THE BOLL WEEVIL PROBLEM ON THE HIGH PLAINS OF TEXAS AND EASTERN NEW MEXICO

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Abstract

Since the boll weevil invaded the High Plains of Texas in 1992, infested acreage has increased each year. Mild winters and the additional overwintering sites provided by Conservation Reserve Program (CRP) grass acreage are considered the primary causes for this latest invasion. Warm, open falls have also contributed to the success of boll weevils overwintering in the area. Unlike previous incursions, this most recent one has established a resident population in most areas of the High Plains of Texas and eastern New Mexico. Boll weevil numbers have soared the last two years and reached all time highs in late 1998, in spite of the drought. While the economic impact of the boll weevil to the area economy was highest in 1997, causing losses of over $180 million to producers, losses in 1998 were still second highest, even though reduced acreage and high mid summer boll weevil mortality delayed the buildup of significant numbers of boll weevils until late September. Management guidelines have been developed for the area that capitalize on the uniqueness of the production system. Since cotton is produced in a weather-shortened season, and there is generally a mix of both irrigated and dryland production, producers are encouraged to plant early and finish the crop as early as possible to avoid late season damage, control costs and deny boll weevils a late food supply to reduce successful overwintering. Since overwintering sites in the High Plains area are at a premium, producers are also encouraged to plant cotton away from towns, burn CRP grasses periodically and to cleanup areas beneath trees accumulating broadleaf litter. While eradication plans have been thwarted until recently by producers unable to see the long term impact of the boll weevil on their operation and their unwillingness to fund eradication at levels needed for success, the increased impact of the boll weevil on the area's economy has encouraged at least one of the five High Plains zones to approve eradication to begin late 1999. Hopefully this zone's support of eradication will lead to similar support in the remaining zones. A recent assessment of the economic impact of the boll weevil on the High Plains area made it clear that the largest cotton patch in the world can not coexist with the boll weevil and remain competitive with other areas producing cotton without the presence of the boll weevil.

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Introduction

The boll weevil, *Anthonomus grandis* Boh., has been a major problem for the cotton industry of the United States for well over a century. It has proven to be the most economically damaging pest of cotton, having caused millions of dollars in yield losses and control costs annually and having caused millions of cultivated acres in the southern U.S. to shift from cotton production to alternative crops. Until recently, the area in Texas infested with the boll weevil had not extended further west than the Rolling Plains or further north than the Far West Texas region. However, following two thwarted attempts to invade the High Plains area, first in 1961 and then again in 1967, the boll weevil finally succeeded in establishing a resident infestation, beginning in 1992 (Leser et al. 1997). A fall diapause control program initiated in 1964 and continued in some form until 1996, successfully maintained the High Plains area as boll weevil free for most of its 33 year history. Eventually, a string of mild winters and the expansion of potential overwintering sites in the form of plantings of millions of acres of CRP grasses, led to the establishment of the boll weevil in the High Plains of Texas and Eastern New Mexico as the most damaging pest of cotton (Williams 1996, 1997, 1998, 1999).

The cotton industry is the single most important component of the Texas High Plains economy. The region produces 2.5-3.0 million bales of cotton per year, or about 20% of the cotton produced in the U.S. It constitutes the most concentrated area of cotton production in the world. The cotton-related economic activity generated by input industries, processing, transportation, merchandising, and other related activities, provides more employment and economic activity than any other agricultural enterprise suitable to this region. The potential for the boll weevil to displace significant cotton production and related economic activity poses a serious threat to the region. Prior to the arrival of the boll weevil as a key economic pest of the region, the absence of significant annual expenditures and yield losses due to insects was considered paramount for the High Plains to successfully compete with other cotton producing regions. After all, this was a region where production is often limited by a short growing season, limited water, hail and sand storms. The boll weevil has potentially changed everything. A recent economic assessment of the future impact of the boll weevil on this production area projected an annual net loss of producer income amounting to $142 million, a shift of more than 500,000 cotton acres to alternative crops, a loss of 30% of the existing gins and a loss of more than 9,000 jobs (Boll Weevil Economic Impact Task Force 1997).

