Control of the Green Peach Aphid[1] and Suppression of Leaf Roll on Potatoes by Systemic Soil Insecticides and Multiple Foliar Sprays[2, 3]

by
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ABSTRACT

Systemic insecticides were applied to the soil on each side of potato seed pieces at planting time and/or were sidedressed into the soil when 75% of the plants emerged, and multiple foliar sprays were applied to obtain seasonal control of Myzus persicae (Sulzer) and the suppression of potato leaf roll virus on "Russet Burbank" potatoes in Eastern Washington. Aldicarb gave superior control of aphids and suppressed spread of the virus; disulfoton gave fair control of aphids, but not much suppression of potato leaf roll virus; and phorate did not give sufficient control of aphids or the disease. The 2 applications of the systemic insecticides were more effective than either single application. Endosulfan and oxydemetonmethyl as foliar sprays (2-5 applications) gave better control of aphids than demeton and disulfoton, but none significantly suppressed spread of the virus. All applications of systemic insecticides in combination with multiple applications of foliar spray gave significant control of aphids, and most treatments significantly suppressed the spread of disease.

The green peach aphid, Myzus persicae (Sulzer), is the most efficient of the vectors of the potato leaf roll virus (PLRV). Therefore, in Washington, where this aphid generally represents ca. 95% of all aphids found on potatoes, the species can substantially reduce the yield and grade of "Russet Burbank" potatoes by its primary feeding and its transmission of the disease. Moreover, Bishop (1968) reported that the potato plant adjacent and in the same row with an infected plant was highly subject to infection. In other words, a few aphids on infected potato plants can spread the virus to adjacent plants, but a large number of aphids in a potato field without a source of virus can cause little or no spread of the virus. As a result, as one of us (Powell 1966) showed, proper timing of applications of multiple foliar insecticide sprays can control the aphids and suppress the spread of disease. Also, Knutson and Bishop (1964) showed that 34-92% of the tubers of a current-season plant infected with PLRV will be infected and that most of these tubers will develop the symptoms of net necrosis (phloem necrosis), which renders them unmarketable as food. The commercial potato grower therefore tries to control the green peach aphid to prevent net necrosis. The present paper reports tests made between 1967 and 1970 in eastern Washington in which methods of applying systemic insecticides to the soil were evaluated in combination with multiple applications of foliar sprays for control of aphids and suppression of PLRV.

Materials and Methods. - All tests were made in a somewhat isolated field of Russet Burbank variety potatoes in the sand dune area near Moses Lake, Wash. The nearest potato fields were at least 1/2 mile away. In 1967, the 1st year of cultivation, few plants were infected because certified seed potatoes were planted; thereafter, infected volunteer potato plants provided a convenient source of the virus. A population of green peach aphids was artificially established in 1968, 1969, and 1970 on black nightshade, Solanum nigrum L., ca. 100 ft outside the experimental area to assure pressure of the vector against the treatments.

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[1] Homoptera: Aphididae.

[2] In cooperation with the College of Agriculture, Research Center, Washington State University, Pullman 99163, and the Washington State Potato Commission. Received for publication Apr. 28, 1972.

[3] This paper reports the results of research only. Mention of a pesticide does not constitute recommendation by the USDA.

Systemic insecticides were applied as granular formulations in narrow bands 4 in. to each side and 1 in. below the potato seed piece at planting time (PT) and also were sidedressed into the soil (SD) when 75% of the plants had emerged. In 1967 and 1968, the foliar sprays (S) (prepared with emulsifiable concentrates) were applied at 20 gal spray/acre per application with a tractor sprayer equipped with 4 nozzles directed toward each row; 2 nozzles sprayed upward from beneath the foliage, and 2 nozzles sprayed down from the top of the plants. In 1969 and 1970, the foliar sprays were applied by aircraft at 10 gal spray/acre per application. The individual plots used in all 4 years were 4 (34-in.) rows wide and 100 ft long.

Tests. - Table 1 outlines the 30 treatments evaluated in 1967 and in 1968. Each treatment was replicated 4 times. Table 2 outlines the 20 treatments evaluated in 1969 and 1970. However, in 1969 and 1970 the 9 soil treatments and the check were replicated within each of 6 main plots of a split-plot design. Main plots were 3 replicates of 2 treatments, multiple foliar spray, and no foliar sprays.

Table 1. - The 30 treatments evaluated in 1967 and 1968 for control of aphids and suppression of potato leaf roll virus. Moses Lake, Wash.

