TRIALS WITH CHEMICALS[1/] FOR CONTROL OF COMMON SCAB[2/] AND THE POTATO SCAB GNAT[3/] ON RUSSET BURBANK POTATOES[4/]

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Common scab, which is caused by Streptomyces scabies (Thaxter) Waksman and Henrici, is a well-known and widely distributed fungus disease of potatoes, and is most likely to infect potatoes grown in soils of Washington having a range of pH[7/] between 5.5 and 7.5; it rarely occurs there when the soils have a pH below 5.3 or above 8.0 (Blodgett and Rich 1949) though Bonde and McIntyre (1968) reported a Streptomyces sp. causing scab in Maine soils with a pH below 5.

In 1917, Morris et al. reported that common scab was much less prevalent in Washington than in many other parts of the country. However, Ohms and Fenwick (1961) reported that common scab was observed attacking potatoes grown on land soon after it was cleared of sagebrush near Jerome, Idaho in 1916. Also, in Washington, what may have been the first serious trouble with the common scab developed in land shortly after it had been cleared near Moses Lake in 1946 (oral communication in 1946 from Dr. J. D. Menzies, Plant Pathologist, Agr. Res. Serv., USDA, formerly stationed at Prosser, Wash).

Potato tubers can also be attacked by the larvae of a small fly, the potato scab gnat, Pnyxia scabiei (Hopkins), if the soil pH is above 5.0 (Gui 1933), and frequently, the deep pits produced by these larvae (filled with deep granular excrement) occur beside, or have been superimposed on, the scab lesions. Thus, the scab gnat larvae frequently infest and enlarge the lesions.

To date, in Washington, the potato scab gnat has only been found attacking potatoes when common scab is present. However, the gnat has not been reported from Idaho. The first record of the potato scab gnat and deep pits in common scab in Washington was that of B. J. Landis who found from 1 to 3 larvae/pit in White Rose potatoes grown 8 miles west of Toppenish in August 1948 (1948 unpublished field notes). A year later Blodgett and Rich (1949) reported that when deep pits were found in scab lesions, the appearance suggests secondary injury by insects or other very small pests. Next, the potato scab gnat was found in 2 large potato fields located in the vicinity of Eureka, Walla Walla County, in 1970. These potatoes (approximately 2,000 acres) were more or less infected with common scab, and approximately 500

1/ This paper reflects the results of research only. Mention of a pesticide or a proprietary product in this paper does not constitute a recommendation or an endorsement of this product by the USDA or Washington State University.

2/ Schizomycetes; Streptomyces scabies (Thaxter) Waksman and Henrici.

3/ Diptera; Sciaridae: Pnyxia scabiei (Hopkins).

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7/ The symbol used for expressing both acidity and alkalinity on a scale of 0 to 14; 7 represents the value for pure water. Values greater than 7 indicate increasing alkalinity.

acres were also heavily infested with the gnat. When the affected potatoes were sold to a processor, he reported that paring waste amounted to as much as 30% in some truckloads and that about 20% of the waste occurred because of deep pits in the scab; the pits ranged from a little more than skin deep to more than 0.5 in. deep.

Common scab has been treated with several chemicals, and a few seem to be effective in some areas but not in others. In Washington, Morris et al. (1917) suggested that sulfur might reduce scab considerably in certain soils if it was broadcast at a rate of 350-900 lb/acre and worked into the soil surface just before planting time. Also, in Washington, Harris and Brannon (1962) reported that several fumigants had given effective control though they were costly. In Idaho, Ohms and Fenwick (1961) reported that applications of sulfur did not decrease the severity of scab and that pentachloronitrobenzene (PCNB) and urea formaldehyde also did not provide effective control. Also, though the potato scab gnat has been a serious but intermittent pest of potatoes in West Virginia (Hopkins 1895), Missouri (Howard 1895), New York (Johannsen 1912), Ohio (Gui 1933), and Ontario (Wood 1937), no suitable insecticide has been developed for its control.

