Postharvest Potato Tuberworm[1] Population Levels in Cull and Volunteer Potatoes, and Means for Control[2]

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ABSTRACT

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Postharvest samples of cull tubers and volunteer plants in commercial potato fields provided a large food resource for *Phthorimaea operculella* (Zeller) during noncropping periods. In commercial, spring-planted fields sampled in 1977 and 1978, 27.6 and 74.3 surface culls/100 m^2 and 1092.9 and 1670.0 subsurface culls/100 m^2, respectively, were recovered 2 months after harvest. In 1977 and 1978, 19.7 and 53.8 adult potato tuberworms/100 m^2, respectively, were reared from the surface culls, and 880.5 and 2368.1/100 m^2 were reared from the subsurface culls, respectively. In 1977, 187.2 volunteer sprouts/100 m^2, infested with a mean of 866.8 potato tuberworm larvae/100 m^2, were present 3 mo after harvest.

Culls and volunteers from the spring plantings harbored potato tuberworm larvae until the following spring planting, at which time potato tuberworm populations increased until host material was no longer available. Maleic hydrazide, a sprout inhibitor, effectively reduced volunteer sprouting. It also reduced the surviving potato tuberworm population, as indicated by larval and pheromone trap counts.

The potato tuberworm, *Phthorimaea operculella* (Zeller), is a serious and perennial pest of potatoes in California (Bacon 1960, Shorey et al. 1967). In Riverside Co. in southern California, there are 2 potato cropping seasons: the spring planting is made in Mar. and Apr. and harvested in July and Aug.; the late-summer planting is made in July and Aug. and harvested in Dec. and Jan. The potato tuberworm is a more serious pest on the spring planting, during which populations typically build up as the crop matures and peak around harvest time (Shelton and Wyman 1979 a, b). The late-summer planting is subjected to much lower potato tuberworm pressure, although insecticides are frequently required to control this pest early in this season.

Postharvest practices and survival of the nondiapausing potato tuberworm during noncropping periods are important aspects in a pest management program for this insect on potatoes. Survival of overwintering potato tuberworm populations was investigated in Virginia where Spencer and Strong (1925) reported relatively high survival rates, whereas Underhill (1926), Poos and Peters (1927), and Hofmaster (1949) reported very low survival.

Reported here are investigations into postharvest survival and overwintering sources of potato tuberworm in southern California and means of reducing such sources.

Materials and Methods

Postharvest survival of the potato tuberworm was investigated in 2 separate, spring-planted commercial fields at Lakeview and Hemet in Riverside Co. The investigation involved 2 time periods: the 1st period of survival (1st year) encompassed the time from harvest (Aug.) to 1st freeze (Dec.); the 2nd period (2nd year) represented the time from volunteer sprouting in the spring of the succeeding year (Feb.) until desiccation of the overwintering sources (May–July). Experiments also were conducted at the Univ. of California's Moreno Field Station, Riverside Co., to determine the effect of a sprout inhibitor on tuberworm survival in the 2nd period only.

For 1st-year survival, larval populations were monitored in unharvested cull potatoes and volunteer potato plants sprouting from the culls. Subsurface cull samples consisted of any tuber sifted from an area of 2.5 m^2 of soil to a depth of 30 cm. Surface cull samples consisted of any visible, or partly visible, tuber in an area of 232.5 m^2 of soil. Tubers were held in the laboratory in bulk emergence containers constructed from (64×32×32 cm) cardboard boxes with clear polyethylene lids. The lids were coated with Tack Trap® (Animal Repellents, Inc., Griffin, GA) to trap emerging adults. After holding the material for 3 wk at 20°±10°C, emerged adults were recorded. Larval populations in volunteer plants were estimated either by dissecting 5% of the sprouts from each sample to detect larval mining in the leaves and stems, or by placing the sprouts with uninfested potato tubers in emergence containers. The larvae transferred to the tubers when the volunteer sprouts became desiccated and, after completion of development, emerged adults were counted.

For 2nd year survival, larval populations were monitored in randomly selected surface culls and volunteer sprouts which were held in emergence containers. Adult populations were monitored weekly with 4 waterpan pheromone traps (Bacon et al. 1976) spaced equally along the edge of each field. Traps were placed 8 m into the field and baited with rubber septa impregnated with *trans*-4, *cis*-7-tridecadienyl acetate (Zoecon Corp., Palo Alto, CA). Trap catches were converted to moths/trap/night for successive 14-day intervals.