Foliar spray (lb AI/acre per application)	No. foliar sprays applied to plots receiving indicated treatment[a] with disulfoton (3 lb AI/acre per application) — No treatment	Pt only	SD only	Both PT and SD
	1967[b]			
Endosulfan (1.0)	3,2	3,2	2	2
Demeton (0.5)	3,2	3,2	2	2
Disulfoton (0.5)	3,2	3,2	2	2
Oxydemetonmethyl (0.5)	3,2	3,2	2	2
No spray	(2 plots)	(2 plots)	2	2
	1968[c]			
Endosulfan (0.1)	4,3	4,3	3	3
Demeton (0.5)	4,3	4,3	3	3
Disulfoton (0.5)	4,3	4,3	3	3
Oxydemetonmethyl (0.5)	4,3	4,3	3	3
No spray	(2 plots)	(2 plots)	3	3

[a] PT, at planting; SD, as sidedressing.
[b] In 1967: PT, May 16; SD, June 6; and spray applications made June 8 and 23 and July 18. First application omitted when only 2 were applied.
[c] In 1968, PT, May 23; SD, June 23; and spray applications were made June 19 and 26 and July 3 and 12. First application omitted when only 3 were applied.

Table 2. - The 20 treatments evaluated in 1969 and 1970 for control of aphids and suppression of potato leaf roll virus. Moses Lake.

Systemic insecticide	Systemic insecticide (lb AI/acre) applied to sprayed and unsprayed plots in indicated treatment: Sprayed plots PT	SD	PT + SD	Unsprayed plots PT	SD	PT + SD
			1969[a]			
Disulfoton	3	3	3+3	3	3	3+3
Aldicarb	3	3	3+3	3	3	3+3
Phorate	3	3	3+3	3	3	3+3
None	1 plot			1 plot		
			1970[b]			
Disulfoton	2.7	3.0	2.7+3.0	2.7	3.0	2.7+3.0
Aldicarb	2.2	3.0	2.2+3.0	2.2	3.0	2.2+3.0
Aldicarb	.9	1.4	.9+1.4	.9	1.4	.9+1.4
None	1 plot			1 plot		

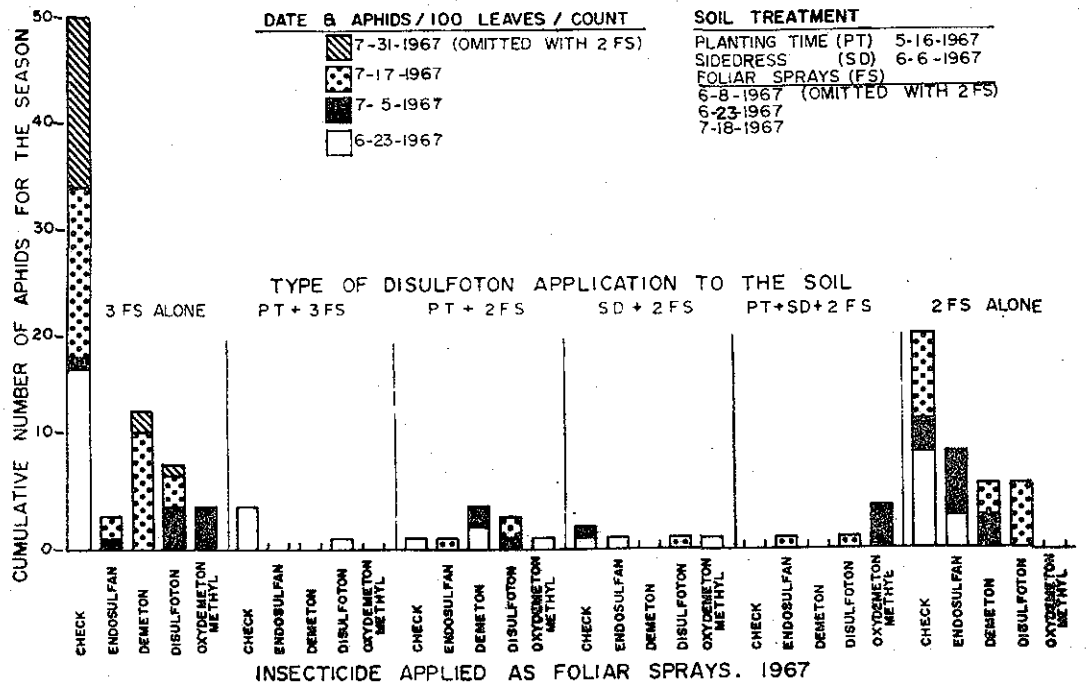
[a] Oxydemetonmethyl (0.5 lb AI/acre) applied as foliar spray June 28 and July 17 and 28.
[b] Endosulfan (1.0 AI/acre) applied as foliar spray June 24, July 9 and 23, and Aug. 6 and 14.

