PRELIMINARY ANALYSIS OF PINK BOLLWORM POPULATION DISTRIBUTIONS IN A LARGE ACREAGE OF GENETICALLY ENGINEERED COTTON WITH REGARD TO RESISTANCE MANAGEMENT

M. Walters and R. Staten
USDA APHIS PPQ
Phoenix, AZ
R. Sequeira
USDA APHIS PPQ
Raleigh, NC
T. Dennehy
University of Arizona
Tucson, AZ

Abstract

Resistance of PBW to the Bt toxin is currently managed using a specified percentage of refugia and restricted pesticide use. We consider released, sterile PBW as pseudo-refugia. The mating of native and sterile moths prevents selection for resistance because the mating produces no offspring. We are investigating the role of sterile PBW as well as optimal dispersal of refugia as resistance management tactics.

Introduction

This paper discusses spatial analysis of PBW trap data in the Palo Verde Valley, California. Please refer to Staten et al, current proceedings, for a discussion of PBW and current pest management projects. Native and sterile PBW were monitored season-long in the Palo Verde Valley of California using standard Delta traps baited with standard PBW pheromone. Traps were checked twice per week and numbers of male moths (native and sterile) were recorded; numbers were totaled for this analysis. Each cotton field had two traps and the geographic boundary and center-point of each field was known.

Materials and Methods

The graphics depict field locations and weekly PBW population values, using geostatistics. Geostatistics emphasizes mapping of spatially distributed populations, typical of insect populations. Geostatistics supports autocorrelations and irregular sampling patterns. Sample (trap or boll) data for PBW is often sparse and invariably occurs on irregular grids - because cotton is not planted in an entire valley, for instance. This presents the problem of estimation, that is, using sample data to predict values in unsampled areas. Kriging is a technique for the optimal interpolation of points across the spatial domain. Kriging handles spatial autocorrelation and it is not sensitive to preferential (uneven) sampling in specific areas. Kriging constructs a weighted moving average equation that estimates the value of a spatially distributed variable from adjacent values while considering their inter-dependence. This equation minimizes the effect of the relatively high variance of the sample values by including knowledge of the covariance between the estimated point and other sample points within the range. Kriging results in a marked smoothing effect with high original values tending to be underestimated and low values being overestimated and less variable than the original points. Kriging is a best linear unbiased estimator (B.L.U.E.) because it minimizes the variance of the estimation errors. The user defines both the boundaries and grid spacing or interpolation grid (Ingram 1999, Sharov 1999).

We generated 5,625 points based on the 300-latitude/longitude center points of each cotton field in the Palo Verde Valley. We then covered the entire valley in a 1-kilometer grid. The 1-kilometer range of influence setting indicates that only fields at or less than 1 kilometer apart affect each other. We feel this reflects the day to day movement of PBW adults in green cotton fields and limits the undue mathematical influence of a "hot" field on a large area. We truncated trap values at 100 moths/field/week as this indicates a "hot" field biologically and also, because a weighted average is used in Kriging; capping the high values limits undue graphical influence of a single field (Staten et al 1995, Walters et al 1998).

Results

The current analysis illustrates the development of two PBW populations. We began release in Mid-May in an effort to have good ratios (greater than 60 sterile to 1 native is considered a good ratio) of sterile moths in the field before native populations could develop. This is illustrated in Figures 1 and 2, sterile and native populations, respectively. During this period, sterile moths were released primarily over conventional cotton fields. As the season progressed, sterile moth release was modified according to trap catches and the heaviest releases were over the hottest conventional cotton fields, with the remainder of the moths distributed over the remaining conventional cotton. The sterile population held good ratios against most of the valley (Figure 3), with the exception of the native "hot spot" on the central western side. This area led the development of the native population (Figure 4). Toward the completion of boll set (Figures 5 and 6), the native population broke ratio in most of the valley. At this point sterile release was shifted away from conventional cotton fields and onto the "hottest" Bt fields as a hedge against resistance.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:989-991 (1999)
National Cotton Council, Memphis TN

Conclusions

Throughout the season there was seldom a Bt field that did not have some native PBW activity. Given the extremely low boll populations previously reported (see Staten et al, current proceedings) it appears that much if not all of this activity was refugia related. It is encouraging that even in this valley, with a very clumped refugia distribution, moths appear to move throughout the area, season-long

We observed that the far northeastern corner of the valley seemed well protected by an early-season pheromone rope application. In contrast, the central western side of the valley was considered a hot spot for most of the season. A large proportion of the total sterile moths were deliberately and repeatedly released over that area, in an effort to best control the native moth population. This analysis and other observations have led us to better understand the importance of in-field refugia versus full-field refugia, when those refugia are untreatable with pheromones.