The apparent severity of the problem of common scab plus potato scab gnats at Eureka in 1970 therefore caused us to make some exploratory pathological and entomological tests in cooperation with a grower at Eureka. The 1971 tests were made in the laboratory in a field where common scab and the potato scab gnat had heavily damaged Russet Burbank potatoes in 1970. The following report summarizes the results of the field trials of a variety of treatments and reports some data concerning the biology of the potato scab gnat.

MATERIALS AND METHODS

Examination of many scabby potatoes left in a field following harvest in 1970 showed that some contained fly larvae. Therefore, several hundred pounds of tubers were collected and brought to the laboratory at Yakima for study. Some were placed in gallon-size glass jars with river bottom loam soil for rearing the insects to the adult stage so that they could be identified more easily. Others were buried 6 to 8 in. deep in the same kind of soil in a greenhouse bench.

Also, since Gui (1933) found that the first generation of the potato scab gnat was often produced in planted potato seed pieces, greenhouse tests were conducted to determine whether the seed pieces could be protected with chemicals before planting. In one trial, 10 freshly cut Russet Burbank potato seed pieces were soaked for 5 min in a 1% water emulsion of azinphosmethyl and then planted alternately and 4 in. apart with untreated seed pieces in a greenhouse bench stocked with the scab gnat. Then, approximately 3 months later, each seed piece was removed from the soil and dissected, and the number of potato scab gnat larvae present were counted. In another trial, 10 freshly cut Russet Burbank potato seed pieces each were soaked for 5 minutes in 1% water emulsions of Orthene[R] (dimethyl-O,S acetyl phosphoramidothioate), methomyl, menazon, or cartap and 10 seed pieces were not treated. Each treated or untreated seed piece was considered a plot and planted 5 in. apart in a randomized complete block design in a greenhouse bench. Then 41 days after planting (during this time, some scab gnat larvae probably completed development and emerged as adults), the seed pieces were harvested, placed individually in half-pint jars with sand, and held for 4 days to allow additional flies to emerge.

The field tests were made on about 0.3 acre of land near Eureka, where the Russet Burbank potatoes had been heavily scabbed and infested with potato scab gnat in 1970. (Examination in the spring of 1971 of potato tubers that had overwintered in the test area showd that both common scab and the potato scab gnat had overwintered successfully.) The tract was divided into 48 narrow plots each 50 ft. long and 5 ft. 8 in. wide (enough for two 34-in. wide rows of potatoes), and each of the treatments was replicated 6 times. The plots treated with ammonium sulfate fertilizer received applications of 400 lb N/acre broadcast and worked 4 to 6 in. deep into the soil before planting.

The 8 treatments were as follows:

1. ammonium sulfate (400 lb/acre) plus captan treatment (0.6 lb a.i.) of seed pieces.

2. ammonium sulfate (400 lb/acre) as in treatment 1 and captan treatment (0.3 lb a.i.) of seed pieces plus 800 lb of prilled sulfur/acre applied to the planting furrow at planting time.

3. ammonium sulfate and captan as in treatment 2 plus 38 gal of Telone R (Mixed dichloropropenes, 85%, chloropicrin, 15%)/acre injected into the soil before planting.

4. ammonium sulfate and captan as in treatments 2 and 3 plus 800 lb of prilled sulfur/acre sidedressed after the potatoes were planted.

5. ammonium sulfate as in treatments 1-4 broadcast and worked into the soil before planting.

6. ammonium sulfate and captan as in treatments 2-4 plus water soluble pellets containing 30% a.i. Shell SD-1836 (2-chlorovinyl diethyl phosphate) sidedressed on each side of the planted rows at a rate of 6 pellets/ft or 3 pellets on one side of the row staggered with 3 pellets on the other side in each foot (2 lb a.i./acre). The pellets were applied 2 in. to each side and level with the seed pieces with a modified seeder.

