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Review of the Biology and Management of the Potato Tuberworm

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Note: This is an extract of PNW594 April 2007 "Biology and Management of the Potato Tuberworm in the Pacific Northwest" www.extension.oregonstate.edu.

Potato tuberworm (PTW) is one of the most important constraints to potato productivity worldwide and over the years many farmers in other parts of the world have relied extensively on insecticides. Adequate control of PTW is critical because larvae infest tubers, rendering them unmarketable. Besides potato, PTW has also been reported to infest solanaceous plants such as tomato, pepper, eggplant, tobacco, and nightshade. In the Pacific Northwest (PNW), PTW has only been found infesting potatoes.

BIOLOGY. PTW has four life stages: adult, egg, larva and pupa. Adults are small moths are approximately 3/8" long with a wingspan of about 1/2"; forewings have dark spots (2-3 dots on males; "X" on females) (Figure 1). Females lay their eggs on foliage, soil and plant debris, or exposed tubers. Moths can crawl through soil cracks or burrow short distances through loose soil to find tubers and deposit eggs. Eggs are ≤ 0.02", spherical, translucent, and range in color from white or yellowish to light brown. Larvae are usually light brown with a characteristic brown head (Figure 2). Mature larvae (approximately 3/8" long) may have a pink or greenish color. Larvae feed on leaves throughout the canopy but prefer the upper foliage. Larvae mine the leaves, leaving the epidermal areas on the upper and lower leaf surface intact. Larval feeding results in necrotic areas on leaves. Leaf damage is unremarkable and not always readily found without careful scouting. Larvae also move via cracks in the soil to find tubers. Exposed tubers are predisposed to PTW damage. Larvae close to pupation drop from infested foliage to the ground and may burrow into the tuber. Ultimately, larvae will spin silk cocoons and pupate on the soil surface or in debris under the plant.

Figure 1. Female (left) and male (right) PTW. Credits (OSU)

Figure 2. PTW larva (Credits. IPC)

Early studies in Maryland and Virginia indicated that PTW can survive sub-freezing temperatures. In the Columbia Basin of Oregon, trapping data from spring 2004 to fall 2005 showed that PTW males were present every week except one (in mid-January), with the highest numbers per trap occurring in December. It is unknown where PTW overwinter in the lower Columbia Basin. PTW eggs, larvae, and pupae can potentially survive in cull piles, potato tubers left in the soil from harvest or in volunteer potatoes; PTW pupae may also survive as pupae in soil.

TRAPPING

Growers in areas potentially impacted by this insect are encouraged to monitor insect numbers using pheromone traps by placing at least one trap per potato field, beginning after canopy closure. Adult male moths are attracted by pheromone impregnated in a rubber septum in the center of a sticky liner in the trap, and are caught. Pheromones are concentrated quantities of the female "scent". Since some other insects, including other Gelechiidae moths could be trapped in the sticky liners, they should be changed once a week. Lures should be changed monthly but may be used longer, depending on environmental conditions. Keep in mind that cooler temperatures increase the longevity of the lures.

CONTROL METHODS

The most effective management program combines cultural and chemical approaches. There are a number of insecticides that have been proven effective in controlling this insect. Since PTW prefers foliage over tubers and tuber infestation is reduced when a full or partial canopy is present, early use of insecticides may not be warranted. For current pesticide recommendations, see http://insects.ippc.orst.edu/pnw/insects.

I. CULTURAL CONTROL

i. Elimination of cull piles and volunteers. Eliminate cull piles and volunteer potatoes to reduce overwintering stages, which are a source of next years' populations.

ii. Vine-kill. One important aspect to remember is that PTW moths and larvae are forced to go into the ground as vines are killed and, consequently, the risk of tuber damage increases. Adults go into the soil via soil cracks to find shelter from the light and to lay their eggs on tubers whereas larvae are forced there to find food. Tubers that are exposed or close to the surface are at high risk for PTW damage. In addition, growers need to do everything possible to maintain more than 2 inches of soil over the tubers during the season.

iii. Soil moisture at and after vine kill. Keeping the soil moist via overhead irrigation, particularly later in the season when vines are beginning to die, reduces PTW tuber infestation. Research at OSU has shown that irrigating daily with 0.10" through a center pivot irrigation system from vine kill until harvest decreased PTW tuber damage and did not increase fungal or bacterial diseases. The daily irrigation application probably closed soil cracks, reducing tuber access. PTW possibly died from lack of oxygen in the soil due to water saturation, and/or their mobility was reduced by wet soil decreasing their ability to find a tuber to infest.

iv. Length of time between desiccation and harvest. Field observations support the premise that PTW prefer green foliage over tubers for oviposition and feeding, and when foliage starts to decline tuber infestation naturally increases. Thus the length of time between desiccation and harvest is crucial. The longer the vines are dead and left in the field, the greater the likelihood of tuber infestation.

v. Rolling hills or covering hills. Research at OSU found that rolling of potato hills in sandy soil caused soil to slough off the hill, which resulted in increased PTW damage and therefore is not recommended in areas with sandy soils. Covering hills with 1-2" of soil immediately after vine-kill has been shown to significantly reduce tuber infestation. This can be accomplished with a rotary corrigator.

