Time of Tuber Infestation and Relationships Between Pheromone Catches of Adult Moths, Foliar Larval Populations, and Tuber Damage by the Potato Tuberworm

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Time of Tuber Infestation and Relationships Between Pheromone Catches of Adult Moths, Foliar Larval Populations, and Tuber Damage by the Potato Tuberworm[1,2]

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ABSTRACT

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Time of tuber infestation by *Phthorimaea operculella* (Zeller) was markedly affected by the type of irrigation system employed. Tuber infestation under furrow irrigation was above 25% for 4 wk prior to vine senescence while sprinkler irrigated potatoes sustained less than 5% damage during this period. After irrigation was terminated, infestation increased rapidly in sprinkler irrigated plots. Tuber infestation continued to increase in all irrigation blocks late in the season, but rows which were hilled and rolled sustained less damage than ones which were only rolled.

Larval populations in the foliage and moth counts in pheromone traps increased during the season and were significantly correlated. Under furrow irrigation, pheromone trap catches and larval counts in the foliage were significantly correlated with tuber damage.

Several approaches are available for the development of an integrated pest management system for the potato tuberworm, *Phthorimaea operculella* (Zeller), on potatoes. Traynier (1975) demonstrated that eggs are preferentially laid in the soil at the base of plants and suggested this site as useful in relation to control. A number of foliar insecticides are used against the potato tuberworm, but control of foliage infestation does not always prevent tuber infestation (Bacon 1960, Foot 1974). In the absence of pesticides, natural controls constitute an important mortality factor, particularly in fall plantings (Oatman and Platner 1974). Cultural controls that utilize deeper seed planting and hilling of rows also help to prevent tuber infestation (Langford 1933, Foot 1976). Irrigation practices can reduce tuber infestation with sprinkler irrigation significantly reducing damage when compared to furrow irrigation (Shelton and Wyman 1979).

Following the identification of the potato tuberworm sex pheromone (Roelofs et al. 1975, Persoons et al. 1976) and the development of an effective trapping system (Kennedy 1975, Bacon et al. 1976), a new tool for evaluating tuberworm field populations became available. To facilitate commercial utilization of this pheromone, we conducted studies to determine when tuberworm infestation occurs under different irrigation systems, as well as the relationship between pheromone trap catches and foliar larval counts, and their relationships to tuber damage.

Materials and Methods

Experiments were conducted in 1978 at the University of California's Moreno Field Station, Riverside Co., with spring planted (Mar. 27) 'Kennebec' potatoes. This cultivar was used since it is a shallow-setting variety with high susceptibility to potato tuberworm. Rows were on 0.81-m centers, and the soil type was uniform sandy loam. Standard commercial cultivation practices were utilized, except that no insecticides were used to control the potato tuberworm.

A 2.39-ha rectangular, experimental area was subdivided longitudinally into 3 blocks. Blocks were oriented in a N–S direction because potato tuberworm moths normally move into the area from the south. Each block received one of 3 common irrigation practices: furrow (one 24-h set/week); sprinkler 1X (one 18-h set/week); and sprinkler 3X (three 6-h sets/week). Sprinkler laterals were spaced 12.2 m between uprights and 2.4-mm nozzles were used.

Six sampling areas (plots) were established in each block and buffered by 12.2 m on N–S sides and 19.5 m on E–W sides. Each plot was subdivided into 4 rectangular subplots (44.6 m^2 each) positioned within the plot so that, together with border areas, they formed a rectangle (267.6 m^2). In the center of each plot, a UC/Davis water trap (Bacon et al. 1976) was placed at ground level and baited with a rubber septum that was impregnated with potato tuberworm sex attractant (trans-4, cis-7-tridecadienyl acetate, Zoecon Corp., Palo Alto, CA). Trap pans were filled to within 2 cm of the top with water that contained one ml of detergent/3.8 liters of water. A one-m area around each trap was cleared of foliage. Trapping was initiated 76 days after planting when moth populations began to increase, and traps were monitored weekly for 7 wk.

Two plants and 5 tubers from each of the plants were removed weekly from each subplot at random, beginning 76 days into the growing season. Weekly subsamples were combined to make a total of 8 plants and 40 tubers from each plot. Tubers and plants were returned to the laboratory and examined for potato tuberworm infestation. Tubers were characterized as either infested or noninfested, and the lower half of each potato plant was dissected to detect potato tuberworm larvae which were found in both foliage and stems. Infested tubers were expressed as a percentage of the total harvested per plot per week, larvae as the mean no. per plot per week, and adult moths as the mean no. per trap per night for weekly periods.

Most vine senescence occurred between 108–118 days after planting; the last foliage sample was taken and irrigation was terminated at 111 days. At 118 days, remaining vines were rotochopped, and beds in half of each plot were rolled while beds in the other half received an additional hilling before being rolled. Two additional weekly tuber samples were taken after vine re-

[1] Lepidoptera: Gelechiidae.

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moval to determine the effect of the extra hilling on tuber infestation. At the conclusion of the experiment, tuber yields were determined by harvesting six 6-m bed samples/irrigation regime.

