Potato Tuberworm Research - 2006

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INTRODUCTION

The potato tuberworm (PTW), *Phthorimaea operculella* (Zeller), emerged as a potential economic pest of potatoes in the Pacific Northwest (PNW) since reported in damaging numbers in the early 2000's. Although high numbers of PTW were found throughout the year in 2004 and 2005, the 2006 growing season was substantially different. PTW numbers have been lower than counts from the previous two years (Figure 1). A previous study (Lal 1949) suggested that the severity of PTW damage was primarily dependent upon its ability to overwinter in larger numbers; this statement may hold true in the Columbia Basin since last winter may have reduced PTW overwintering populations. However, this pest is still present and well established in the region. Will the population of PTW be different the next growing season? We cannot predict at this time, although current numbers are on the rise.

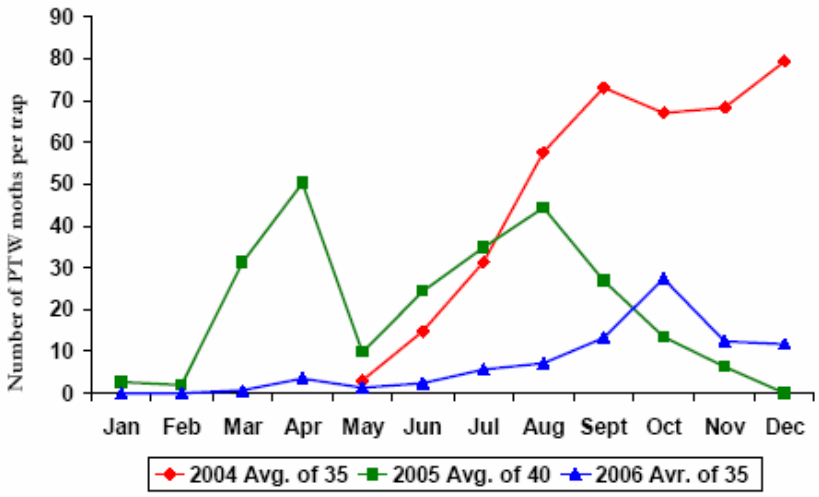

Figure 1. Population dynamics of the potato tuberworm in the Columbia Basin, Oregon

In response to the seriousness of this pest, a comprehensive research program addressing the biology, overwintering ecology, and control of PTW was launched in 2005 at Oregon State University's Hermiston Agricultural Research and Extension Center (HAREC). This report describes objectives and accomplishments of the research effort for the 2006 season.

REGIONAL AND NATIONAL IMPORTANCE OF PTW

Control of PTW damage is critical because PTW larvae infest tubers, rendering them unmarketable. Since this region stores large quantities of potatoes, additional losses are expected from infested tubers (there is a zero level of tolerance for live PTW in fresh and processed potatoes), and from increased rot in storage due to damaged tubers. Attempts at direct control through the use of insecticides, without adequate knowledge of the biology or population dynamics of the pest in this region, is estimated to cost growers an additional $125/acre in the southern Columbia Basin. This cost will increase if the population and range of PTW continue to increase.

PTW BIOLOGY, HOST RANGE AND OVERWINTERING

Most of the information available on the biology of PTW comes from tropical and subtropical regions of the world. In the U.S., some work was conducted during the late 20's, early 30's, and also during the late 1970's and early 1980's (Langford 1934, Underhill 1926, Shelton and Wyman 1979, 1980). In the PNW, preliminary research in 2005 and 2006 provided a good understanding of the basic biology of the PTW strain, such as the optimal and extreme temperatures for egg, larval, and pupal development, and the ability of the adult to survive storage conditions.

Besides potato, PTW has also been reported to infest solanaceous plants such as tomato, pepper, eggplant, tobacco, and nightshade. In the Pacific Northwest, PTW has only been found infesting potatoes. Thus, it is possible that the majority of current season PTW population originates from infested previous-season in potato fields (Figure 2) and cull piles. Destruction of cull piles is a recommended cultural tactic practiced around the world (Kroschel, 1995).

