# Movement of Boll Weevils in Three Areas of Texas Relative to Cotton Plant Phenology

*J.R. Coppedge and G.D. Jones*
United States Department of Agriculture – Agricultural Research Service
South Central Research Laboratory

## ABSTRACT

*This investigation was conducted in three separate areas of Texas using baited traps around cotton fields and in all four directions one mile apart, up to five miles from the test site, to define the movement and mechanism of boll weevil survival during the cotton season. Generally, more boll weevils were captured at sites away from cotton fields. Boll weevil captured in remote sites during the entire cropping season indicated that they may enter cotton fields from adjacent areas at any time during the summer. In two of the three areas, 50 % or less of the overwintering boll weevils entered cotton fields by the one third grown square. Evidence is presented suggesting that a portion of the F1 boll weevils leave cotton and move to remote areas even though there is ample food and oviposition sites in the cotton field. Pollen analyses determined alternative foraging resources of boll weevil adults in the three locations. Eighty percent of the captured weevils contained a total of 311 pollen types, representing 52 families, 97 genera and 31 species. These studies demonstrate that boll weevil in Texas use a wide range of foraging resources for survival in the spring and summer.*

## Introduction

Although the boll weevil, *Anthonomus grandis* Boheman has been eradicated from over 2 million acres of cotton in the USA, it remains the leading pest of cotton in the country. The boll weevil eradication program is proceeding in increments of up to 500,000 acres. As each increment is completed reinfestation becomes a major concern. This concern has stimulated the initiation of research to gain a better understanding of boll weevil movement.

Boll weevil movement in specific areas of Texas has been documented. Wade and Rummell (1978) and White and Rummel (1978) studied boll weevil movement and colonization of cotton on the High and Rolling Plains of Texas. Jones and Sterling (1979) conducted similar studies in the Brazos Valley (South Central Texas) area, while Wright and Chandler (1990) and Guerra (1986) reported on boll weevil movement in South Texas and Northern Mexico. These researchers made no attempt to compare movement patterns in different areas of the state.

Boll weevil movement in the spring probably results from the search for feeding and oviposition sites. Originally, only malvaceous taxa were thought to be the foraging host (Coad, 1914; Stoner, 1968; Cross *et al.*, 1975). However, recent research has shown that boll weevil adults are generalists in feeding behaviour (Cate and Skinner, 1978; Jones *et al.*, 1993; Jones and Coppedge, 1996; Jones *et al.*, 1997).

The purpose of this research was to compare certain parameters of boll weevil movement and the range of feeding host species in three areas of Texas.

## Material and Methods

Three sites were selected for these studies, near Uvalde, Texas (Uvalde County) near Crockett, TX (Houston County), and near Munday, TX (Knox County). These three areas are known to have moderate to heavy boll weevil populations and are quite distinct climatically. At each location a core area of 1 or more cotton fields were selected and traps were placed in turn-row or fence lines next to the fields. The number of traps deployed per core area varied according to the size of the core area i.e., in Uvalde County and Knox County the core field were 12-15 ha and 3 traps were used, while in Houston County the core field was 300 ha and 7 traps were deployed. Next pheromone-baited traps were deployed along directional lines at 1.6 km intervals from the core area up to 8 km from the core area. In 1995 trapping was initiated between planting and first square. In 1996 the traps were checked throughout the year. In 1997 only the Uvalde County and Knox County traps were checked only until mid-summer.

The traps were installed on slotted ¾" PVC pipe at 91 to 106 cm above the ground. Boll Weevil Scout® traps baited with Hercon Luretape Grandlure-10®were used. Traps were inspected twice weekly (generally 3-4 day intervals) and the lures were replaced biweekly. Boll weevil trap captures were recorded at each inspection. At weekly intervals from first square to crop termination, 50 to 100 cotton plants were selected at random and monitored in the core field(s). The number and size of fruit were recorded. Weather data were obtained from on-site weather stations at the Houston County locations and from Texas A and M Experiment Station records for Uvalde and Knox County.

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At intervals during the spring and early summer, samples of boll weevil adults were removed and frozen for later pollen assayed. At time of processing, frozen boll weevil was placed in individually marked 12-ml conical centrifuge tube and allowed to thaw. After rinsing and decanting three times with 95% ethyl alcohol (ETOH) to remove external pollen, each boll weevil was squashed with a small wooden stirring rod. The samples were acetolyzed to remove the insect tissue but not the pollen (Jones and Coppedge, 1996).

Light micrographs were taken of all unknown pollen types. No attempt was made to identify or count fungal spores. Pollen identification was made utilizing the Areawide Pest Management Research Unit (APMRU) pollen reference collections. Pollen types were identified to the lowest classification possible; family, genus, or species.

## Results and Discussion

Knox County is a dry, temperate area, Houston County is a wet and almost sub tropical area, and Uvalde County is near sub tropical but has a low average annual rainfall (59 mm) (Table 1). The higher rainfall and humidity in Houston County moderates the temperature during the winter and make the area seem considerably cooler than Uvalde County.

