INFLUENCE OF CULTIVAR, TUBER DEPTH, AND SOIL MOISTURE ON POTATO TUBERWORM[1/] INFESTATION OF POTATOES

A. M. Shelton[2/] and J. A. Wyman[3/]

Department of Entomology
University of California
Riverside, CA 92521

ABSTRACT

Tuber infestation by the potato tuberworm, Phthorimaea operculella (Zeller), differed significantly between potato cultivars and was inversely related to tuber depth. In single row beds, mean tuber depth and potato tuberworm infestation did not differ significantly between the cultivars 'Kennebec' (5.7 cm and 15.1%, respectively) and 'White Rose' (6.0 cm and 11.3%); however, 'Norgold' tubers were significantly deeper (9.1 cm) and sustained significantly less tuberworm infestation. Double bedded rows sustained slightly reduced tuber infestation compared to single row beds, but differences were not significant. Soil moisture markedly affected tuber infestation by potato tuberworm larvae in the laboratory. First and 3rd stage larvae penetrated dry, uncracked soil and infested tubers buried at 4 and 6 cm, respectively. In wet, uncracked soil, infestation did not occur when tubers were buried at 2 cm.

INTRODUCTION

The potato tuberworm, Phthorimaea operculella (Zeller), occurs in many areas of the world and is a perennial pest of potatoes in southern California. Tuberworm larvae mine the leaves and stems of potato plants and, toward the end of the growing season, will infest the tubers if the soil is cracked or dried and tubers are near the surface (Shelton and Wyman 1979a,b). In southern California, severe tuberworm infestations have been commonly associated with spring-planted 'Kennebec' potatoes. In New Zealand, potato cultivars have been specifically tested for susceptibility to potato tuberworm injury and, although no data on plant growth characteristics were reported, it was observed that varieties with a prolonged, upright growth habit and few leaves close to the soil sustained low foliage populations of potato tuberworm. It was also observed that less tuber infestation was associated with deeper tuber set, but again no data were presented (Foot 1976).

Reported here are results of studies to determine tuber susceptibility of 3 common potato cultivars to tuberworm damage, effects of tuber depth and soil moisture on infestation, and effect of double-bedded plantings on tuber infestation levels.

1/ Lepidoptera: Gelechiidae.

2/ Current address: New York State Agricultural Experiment Station, Department of Entomology, Cornell University, Geneva, NY 14456.

3/ Current address: Department of Entomology, University of Wisconsin, Madison, WI 53706.

MATERIALS AND METHODS

Field. Experiments were conducted in 1978 at the University of California's Moreno Field Station, Riverside County, on late summer planted (Aug. 21) potatoes grown in uniform sandy loam soil. Rows were on 0.81 m centers and the crop was sprinkler-irrigated twice weekly from Sept. 15 until Nov. 23. During each 4 h irrigation period, 38.4 kiloliters of water were applied per hour per ha. The cultivars 'Kennebec', 'White Rose' and 'Norgold' were replicated 3 times in a split plot design with cultivars as main plots and bed widths as subplots. Each plot consisted of four 12.2 m long rows subdivided into 2 adjacent single beds and 1 double bed. The double bed was formed by removal of the middle shovel on the potato planter. Plots were separated by ca. 1.5 m fallow ground on all sides. Seed pieces of all cultivars were planted 14 cm deep and beds were rehilled on Oct. 12. Vines were killed by frost (Dec. 5) and, prior to harvest, the natural tuberworm population was augmented by evenly distributing 17,000 laboratory-reared mature eggs (Platner and Oatman 1968) throughout the field. Beds were sliced open (Dec. 27) and the positions of 10 tubers from each single bed and 20 tubers from each double bed were measured in relation to their nearest point to the bed surface. Bed heights at 3 locations/row also were recorded (Shelton and Wyman 1979a). At harvest (Dec. 28), samples of 50 tubers from each single bed and 100 from each double bed (50/row) were examined in the laboratory for potato tuberworm damage. Mean bed heights, tuber depths, and arcsine transformations of percent tuber infestation for each plot were used for analyses.

Laboratory. Tests were conducted to determine the ability of 1st and 3rd stage larvae to infest potatoes buried at various depths in soil collected from the field trial and adjusted to 2 different moisture levels. Dry soil (ca. 1% water) was obtained by oven-drying and wet soil, at field saturation level (ca. 14%), by autoclaving. 'Norgold' tubers were buried singly in plastic pots (27 cm diam. x 35 cm deep) at 0, 2, 4, 6, 8, and 10 cm. Tubers were exposed to 1st stage larvae that hatched from small swatches of muslin cloth. The cloth contained ca. 100 mature eggs which were placed on top of the soil directly above the buried tubers. Tuber infestation by 3rd stage larvae was evaluated by removing 5 larvae from infested potatoes (Platner et al. 1969) and placing them on the soil surface directly above the tubers. When the tuber was on the soil surface (0 cm depth), the egg cloth and larvae were placed ca. 2 cm to the side of the tuber. Each tuber depth was replicated 10 times for each larval stage and each moisture regime. Pots were held at 24° ± 4°C and tuber damage was evaluated after 7 days.