Analysis of Data. - Effectiveness of the treatments was determined by collecting 25 compound potato leaves from the lower 2/3 of randomly selected plants in each plot at intervals during the season and counting the aphids, except that in 1968 these counts were discontinued after July 11 in plots treated with 3 sprays because of the few aphids and a shortage of labor. Also, samples of tubers (75/plot) were collected from each plot at harvesttime and stored at 40-44°F. Then the following spring the samples were scored for net necrosis by cutting 1/4-1/2 in. from the stem end of each tuber and examining the cut portion. In addition, 1 large seed piece from the stem end of each tuber was planted in field plots, and the resulting plants were scored for chronic (tuber-borne) leaf roll (CLR). However, in 1970, the test plots were sprayed by the grower with a sprout inhibitor, so tubers from these plots were not planted for CLR indexing.

The data collected (number of aphids per season, percentage of net necrosis in the tubers, and percentage of plants from the tubers with CLR for each year) were analyzed by a simple analysis of variance with all treatments and also analyzed in factorial designs wherever practical. The factorial designs used in analysis for treatment comparisons for the 1967 and 1968 data were: (1) 2x5 for no soil treatment + 3 S vs. PT + 3 S; (2) 2x5 for no soil treatment + 3 S vs. no soil treatment + 2 S; and (3) 4x5 for 5 insecticides as 2 S vs. 4 methods of soil treatment (PT, SD, PT + SD, and no soil treatment). The factorial design used for treatment comparisons for 1969 and 1970 was a 3x3x2 factorial split-plot design for 3 methods of soil treatment, 3 soil systemic insecticides, and 2 foliar treatments (sprayed and unsprayed).

Results. - 1967 Test. - Few aphids were found on potatoes in the Moses Lake area; however, a slight buildup did occur, especially in the untreated check plots, in replicates near plots treated with 3 S. Also, populations remained low or 0 in all plots treated with disulfoton compared with the untreated checks (Fig. 1): in some, aphids were not found during the entire season, though they were found in all untreated plots and in all plots treated with S only except in plots treated with 2 S of oxydemetonmethyl only (Fig. 1).

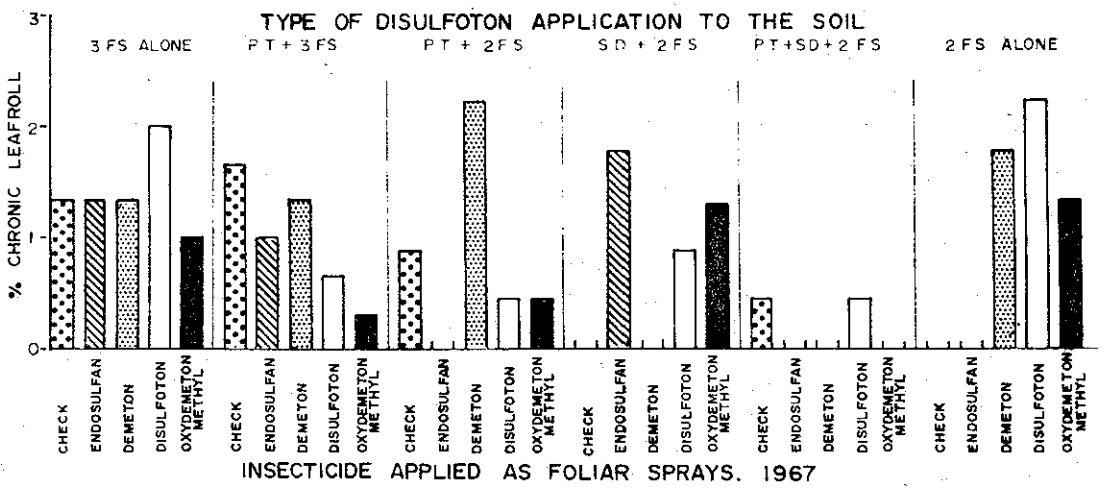
Figure 1. - Seasonal control of the green peach aphid on potatoes with systemic soil insecticide (disulfoton at PT at 3 lb and SD at 3 lb AI/acre) and multiple foliar sprays (endosulfan at 1 lb AI/acre per application and demeton, disulfoton, and oxydemetonmethyl at 0.5 lb AI/acre per application).



Also, significantly fewer aphids were found in plots treated with disulfoton at PT or at SD and in plots treated with disulfoton at both PT + SD than in plots not treated with disulfoton. Plots treated with S had significantly fewer aphids than the unsprayed plots, but there were no significant differences between the insecticides applied as sprays.