In Knox County, a high percentage ($\bar{x}$ = 82.1) (Table 2) of boll weevil captures were before first 1/3 grown square while in Uvalde and Houston County only about one-half of the boll weevils were captured before the first 1/3 grown square.

The Knox County area has uniform voluntary planting dates in late May and it appeared that many of the producers in our test area were adhering to that planting date. The effectiveness of such a program in Uvalde or Houston County would be questionable.

In all three areas, more boll weevils were captured in remote areas than around the core cotton fields (Table 3). As the production season progressed the number of boll weevils collected at all sites declined but the rate of decline was considerably faster in core area traps. When evaluated statistically with the exception of 1996 in Knox County, the remote traps ($M_1$-$M_5$) captured significantly more boll weevils than those around the core area (Table 4). Traps 8 km from cotton were as likely to catch a boll weevil as those 1.6 km from cotton.

The reason for differences in trap captures in the core and remote areas is unclear however, it may be quite simple. The areas around the core fields, i.e. turn-rows and fence lines are relatively devoid of plants that may serve as foraging resources for boll weevils, while the remote traps were usually in close proximity to flowering plants that could serve as foraging hosts for adult boll weevils. There is probably little reason for boll weevils to be in areas where foraging resources are virtually non-existent at or near the cotton field before squaring.

In the three areas, the highest catch of overwintered boll weevils occurred about two weeks before first 1/3 grown square (Table 5). Catches then dropped off rapidly until 4-5 weeks after the first 1/3 grown square, when there is a general increase in trap catch. This increase occurred consistently from area to area and year to year. These data suggest that some of emerging boll weevils leave the cotton field although there are abundant cotton squares at the time. Available data do not provide any insight into what percentage of boll weevils leave the cotton but based on the numbers trapped as cotton terminates, the percentage leaving the field appears small.

More boll weevils were captured north of the core fields (Table 6). The second highest catch was in traps east of the core field. The prevailing winds during this period are from the south-west, thus it appears that boll weevils normally move with the wind. This movement is under further study at the USDA-ARS, Areawide Pest Management Research Laboratory, College Station, TX.

Finally, the research clearly indicated that boll weevils are opportunistic pollen feeders. An average of 80% of boll weevils had internal pollen (Table 7). Boll weevils from Houston County had the highest number of pollen types while those from Knox County had the lowest. Apparently, adult boll weevils are involved in a continuous search for pollen for survival. This search may eventually bring them to cotton.

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**Table 1. Comparison of climatic conditions in the three test areas in Texas.**

| Location (County) | Ave. Annual Precip (mm) | Ave. Date First Frost | Average Temp (°C) | | Ave. Frost Free Days | Avg Date Last Frost |
|---|---|---|---|---|---|---|
| | | | Winter | Summer | | |
| Uvalde | 59 | Nov 21 | 4.4 | 35.6 | 255 | March 10 |
| Knox | 62 | Nov 6 | - 2.2 | 36.7 | 217 | April 3 |
| Houston | 106 | Nov 26 | 3.3 | 35 | 265 | March 6 |

**Table 2. Capture of overwintered boll weevils in study areas before first one-third grown square.**

| Location (County) | Percent of overwintered boll weevils captured before first 1/3 grown square[1] | | | |
|---|---|---|---|---|
| | 1995 | 1996 | 1997 | Mean |
| Uvalde | 70.4 | 41.1 | 58.9 | 51.4 |
| Knox | 88.1 | 77.8 | 87.2 | 82.1 |
| Houston | 49.5 | 26.7 | ____ | 42.8 |

[1]Percent overwintered boll weevils = captured from to first 1/3 grown square + 30 days/total captured.

**Table 3. Boll weevil trap captures and cotton plant phenology.**

| Plant Growth Stage[1] | Average number of boll weevils captured/trap | | | | | |
|---|---|---|---|---|---|---|
| | Core Field | Distances from core field (km) | | | | |
| | | 1.6 | 3.2 | 4.8 | 6.4 | 8.0 |
| | | | Uvalde County | | | |
| 1 | 2.8 | 2.9 | 6.5 | 6.5 | 6.7 | 6.7 |
| 2 | 0.5 | 1.2 | 2.8 | 5.1 | 5.2 | 4.0 |
| 3 | 0.7 | 1.5 | 3.9 | 3.5 | 3.7 | 4.0 |
| | | | Houston County | | | |
| 1 | 9.0 | 12.5 | 12.0 | 23.2 | 12.0 | 5.8 |
| 2 | 2.2 | 15.7 | 30.5 | 23.8 | 23.0 | 17.5 |
| 3 | 1.2 | 10.9 | 17.8 | 13.4 | 13.6 | 12.2 |
| | | | Knox County | | | |
| 1 | 13.1 | 53.9 | 59.1 | 29.3 | 44.1 | 35.9 |
| 2 | 0.4 | 8.5 | 13.6 | 5.4 | 7.9 | 7.2 |
| 3 | 0.3 | 0.3 | 0.8 | 0.2 | 0.8 | 0.7 |
| | | | Combined Results of all 3 Counties | | | |
| 1 | 7.6 | 21.1 | 23.9 | 18.4 | 19.4 | 15.0 |
| 2 | 1.1 | 7.7 | 15.3 | 10.8 | 11.1 | 8.8 |
| 3 | 0.7 | 4.9 | 7.0 | 5.7 | 6.7 | 5.4 |