RESULTS

Field. Infestations of 'Kennebec' and 'White Rose' tubers, although not significantly different from each other, were significantly higher ($P = 0.05$) than 'Norgold' tubers (Table 1). In single row beds, 'Kennebec' and 'White Rose' tubers sustained significantly higher infestation (15.1 and 11.3%, respectively) than 'Norgold' tubers (2.3%). Within cultivars there were no significant differences ($P = 0.05$) in tuber infestation between single and double-bedded plantings, although infestation was slightly lower in double row beds.

Bed heights for all varieties and both bed types were not significantly different (Table 1). In single row beds, 'Norgold' tubers were significantly deeper (9.1 cm) than 'White Rose' (6.0 cm) and 'Kennebec' (5.7 cm) tubers; double row beds did not alter tuber setting depth. Tuber depth was inversely related to % tuber infestation under both bedding practices, and regression lines for tuber depth-tuber infestation for the 2 bed types were compared. Since the lines were not significantly different from each other ($P = 0.05$), tuber depth-tuber infestation for both types of beds was combined to give a

more reliable estimate of p (Snedecor and Cochran 1967). By this method, tuber infestation over all varieties was significantly inversely correlated ($P = 0.1$, $r = -0.811$, 16 df) with tuber depth.

TABLE 1. Bed Height, Tuber Depth and Potato Tuberworm Infestation of 3 Potato Cultivars, Moreno, CA. 1978.

Cultivar	Bed type	Bed height (cm)[a]	Tuber depth (cm)[a]	% infestation[a]
Kennebec	Single	18.9 a	5.7 a	15.1 a
Kennebec	Double	19.3 a	6.1 a	13.6 a
White Rose	Single	19.7 a	6.0 a	11.3 a
White Rose	Double	20.6 a	6.4 a	10.2 a
Norgold	Single	19.2 a	9.1 b	2.3 b
Norgold	Double	19.8 a	9.0 b	1.7 b

[a] Mean separation vertical: means flanked by the same letter are not significantly different at $P = 0.05$ by Duncan's multiple range test.

Laboratory. Both 1st and 3rd stage larvae penetrated dry, uncracked soil and infested buried tubers (Table 2). Third stage larvae infested 10% of the tubers buried at 6 cm while 1st stage larvae penetrated soil to a depth of only 4 cm and caused 50% infestation. Surface tubers in wet soil were infested, but neither larval stage infested buried tubers.

TABLE 2. Effect of Tuber Depth and Soil Moisture on Tuber Infestation by 1st and 3rd Instar Potato Tuberworm Larvae.

	Mean tubers infested (%)			
	1st stage larvae[a]		3rd stage larvae[b]	
Tuber depth (cm)	Dry soil	Wet soil	Dry soil	Wet soil
0	100	100	100	90
2	100	0	50	0
4	50	0	10	0
6	0	0	10	0
8	0	0	0	0
10			0	

[a] 100 eggs/pot, 10 replicates.
[b] 5 larvae/pot, 10 replicates.

DISCUSSION

Although other plant characteristics also may be involved in tuber susceptibility, depth of tuber set alone can be used to explain the differences in tuberworm infestation between these varieties. Differences in susceptibility may also be influenced by other factors, such as larger tubers in both the 'Kennebec' and 'White Rose' cultivars which may account for their closer proximity to the soil surface, or cause extensive soil cracking leading to greater susceptibility to tuberworm.

In laboratory tests, high soil moisture inhibited tuberworm infestation of potatoes. These data agree with previous reports of laboratory studies (Langford 1933) and field observations (Hofmaster 1949). Under similar irrigation regimes in the field, single beds, because of their greater exposed surface area, should become drier than double beds and, hence, incur more tuber infestation. The interval between termination of irrigation and harvest, however, is more important for tuber infestation since soil moisture is decreasing and infestation is increasing (Shelton and Wyman 1979b). Therefore, double-bedded plantings may incur less infestation than single beds if this interval is shortened.

LITERATURE CITED

Hofmaster, R. N. 1949. Biology and control of the potato tuberworm with special reference to eastern Virginia. Va. Truck Exp. Stn. Bull. No. 111. 59 pp.

Langford, G. S. 1933. Observations on cultural practices for the control of the potato tuberworm Phthorimaea operculella (Zell.). J. Econ. Entomol. 26:135-7.

Platner, G. R., and E. R. Oatman. 1968. An improved technique for producing potato tuberworm eggs for mass production of natural enemies. J. Econ. Entomol. 61:1054-7.

Platner, G. R., P. D. Greany, and E. R. Oatman. 1969. Heat extraction technique for recovery of potato tuberworm larvae from potato tubers. J. Econ. Entomol. 62:271-2.

Foot, M. A. 1976. Susceptibility of twenty potato cultivars to the potato moth at Pukekohe: a preliminary assessment. N. Z. J. Exp. Agric. 4:239-42.

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

Shelton, A. M., and J. A. Wyman. 1979b. Time of tuber infestation and relationships between adult and larval populations and tuber damage by the potato tuberworm. J. Econ. Entomol. 72:599-601.

Snedecor, G. W., and W. G. Cochran. 1967. Statistical methods. Iowa State Univ. Press, Ames, Iowa, 593 pp.