2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

TRAPPING COMPARISONS OF STANDARD GRANDLURE WITH THE SUPER FORMULATION FOR BOLL WEEVILS IN THE RIO GRANDE VALLEY OF TEXAS

J. Scott Armstrong, Dale W. Spurgeon and Charles Suh
USDA, ARS, Area Wide Pest Management Research Unit
Weslaco, TX

Abstract

The Southeastern Boll Weevil Eradication Program has recently emphasized the importance of reducing maintenance program costs within eradication zones. One suggested cost-reduction measure is the use of an extended-life "superlure" in the pheromone traps. However, no field study has adequately evaluated superlure effectiveness relative to a standard lure. We compared captures of boll weevils (*Anthonomus grandis* Boheman) in traps baited with a standard lure (10 mg grandlure) to those of traps baited with the superlure (30 mg eugenol plus 25 mg grandlure) in a study near San Benito, TX. Four treatments (standard and superlure, replaced bi-weekly or not replaced) were included in three month-long experiments conducted during distinct seasonal periods (February-March, June-July, and October-November) of 2004. Meaningful differences among the lure treatments were observed only in the final week of the first trapping period, when weevil captures (mean ± SE) were highest for the superlure replaced after 2 wks (45.0 ± 4.33 weevils/trap), intermediate for the superlure not replaced (29.0 ± 4.19) and the standard lure replaced after 2 wks (27.7 ± 4.08), and lowest for the standard lure not replaced (11.7 ± 4.48 weevils/trap). Captures during other trapping periods may have been too low to detect differences among lure treatments, but numerical trends were similar to those observed during the first period. Our preliminary results do not suggest trapping effectiveness of the superlure replaced monthly would be different from that of the standard lure replaced bi-weekly.

Introduction

The pheromone trap is the primary means of detecting and monitoring the boll weevil (*Anthonomus grandis* Boheman) in eradication programs. Contemporary eradication programs typically employ one or more commercially available lure formulations containing 10 mg of the four-component boll weevil pheromone (grandlure). Traps are normally inspected for captured weevils weekly, while the pheromone lure is replaced biweekly. Over the past several years, a number of amended lure formulations have been evaluated for increased trapping effectiveness (McKibben 2000, 2001, McKibben and Dickerson 2002, Parajulee and Slosser 2001). Although some of these formulations showed promise for improved trap effectiveness, none has been widely adopted for this purpose. However, the Southeastern Boll Weevil Eradication Foundation has expressed interest in a newly available "superlure" for reducing the costs of post-eradication maintenance trapping programs. The superlure contains 25 mg of grandlure and 30 mg of eugenol, and is intended to reduce the labor costs of trapping by increasing the trap maintenance interval to three or four weeks. McKibben and Dickerson (2002) suggested the superlure remained effective in traps for one month or longer, but their data were extremely limited. Herein we report preliminary results of a study to examine the effectiveness of the superlure at standard (two-week) and extended replacement intervals, relative to the standard lure.

Materials and Methods

Experimental Design

Trapping studies were conducted on the Russell Plantation near San Benito, TX, during distinct four-week periods. During each period, a complete replication consisted of four consecutive Southeastern Eradication Foundation traps (Technical Precision Plastics, Mebane, NC), spaced at 50-m intervals. Each trap within a replicate was randomly assigned to a lure treatment. Lure treatments included: 1) a standard boll weevil pheromone lure (Scentry Biologicals, Billings Montana) containing 10 mg grandlure and replaced biweekly; 2) a standard lure not replaced during a 4-week trapping period; 3) a superlure (25 mg grandlure and 30 mg eugenol, Hercon Environmental, Emigsville, PA) replaced biweekly; and 4) a superlure not replaced during the trapping period.

Sixteen replicates (a total of 64 traps) were distributed among seven trapping sites characterized by the presence of prominent vegetation and an orientation roughly perpendicular to prevailing southeasterly winds. These sites were either wooded resaca (the remnants of a former channel of the Rio Grande River) or brush-lined drainage canal.