Net necrosis was not found in any tubers harvested in 1967. Chronic leaf roll in plants from these tubers also was low (0-2.3%), and the differences between spray treatments gave a nonsignificant "F" (Fig. 2).

Figure 2. - The incidence in 1968 of chronic leaf roll in potato plants from tubers collected from the 1967 treated plots.



1968 Test. - In 1968, the number of aphids increased slightly but was still lower than normal in the potato growing area. Fig. 3 shows the number of aphids per 100 compound potato leaves per count and the cumulative number of aphids for the season. In plots with 4 S, no significant differences were apparent between the insecticides applied as sprays, but all sprayed plots had significantly fewer aphids than the untreated check, and the plot treated with disulfoton PT had significantly fewer aphids than the plot not treated with disulfoton. In contrast, in plots treated with only 3 S or with 3 S plus systemic disulfoton no differences were apparent between the sprayed and unsprayed plots in the cumulative number of aphids, but plots treated with disulfoton at PT + SD and SD had significantly fewer aphids than no soil treatment, though no soil treatment was not significantly different compared with PT soil treatment.

In 1968, the percentage of tubers with net necrosis ranged from 0 to 5.3% (Fig. 4). It was not surprising that some plots, including one of the untreated check, had no net necrosis, because there were so few aphid vectors and because PLRV was either lacking or the potato plants were infected late in the season. The general spread of the virus late in the season was indicative of the increased number of tubers that produced plants with chronic leaf roll (Fig. 4). However, in this respect, there were no significant differences between the insecticides as 4 S, each treatment significantly reduced the percentage of CLR plants compared with unsprayed plots, and disulfoton treatment at PT did not significantly reduce CLR compared with no disulfoton. At the same time, 4 S did significantly reduce the percentage of CLR over 3 S. Also, when 3 S and the disulfoton soil treatment were compared, there were no significant differences in the percentage of CLR between insecticides applied as sprays, but disulfoton at PT + SD or at SD significantly reduced the percentage over no soil treatment. No soil treatment was not significantly different compared with PT, and PT was not significantly different compared with SD.

Figure 3. - Seasonal control of the green peach aphid on potatoes with systemic soil insecticide (disulfoton at PT at 3 lb and SD at 3 lb AI/acre) and multiple foliar sprays (endosulfan at 1 lb AI/acre per application and demeton, disulfoton and oxydemetonmethyl at 0.5 lb AI/acre per application).