Lakeview (1977–78)

The field was a 92-ha rectangular field of 'Kennebec' potatoes planted in early Apr., 1977, and harvested in mid-Aug. It was disced to remove volunteer potatoes in mid-Sept. and early Dec., 1977, and in early Jan., 1978, and was left fallow during 1978. To determine 1st year

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survival (1977), subsurface cull samples were obtained on Sept. 27–29 from 18 randomly selected sites, and surface culls were obtained from 10 random sites on Oct. 3. Volunteer plants began to sprout in early Nov., and on Nov. 10, all sprouts were counted in 10 random sites. Larval populations in volunteer plants were estimated by examining 5% of the sprouts.

Second-year survival (1978) was monitored fortnightly by removal of 50 surface culls and 50 volunteer sprouts from Mar. 3 through July 22. Culls and sprouts were placed in emergence containers as previously described. Adult populations were monitored in pheromone traps from Mar. 3 to July 22. Additionally, pheromone traps were operated from Mar. 16 until May 25, 1979, to determine any residual population 2 yr after planting.

Hemet (1978–79)

This 32-ha field of Kennebec potatoes was planted in early May, 1978, and harvested in late Aug. It was disced in early Oct., 1978, and early Feb., 1979, and was seeded to barley soon after the 2nd discing operation. First-year survival (1978) was determined by 8 subsurface and 8 surface cull samples taken on Oct. 24–26. An early freeze prevented volunteer sampling in 1978. For 2nd-year survival (1979), few surface culls were present; therefore, survival was monitored by 25 randomly selected volunteer sprouts which were held in emergence containers. Additionally, four 50-m^2 sample areas were delineated in the field, and the number of volunteer sprouts was recorded weekly from Mar. 16 through May 25. Adult populations were monitored weekly from Mar. 16 through May 25.

Effect of Maleic Hydrazide on Volunteer Potato Sprouting and Potato Tuberworm Populations (1978–79)

Since previous studies indicated that volunteer plants were an important source of potato tuberworms, experiments were conducted on the Univ. of Calif. Moreno Field Station, Riverside Co., to determine the effect of a commercially available sprout inhibitor, maleic hydrazide (Uniroyal, Inc.) in reducing the source of infestation. Six 0.35-ha plots of spring planted (Apr. 28, 1979) Kennebec potatotes were grown with a 2.75-ha experimental area. Plots were separated by ca. 12.9 m of unplanted ground. Three plots were sprayed by air (90 liters/ha) with maleic hydrazide (3.37 kg/ha) at 88 days into the cropping season, and 3 were not treated. After harvest (Aug. 31), all plots were disced twice (Oct. 5, Nov. 13) and planted in nonirrigated barley on Nov. 20. In the middle of each plot, one 50 m^2 sampling area for volunteer sprouts was designated. One pheromone trap was placed in each plot near the sampling area, and the numbers of volunteer sprouts/50 m^2 and adults caught in traps were recorded weekly from Mar. 9 through May 25, 1979. Weekly samples of 5 volunteer sprouts/plot (15/treatment) were returned to the laboratory where adults were reared out on potatoes in emergence containers, as previously described.

Results

First-Year Survival

Cull samples from 1977 and 1978 demonstrated that an extremely large potato tuberworm reservoir remained in commercial fields after harvest (Table 1). Two mo after harvest in Lakeview (1977), 655 surface culls were found in the sampled area (27.6 cull/100 m^2), and 466 potato tuberworm adults were reared from these (19.7/100 m^2). Subsurface culls were more abundant (1092.9/100 m^2) than surface culls and yielded more moths (880.5/100 m^2). Three mo after harvest, 187.2 volunteer sprouts/100 m^2 were present and 866.8 larvae were dissected from the foliage (4.6 larvae/sprout).

In Hemet (1978), the density of both surface culls (74.3/100 m^2) and subsurface culls (1607.0/100 m^2) was greater than in Lakeview and levels of potato tuberworm infestation were higher with 53.8 and 2368.1 adults/100 m^2 reared from surface and subsurface culls, respectively.

Second-Year Survival

Culls and volunteer sprouts harbored a large potato tuberworm population in the year following harvest. In Lakeview (1978), larval populations reached peaks on Mar. 17, Apr. 28, and June 23, and an average of 43.9 adults was reared from 50 surface culls and 50 volunteers collected between Mar. 3 and July 8 (Fig. 1a). Adult populations, as indicated by pheromone trap catches, reached peaks on Apr. 14 and June 9 (Fig. lb). The peak larval populations in culls and volunteers in Mar. and Apr. resulted in pheromone trap peaks on Apr. 28 and June 9, respectively. In early June, culls and volunteers began to desiccate and the peak in larval populations on June 9 probably did not survive in the field

Table 1.—Surviving potato tuberworm populations in relation to the number of postharvest culls and volunteer sprouts in commercial potato fields, Riverside Co., CA, 1977–8.