Such sites were chosen to take advantage of the positive influences of prominent vegetational features on trap captures (Spurgeon et al. 1998, Sappington and Spurgeon 2000). The compass orientation and spacing of sets of traps in a line were selected to minimize the chances of confounding interactions between adjacent traps (Sappington 2002). One to five experimental replications were established at each site (depending on available space) so that replications of the study were separated by ≥100 m. Individual traps were supported about 1 m above ground level on metal conduit located in small clearings (1 – 1.5-m radius) directly on the edge of the vegetation.

The study was conducted during three distinct four-week trapping periods. These trapping periods (period 1, before cotton emergence, 11 February to 10 March; period 2, bloom and boll set, 15 June to 13 July; period 3, after harvest and stalk destruction, 5 October to 2 November) were selected to allow evaluation of the lure treatments under differing environmental conditions and weevil population levels. During these periods, traps were inspected weekly. At each inspection, lures were replaced as scheduled and trap contents were emptied into sealable plastic bags. Also, each trap was examined for interference by spider webbing or predators. If the wire cone of the trap was obstructed with spider webbing, or the presence of weevil parts suggested the activity of predators, these observations were omitted from subsequent analysis. Weevils were counted in the laboratory.

Statistical Analysis

The numbers of boll weevils captured each week were compared among lure treatments using the MIXED procedure of SAS (SAS Institute 2001). The ANOVA model contained fixed effects of lure treatment, trapping period, week within trapping period, and their interactions. Trapping site and replicate nested within site [replicate(site)] were random effects. Denominator degrees of freedom were estimated using the Kenward-Rogers adjustment (ddfm=KR option of the MODEL statement). Differences among levels of main effects were separated using the Tukey-Kramer adjustment to control the experiment-wise type I error rate (the ADJUST=TUKEY option of the LSMEANS statement). Significant interaction terms were explored by controlling for a single factor at a time using the SLICE option of the LSMEANS statement. Selected differences among levels of interaction terms were further examined using orthogonal contrasts.

Results and Discussion

Of the 768 trap observations, 185 (24%) were excluded from analysis because of spider webbing or predation, and two additional observations were omitted because of downed traps. The main effects of trapping period (F=31.84; df=2, 527; P<0.01), week of trapping (F=31.48; df=3, 527; P<0.01), and lure type (F=4.62; df=3, 527; P<0.01) were all statistically significant. Overall, weevil captures were highest during the first trapping period (period 1, February to March, 21.0 ± 2.26 weevils trap^{-1} week^{-1}). Captures during the other periods (period 2, June to July, 9.4 ± 2.23; period 3, October to November, 11.9 ± 2.19 weevils trap^{-1} week^{-1}) were not different from each other.

When averaged over all trapping periods, the mean number of weevils captured was highest during weeks 1 (18.0 ± 2.29 weevils trap^{-1}) and 2 (21.0 ± 2.30 weevils trap^{-1}). Also, captures for week 4 (11.0 ± 2.34 weevils trap^{-1}) were higher than for week 3 (6.4 ± 2.29 weevils trap^{-1}). However, a significant period*week interaction (F=24.00; df=6, 527; P<0.01) indicated the pattern of weekly captures varied among trapping periods. Examination of the statistics provided by the SLICE option indicated significant variation in trap captures among weeks within each trapping period (period 1, F=23.47; df=3, 527; P<0.01; period 2, F=8.58; df=3, 527; P<0.01; period 3, F=52.54; df=3, 527; P<0.01; Table 1). During the second and third trapping periods, captures tended to be highest during the initial two weeks. In contrast, captures during trapping period 1 were highest during weeks 2 and 4. Although decreasing effectiveness of pheromone lures that were not replaced should result in decreasing trap captures over each 4-week period, this explanation was not consistent with the weekly pattern observed for the first trapping period. However, interpretation of these patterns is not straightforward because other factors, including fluctuations in the weevil population available for capture and changes in prevailing weather conditions (temperature, wind speed, wind direction), likely masked temporal changes in lure attractiveness. These results also illustrate the substantial uncontrolled variation that is typical of field studies of boll weevil response to pheromone.

Table 1. Temporal patterns of boll weevil trap captures (least-squares mean weevils trap^{-1} week^{-1} ± SE) during three monthly trapping periods near San Benito, TX, 2004.

