercial green trap. As eradication programs continue to advance to post-eradication where far fewer traps are used, the ability to readily see widely scattered traps may be advantageous. Studies to optimize the color of the trap base will continue with experiments scheduled for the 2004 season.

References

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Table 1. Percentage reflectance of light in the 500 – 525 nm wavelength of the two different trap bases.

	Percentage reflectance	
Wavelength in nm	**Yellow base**	**Green base**
500	12.9	50.7
505	16.0	55.6
510	21.4	59.5
515	29.0	62.1
520	27.8	63.8
525	46.5	64.8

Table 2. Percentage reflectance of light in broad ranges.

		Percentage reflectance		
Trap base	**UV**	**Visible**	**NIR**	**Solar**
Yellow	5.9	44.4	44.5	42.5
Green	5.0	33.8	53.3	41.8

Table 3. Boll weevil captures in the Rio Grande Valley with traps having green or yellow colored base cups.

	Green Trap		Yellow Trap	
Date	**Weevils**	**Std. Error**	**Weevils**	**Std. Error**
8/07	118.5	16.6	95.4	14.3
8/14	439.8	46.3	452.2	36.6
8/21	130.8	16.7	103.9	10.6
8/28	205.1	27.5	157.2	20.4
Avg	223.5		195.8	

Table 4. Overall statistics for boll weevil trap-base color trial – Rio Grande Valley study.

	Degrees of freedom	**f**	**p**
Date	3.71	72.31	<0.01
Color	1.71	1.41	0.2388
Date*Color	3.71	0.46	0.7144

Table 5. Summary of trap studies conducted in Northeast Texas and Mississippi County Arkansas.

	Weevils per trap per day	
	Commercial green trap	**Experimental yellow trap**
TX Study 1	0.259	0.254
TX Study 2	7.05	7.31
TX Study 3	72	72
Arkansas Study	1.63	1.81

Figure 1. New capture cylinder on the left and old capture cylinder on the right.

Figure 2. New trap base with modified device for mounting base onto a bamboo stake.

Figure 3. Experimental yellow trap on left and commercial green base on right.

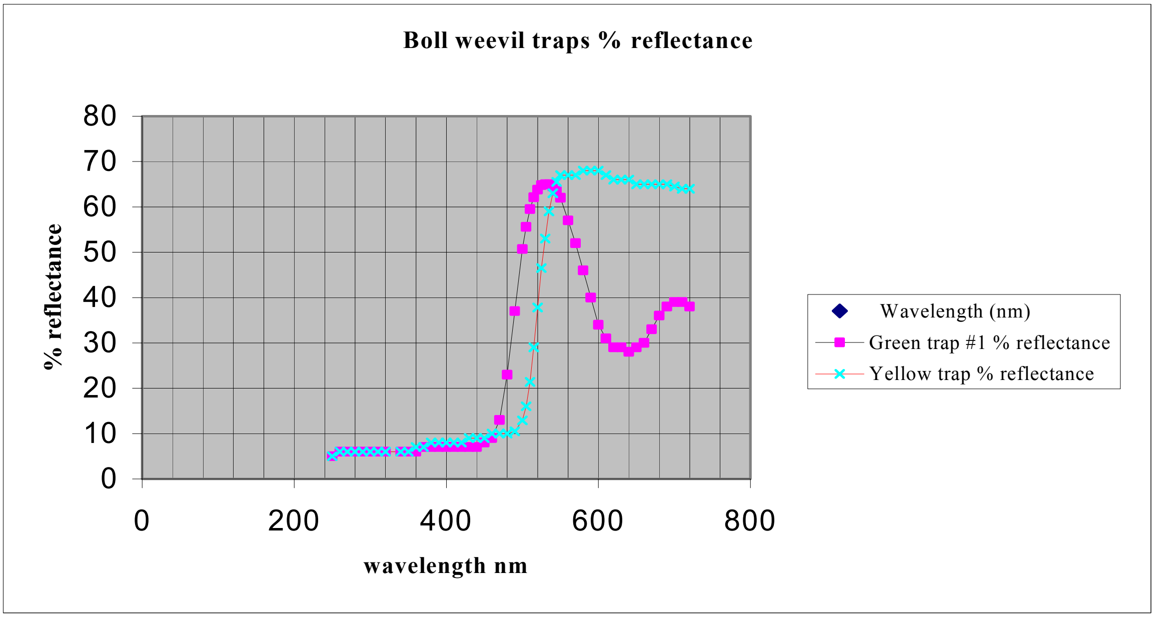

Figure 4. Percentage reflectance of two different colored trap bases.