Spatial analysis is very instructive in that it bears out and clearly illustrates field observations and trap data. The Kriging technique of geostatistics is far more instructive than simple thematic mapping of trap values.

Acknowledgements

Analysis conducted with the help of Amit Patel. Technical assistance and programming provided by Tom Kolaris.

References

Ingram, P. 1999, Geostatistics, http://137.111.98.10/users/pingram/ geostat.html

Sharov, A., 1999, Alexia Sharov, http://www.gypsymoth.ento.vt.edu/ ~sharov/alexei.html

Staten, R. T., L. Antilla, and M. L. Walters, 1995. Pink Bollworm Management: Prospects for the Future. Proceedings of the Beltwide Cotton Conferences, Cotton Insect Research and Control Conference. 9: 153-156.

Walters, M., R. T. Staten, and R. C. Roberson, 1998. Pink Bollworm Integrated Management Technology Under Field Trial Conditions in the Imperial Valley, CA. Proceedings of the Beltwide Cotton Conferences. 12: 1282-1284.

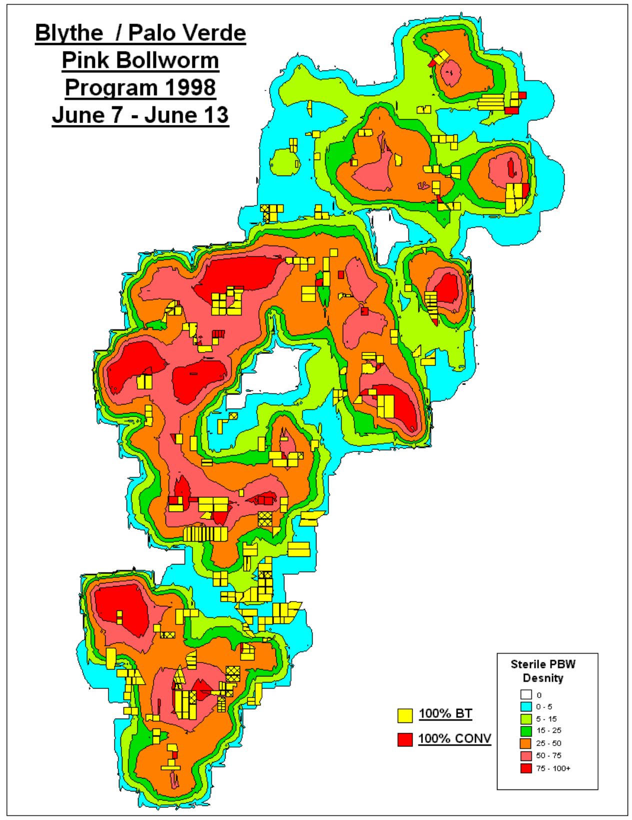

Figure 1. Sterile PBW population distribution in early season.