The boll weevil now appears firmly established in much of the Texas High Plains cotton acreage. More than 60% of the harvested acreage, or 1.9 million acres, was considered infested in 1996 (Leser et al. 1997). Most other cotton producing regions would be characterized as "a sea of overwintering habitat with islands of cotton". The High Plains would generally be characterized as "a sea of cotton with islands of overwintering habitat". In spite of this apparent scarcity of favorable overwintering sites and likelihood of significant cold winter weather, boll weevils have continued to expand their territory. There is always a chance that a series of really harsh winters would significantly reduce boll weevil numbers for a year or two, but it is unlikely that this would eliminate the population. However, many producers still believe that a harsh winter would remove the boll weevil problem. The continued presence of economically damaging infestations of boll weevils poses a major threat to the cotton industry as more areas of the cotton belt eradicate the boll weevil. For producers in the High Plains, boll weevils are still a new pest with little history to encourage them to embrace eradication. Until such time, they must learn to grow cotton under the shadow of the boll weevil, which means adopting new management strategies that will require shortening an already weather-shortened growing season.

Material and Methods

For purposes of simplifying the presentation of most of the data, overwintering site survey and trapping data was grouped by boll weevil eradication zones rather than by counties. The five eradication zones with their counties are listed in Table 1.

Winter Habitat Sampling

This survey was conducted to a limited degree in Dawson County in 1995 and Dawson, Gaines, Terry, Yoakum and Lubbock counties in 1996. This survey was later expanded to 16 counties in 1997. The objectives of this survey were to determine which were the better habitats for successful boll weevil overwintering and to establish the distribution and survival of boll weevils in overwintering sites.

Boll weevil overwintering sites were sampled in 16 counties in early spring of both 1997 and 1998. While several different habitats were sampled, litter under clumps of elm trees and Conservation Reserve Program (CRP) grasses were the most commonly sampled habitats. Sixty-four sites and 114 samples from these sites were examined following the winter of 1996/1997. One hundred and ninety-one sites and 342 samples were examined in 1998. Habitats sampled in 1997 were generally the dominant plant type in the community. In 1998, increased emphasis was placed on sampling elm and CRP grasses in each county. Elm tree leaf litter was considered to represent the best overwintering sites while CRP grasses were considered the most abundant. Habitats sampled included: elm, brush shinnery oak, Osage orange, pecan, cottonwood, salt cedar, Arizona cypress, mesquite/grass pastures and CRP grasses.

Three 1 M^2 samples were taken from each site. Litter samples were collected by placing a 1 M^2 wooded frame on the surface within the prescribed habitat and collecting all plant debris within the frame. Collection sites were within 2.5 miles or less of cotton fields. Samples included the upper 3 inches of soil. This material was placed in a large plastic bag for transportation to the Texas A&M Research and Extension Center in Lubbock. All samples were processed and examined within 3 days in 1997 and 24 hours in 1998. All samples were processed through a separating machine used to sort out materials approximately the size of a boll weevil from soil and larger debris. The materials remaining after separation were spread out and examined on a heated table which facilitated the location of live boll weevils. Both dead and live boll weevils were counted.

Trapping Studies

A number of boll weevil pheromone traps has been placed in a grid pattern across the High Plains production region beginning in 1995. The purpose of this trapping program was to track the spread of the boll weevil across the area, monitor emerging overwintered boll weevils to evaluate winter mortality and the level of suicidal emergence, and to gauge the population level late in the season as a means of assessing the potential overwintering population.

Foundation boll weevil pheromone traps were placed in counties at the average rate of 24 traps per county. The actual number varied from 4 to 42, depending upon the geographical size of the county and the amount of cotton acreage. The grid trapping program was expanded from 16 counties to the 28 counties comprising all the potential High Plains boll weevil eradication zones. Traps were only placed in areas where cotton was grown. Traps were established along public right-of-ways and not actually in cotton fields or overwintering sites. A total of 537 traps were in the grid in 1997 and 1998. Trapping was initiated the first week of April. Traps were checked on a weekly basis until the second week of November, when a plant-killing freeze usually had occurred. Pheromone was changed biweekly and kill strips monthly. Distribution maps of trap catches were developed using Map Info software.