II. CHEMICAL CONTROL

i. Insecticide use after vine kill. Research at OSU has shown that applying insecticides at and after vine kill almost always reduces PTW damage in tubers. The use of insecticides prior to vine kill is discussed below under pesticide timing.

ii. Pesticide screening. Many insecticides have been tested for efficacy for controlling PTW. In 2005 and 2006, insecticides or combinations of insecticides applied by ground sprayer or chemigation were tested at the Hermiston Agricultural Research and Extension Center in Oregon and at the USDA-ARS research site near Paterson, WA (trials conducted by Agriculture Development Group, Inc.). Products that have been found to be effective for control of PTW in Oregon and Washington can be found at http://insects.ippc.orst.edu/pnw/insects.

iii. Pesticide Timing. When to begin application of insecticides to reduce tuber damage is a very important question. Trials in 2005 in the Columbia Basin suggest that when application of three insecticides (Asana, Monitor 4, and Lannate LV) began at different intervals before vine kill, all insecticide treatments significantly reduced tuber damage, and there was no advantage in beginning control efforts earlier (4 weeks prior to vine-kill) than later (1 week prior to vine-kill). This information was generated for potatoes that were chemically killed down. Practices to be followed in fields that are allowed to slowly and naturally die down have not been adequately addressed but that situation poses a different question since tuber infestation could occur as the canopy opens slowly over a long time period.

TRAPPING PTW IN 2007

Since 2004, a pheromone trapping network has been deployed in the Columbia basin of Oregon and Washington to assess the distribution and document the spread of this pest.

For current information on PTW trapping in Oregon visit http://oregonstate.edu/Dept/hermiston/TrapReports.php (OSU, HAREC), in Washington, www.potatoes.com/research.cfm (Washington State Potato Commission).

Insects and Other "Bugs" in Potato Tubers

Since the arrival of tuberworm in the Columbia Basin, I (Andy Jensen) have been working to learn about all the insects that invade potato tubers. Several species of flies, beetles, and the like have already been seen and photographed, but I would like your help. If you find potato tubers that have maggots, worms, or other "bugs" in them, I'd like to have a sample. Just give me a call at 509-760-4859 or drop me an e-mail at ajensen@potatoes.com.

Checklist for Managing Late Blight Infected Tubers in Storage

Dennis A. Johnson, Plant Pathologist, Washington State University

Late blight was present this growing season in the Columbia Basin. Following is a checklist for managing potatoes in storage that may contain late blight infected tubers. These suggestions also apply for pink rot and *Pythium* leak. Additional information can be found at http://classes.plantpath.wsu.edu/dajohn.

1. Continue late blight fungicide applications until harvest.
2. Harvest only during dry weather.
3. Harvest when tuber pulp temperature is 45-65° F.
4. Store known infected tuber lots separate from non-infected lots.
5. Store known infected tubers lots where they can be easily obtained for processing.
6. Sort for rot going into storage - Provide sufficient light and people to do the job.
7. Provide adequate air flow rate throughout the storage (25 cfm/ton).
8. Cool and dry the tubers as quickly as possible.
9. Cure tubers at the lowest temperature possible (50° F) or eliminate the curing period, depending on the amount of rot.
10. Cool the pile to the final storage temperature as quickly as possible - about 38° F for seed, 42° F for tablestock, 45° F for French fry processing and 50° F for potato chips. It may be necessary to cool and hold tubers for processing and chips below the typically recommended temperatures.
11. Do not humidify.
12. Run fans continuously. Recirculate air through the tubers at all times, even when outside air is not being introduced.
13. Keep the piles shallow to promote air movement and removal of hotspots.
14. Monitor the storage daily. Determine temperature of the piles at various depths and locations. Serious late blight problems usually show up within 6 weeks of storage.
15. Do not expose cold tubers to outside air or any tubers to air at or below freezing.