Results

Time of Infestation and Tuber Yield

Almost all tuber infestation under the 3 irrigation systems occurred from 76–118 days after planting (Fig. 1). Percent tuber infestation under furrow irrigation increased as the season progressed, with infestation above 25% for 4 wk prior to vine senescence and termination of irrigation (111th day). Tubers grown under both sprinkler irrigation regimes sustained less than 5% tuber infestation prior to vine senescence. After vine senescence and termination of irrigation, tuber infestation in the sprinkled blocks increased rapidly, rising from 2.5 to 43.7% for sprinkler 1X and 3.3 to 37.8% for sprinkler 3X, between 111 and 118 days.

Under all irrigation systems, tuber infestation increased between 118 and 132 days after planting, but increases in rolled and hilled beds were less than those in rolled beds (Table 1). Percent infestation was compared at both 125 and 132 days within each irrigation regime, using a paired t-test with arcsine transformations. There were no significant differences ($P>0.10$) between the tuber infestation at 125 days (Table 1). At 132 days, tuber infestation in rolled and hilled beds was significantly less ($P<0.05$) than in rolled beds in both sprinkler 3X ($t = 6.23$, 5 df) and sprinkler 1X ($t = 2.63$, 5 df) blocks.

Irrigation treatments did not affect tuber yield. Avg tuber yields per irrigation regime per 6-m bed were: sprinkler 3X, 14.9 kg (100.3 tubers); furrow, 14.4 kg (97.0 tubers); and sprinkler 1X, 15.2 kg (93.8 tubers).

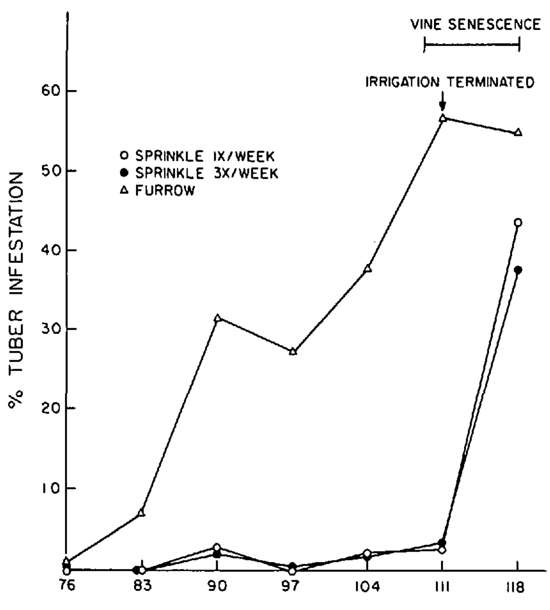

FIG. 1.—Time of potato tuber infestation by the potato tuberworm in spring planted potatoes grown under different irrigation systems, Moreno, CA, 1978.

Foliage Larval Counts and Pheromone Trap Catches

Potato tuberworm larval populations in the foliage increased steadily under all irrigation regimes as the season progressed (Fig. 2). Weekly foliar larval populations were similar between irrigation systems, averaging below 5 larvae/plot at 76 days and increasing to 46–50 larvae/plot at 111 days after planting.

Pheromone trap catches also increased as the season progressed although they were more variable than foliar larval counts (Fig. 2). Pheromone trap catches per trap per night for all 3 irrigation systems averaged below 25 at 76 days and between 205 and 257 at 125 days after planting. The seasonal mean moths per trap per night averaged 96.1, 93.6, and 88.8 for the sprinkler 3X, furrow, and sprinkler 1X blocks, respectively.

Correlation between Larval Counts, Pheromone Trap Catches, and Tuber Damage

Pheromone trap catches were linearly and positively correlated with foliar larval counts within each irrigation regime when the mean number moths per trap per night for a particular week was paired with the mean number larvae per plot for the following week: sprinkler 1X ($P<0.05$, r = 0.891, 3 df); furrow ($P<0.02$, r = 0.941, 3 df); sprinkler 3X ($P<0.10$, r = 0.810, 3 df).

Tuber damage prior to vine senescence was markedly affected by the type of irrigation employed, with extensive tuber damage occurring only after 111 days under sprinkler irrigation, although foliar larval counts and

