Reducing Potato Tuberworm Damage with Cultural Practices

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Introduction

The potato tuberworm (PTW) *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) is one of the most important constraints to potato (*Solanum tuberosum* L.) productivity worldwide. It is a cosmopolitan, oligophagous pest of solanaceous crops commonly found in tropical and subtropical regions. It was first detected in Umatilla County (Hermiston), Oregon, in 2002, with a handful of reports of minor damage.

In 2003, several fields were lost due to PTW, resulting in an estimated economic loss of about $2 million USD. Economic losses increased substantially in 2004 and 2005, due to increased PTW densities in areas already infested, range expansion, tuber damage, and the cost of control measures. In two years, its range has expanded 140 miles north of Hermiston, OR, to the area of Wilbur, Washington. Recent reports confirm PTW in Western, Central and Eastern OR, including Klamath Falls, Union County; northeast WA and in at least two counties in Western Idaho. In all sites, distribution and population information is incomplete at this time.

Field trials were initiated in 2004 to evaluate the potential to reduce PTW damage through cultural practices, including timing of pesticide application programs, application of post vine-kill irrigation with and without chemical desiccation, and rate of vine kill through use of various desiccants with and without insecticide application.

Cultural Practices

Two trials were initiated in the fall of 2004 on the Hermiston Agricultural Research and Extension Center (HAREC) to evaluate the potential for PTW control at vine-kill with different cultural practices. In the first trial, hills were rolled and vines desiccated (vine-kill) with Enquik applied at 20 gpa applied in 40 gpa. Treatments included: 1) roll hills and vine-kill; 2) Success (spinosad) applied at 6 oz/acre; 3) Agri-Mek (abamectin) applied at 12 oz/acre; and 4) covering hills with 2" soil. Plots were comprised of 4-30' rows/plot. The experimental design was a complete factorial, with four replications. Insecticides were applied in 30 gpa at vine-kill (1X), and at vine-kill and one week following vine-kill (2X). Hills were covered by hand. Plots were harvested two weeks following vine-kill and 100 8-10 oz tubers from the center two rows of each plot were stored for 2 weeks at ambient temperature. Tubers were then evaluated for the presence or absence of PTW damage.

In this trial, covering the hills immediately after vine-kill prevented any tuber damage (Table 1). Neither rolling the hills nor application of Success or Agri-Mek affected PTW damage.

Table 1. Effect of cultural practices on potato tuberworm damage, HAREC, 2004.

Treatment	Infested tubers
	%
Vine-kill	10.5a
Roll, Vine-kill	12.0a
Vine-kill, Cover	0.0 b
Vine-kill, Success—1X	17.5a
Vine-kill, Success—2X	18.0a
Vine-kill, Agri-Mek—1X	17.5a
Vine-kill, Agri-Mek—2X	10.0a
	**

** Treatment effect significant at P=0.01.
Means followed by different letters significantly different at P=0.05.

In a second 2004 trial, treatments included: 1) vine-kill alone; 2) roll hills, then vine-kill; 3) flail chop vines, cover immediately; and 4) vine-kill, cover 3 days later.

Again, immediate covering had the most significant effect in reducing tuber damage (Table 2). Covering hills 3 days after vine-kill also reduced tuber damage, but not to the same level as immediate covering. Rolling the hills was ineffective.

Table 2. Effect of cultural practices on potato tuberworm damage, HAREC, 2004.

Treatment	Infested tubers
	%
Vine-kill	12.6a
Roll, Vine-kill	14.6a
Flail chop, Cover	1.2 c
Vine-kill, Cover 3 d.	5.2 b
*	

* Treatment effect significant at P=0.05.
Means followed by different letters significantly different at P=0.05.

In 2006, an on-farm trial in a commercial potato field compared flail chop for vine-kill with flail chop followed immediately by covering using a rotary corrigator. Tubers were evaluated as in the previous trials, except that they also were rated for the intensity of mining within the tubers.

In this trial, the vines were almost completely dead at the time the treatments were applied. However, covering the hills with 1-2" of soil again significantly reduced the percent tubers with damage, as well as the intensity of mining.

Table 3. Effect of cultural practices on potato tuberworm damage, commercial production field, 2006.

Treatment	Infested tubers	Mining intensity
	%	
Flail chop	8.8	22.5
Flail chop, Cover	2.5	4.3
	*	*

* Treatment effect significant at P=0.05.