Results and Discussion

The boll weevil has made continuous inroads into the cotton production region of the High Plains. Since 1991 when established infestations were first found many miles from the edge of the Caprock Escarpment, the percent of acres infested has steadily increased to levels now exceeding 80% (Figure 1). This has resulted in an increase in acres treated, increased yield losses and control costs (Table 2). 1997 was by far the most damaging year with 1,500,000 acres treated and losses due to boll weevils exceeding $184 million. This placed Texas, and in fact the High Plains, as the production region with the most losses due to the boll weevil. The drought of the 1998 season resulted in a significantly reduced boll weevil problem, although losses in this year were second only to 1997.

Winter Habitat Sampling

Earlier overwintering site surveys indicated that boll weevils were able to survive the winter in the High Plains in a number of habitats including broadleaf litter, mesquite/grass pasture, and CRP grasses (Doederlein 1998). The broadleaf litter sites which consisted mainly of elm trees and sand shinnery oak appeared to provide the best survival. This habitat was more limited in distribution but was considered abundant enough to insure the continued establishment of boll weevils in the High Plains. A comparison of boll weevils recovered from overwintering sites between 1997 and 1998 is presented in Table 3. Except for the Northwest Zone, the number of boll weevils recovered per M^2 in 1998 increased between 2.2 and 11.5 times over that of 1997. Overall, there was a 4.25X increase from 1997 to 1998. This was expected as the number of boll weevils trapped late in the 1997 season were much higher than previous years, indicating an increased potential for overwintering populations. Another mild winter also appeared to guarantee high surviving boll weevil populations. The Northwest Zone continued with low numbers of boll weevils, even in the better habitats, possibly due to harsher winter conditions.

In 1997, CRP samples yielded the highest numbers of overwintered boll weevils (Table 4). This was followed by Elm tree litter and other broadleaf litter. This was not the case in 1998 when 81% of all recovered boll weevils were found in elm or other broadleaf litter. CRP samples yielded the fewest boll weevils in 1998. These site surveys clearly support earlier investigations which indicated that CRP would provide a suitable overwintering site, at least during mild winters. Even though the number of tree broadleaf litter sites is much more limited than sand shinnery oak, CRP or mesquite/grass pastures; these sites are probably sufficient in themselves to provide enough surviving overwintering weevils the following season to initiate economically damaging infestations, at least by late in the season. Winter weather conditions have been generally mild for the last eight years, with survival in the better habitats ranging from 10- 60% (average 26%) (Rummel unpl.). During the six years previous to this period, survival ranged from 2-16% (average 6%).

Trapping Studies

Except for the reduced numbers of emerging boll weevils trapped following the 1995/96 winter, numbers of trapped emerging overwintered boll weevils have generally increased since grid trapping began in 1995 (Table 5). There were reductions from 1997 to 1998 in the Northwest Zone and the Northern Zone. The actual numbers of boll weevils trapped in early 1998 were far below predictions. With the large numbers of boll weevils trapped in late 1997, higher number of boll weevils recovered in overwintering site surveys, and the high winter survival (30%) measured in emergence cage studies (Rummel unpl.), the emerging boll weevil population was expected to be 6 times higher in 1998 than in 1997. Because of the dry conditions experienced early in 1998, it was thought that many boll weevils could have succumbed to desiccation in their overwintering sites prior to emergence. In retrospect, when sampling overwintering sites in the March of 1998, many of the samples were very dry. Boll weevil numbers appeared to be consistently lower in the drier samples than the ones with higher moisture levels.