Washington Potato Acreage, Production, and Storage Data

Crop Year	Harvested Acreage	Yield Per Harvested Acre (cwt)	Tons/A	Production (000cwt)	Stocks on Hand (000 cwt) Dec. 1	Jan. 1	Feb. 1	Mar. 1	Apr. 1	May 1	June 1
1966	58,000	376	18.8	21,830	18,300	7,150	5,500	3,950			
1967	64,000	345	17.3	22,090	10,660	8,800	6,600	4,400			
1968	64,000	378	18.9	24,173	10,430	8,800	7,050	5,100			
1969	71,700	415	20.8	29,796	15,300	13,100	10,300	7,800			
1970	87,000	386	19.3	33,590	18,500	16,000	12,500	9,700			
1971	78,000	386	19.3	30,110	16,450	13,500	10,350	7,500			
1972	75,000	418	20.9	31,365	15,800	13,400	10,300	7,100	4,200		
1973	82,000	430	21.5	35,260	18,600	15,600	12,600	9,100	5,500		
1974	98,000	420	21.0	41,160	22,500	20,500	16,800	12,800	8,900		
1975	105,000	460	23.0	48,300	27,900	24,100	19,900	11,500	10,000		
1976	124,000	450	22.5	55,800	33,200	29,700	25,000	20,100	15,200		
1977	110,000	460	23.0	50,600	28,400	24,700	20,800	15,900	11,300		
1978	109,000	465	23.3	50,685	32,000	28,800	24,000	19,300	14,500	9,500	
1979	103,000	475	23.8	48,450	30,800	27,300	23,300	19,000	14,400	10,500	
1980	87,000	505	25.3	43,935	24,300	22,000	18,500	14,600	10,900	7,200	
1981	108,000	490	24.5	52,920	29,200	25,100	21,000	17,000	12,600	8,200	
1982	110,000	480	24.0	52,800	29,200	25,100	21,600	17,100	13,200	8,600	
1983	103,000	520	26.0	53,560	29,500	25,600	21,800	16,500	11,000	7,100	
1984	115,000	495	24.8	56,925	29,600	25,900	20,800	16,600	11,300	7,000	
1985	127,000	505	24.3	61,100	33,500	30,000	25,700	21,000	16,200	9,700	
1986	118,000	510	25.5	60,200	32,300	28,000	24,400	20,400	14,600	8,700	
1987	124,000	540	27.0	67,000	36,600	32,900	28,300	22,800	17,500	12,400	
1988	115,000	550	27.5	63,300	36,700	32,100	27,700	22,500	16,200	10,700	
1989	118,000	545	27.3	64,310	34,500	30,400	25,100	20,000	13,100	7,100	
1990	132,000	515	25.8	67,980	35,500	29,500	24,500	19,800	15,100	10,400	
1991	141,000	535	26.8	75,440	37,000	32,200	27,000	21,200	15,000	9,600	
1992	125,000	525	26.3	69,300	31,000	26,700	24,900	19,800	13,000	8,200	
1993	150,000	590	29.5	88,500	43,500	38,500	32,000	26,500	20,000	13,500	
1994	152,000	585	29.3	88,900	47,500	43,000	37,500	30,500	23,500	17,000	
1995	147,000	550	27.5	80,850	39,500	33,000	30,500	25,000	18,000	12,500	
1996	161,000	590	29.5	94,990	48,000	42,000	36,500	30,000	23,000	16,500	
1997	152,000	580	29.0	88,060	47,000	41,500	36,500	29,500	22,500	16,000	
1998	165,000	565	28.3	93,225	49,000	43,500	36,500	29,500	21,500	14,500	7,500
1999	170,000	560	28.0	95,200	48,000	41,000	35,000	28,000	20,500	14,500	7,000
2000	175,000	600	30.0	105,000	59,000	52,000	44,500	37,500	29,500	21,500	13,000
2001	160,000	590	29.5	94,400	53,000	45,500	40,000	32,500	25,000	18,000	10,000
2002	165,000	560	28.0	92,400	53,000	46,500	40,000	33,000	25,500	19,500	12,000
2003	162,000	575	28.8	93,150	51,000	44,000	38,000	29,500	21,500	15,000	7,000
2004	159,000	590	29.5	93,810	50,000	43,000	36,500	29,000	22,000	15,500	8,000
2005	154,000	620	31.0	95,480	52,500	46,500	40,500	32,500	25,000	17,000	9,000
2006	155,000	580	29.0	89,900	49,000	42,500	36,500	28,500	21,000	14,000	7,000
2007	165,000	**Any guesses?**									

Data from National Agricultural Statistics Service