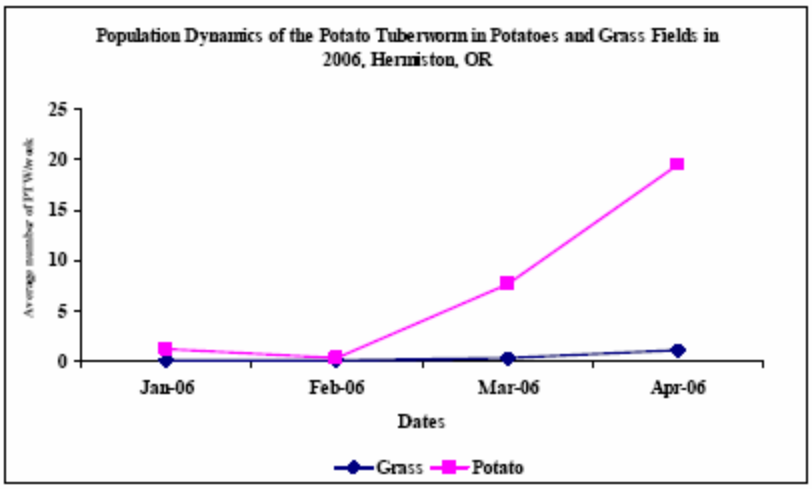

Figure 2. PTW emergence originates from infested potato fields, HAREC 2006

Early studies of overwintering biology of PTW indicated that PTW could survive sub-freezing temperatures. In OR and WA, trapping data from spring 2004 to fall 2005 showed that PTW males were present every week except one (in mid-January) (Figure 1), with the highest per trap numbers occurring in December. Several questions remain unanswered: which stage(s) are capable of overwintering? where does overwintering occur and how long does it last? could PTW survive the winter if tubers they begin the winter in/on are killed?

2006 RESEARCH OBJECTIVES

1. Determine effective PTW monitoring techniques: a) relative efficacy of various commercial traps; b) whole plant vs. partial counts; c) develop a scouting protocol.
2. Determine economic threshold by monitoring adult PTW population using pheromone traps in commercial farms.
3. Assess PTW parasitoids.
4. Communicate and disseminate information about this pest to the industry.

Other objectives include a Phylogeography study to determine the origin of the Columbia basin PTW population, cold temperature studies, and depth of emergence experiments. Data is still pending. Also, study the impact of cultural practices in the control of PTW and continue pesticide screening. Information is available in Rondon et al. 2007 http://extension.oregonstate.edu/catalog/pdf/pnw/pnw594.pdf

ACCOMPLISHMENTS

Objective 1. *Determine effective PTW monitoring techniques: a) relative efficacy of various commercial traps; b) whole plant vs. partial counts; c) develop a scouting protocol.* In 2006, we evaluated different sampling strategies to assess PTW populations in potato fields to aid in developing environmentally sound management strategies for this pest. In ten commercial fields, PTW population size was estimated using three strategies: binomial sampling (presence/absence), complete plant scouting, and pheromone traps.

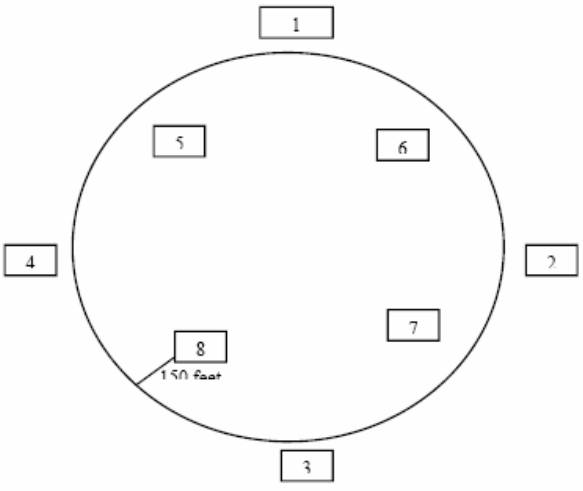

Figure 3. Traps layout in a grower's field. Traps 1&8 (Chemtica); 2&6 (Biolure); 3 & 7 (Trece); 4 &5 (Control)