[a] Plant phenology during stage 1) four leaf to 1/3 grown square, Stage 2) 1/3 grown square to f first bloom, and Stage 3) first bloom to mature boll.

**Table 4. A comparison of capture of boll weevil at core field and at different distances from core field[1].**

| Location | Year | Comparison[3] | $R_i/n_i - R_i/n_i$ | Critical Value | Sig. Diff.[2] |
|---|---|---|---|---|---|
| Houston | 1995 | C - (m1-m3) | -32.25 | 13.01 | Yes |
| | | C - (m3-m5) | -30.04 | 13.01 | Yes |
| | | (m1-m3) - (m3-m5) | 2.21 | 13.01 | No |
| | 1996 | C - (m1-m3) | -24.46 | 13.07 | Yes |
| | | C - (m3-m5) | -32.93 | 13.07 | Yes |
| | | (m1-m3) - (m3-m5) | -8.47 | 13.07 | No |
| Knox | 1995 | C - (m1-m3) | -25.07 | 13.61 | Yes |
| | | C - (m3-m5) | -24.84 | 13.61 | Yes |
| | | (m1-m3) - (m3-m5) | 0.236 | 13.61 | No |
| Uvalde | 1995 | C - (m1-m3) | -16.78 | 12.70 | Yes |
| | | C - (m3-m5) | -21.00 | 12.70 | Yes |
| | | (m1-m3) - (m3-m5) | -4.22 | 12.70 | No |
| | 1996 | C - (m1-m3) | -22.97 | 16.12 | Yes |
| | | C - (m3-m5) | -28.37 | 16.12 | Yes |
| | | (m1-m3) - (m3-m5) | -5.41 | 16.12 | No |

[1] The core field is represented by C and the remote traps are indicated by m followed by the number of kms from the core field.

[2] The comparisons were made using the nonparametric Kruskal-Wallis test ($\propto = 0.05$)

[3] M = 1.6 km, M2 = 3.2 km, M3 = 4.8 km, M4 = 6.4 km, and M5 = 8 km.

**Table 5. Boll weevil trap captures relative to the presence of the first one-third grown square.**

| Weeks from first 1/3 grown square | Average Number of boll weevils captured/trap | | | | | |
|---|---|---|---|---|---|---|
| | Core field | Distances from core field | | | | |
| | | 1.6 | 3.2 | 4.8 | 6.4 | 8.0 |
| -4 | 1.8 | 4.1 | 8.3 | 3.4 | 10.6 | 8.2 |
| -2 | 4.0 | 7.4 | 33.7 | 16.6 | 26.3 | 14.1 |
| 0 | 1.6 | 13.3 | 16.8 | 13.5 | 13.3 | 10.9 |
| +2 | 0.5 | 7.8 | 11.3 | 7.1 | 8.3 | 6.2 |
| +4 | 0.4 | 3.3 | 0.9 | 1.6 | 2.2 | 2.8 |
| +5 | 1.2 | 8.8 | 16.3 | 10.8 | 9.8 | 11.5 |
| +9 | 0.7 | 2.2 | 3.3 | 2.8 | 5.7 | 2.3 |

**Table 6. Capture of boll weevils at different directions from core field: combined results 1995-1996.**

| Growth Stage[2] | Average number of boll weevils captured/trap[1] | | | | |
|---|---|---|---|---|---|
| | Core Field | North | East | South | West |
| 1 | 3.9 | 32.8 | 17 | 7 | 13.4 |
| 2 | 0.9 | 13.4 | 9.1 | 3.7 | 4.4 |
| 3 | 1.6 | 11 | 6.2 | 3 | 5.0 |

[1] Direction from core field

[2] Plant phenology during stage 1) four leaf to 1/3 grown square, Stage 2) 1/3 grown square to first bloom, and Stage 3) first bloom to mature boll.

**Table 7. Pollen analysis from boll weevils captured in the three test areas.**

| Stem | Uvalde Co | Houston Co | Knox Co | Total |
|---|---|---|---|---|
| No. of Boll | 216 | 162 | 108 | 486 |
| Weevils examined | | | | |
| No. with pollen | 195 | 128 | 74 | 389 |
| % with pollen | 91 | 79 | 69 | 80 |
| No. identified | 131 | 61 | 55 | 159 |
| No. pollen type | 156 | 161 | 82 | 311 |