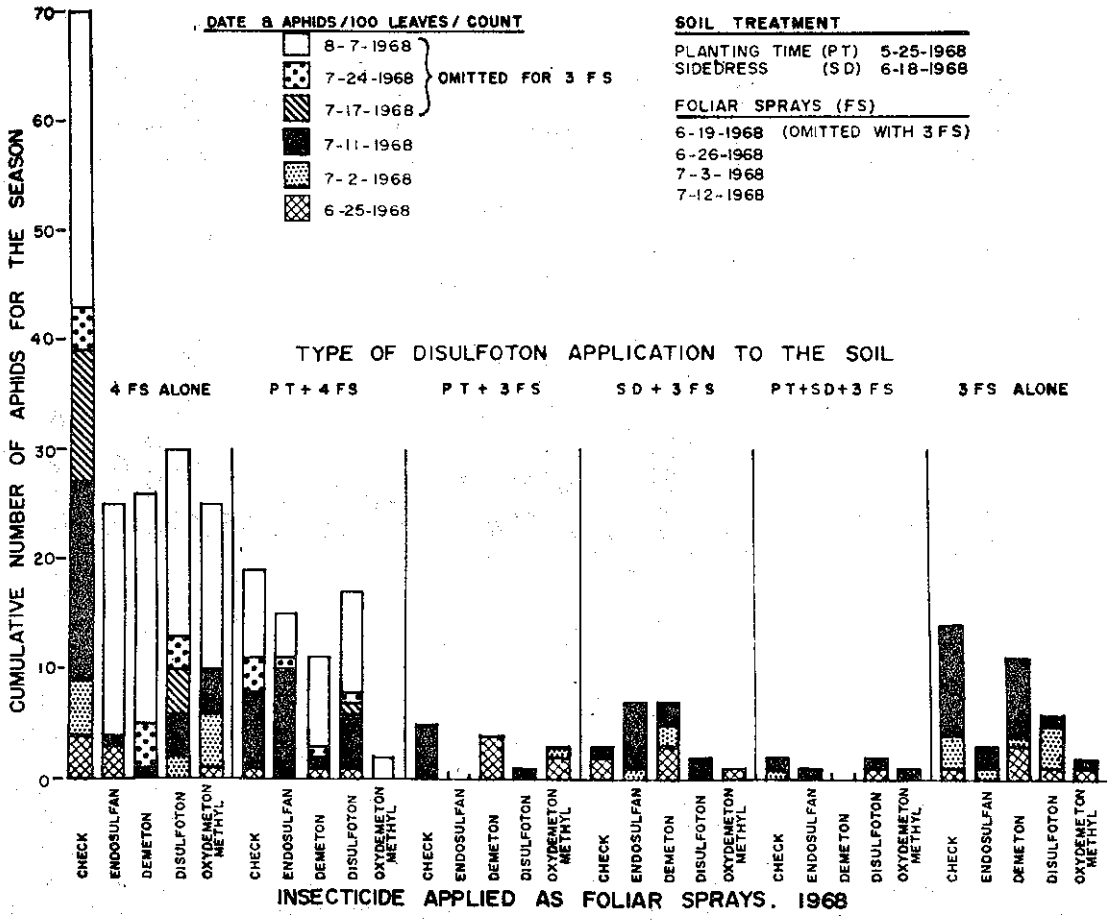
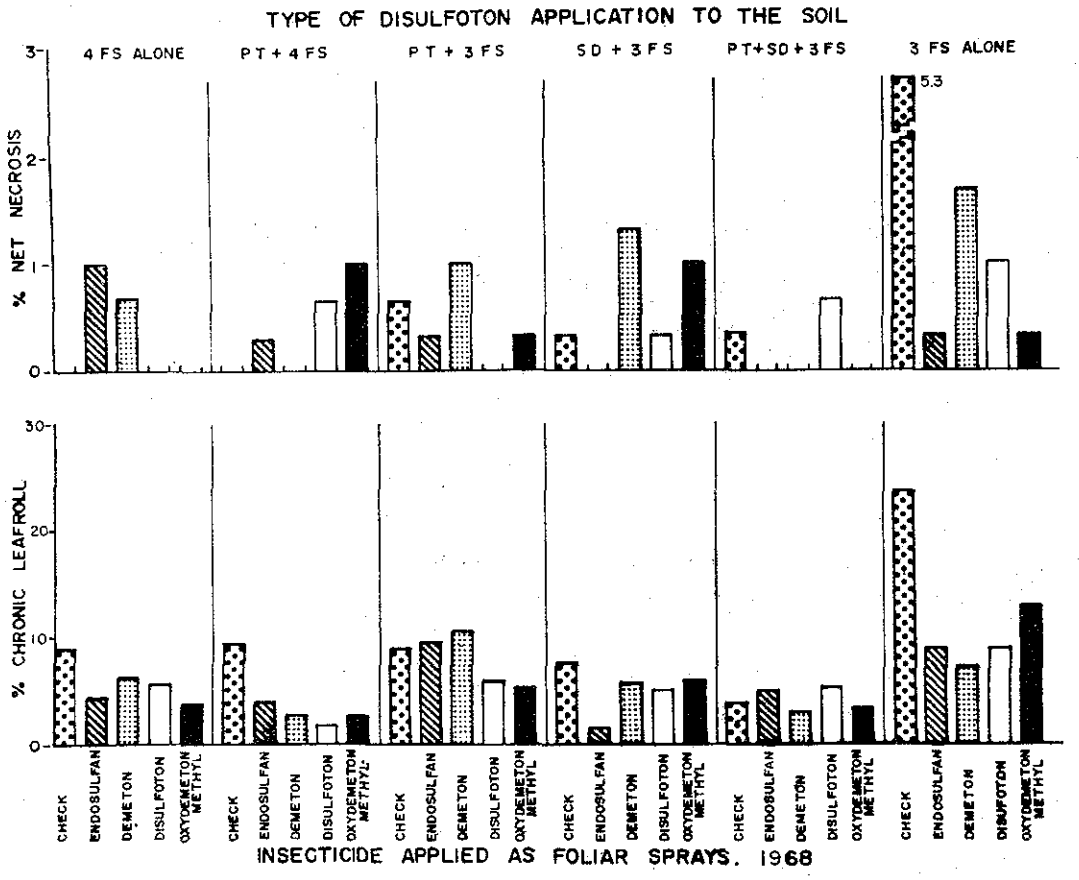


Figure 4. - The incidence in 1969 of PLRV net necrosis in tubers and chronic leaf roll in potato plants from tubers collected from the 1968 treated plots.