Crop residue sampled	Area sampled (m^2)	No. in sample	No./100 m^2	Total no. potato tuberworms	No. potato tuberworms/100 m^2
		Field 1 (1977)			
Surface culls	2370.2	655	27.6	466[a]	19.7[a]
Subsurface culls	45.2	494	1092.9	398[a]	880.5[a]
Volunteer sprouts	2325.0	4353	187.2	20154[a]	866.8[b]
		Field 2 (1978)			
Surface culls	1880.1	1397	74.3	1011[a]	53.8[a]
Subsurface culls	20.1	323	1607.0	476[a]	2368.1[a]

[a] No. adults reared from culls.
[b] No. larvae excised from plants; 5% of plants were examined.

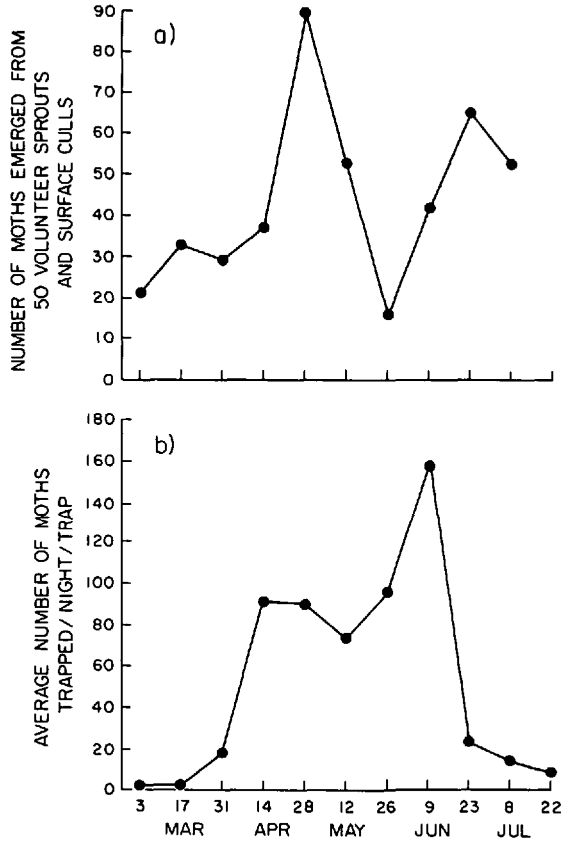

FIG. 1.—Emergence of potato tuberworm adults from potato culls and volunteers (a) and pheromone trap counts (b) in a commercial potato field after harvest, Lakeview, CA, 1978.

and, thus, there was no corresponding increase in pheromone catches in July. In the additional 3rd year survey in Lakeview in 1979, pheromone catches remained below 0.4 moths/trap/night from Mar. 16 through May 25. A field survey on Apr. 20, 1979, revealed no potato tuberworm host material in the field.

In Hemet (1979), volunteers harbored a low potato tuberworm population. The number of volunteer sprouts/50 m^2 (Fig. 2a) increased from the 1st sampling date (23.4 on Mar. 16) to a peak on Apr. 20 (62.5). The presence of fast-growing grain in Hemet shaded the emerging volunteers and this, coupled with increased competition for available soil moisture, probably caused a subsequent decline in the number of volunteer sprouts so that none were present by May 25. The number of moths emerging from 25 volunteer sprouts was below 10 from Mar. 9 through Apr. 6, but quickly increased thereafter to a peak of more than 40 moths/25 sprouts from Apr. 20 until May 4 (Fig. 2b). This increase in the field larval population during Apr. resulted in higher pheromone catches in May, which reached a peak (12.7 moths/trap/night) on May 11 (Fig. 2c). Both larval populations in the volunteers and pheromone trap catches declined rapidly in late May.

Effect of Maleic Hydrazide on Volunteer Potato Sprouting and Potato Tuberworm Populations

Maleic hydrazide was effective in reducing the number of volunteers sprouting from unharvested culls (Fig. 3a). From Mar. 9 through Apr. 20, an average of 48.0 volunteer sprouts/50 m^2 was detected in maleic hydrazide treated plots compared with 191.9/50 m^2 in untreated plots. With increasing temperatures and declining soil moisture in late Apr., the number of volunteer sprouts/50 m^2 in both treatments rapidly declined until no volunteer sprouts were detected on May 25. The number of moths reared from 15 volunteer sprouts/treatment was similar throughout the season (Fig. 3b). However, with the lower density of volunteer plants in the maleic hydrazide treated plots, fewer total moths emerged from these plots and, hence, pheromone catches were markedly lower from Apr. 27 through May 11 (Fig. 3c).