Pesticide Timing Trial

Trials were conducted in 2005 and 2006 to determine when a PTW program should be implemented to control tuber damage. Asana (esfenvalerate), Monitor 4 (methamidophos), and Lannate LV (methomyl) were applied beginning at different intervals before vine kill; Avaunt (indoxacarb) was applied at vine-kill and one week later (Table 4). Plot size was 30 feet long and eight rows wide. Treatments were replicated four times. 'Ranger Russet' potatoes were planted under center pivot irrigation. Normal commercial production practices were followed. Pre vine-kill insecticide treatments were applied in 20 gpa; Enquik was applied in 40 gpa. Avaunt treatments were applied with a chemigation simulator in 0.14"/acre water. One hundred tubers in the center portion of the inner two rows of each plot were sampled 15 days after the desiccant application. Potatoes were stored at ambient temperature for 12-14 days after harvest to increase the likelihood of detecting PTW damage. Tubers were processed with a French fry cutter and damage was measured as the percent tubers with PTW damage in 100 potatoes.

The trial in 2006 followed similar methods, except that Lannate was applied on a seven day interval, and the post vine-kill treatments were not included.

Table 4. Potato tuberworm insecticide timing trial treatments, Hermiston, OR, 2005.

		Application	
	Rate	Interval	Number
Pre vine-kill treatments			
Asana (esfenvalerate)	7.5 oz	7 days	5
Lannate LV (methomyl)	2.25 pt	5 days	6
Monitor 4 (methamidophos)	1.75 pt	7 days	5
Post vine-kill treatments			
Avaunt (indoxacarb)	3.0 oz	7 days	2
Avaunt (indoxacarb)	5.0 oz	7 days	2

In 2005, all insecticide treatments significantly reduced tuber damage as compared to the control (P=0.004) (Figure 1). Time of initiation of treatment prior to vine-kill did not affect tuberworm damage.

In the post vine-kill trial, Avaunt applied at desiccation and one week later at the 3 oz/acre rate significantly reduced tuber damage from 5.25% in the untreated control to 3.0%, and application at 5 oz/acre further reduced tuber damage to 1.5%.

Tuberworm pressure in 2006 was extremely low. The percent tubers with larval damage in the untreated control was only 1.75%. The Lannate and Asana treatments averaged 1.4% and 1.1%, respectively, which did not differ significantly from the control. However, tuber damage averaged 0.6% across the Monitor treatments, which was significantly less than the untreated control. Again, there were no differences associated with time of initial application prior to vine-kill.

The data from these trials indicate that there is no apparent advantage in beginning control efforts earlier in the season versus later; there was no trend for PTW tuber damage to increase as the beginning of the pesticide application program was delayed (lines on Figure 1 illustrate effect expected if there was an advantage to early control).