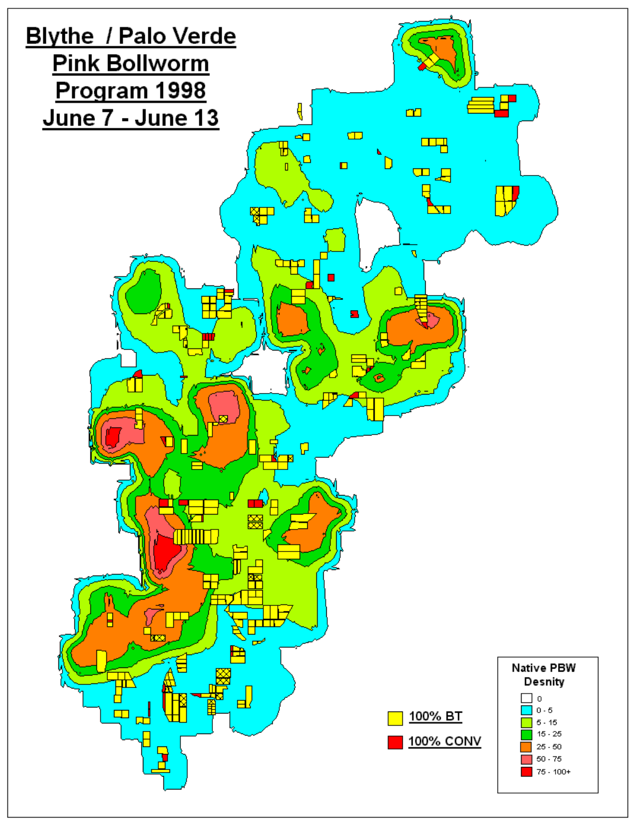

Figure 2. Native PBW population distribution, early season.

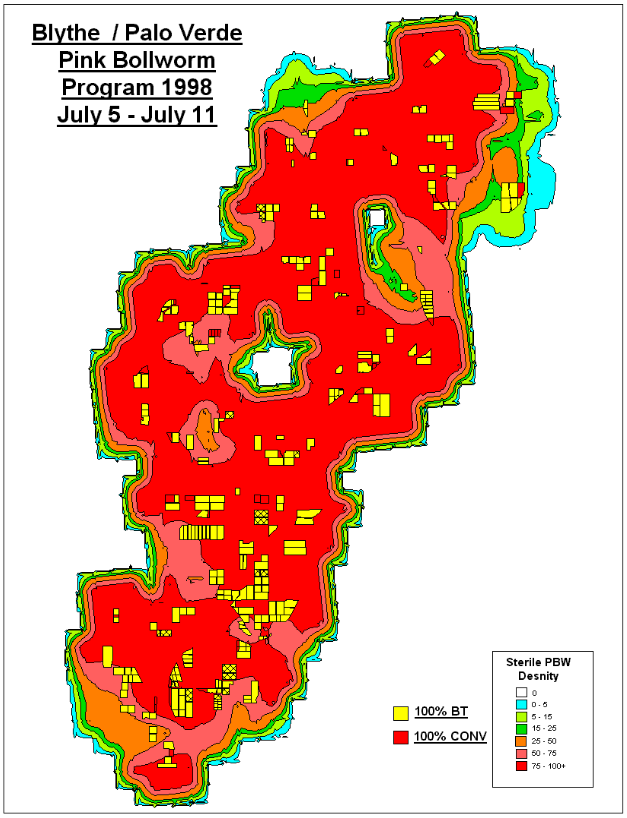

Figure 3. Sterile PBW population distribution, mid-season, showing complete coverage.

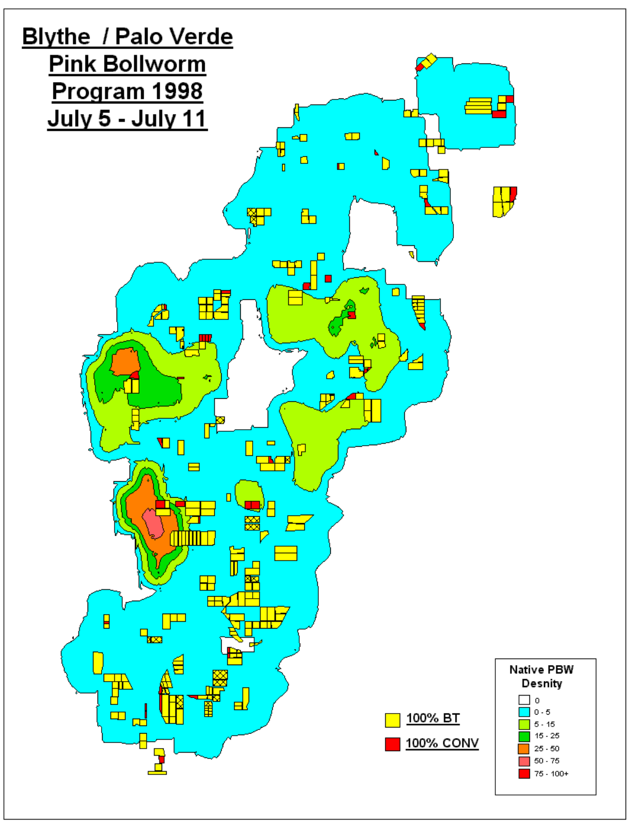

Figure 4.