7. ammonium sulfate and captan as in treatments 2 & 4 plus seed pieces soaked 5 min in a 1% water emulsion of azinphosmethyl immediately before planting.

8. ammonium nitrate (400 lb/acre) broadcast on the soil and worked into the soil before planting plus captan as in all treatments except 1 and 5.

The broadcast applications of the 2 fertilizers were made about April 12, and the Russet Burbank potatoes were planted April 15. The sidedress application of Shell SD-1836 was made April 16.

Also, 2 chemicals were tested in adjacent plots outside the main test area: Pennwalt TD-5056 (2-(methylsulfonyl)-6-nitrobenzothiazole) and Pennwalt Td-1771 (dimethyl 4,4'-*o*-phenylenebis[3-thioallophanate]). For this test, enough potato seed pieces to plant two 50-ft long, single-row plots of each material were tumbled with 5% dust mixtures of the 2 chemicals and then planted in duplicate plots at the ends of the main plots.

The potatoes were irrigated approximately every 14 hr with an overhead sprinkler, 0.4 in. of water/acre. On October 4, an experimental 1-row harvester was used to harvest the tubers from 30 ft of row from the center of 1 of each 2-row plot. The potatoes were taken to a warehouse, weighted, graded for No. 1's as to size and shape, and then sorted into 2 lots, one consisting of tubers having 0-5 common scab lesions infested with potato scab or scab gnat pits/tuber, and the other of tubers having more than 5 such lesions and pits. Each of these 2 lots of potatoes was also weighed. Then, 25 of the largest tubers of the lot containing 6+ scab or scab gnat lesions/tuber from each plot were taken to the laboratory where the number of potato scab gnat pits (regardless of size) were counted.

RESULTS

A total of 7 species of flies were reared from potato tubers collected in the fields at Eureka in 1970 and 1971 as follows: the potato scab gnat, *Lycoriella sativae* (Johannsen), *Sciara* sp., *Scatopse fuscipes* Meigen, *Leptocera* n. sp., *Eumerus tuberculatus* Rondani and *Ceroxys latiusculus* (Loew). *Pnyxia scabiei*, *L. sativae*, *Sciara* sp., and *Scatopse fuscipes* are probably all involved in the scab-gnat complex; the other, larger flies are believed to be primarily scavengers that feed on decaying tubers.

The potato scab gnat was reared in the laboratory quite easily during the winter of 1970-1971. New colonies could be started simply by removing several females (the females are all wingless) and several males (males are all winged) from the bottom of an old rearing jar and placing them in a new glass jar containing a little moist sand and freshly cut pieces of potato tuber. The females laid eggs on the cut surface of the potato; these hatched within a few days, then the larvae fed on the potato and formed pits of various sizes before they moved to the outside where they pupated. A few days later, the new adults emerged, and a new cycle started. The scab gnat can overwinter in potatoes left in the field in the Washington area or in washed or unwashed potatoes placed in common storage. The life cycle is completed in from 15 to 23 days in the laboratory (Gui 1933) and is probably much the same in the field during the summer. Since reproduction is continuous during the growing season and during much of the storage period, several generations may be produced annually.

The first greenhouse bench experiment showed that 9 of the 10 untreated potato seed pieces were infested with potato scab gnat larvae after 3 months (an average 22 larvae/seed piece), but none of the 10 seed pieces treated 3 months earlier with azinphosmethyl were infested. Also, the treated seed pieces did not appear to be affected by the azinphosmethyl since 9 of the 10 seed pieces produced plants. Because of these results, the azinphosmethyl seed soak was included in the field experiment at Eureka.

In the 2nd greenhouse bench experiment, only the cartap seed soak treatment seemed to be as effective in protecting the potato seed pieces as the azinphosmethyl treatment used in the first experiment (Table 1).

Table 1.--Effects of 4 insecticidal soaks on the condition of treated potato seed pieces, the rate of growth on the resulting plants, and the number of adult scab gnats recovered during a 4-day holding period (10 pieces/treatment). Yakima, Wash., April 1971.