1969 Test. - Aldicarb was significantly superior as a systemic insecticide to disulfoton, disulfoton was superior to phorate, and phorate was superior to no soil treatment in cumulative number of aphids. Also, aldicarb alone was the only systemic insecticide that gave effective control for the entire season. Three S of oxydemetonmethyl were not effective for season-long aphid control, but effective season-long control was obtained with 3 S of oxydemetonmethyl plus any 1 of the systemic insecticides (aldicarb, disulfoton, or phorate) (Fig. 5). No aphids were ever found in plots treated with aldicarb and 3 S (PT + 3 S; SD + 3 S, or PT + SD + 3S) (Fig. 5). Systemic insecticides applied at PT + SD were significantly superior to those applied at PT, and application at PT was superior to application at SD for seasonal control (Fig. 5).

The same aldicarb treatments that gave superior control of aphids also significantly reduced the amount of net necrosis and the percentage of plants affected with chronic leaf roll (Fig. 6). Thus, at the test conditions, that is, with some aphid pressure and an abundance of PLRV in volunteer potatoes, an effective soil systemic and a foliar spray program did suppress the spread of PLRV and net necrosis in potatoes.

1970 Test. - In 1970, the high rates of aldicarb (PT at 2.2 lb or SD at 3.0 lb) gave sufficient seasonal control of the green peach aphid (Fig. 7); however, the combination of the high rates of aldicarb (at PT + SD) was the most effective soil treatment. Slightly more aphids were found in plots treated with the low rates of aldicarb (PT at 0.9 lb or SD at 1.5 lb) than in plots treated with disulfoton (PT at 2.7 lb or SD at 3.0 lb). Also, control was not greatly increased by disulfoton at PT + SD or by low rates of aldicarb at PT + SD (Fig. 7). Five S of endosulfan were

were comparable to the low rates of aldicarb or disulfoton alone. Any systemic soil treatment plus the 5 S of endosulfan gave satisfactory seasonal control. All insecticide treatments (soil systemic insecticides or endosulfan foliar sprays) produced significantly fewer aphids than no treatment (Fig. 7).

Figure 5. - Seasonal control of the green peach aphid on potatoes with systemic soil insecticides (aldicarb, phorate, and disulfoton each applied at PT at 3.0 lb AI/acre and SD at 3.0 lb AI/acre and multiple foliar sprays of oxydemetonmethyl.)

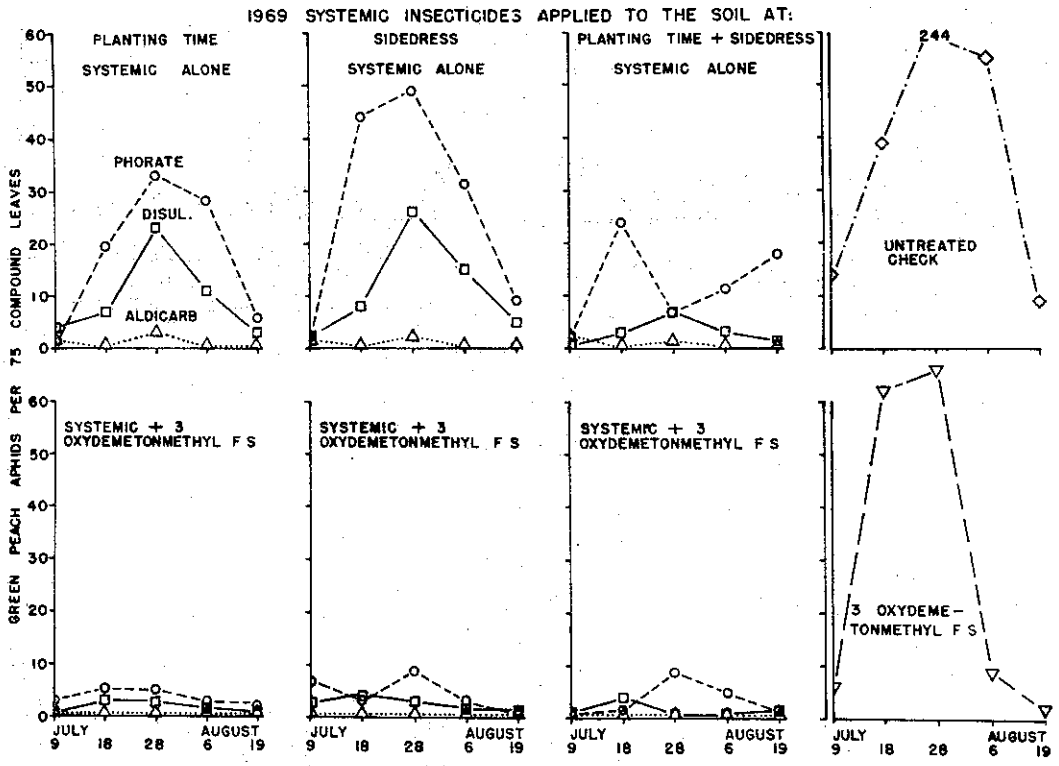


Figure 6. - Incidence in 1970 of PLRV net necrosis in tubers and chronic leaf roll in potato plants from tubers collected from the 1969 treated plots.