Monthly trapping period

Week	2 Feb. – 3 Mar.	15 June – 13 July	5 Oct. – 2 Nov.
1	13.0 ± 3.13 B	11.4 ± 2.72 B	29.5 ± 2.64A
2	32.1 ± 2.95A	17.1 ± 2.73A	13.9 ± 2.82 B
3	10.6 ± 3.02 B	6.0 ± 2.73 C	2.7 ± 2.71 C
4	28.4 ± 2.74A	3.2 ± 3.28 C	1.6 ± 2.73 C

Means within a column followed by the same letter are not significantly different (Tukey-Kramer test, α=0.05).

When averaged over all trapping periods and weeks, weevil captures for the superlure replaced biweekly (17.6 ± 2.30 weevils trap^{-1} week^{-1}) were similar to those for the superlure that was not replaced (14.4 ± 2.30 weevils trap^{-1} week^{-1}). Captures for the standard lures (changed biweekly, 12.0 ± 2.31 weevils trap^{-1} week^{-1}; not replaced, 12.4 ± 2.31 weevils trap^{-1} week^{-1}) were not significantly different from those for the superlure that was not replaced. Mean captures for the standard lure treatments were significantly lower than for the superlure replaced biweekly. The period*lure treatment interaction (F=0.99; df=6, 527; P=0.43) suggested that differences among the lure treatments were consistent among the three trapping periods. However, week*treatment (F=2.51; df=9, 527; P<0.01) and period*week*treatment (F=1.96; df=18, 527; P=0.01) interactions indicated that differences among lure treatments varied among combinations of trapping period and week.

The significant week*lure treatment interaction indicated differences in the numbers of weevils captured by the various lure treatments were not consistent among weeks when averaged over trapping periods. Such a pattern would be expected if aging of lures in the traps affected trap captures. That is, differences among lure treatments should become more apparent in the latter weeks of each trapping period when lure age is maximal. These data are not shown because the significant period*week*treatment interaction indicated the weekly patterns in trap captures associated with the respective lure treatments varied among trapping periods. Results of the SLICE operation indicated a significant week*treatment interaction within each trapping period (period 1, F=8.47; df=15, 527; P<0.01; period 2, F=3.22; df=15, 527; P<0.01; period 3, F=11.00; df=15, 527; P<0.01). Significant differences among lure treatments observed during the second week of trapping periods 1 and 2, and during the first week of trapping period 3 (Table 2), were anomalous because treatments corresponding to different replacement schedules of the respective lure types were equivalent during those times. These differences were not interpretable and likely resulted from random chance given the large number of comparisons that were made. The only interpretable differences we observed occurred during the fourth week of the first trapping period (Table 2). During that week, the superlure treatments tended to be associated with higher trap captures than the standard lures, and lures replaced biweekly tended to result in higher weevil captures than those that were not replaced. Although trends in trap captures among lure treatments during the fourth week of periods 2 and 3 were similar to those observed during the first trapping period, no statistical differences among lure treatments were demonstrated.

The results presented herein should be viewed as preliminary. Still, these results provide some evidence that the superlure replaced monthly is of comparable effectiveness to the standard 10-mg lure replaced biweekly. Even where statistical differences of this type were not indicated (the fourth weeks of trapping periods 2 and 3), trap captures during those weeks generally followed the same numerical trend. Lack of statistical differences among lure treatments in the later weeks of trapping periods 2 and 3 are not necessarily evidence that the lure treatments were equivalent. Rather, generally low trap response of weevils during those time periods probably provided tests of insufficient power to detect differences. Our results also suggest the superlure replaced biweekly is a more effective trap lure than the superlure replaced monthly. Should this difference prove repeatable, it could be important in a maintenance trapping program where detection of immigrant weevils is of critical importance. In summary, our results provide no evidence to suggest that the superlure replaced at three- or four-week intervals is less effective that the standard 10-mg lure replaced biweekly. We hope that additional data, including chemical assays of field-aged lures that await statistical analysis, will provide more definitive conclusions than are currently possible.