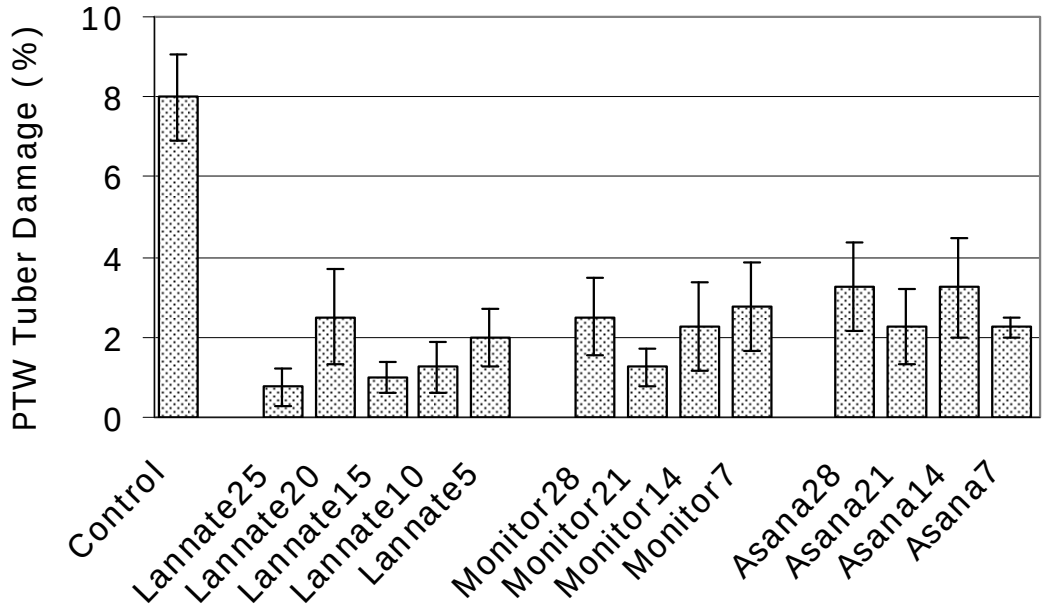

Figure 1. Effect of timing of pesticide application on potato tuberworm tuber damage, 2005. Numbers following insecticide indicate days prior to vine kill applications began. Lines indicate the direction of effect expected if there was an advantage to controlling all season.

Irrigation/Senescence Trial

This study, conducted in 2005 and 2006, was designed to determine the effects of green foliage and soil moisture on PTW tuber damage in early and late season potatoes. The three variables examined were 1) variety, 2) irrigation practices after vine kill, and 3) senescence. The two varieties included 'Russet Norkotah' and 'Russet Burbank'. Potatoes in the irrigated treatment received 0.10" daily by center pivot from vine-kill until harvest. Potatoes in the non-irrigated treatment were not watered after vine-kill. Half the plots were allowed to naturally senesce and half were chemically defoliated with Enquik applied in 40 gpa as previously described.

Plots were 8 rows wide and 30 feet long, with each plot separated from the adjacent plot by 20 feet at the ends and 6 rows (24') on the sides to ensure irrigation was properly applied at the plot level. One hundred tubers in the center portion of the inner two rows were sampled 14 days after Enquik application. Potatoes were stored at ambient temperature for 10 days after harvest to increase the likelihood of detecting PTW damage. Tubers were processed with a French fry cutter and damage was measured as the percent PTW damage in 100 potatoes.

In 2005, the effect of irrigation after vine-kill on PTW tuber damage did not differ significantly between 'Russet Burbank' and 'Russet Norkotah' potatoes or between chemically defoliated or naturally senesced potatoes. Daily irrigation following vine-kill reduced the percent tuber damage (P=0.07) as compared to no irrigation (Figure 2). There was no significant difference in the percentage of rotten potatoes in irrigated and unirrigated plots, indicating that this level of irrigation does not increase fungal or bacterial infection.

In 2006, PTW pressure was extremely low; damage was observed in only 3 of 1600 tubers examined, so there was no effect of any of the applied treatments.

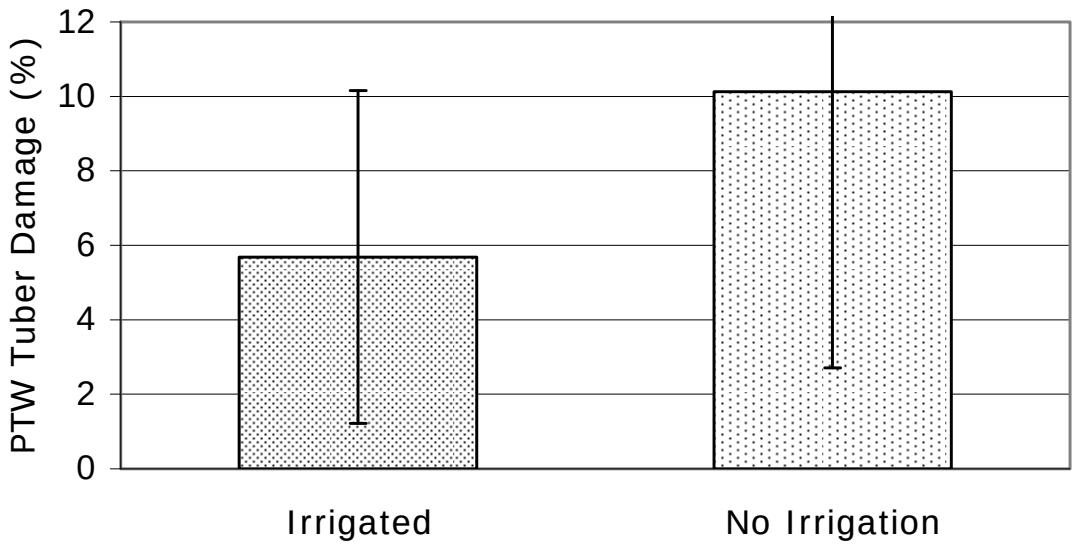

Figure 2. Effect of irrigation after vine kill on potato tuberworm tuber damage in 'Russet Burbank' and 'Russet Norkotah' potatoes, 2005. Irrigation reduced the percent tuber damage at P=0.07. There was no significant difference in PTW damage between varieties or between chemical defoliation and natural senescence.

