EFFECT OF CONTINUOUS AND DISCONTINUOUS SOIL FUMIGATION WITH VINE BURNING ON CONTROL OF VERTICILLIUM ALBO-ATRUM OF POTATO [1/]

by
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SUMMARY

Verticillium albo-atrum propagules (microsclerotial type) overwintering in the soil were reduced by annual preharvest vine burning, but not by continuous and discontinuous soil fumigation. Fumigation reduced soil borne propoagules after spring application, but by fall propagule counts were the same in fumigated and non-fumigated plots. Continued fumigation with vine burning, but not fumigation alone, reduced propagules forming in the stems by fall. Propagules were not reduced in stems once fumigation was discontinued.

Either soil fumigation or vine burning controlled V. albo-atrum and increased yield; of the two, fumigation alone was the most effective. A combination treatment did not give greater control of V. albo-atrum.

The beneficial effects of soil fumigation appear to be an annual response, while those of vine burning remain for over one year.

INTRODUCTION

Work previously reported on this experiment has shown that annual spring fumigation for 5 consecutive years reduced the populations of V. albo-atrum Reinke and Berth. (microsclerotial type) in field soils, delayed plant infection and wilt symptoms and increased yield of potatoes (2, 3). Annual preharvest burning of potato vines to destroy the microsclerotia in stem tissue increased yields after 2 successive years. Burning, however, did not either reduce soil populations of V. albo-atrum, delay plant infection or wilt symptoms unless performed for 3 consecutive years.

In the 6th year we sought to determine if potatoes could be successfully grown in monoculture following continuous and discontinuous fumigation with and without vine burning.

METHODS AND MATERIALS

The cropping history, cultural methods, plot design, methods of fumigation, preharvest vine burning, soil infestment, stem isolations, and soil propagule assay for V. albo-atrum have been previously reported (2, 3). Telone^{R} (1, 3-dichloropropene and related hydrocarbons) + Picfume^{R} (trichloronitromethane) or DD^{R} (1, 3-dichloropropene, 1, 2 dichloropropane, 3, 3 dichloropropene, 2, 3 dichloropropene and related C_3 chloronated hydrocarbons) + Picfume were applied at rates of 20 gal Telone or DD + 5 gal Picfume per acre. The same plots were fumigated each spring 1966-1972. Starting in 1971, however, one-half of each plot previously fumigated was not fumigated and

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one-half of each plot not previously fumigated was fumigated. Soil temperatures at time of fumigation for 1971 and 1972 were 46 and 50 F. Soil moistures on an oven dry basis were 12.3% and 12.0% for 1971 and 1972. Vine burning was continued on the same plots as in previous years. The experimental field was planted with Solanum tuberosum L. 'Russet Burbank'.

Ten stems were collected from each plot in the fall of 1971 to assay for propagules. The stems were air dried at about 70 F for 3 months then ground and screened to 200 mesh. The screened stem tissue (0.5$_g$) was diluted 1:50, 1:1000, 1:10,000, and 1:100,000 with sterile tap water and the propagules were estimated by a method reported earlier (1).

RESULTS

Yearly vine burning reduced the over wintering propagules in the soil (tables 1 and 2). Continuous fumigation reduced the propagules in the soil following application, but fumigation alone failed to reduce over wintering soil propagules. Continuous fumigation with vine burning reduced propagules forming in the stems in the fall. Propagules were not reduced in stems once fumigation was discontinued.

The disease incidence (wilted plants) was reduced and the yields were increased by either annual vine burning or annual soil fumigation (tables 1 and 2). Soil fumigation alone was more effective in controlling V. albo-atrum and increasing yield than vine burning alone. A combined treatment did not give greater control of V. albo-atrum.

The beneficial effects of soil fumigation appear to be an annual response, while those of vine burning remain for a longer period. Reduced disease incidence and increased yield occurred after 2 years of discontinued fumigation in previously fumigated plots with vine burning but only 1 year after vine burning was omitted (tables 1 and 2).

Neither fumigation nor vine burning affected % of U.S. No. 1 tubers; therefore, data was not shown.

DISCUSSION

Only the combination treatment of annual vine burning and soil fumigation reduced V. albo-atrum propagules in stem tissue by fall (table 1). Evidently vine burning destroyed the microsclerotia in the stems (99% reduction, G. D. Easton - unpublished data) which reduced the total number of over wintering propagules, and spring fumigation further reduced the surviving microsclerotia in the soil.

Neither annual soil fumigation nor vine burning alone reduced propagules in stem tissue but vine burning alone significantly reduced the propagules over wintering in the soil (table 1). Two to three million propagules per g of stem tissue still remained after fumigation (table 1) while only 2-3000 propagules per g stem tissue remained after stem burning (G. D. Easton unpublished data). Therefore, the vine burning treatment was more efficient in reducing over wintering soil propagules. Weather conditions have been reported also to affect propagule survival (3).