Table 2. Temporal patterns of boll weevil trap captures (least-squares mean weevils trap^{-1} week^{-1} ± SE) corresponding to standard and extended-life pheromone lures during three monthly trapping periods near San Benito, TX, 2004.

Lure treatment[a]	Week 1	Week 2	Week 3	Week 4
	Trapping period 1 (11 Feb. – 10 Mar.)			
Standard 2	14.3 ± 5.59A	20.9 ± 4.81 C	10.9 ± 4.63A	27.7 ± 4.08 B
Standard 4	20.1 ± 5.03A	34.2 ± 5.28AB	13.7 ± 5.59A	11.7 ± 4.48 C
Superlure 2	7.9 ± 4.82A	42.5 ± 4.81A	10.4 ± 4.64A	45.0 ± 4.33A
Superlure 4	9.6 ± 5.60A	30.7 ± 4.32 BC	7.5 ± 5.04A	29.0 ± 4.19 B
	Trapping period 2 (15 June – 13 July)			
Standard 2	8.1 ± 4.32A	7.2 ± 4.21 C	8.8 ± 4.32A	2.4 ± 5.62A
Standard 4	11.6 ± 4.19A	12.0 ± 4.32 BC	1.2 ± 4.20A	0.3 ± 5.31A
Superlure 2	10.8 ± 4.46A	22.1 ± 4.19AB	7.9 ± 4.32A	7.0 ± 5.61A
Superlure 4	15.0 ± 3.99A	27.0 ± 4.33A	6.1 ± 4.20A	3.1 ± 5.63A
	Trapping period 3 (5 Oct. – 2 Nov.)			
Standard 2	26.5 ± 3.99 B	12.0 ± 4.82A	3.5 ± 4.19A	1.8 ± 4.33A
Standard 4	27.2 ± 3.99AB	14.3 ± 4.47A	1.7 ± 3.99A	0.8 ± 4.32A
Superlure 2	36.3 ± 3.99A	16.3 ± 4.19A	2.9 ± 4.47A	2.3 ± 4.33A
Superlure 4	28.1 ± 4.08AB	13.1 ± 4.47A	2.6 ± 4.10A	1.4 ± 3.99A

Least-squares means in a week within a trapping period followed by the same letter are not significantly different (α=0.05).
[a]Lure treatments were: standard 2, 10 mg grandlure replaced biweekly; standard 4, 10 mg grandlure not replaced; superlure 2, 25 mg grandlure plus 30 mg eugenol replaced biweekly; superlure 4, 25 mg grandlure plus 30 mg eugenol not replaced.

Acknowledgments

We extend our gratitude to Messrs. Frank and James Russell for the use of their farm, and to Mr. Jim Brumley for providing the superlures. Mention of trade names or commercial products in this publication is solely for the purposes of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

References

McKibben, G. H. 2000. Plant derived compounds enhance boll weevil response to grandlure. pp. 1071-1072. *In* Proc. Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

McKibben, G. H. 2001. Field testing of enhanced grandlure in 2000. pp. 937-938. *In* Proc. Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

McKibben, G. H. and W. A. Dickerson. 2002. Optimizing post-eradication monitoring for the boll weevil. Proc. Beltwide Cotton Conferences, National Cotton Council. CD-ROM.

Parajulee, M. N. and J. E. Slosser. 2001. Effect of ethephon on efficacy of grandlure-baited pheromone traps in surveying fall and spring populations of the boll weevil (Coleoptera: Curculionidae). Environ. Entomol. 30: 64-69.

Sappington, T. W., and D. W. Spurgeon. 2000. Variation in boll weevil (Coleoptera: Curculionidae) captures in pheromone traps arising from wind speed moderation by brush lines. Environ. Entomol. 29: 807-814.

Sappington, T. W. 2002. Mutual interference of pheromone traps within trap lines on captures of boll weevils (Coleoptera: Curculionidae). Environ. Entomol. 31: 1128-1134.

SAS Institute. 2001. SAS/STAT user's guide, release 8.02 ed. SAS Institute, Cary, NC.

Spurgeon, D. W., J. R. Raulston, and O. Zamora. 1998. Impacts of habitat types on boll weevil pheromone trap captures. pp. 1333-1336. *In* Proc. Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.