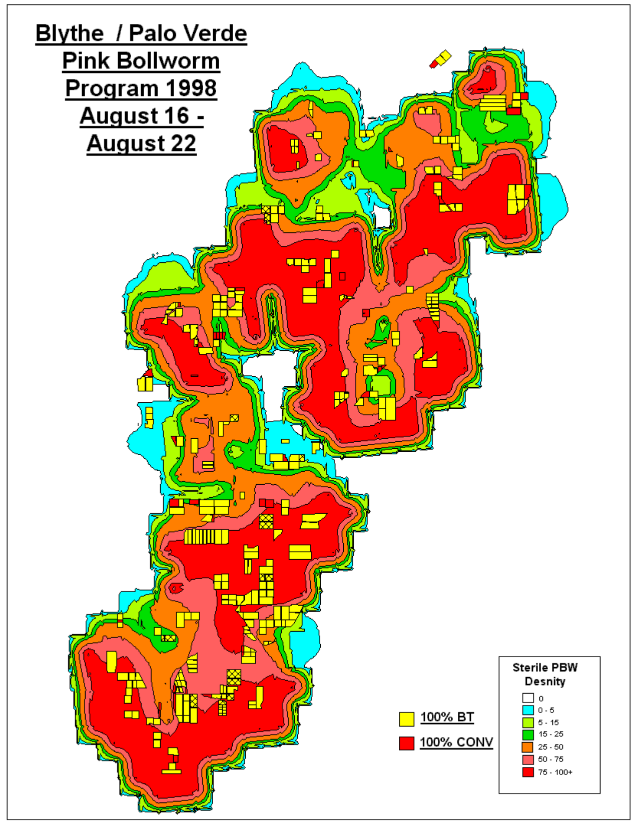

Figure 5. Sterile PBW population distribution, late season, showing good coverage of sterile insects over most conventional and Bt cotton fields.

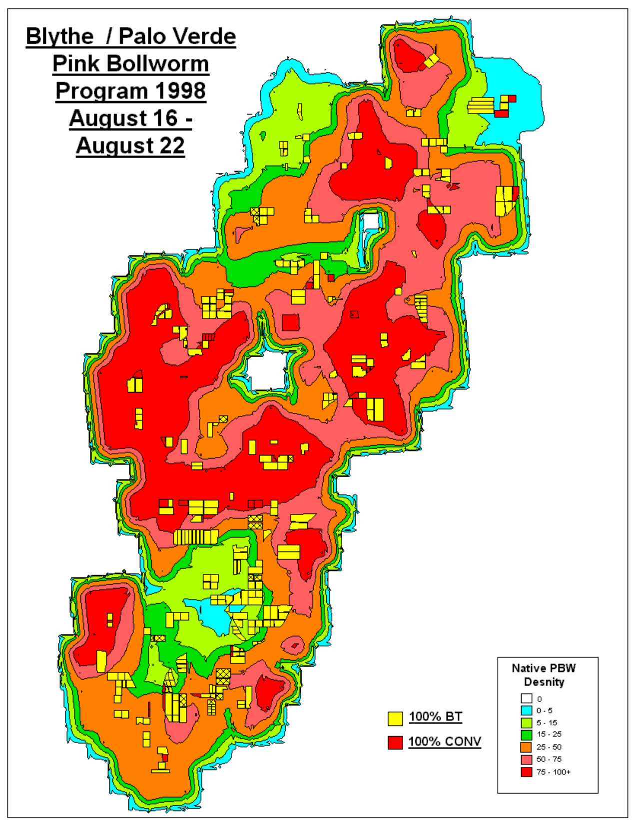

Figure 6. Native PBW population distribution, late season showing widely dispersed, heavy population over most cotton fields.