Desiccant Trial

Five desiccants, which ranged from acting within hours to weeks, were examined with and without weekly application of Monitor 4 beginning 21 days before vine kill (Table 5). Plot size was 30 feet long and eight rows wide. 'Ranger Russet' potatoes were planted. Normal commercial production practices were followed. Monitor 4 was applied in 20 gpa with a tractor-mounted boom sprayer. Desiccants were applied similarly, except that Enquik was applied in 40 gpa. One hundred tubers in the center portion of the inner two rows of each plot were sampled 1 and 15 days after the last desiccant application. Potatoes were stored at ambient temperature for 10 days after harvest to increase the likelihood of detecting PTW damage. Tubers were processed with a French fry cutter and damage was measured as the percent tubers with PTW damage in 100 potatoes.

The main effect of desiccant was not significant, but Monitor application reduced PTW tuber damage from 3.81 to 1.85% (P=0.0001). The average percent tubers damaged increased from 2.58% at vine-kill to 3.08% at 2 weeks following vine-kill, but the increase was not significant. There was a slight interaction between these three variables (P=0.08). At vine-kill, the effect of desiccant

Table 5. Desiccant and insecticide treatments, HAREC.

	Rate	Activity*
Desiccant		
Rely (glufosinate-ammonium)	3.0 pt	14 days
Aim (carfentrazone)	3.6 oz	10 days
ET (pyraflufen ethyl)	5.5 oz	7 days
Reglone (diquat)	2.0 pt	2 days
Enquik (monocarbamide dihydrogen sulfate)	20.0 gal	1 day
Insecticide		
Monitor	1.75 pt	

*Estimates provided by manufacturer's representatives.

was not significant (Table 6). At two weeks following vine-kill, there were significant effects of Monitor 4 application and desiccant, and an interaction between these two main effects (P=0.001). In almost every case, application of Monitor 4 decreased PTW damage. The only exception occurred when the application of Rely + Monitor resulted in increased PTW tuber damage compared to Rely alone. This is believed to be an anomaly.

Results in the 2006 trial were similar. Although the pest pressure was greatly reduced, the percent damaged tubers increased from 0.69% at vine-kill to 1.85% two weeks after vine-kill (P=0.006). Application of Monitor reduced the tuber damage from 1.65% to 0.9% (P=0.07). There was no difference in percent tuber damage associated with the desiccant used. These data support field observations that the rate of vine-dying is not an important factor, as long as there are green vines in the field.

Conclusions

In all trials, tuber damage increased during the period from vine-kill until harvest at two weeks following vine-kill.

The three trials which included covering the hills at vine-kill or shortly after as a treatment clearly demonstrated this as a viable non-chemical control method.

Table 6. Effect of desiccant and insecticide on potato tuberworm damage at vine-kill and 14 days after vine-kill, Hermiston, OR, 2005.

	Tuber damage	
	Vine-kill	Vine-kill +14
Desiccant[1]	Per cent (%)	
Rely	0.63	3.00 b
Aim	3.13	5.00a
ET	2.88	2.50 b
Reglone	4.00	2.00 b
Enquik	2.63	3.13 b
Control	2.25	3.88ab
	NS	*
Insecticide[2]		
Monitor	1.58	2.13
None	3.58	4.04
	**	***

NS,*,**,*** Treatment effect not significant or significant at P=0.05, P=0.01, or P=0.001, respectively.
[1]Mean of 800 tubers/treatment/sample time.
[2]Mean of 2,400 tubers/treatment/sample time.
Means followed by different letters significantly different at p=0.05 (Duncans multiple range test).

The insecticide timing trial demonstrated that weekly application beginning 4 weeks prior to vine-kill was no more effective than a single application one week before vine-kill. All the products tested were effective. Also, application of some insecticides at and following vine-kill can significantly reduce tuberworm damage.

Rate of vine desiccation did not impact tuberworm damage. And light, daily irrigation beginning at vine-kill and continuing until harvest is another effective non-chemical method of reducing damage from the potato tuberworm.

In summary, all these data indicate that the most critical time for initiation of control methods is immediately prior to and at vine-kill.