Discussion

In Riverside Co. late-summer-planted potato fields often are located in close proximity to previously harvested spring-planted fields. Culls remaining in spring-planted fields harbor large potato tuberworm populations and are a significant factor in the need for insecticidal control of the larvae which mine emerging plants of the late-summer crop (Shelton and Wyman 1979b). Moreover, the spring-planted crop's residue harbors a potato tuberworm population which can be carried over to the succeeding year's spring planting, although such a carryover would be likely to occur for only 1 yr.

Levels of postharvest potato tuberworm populations in cull and volunteer potatoes may be influenced by many factors, such as temperature and rainfall, but a

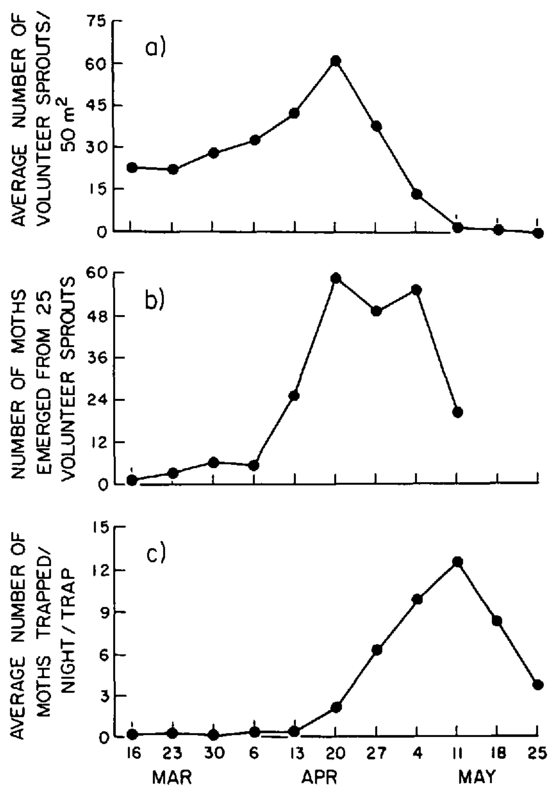

FIG. 2.—Density of potato volunteer plants (a), potato tuberworm larval density (b), and pheromone trap counts (c) in a commercial potato field after harvest, Hemet, CA, 1979.

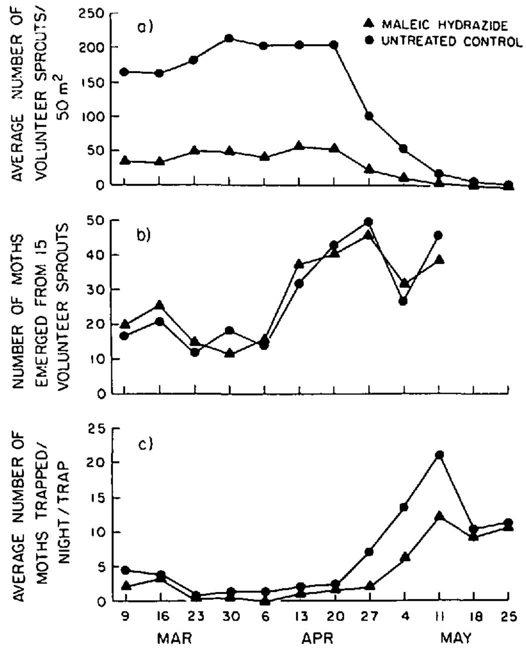

FIG. 3.—Mean density of potato volunteer plants (a), potato tuberworm larval density (b), and pheromone trap counts (c) in maleic hydrazide treated and untreated potatoes, Moreno, CA, 1979.

clean harvest and elimination of infested culls are important and controllable factors for reducing residual potato tuberworm populations. A dense, early-season planting of grain, which would inhibit volunteer potato growth, also would be beneficial in reducing residual populations. In areas where potato volunteers are a perennial problem, maleic hydrazide could be incorporated into a pest management program by effectively reducing volunteer growth and subsequent levels of potato tuberworm populations. Such a treatment, however, would have a minor effect if sufficient infested culls were left in the field and survived until the following cropping season.

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