In addition, we evaluated the effectiveness of commercially available pheromones lures for monitoring PTW. Four traps were located inside and four outside of fields (Figure 3). Lures tested were produced by Trece, Biolure and Chemtica. A control (no lure) was added. Effect of trap location was also evaluated. We anticipate repeating this experiment in the 2007 season.

Objective 2. *Determine economic threshold by monitor adult PTW population using pheromone traps in commercial farms.* To develop an integrated management package for tuberworm control we must quantify potato yield loss due to larval feeding. Despite intensive study of potato tuberworm biology and ecology in various parts of the world, limited economic injury threshold information for this pest is available.
Unfortunately, low natural PTW populations prevented a planned field study designed to determine the relationship between number of PTW caught in pheromone traps, foliar damage, and tuber damage at HAREC in 2006. We modified the experiment by using sixteen field cages (thanks partially to the support of the WSPC & Washington State Commission on Pesticide Registration) to determine the relationship between potato yield loss and PTW pressure in a controlled environment. The walk-in field cages are 6x6x6 ft and covered with mesh lumite. Ten potato plants per cage were infested with 0, 0.5, 1, or 3.5 female PTW/plant. There were 4 replicates per treatment. We were able to collect leaf damage, tuber damage and yield data. We will keep the cages in the same place during the winter to link overwintering studies and to determine when emergence occurs and what PTW stages survive.

Objective 3. *Assess PTW parasitoids and predators.* In 2005, hundreds of PTW larvae were collected in the field and examined in the laboratory, but no parasitoids were found. In 2006, several larvae were found parasitized. Samples were collected and sent to the Museum of Entomology at Corvallis for identification, which is still pending. This information is promising for future steps towards augmentation of natural enemies.

Objective 4. *Communicate extensively about this new emerging pest.* Information on PTW and results of the season's research were disseminated through extension and scientific presentations. Information has also been published in several trade journal articles, newsletters, websites, and newspapers. Interactions with growers and other members of the potato industry has been priority.

RESULTS

Objective 1. PTW scouting techniques: Since PTW populations were low during the summer of 2006, foliar damage (either presence/absence or whole plant counts) was not observed. However, foliar sampling efforts indicated that it would require 3-4 minutes to record the presence or absence (binomial sampling) of PTW on six plants at low PTW densities, and it will take 7-9 minutes for a complete plant sampling.

The preliminary results of the pheromone study indicated that Trece pheromone traps lured significantly greater numbers of adult PTW as compared to other pheromones. Other pheromone traps and the control traps (with no lure) attracted similar numbers of adult PTW. All lures were operated with care to avoid contamination. The study will be extended and repeated in 2007.

Traps located inside potato fields (150 ft from the perimeter) captured more PTW adults than traps located on the perimeter of fields (Figures 3 & 4). However, setting the traps inside the circles may not be time efficient. We anticipate repeating this experiment during the 2007 season, since the information will be incomplete unless we are able to correlate those pheromone trap counts with leaf damage and/or tuber damage.