Effective emergence, as measured by trap catches was significantly reduced in 1998 compared to 1997 (Table 6). Effective emergence is defined as that portion of the overwintered boll weevil population that emerges within a time period which insures that they will find hostable squares before dying. The 1997 effective emergence was very high, averaging almost 70%. This probably was a reflection of a high quality, late food supply for adults in 1996. While larger numbers of boll weevils were recovered in most cases in 1998, these weevils may have had a more limited late season supply of quality squares and small bolls available to accumulate sufficient fat deposits to make it through the winter host free period. Effective emergence in 1998 averaged slightly more than 25%. Zones with the lowest effective emergence generally were areas with more aggressive boll weevil management practices, early crop termination and harvest, or areas with considerable acreage of yield limited dryland production.

Distribution of boll weevils in 1998 across the High Plains area based on trapping is shown in Figures 2-4. Most of the traps in the grid trapping program caught emerging overwintered boll weevils in 1998. However, there were still areas with low trap catches, including the northwest area of the High Plains Deaf Smith, Parmer and Castro counties) and Martin and Midland counties in the south. Widest distribution of trap catches occurred prior to the effective emergence period of June 1- July 25th.

By late June through early August, the number of traps catching boll weevils was reduced to a very few. This was due both to the increased attractiveness of the fruiting cotton acreage and the drought conditions which probably pushed mortality of boll weevil immatures in squares to over 95%. Once irrigated cotton plant canopies closed and especially once a larger proportion of boll weevil immatures infested bolls, boll weevil survival increased dramatically and migrating boll weevil adults were caught in all grid traps, even in the northern most counties and in southern counties where the bulk of the dryland cotton crop was lost to the drought.

Boll weevil population trends, as measured by traps, are shown for Gaines County, southwest of Lubbock, for 1997 and 1998 (Figure 5). Similar trends were measured in other High Plains counties. Higher numbers were trapped early in the season in 1998 than in 1997 but population levels were similar during the months of July and much of August.

Because it is difficult to measure population trends using traps during the middle of the growing season, the impact of the 1998 drought was not apparent until later. Initially, trap catches were higher in 1997 than in 1998 beginning in late August. This is probably a reflection of better in-season survival and higher field populations present in 1997 than in 1998. This initial difference was reversed by October, when 1998 trap catches exceeded 1997 catches.

The number of boll weevils caught late in the season when long distance movement is occurring and the crop is increasingly less attractive to boll weevils as it approaches cutout, were very high in both 1997 and 1998 as compared to 1996 (Table 7). Even the Northwest Zone had a substantial increase in 1998 of 10X over 1997. The high numbers caught in 1998 were in spite of the earlier initial reductions due to desiccation in overwintered sites and mortality from the drought. Increases in 1998 averaged 3.8X, ranging from 1.9 to 10.0X. Similar trends were observed Lea County, New Mexico where almost 16,000 boll weevils were trapped late season as compared to 24,000 in the adjacent Western High Plains Zone of Texas (Table 8). Without significant winter mortality, producers can expect much higher levels of emerging boll weevils next year than in any previous year. The absence of a plant-killing freeze until well into December meant that there was probably a sufficient late food supply to ensure survival and effective emergence of even the latest trapped boll weevils. In fact, boll weevil adults were observed feeding in fields with regrowth squares as late as December 20.

Management Strategy for the High Plains

The factors determining the increase and spread of boll weevil infestations in the High Plains includes primarily: severity of winter weather conditions, health of the overwintering population based on fat deposits, availability of favorable overwintering sites, level of suicidal emergence, summer conditions, effectiveness of producer initiated management practices, and the level of adoption of crop management practices which encourages earliness. The key to managing boll weevils in the High Plains of Texas and New Mexico is to limit late season infestations and damage. This can be done by limiting the establishment of emerging overwintering boll weevils, through appropriate mid season treatments where necessary, through late season management practices which reduce damage potential and limit the food supply needed for successful overwintering, and through overwintering site management. The High Plains management plan is detailed in Rummel et al. 1998. The management plan includes: 1) reducing overwintering sites through periodic burning of CRP grasses and cleanup of abandoned homesteads and broadleaf tree groves; 2) planting early within an optimal moisture and temperature window using high vigor seed, triple treated seed for disease control and Temik for thrips management; 3) applying overwintered boll weevil control based on pheromone trap catches and using "soft" insecticides such as Vydate and endosulfan; 4) August and early September boll weevil control where necessary; 5) terminating boll weevil control in early September based on the COTMAN model; and using harvest aids and insecticides mixed with the harvest aid applications to reduce late boll weevil numbers and remove the late season food supply.