Neither fumigation nor vine burning is a cure since by fall propagule levels in the soil had increased and showed no difference between treatments.

Fumigation provides an annual response which reduces surviving over wintering propagules, delays infection, delays wilt and increases yields (3); vine burning, it seems, is a practice which enhances the overall response of fumigation by reducing over wintering stem inoculum. To maintain high yields in a soil infested with V. albo-atrum it would seem necessary to fumigate and burn vines annually. Fumigation, but not vine burning, could probably be omitted for one season if the field had received both fumigation and vine burning for several years.

Table 1. Effect of annual soil fumigation and preharvest vine burning on *Verticillium albo-atrum* (microsclerotial type) and potato production in 1971.

Treatments[1]	Verticillium propagules per g oven-dried soil[2] Apr. 7[3]	Apr. 22[3]	Aug. 18[3]	Number wilted plants[4] Aug. 30	Verticillium propagules per g stem tissue[5] (x 10^6) Oct. 13	Yield cwt/a
A. Vines burned annually						
Never fumigated	63 a[9]	76 b	80 a	16 b	9.68 c	605 b
Discontinuous fumigation[6]	29 a	38 b	52 a	3 a	7.81 c	745 a
Continuous fumigation[7]	25 a	0 a	92 a	0 a	0.98 a	740 a
Fumigated 1 yr only[8]	84 a	4 a	153 a	0 a	1.88 a	721 a
B. Vines not burned						
Never fumigated	207 b	218 c	438 a	30 c	3.28 b	484 c
Discontinuous fumigation	317 b	267 c	602 a	28 c	9.24 c	573 b
Continuous fumigation	129 b	28 a	37 a	0 a	3.04 b	726 a
Fumigated 1 yr only	232 b	21 a	117 a	1 a	2.38 b	726 a

1/ Results for DD + Picfume or Telone + Picfume at 20 + 5 gal/a applied each spring were statistically equal so data was combined. Experimental plot planted continuously to potatoes 1966-1971.

2/ Average number of propagules as determined by counts made on 54 assay plates per treatment.

3/ Soil fumigated on Apr. 8; planted Apr. 30.

4/ Values given based on an examination of 34 plants per treatment.

5/ Average number of propagules as determined by counts of 36 assay plates per treatment from potato stems collected before vine burning and harvest on Nov. 8.

6/ Fumigated 1966-70, but not in 1971.

7/ Fumigated 1966-71.

8/ Fumigated 1971, only.

9/ Means followed by the same letter are not significantly different at the 5% level according to the individual degrees of freedom test and Duncan's multiple range test.

Table 2. Effect of annual soil fumigation and preharvest vine burning on *Verticillium albo-atrum* (microsclerotial type) and potato production in 1972.

Treatments [1]	Verticillium propagules per g oven-dry soil [2]			Number wilted plants [4]	Yield
	March 29 [3]	Apr. 11 [3]	Oct. 6 [3]	Sept. 12	cwt/a
A. Vines burned annually					
Never fumigated	29 a [8]	72 b	291 a	26 c	542 b
Discontinuous fumigation [5]	60 a	46 b	331 a	28 c	516 b
Continuous fumigation [6]	45 a	27 a	716 a	2 a	605 a
Fumigated 2 yr only [7]	22 a	29 a	767 a	7 a	537 b
B. Vines not burned					
Never fumigated	504 b	286 c	341 a	31 d	450 c
Discontinuous fumigation	152 b	194 c	501 a	34 d	426 c
Continuous fumigation	337 b	16 a	1380 a	10 b	571 a
Fumigated 2 yr only	145 b	10 a	804 a	12 b	561 b

[1] Results for DD + Picfume or Telone + Picfume at 20 + 5 gal/a applied each spring were statistically equal so data was combined. Experimental plot planted continuously to potatoes 1966-1972.

[2] Average number of propagules as determined by counts made on 54 assay plates per treatment.

[3] Soil fumigated Mar. 31; planted on April 14.

[4] Values given based on an examination of 34 plants per treatment.

[5] Fumigated 1966-70, but not in 1971-72.

[6] Fumigated 1966-72.

[7] Fumigated 1971-72, only.

[8] Means followed by the same letter are not significantly different at the 5% level according to the individual degrees of freedom test and Duncan's multiple range test.

LITERATURE CITED

1. Easton, G. D., M. E. Nagle, and D. L. Bailey. 1969. A method of estimating Verticillium albo-atrum propagules in field soil and irrigation waste water. Phytopathology 59:1171-1172.

2. Easton, G. D., M. E. Nagle, and D. L. Bailey. 1971. Effect of annual soil fumigation and annual preharvest vine burning on control of Verticillium. 10th Annual Washington State Potato Conference Proc., Moses Lake 9-14.

3. Easton, G. D., M. E. Nagle, and D. L. Bailey. 1972. Effect of annual soil fumigation and preharvest vine burning on Verticillium wilt of potato. Phytopathology 62:520-524.