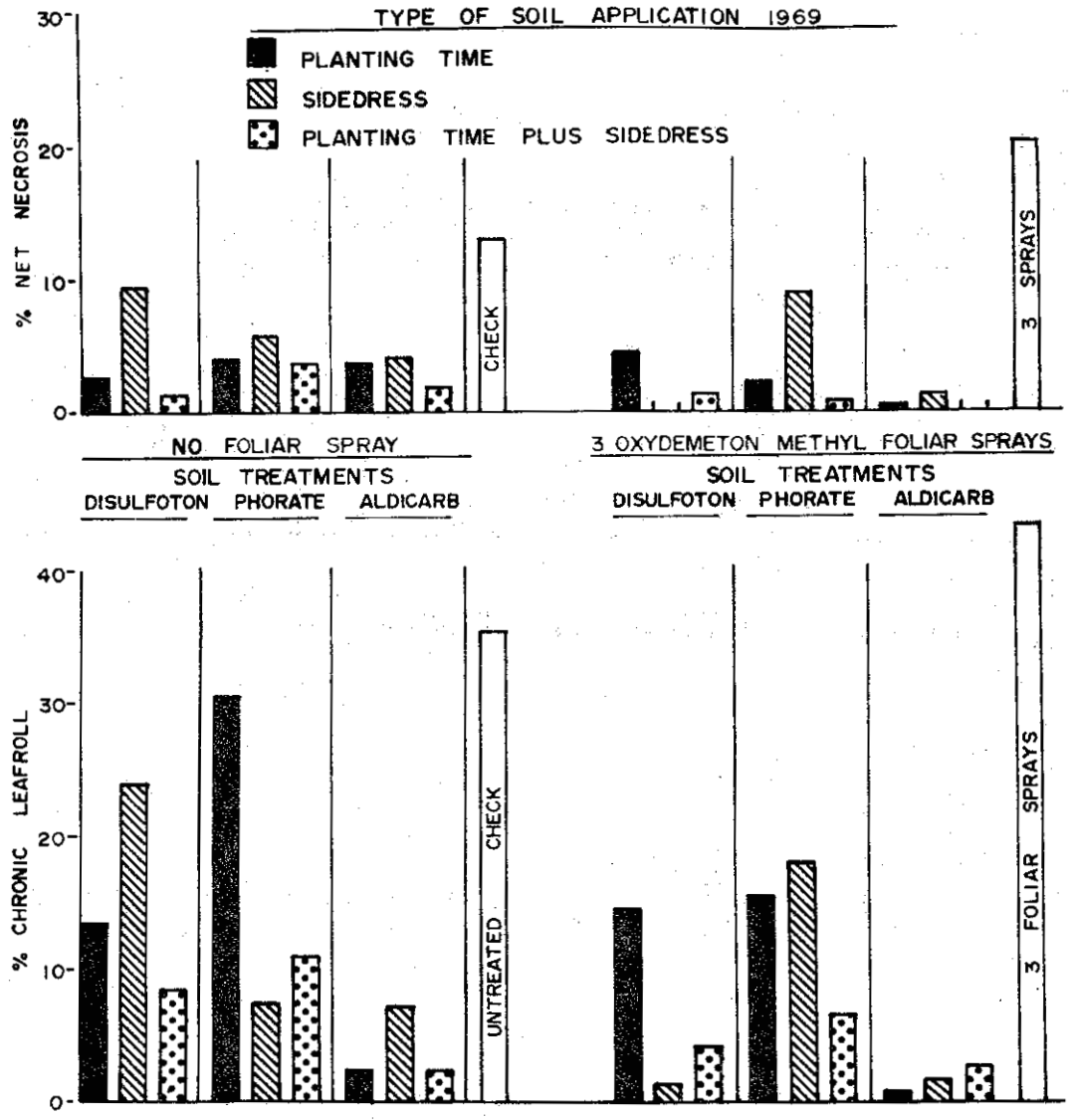


Figure 7. - Seasonal control of the green peach aphid on potatoes with systemic soil insecticides (aldicarb at PT at 0.9 lb and 2.2 lb AI/acre and SD at 1.5 lb and 3 lb AI/acre and disulfoton at PT at 2.7 and SD at 3.0 lb AI/acre) and multiple FS of endosulfan.