Unlike the Rolling Plains area, the High Plains management plan does not rely on a delayed uniform planting date. A short growing season and a considerable mix of both dryland and irrigated production does not permit later or uniform planting. One very important overwintering site includes the cities and towns of the High Plains. These areas have considerable overwintering habitat and generally maintain a warmer temperature than the surrounding area. Producers have quickly recognized that boll weevil problems are more severe around these areas and have opted to move cotton production out and away from towns. How important is it for High Plains producers to minimize late season boll weevil infestations? In irrigated fields averaging 50,000 plants per acre and at least one vulnerable boll left per plant to protect from boll weevils that has sufficient time to mature for harvest, boll weevils could reduce yield by 136 pounds per acre if control was not exercised once 15% of these bolls were damaged (current threshold). This would amount to a loss of $81.61 per acre based on a $0.60 per pound cotton price.

Can the High Plains afford to produce cotton with the continuing and apparently escalating boll weevil problem? Probably not if the rest of the cotton growing areas eradicate the boll weevil and cotton prices remain depressed. In May, 1997, the Texas Supreme Court rendered a decision based on the Hale County lawsuit, finding that the law by which the Texas Boll Weevil Eradication Foundation (TBWEF) operates, was unconstitutional. A new law passed by the Texas Legislature and signed by the governor in June, 1997 granted the Texas Department of Agriculture oversight authority of the TBWEF and reinstated boll weevil eradication in Texas. This law divided the High Plains into two statutory zones, Northern High Plains and Southern High Plains/Caprock (SHP). In August of 1997, a referendum establishing an eradication program failed to pass in the SHP zone. Since that time, High Plains has further divided into 5 zones (Table 1). The Western High Plains passed a referendum in December of 1998 to start an eradication program in the fall of 1999. Votes are scheduled to take place in the new SHP zone in February, and tentatively in March for the Northwestern zone and April for the Permian Basin zone. There has been no organized effort to consider an eradication referendum in the Northern zone. For most of these High Plains zones to fund their proposed eradication budgets requires cost sharing through the State and with federal monies. If all goes well, as much as 2-2.5 million acres in the High Plains could be involved in eradication by late 1999 or at least by 2000. What producers are just now realizing is that boll weevils are a destabilizing force in cotton and that in spite of the assessments, eradication brings long term stability to a region. Even sub-economic infestations of boll weevils late in the season can result in dollar losses exceeding the cost of current budgeted assessments. And finally, cotton producers in an increasingly larger area of the High Plains are discovering that the boll weevil costs them more than any other pest they have faced thus far.

Acknowledgments

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Table 1. Boll weevil eradication zones in the Texas High Plains and their included counties.

- Permian Basin - (Borden), Dawson, Howard, Martin, Midland
- Western High Plains - Andrews, Gaines, (Lynn), (Terry), Yoakum
- Southern High Plains/Caprock - Cochran, Crosby, Dickens, Hockley, Kent, Lubbock, (Lynn), Motley, (Terry)
- Northwest Plains - Bailey, Castro, Deaf Smith, Lamb, Parmer
- Northern High Plains - Armstrong, Briscoe, Floyd, Hale, Randall, Swisher

( ) = partial county

Table 2. Economic impact of the boll weevil in the Texas High Plains, 1995-1998.

Year	Acres infested (millions)	Acres treated	% Yield loss	Yield loss ($) (millions)	Control costs ($) (millions)
1995	2.3	650,000	4.0	37.4	18.2
1996	1.9	552,520	3.2	28.7	12.8
1997	3.1	1,500,000	13.6	148.0	36.1
1998	1.7	1,235,000	8.5	49.1	19.1

Table 3. Number of boll weevils per M^2 of overwintering habitat sampled in March in the Texas High Plains.