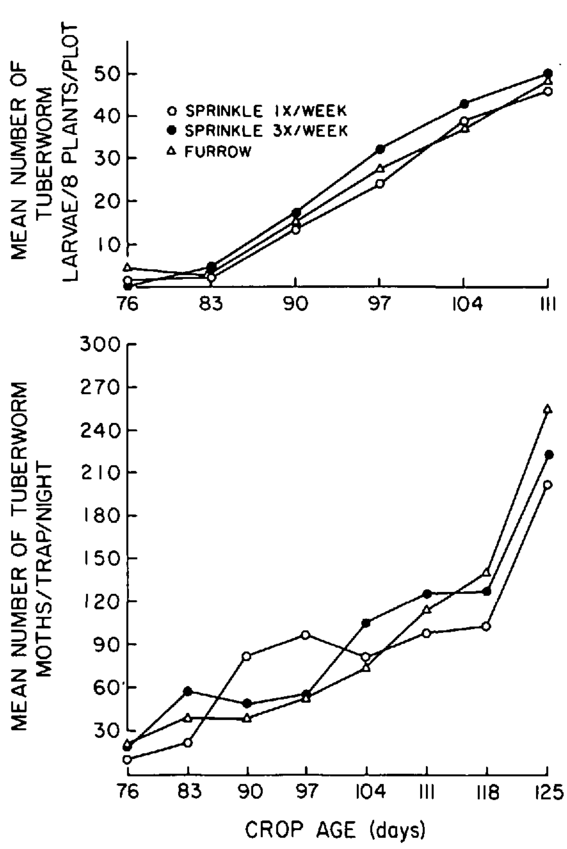

FIG. 2.—Effect of irrigation systems on larval and adult potato tuberworm populations during the growing season of spring planted potatoes, Moreno, CA, 1978.

Table 1.—Effect of post-vine senescence cultural practices on potato tuberworm infestation, Moreno, CA, 1978.

Days after planting	Mean tubers infested (%)[a]					
	Sprinkler 1X		Sprinkler 3X		Furrow	
	Rolled	Rolled, hilled	Rolled	Rolled, hilled	Rolled	Rolled, hilled
118[b]	43.7	43.7	37.8	37.8	55.4	55.4
125	55.5	50.7	59.5	51.7	60.0	55.4
132	63.3*	53.3*	65.8*	50.8*	72.5	64.2

[a] * Denotes significant differences at the 5% level between cultural practices with 1 irrigation regimen for 1 sampling date.
[b] 118 day sample taken prior to post-vine senescence cultural practices.

pheromone trap catches had increased substantially prior to vine senescence. Under furrow irrigation, tuber damage was sustained earlier in the season and was more closely related to increases in larval and pheromone counts. Thus, under furrow irrigation the weekly mean number larvae per plot was linearly and positively correlated ($P < 0.01$, $r = 0.935$, 3 df) with the mean % tuber damage per plot for the same week. The mean number moths per trap per night under furrow irrigation was also linearly and positively correlated ($P < 0.02$, $r = 0.883$, 4 df) with the mean % tuber damage per plot for the following week.

Discussion

The extent and time of damage to tubers were determined largely by time of harvest, type of irrigation, and cultural practices and, thus, foliage larval populations and pheromone trap counts would not always give an accurate prediction of tuber damage. Foliar larval counts and pheromone trap counts were correlated under all irrigation regimes tested however, and pheromone trap data could be used to predict foliar damage. When tubers are accessible, as under furrow irrigation or following vine senescence under sprinkler irrigation, pheromone traps may aid in directly assessing potential damage without resorting to foliage or tuber counts, both of which are extremely time consuming. Most tuber damage under sprinkler irrigation occurred after the vines senesced and irrigation was terminated. If vines were killed before complete senescence and tubers harvested soon thereafter, tuber infestation would be reduced. If harvest is delayed, cultural practices, such as an additional hilling in conjunction with rolling, would reduce tuber accessibility and subsequent damage.

REFERENCES CITED

Bacon, O. G. 1960. Control of the potato tuberworm in potatoes. J. Econ. Entomol. 53: 868–71.

Bacon, O. G., J. N. Seiber, and G. G. Kennedy. 1976. Evaluation of survey trapping techniques for potato tuberworm moths with chemical baited traps. Ibid. 69: 569–72.

Foot, M. A. 1974. Field assessment of several insecticides against the potato tuber moth *Phthorimaea operculella* (Zell.) at Pukukohe. N.Z.J. Exp. Agric. 2: 191–7.

1976. Cultural practices in relation to infestation of potato crops by the potato tuber moth. Ibid. 4: 121–4.

Kennedy, G. G. 1975. Trap design and other factors influencing capture of male potato tuberworm moths by virgin female baited traps. J. Econ. Entomol. 68: 305–8.

Langford, G. S. 1933. Observations on cultural practices for control of the potato tuberworm *Phthorimaea operculella* (Zell.). Ibid. 26: 135–7.

Oatman, E. R., and G. R. Platner. 1974. Parasitization of the potato tuberworm in southern California. Environ. Entomol. 3: 262–4.

Persoons, C. J., S. Voerman, P. E. Verwiel, F. J. Ritter, W. J. Nooyen, and A. K. Minks. 1976. Sex pheromone of the potato tuberworm moth, *Phthorimaea operculella:* isolation, identification and field evaluation. Entomol. Exp. Appl. 20: 289–300.

Roelofs, W. L., J. P. Kochansky, R. T. Cardé, G. G. Kennedy, C. A. Hendrick, J. N. Labovitz, and V. L. Corbin. 1975. Sex pheromone of the potato tuberworm *Phthorimaea operculella*. Life Sci. 17: 699–705.

Shelton, A. M., and J. A. Wyman. 1979. Potato tuberworm damage to potatoes grown under different irrigation and cultural practices. J. Econ. Entomol. 72: 261–4.

Traynier, R. M. 1975. Field and laboratory experiments on the site of oviposition by the potato moth. Bull. Entomol. Res. 65: 391–8.