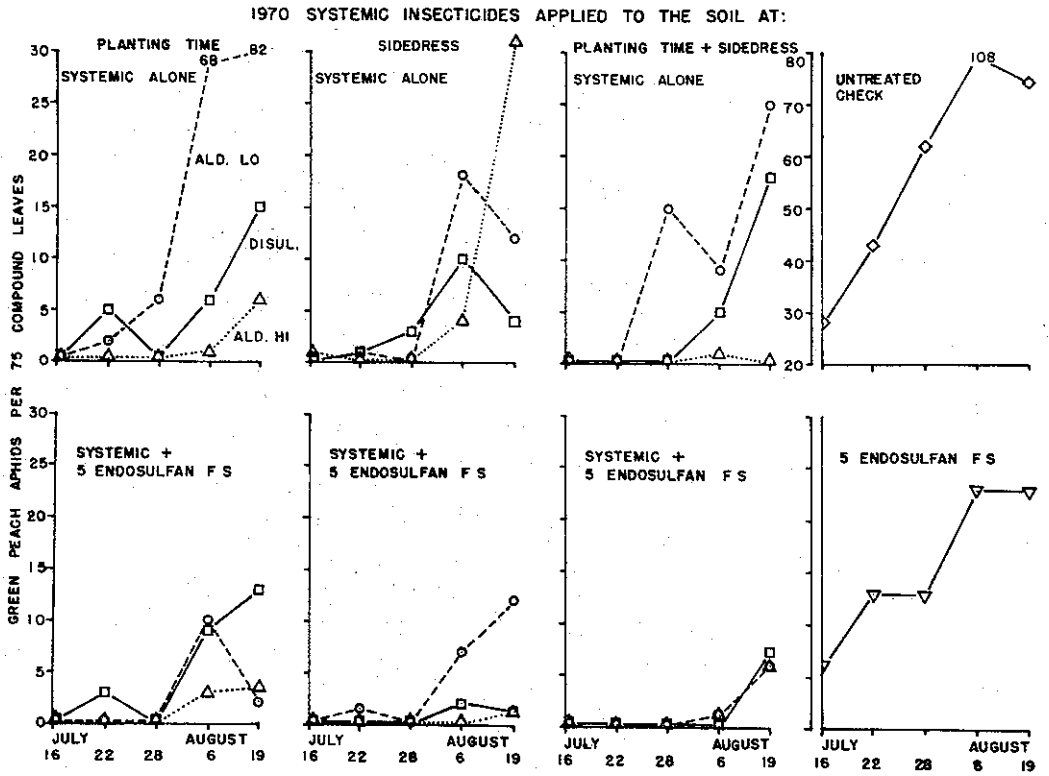
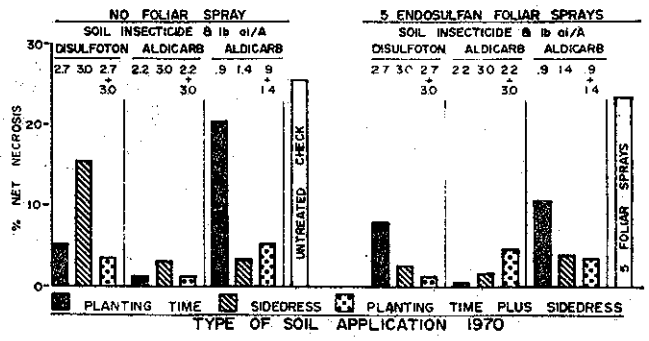


Figure 8. - The incidence in 1971 of PLRV net necrosis in tubers collected from 1970 treated plots.



Thus, in fields where potatoes had grown for 4 consecutive years, the spread of potato leaf roll virus by aphids was not prevented, because infected volunteer potato plants were so numerous and aphids had been established on black nightshade plants outside the test area. Also, though all treatments in 1970 significantly reduced the populations of aphids on the potatoes, the amount of net necrosis in 1971 in the tubers from the plots treated with 5 S of endosulfan only, with disulfoton SD alone, or with the low rate of aldicarb as SD alone was not significantly reduced over that of the untreated checks (*Fig. 8*). *All the other soil treatments* and soil treatments plus 5 S significantly reduced the amount of net necrosis in the tubers compared with the untreated check. Tubers from plots receiving 5 S of endosulfan alone, disulfoton alone as SD, the low rate of aldicarb at PT only, or the low rate of aldicarb at PT + 5S would be rejected from the fresh market because of the amount of net necrosis present (*Fig. 8*). *Inversely, the amount of net necrosis in* tubers from all other plots would not cause these tubers to be rejected from the fresh market.

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