Zone	1997	1998
Northwest Plains	0.1	0.1
Northern High Plains	0.4	1.0
Southern High Plains/Caprock	0.6	1.3
Western High Plains	0.4	4.6
Permian Basin	2.7	10.0
Average	0.8	3.4

Table 4. Number of boll weevils per M^2 of overwintering habitat sampled based on habitat type. Texas High Plains.

Habitat	1997	1998
Elm	0.8	4.4
Brush Shinnery Oak	0.3	1.0
Other Broadleaf	0.7	7.5
CRP	1.4	0.7
Rangeland/Pasture	0	1.1

Table 5. Overall average number of emerging overwintered boll weevils trapped by eradication zone. Texas High Plains. 1/

Zone	1995	1996	1997	1998
Northwest Plains	2.6	0.8	100.4	40.2
Northern High Plains	88.0	37.8	333.4	258.6
Southern High Plains/Caprock	29.0	37.0	471.0	775.7
Western High Plains	247.7	134.7	1,240.0	1,842.0
Permian Basin	718.7	136.2	410.2	992.7

1/ Adjusted to 24 traps per county.

Table 6. Percent of emerging overwintering boll weevils trapped during the effective emergence period by eradication zone. Texas High Plains. 1/

Zone	1997	1998
Northwest Plains	84.7	24.9
Northern High Plains	88.2	24.7
Southern High Plains/Caprock	69.8	16.5
Western High Plains	47.1	20.2
Permian Basin	57.8	40.8
Average	69.5	25.4

1/ Adjusted to 24 traps per county. June 1 - July 25 trapping period.

Table 7. Accumulative number of boll weevils trapped late season by eradication zone. Texas High Plains. 1/

Zone	1996	1997	1998
Northwest Plains	358	878	8,783
Northern High Plains	1,794	17,764	40,961
Southern High Plains/Caprock	1,814	16,785	39,551
Western High Plains	5,366	24,161	47,355
Permian Basin	1,802	23,066	58,979

1/ Adjusted to 24 traps per county. August 1 - November 7 trapping period.

Table 8. Comparison of pheromone trap catches of boll weevils during the effective emergence and late season periods between the Western High Plains Zone in Texas and adjacent Lea County in New Mexico, 1997. 1/

Location	Effective Emergence 2/	Late season 3/
Western High Plains Zone	584	24,159
Lea Co., NM	266	15,862

1/ Based on a 24 trap equivalency.
2/ June 1 - July 7
3/ August 4 - November 11

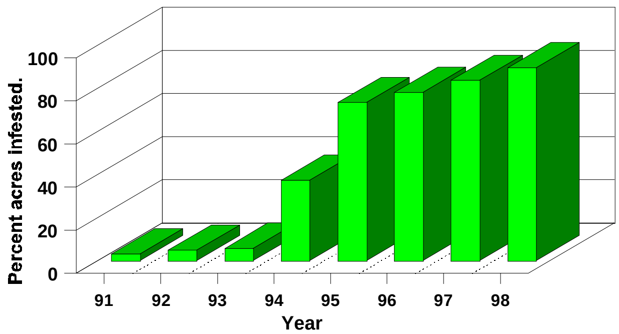

Figure 1. Percentage of acreage infested by boll weevils in the High Plains of Texas, 1991-1998.