Chemicals [a]	% Sound potato seed pieces	% Pieces producing plants	% Plants indicated condition: Very small	Small	Medium	No. gnats produced in 4 days
Orthene	50	5	0	20.0	80.0	4
Methomyl	20	3	66.3	0	33.3	7
Menazon	70	8	12.5	12.5	75.0	2
Cartap	100	9	33.3	33.3	33.3	1
Untreated check	50	9	22.2	0	77.8	2

a/ Five-minute seed soak in 1% insecticide emulsions before planting.

Only one adult potato scab gnat fly was reared from the 10 seed pieces treated with cartap during a 4-day holding period, and all 10 seed pieces seemed to be in a sound condition; in other treatments and in the check, from 30 to 80% of the seed pieces were infested with scab gnat larvae and were partly decomposed.

Table 2.--Yields, grade, infestations of common scab and potato gnat scab infestations in Russet Burbank potatoes[a/], Eureka, Wash., 1971.

Treatment	Avg. yield: hundred-weight	% U.S. No. 1 tubers (size and shape)	% scab and scab gnat infested tubers with 0-5/tuber	>6/tuber	Avg. no. scab gnat pits/ 25 tubers
(6) ammon. sulfate + Shell SD 1836 sidedress	252 ab	29.41 a	35.42 a	64.58 a	92.3 a
(2) Same as (1) + prilled sulfur in planting furrow	256 ab	29.94 a	43.35 a	56.65 a	103.8 a
(4) Same as (1) + prilled sulfur sidedressed	227 b	27.48 a	40.28 a	59.72 a	119.0 a
(1) ammon. sulfate + captan treated seed	242 ab	32.31 a	32.51 a	69.49 a	144.3 ab
(3) Telone C soil treatment + ammon. sulfate + captan seed treatment	290 a	34.54 a	33.34 a	66.66 a	145.2 ab
(5) ammon. sulfate only	247 ab	26.97 a	31.36 a	68.64 a	173.8 abc
(8) ammon. nitrate + captan seed treatment	218 b	27.00 a	24.66 a	75.34 a	217.8 bc
(7) ammon. sulfate + azinphosmethyl seed soak	223 b	25.90 a	25.66 a	74.34 a	236.2 c

a/ Means followed by the same letter do not differ significantly at the 5% level of error.

The results of the field test were disappointing (Table 2). However, a significantly greater yield was obtained with Telone C than with ammonium sulfate + azinphosmethyl, the ammonium nitrate + captan, or ammonium sulfate + captan + sidedressed sulfur. No significant difference was apparent in either the number of tubers that met U.S. No. 1 standards for size and shape or the percentage of tubers in either of the 2 classes. However, significantly fewer lesions were found on tubers that received treatments with ammonium sulfate + captan + furrow application of sulfur, ammonium sulfate + sidedress Shell SD-1836, the ammonium sulfate + captan treatment, ammonium sulfate + captan + Telone C, and ammonium sulfate + captan + sidedress sulfur than of tubers from the other treatments. The Shell DS-1836 treatment was the most promising treatment for control of potato scab gnats, but the azinphosmethyl treatment that had appeared promising in the greenhouse for the control of the gnat did not prevent larvae from entering the developing potato tubers.

In the exploratory tests with Pennwalt TD-1771 and TD-5056, neither treatment reduced the percentage of tubers with 0-5 lesions/tuber below the number obtained with the most effective treatment in the larger experiment.

CONCLUSIONS

The results of the exploratory field trials indicated that though ammonium sulfate may be preferred to ammonium nitrate for agronomic reasons, ammonium sulfate, 800 lb of prilled sulfur/acre, or fumigation with Telone C did not control common scab. However, some treatments, especially ammonium sulfate broadcast plus a sidedress application of Shell SD-1836 granules, significantly reduced the incidence of pits of the potato scab gnat in the tubers. Therefore, insecticides may reduce the damage caused by potato scab gnats.

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