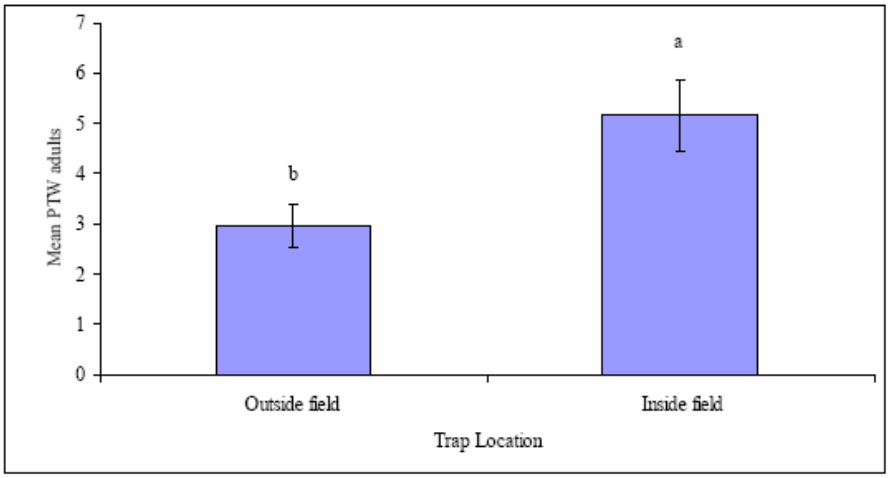

Figure 4. Pheromone traps location effect on PTW captures, 2006 (outside or perimeter; inside, 150 ft from perimeter)

Objective 2. Developing economic thresholds. Preliminary results indicated that higher level of infestation increased numbers of mines on potato foliage and tubers until certain point (Figure 5 A & B). However, none of the infestation levels significantly reduced potato tuber yield (Figure 5 C). We will repeat the experiment eliminating all other factors that may contribute to yield loss. Due to nature of tuberworm feeding and economic impact, several components such as effect of soil type, irrigation, desiccant effect and potato variety should be taken into consideration. We must continue this study to establish long term sustainable control programs.

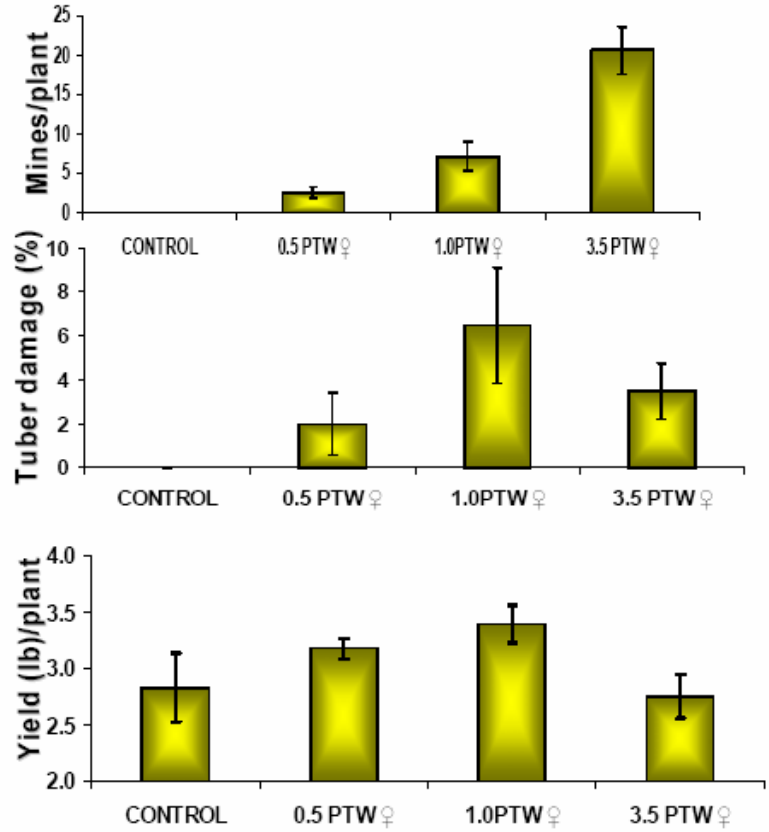

Figure 5. Effect of PTW density on leaf mining, tuber damage and tuber yield, 2006

Objective 3. PTW parasitoids
Samples were sent to Jim Woolley in Texas A&M for identification. At predict that at least two different species will be identified (microhymenopteras).

Objective 4. Communication/Extension
Information on PTW and results of the season's research were disseminated through extension presentations, scientific presentation, trade journal articles, and numerous interactions with growers and other members of the potato industry.

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