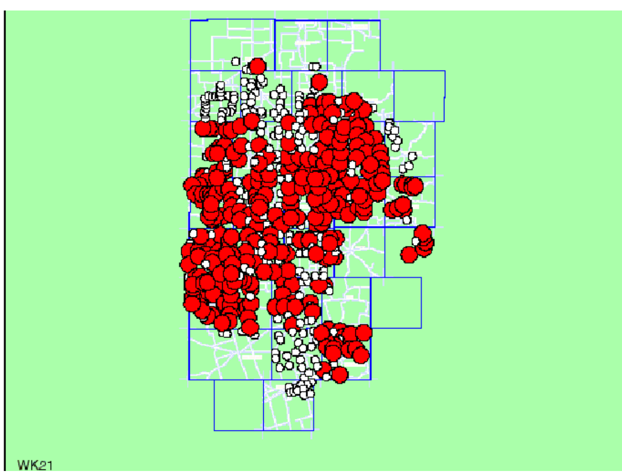

Figure 2. Distribution of boll weevils in the Texas High Plains for the period May 17-23 based on weekly trap catches in a 28-county area and 537 total traps. ● = 1 or more boll weevils caught in trap. ○ = no boll weevils caught in trap.

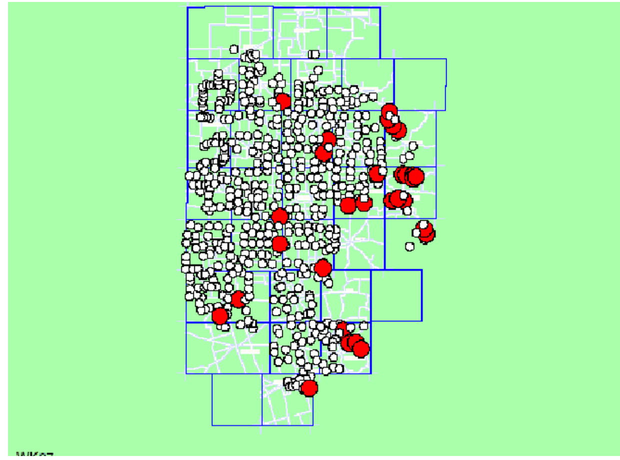

Figure 3. Distribution of boll weevils in the Texas High Plains for the period June 28-July 4 based on weekly trap catches in a 28-county area and 537 total traps. ● = 1 or more boll weevils caught in trap. ○ = no boll weevils caught in trap.

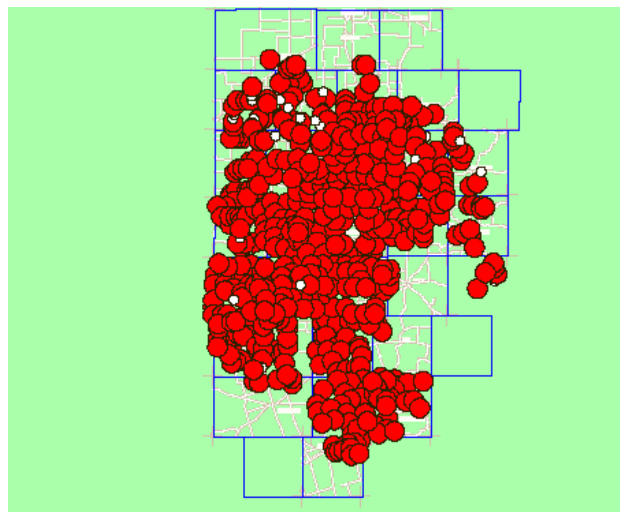

Figure 4. Distribution of boll weevils in the Texas High Plains for the period September 27-October 3 based on weekly trap catches in a 28-county area and 537 total traps. ● = 1 or more boll weevils caught in trap. ○ = no boll weevils caught in trap.

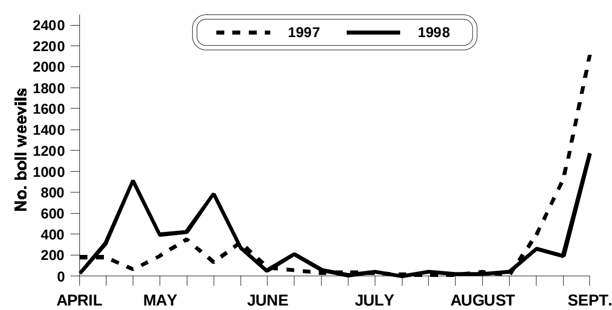

Figure 5. Average number of boll weevils caught per 24 traps in Gaines County, Texas.