EFFECT OF SOIL TEMPERATURE FOLLOWING FUMIGATIONS ON VERTICILLIUM WILT DELAY AND YIELD INCREASE[1]/

Gene D. Easton, Assist, Plant Path., Dept, of Plant Path., WSU, Irrigated Agr. Research and Ext. Center, Prosser

INTRODUCTION

Information concerning the effect of soil temperature on fumigation usually deals with control of nematodes rather than fungal pathogens such as Verticillium wilt. However, basic principles should apply to both problems. Goring (2) and Fisher (1) reported that temperature can affect the diffusion and action of a fumigant in many ways. For a fumigant to be effective it must change from a liquid to a vapor and this process is greatly influenced by soil temperature. As temperature increases, vaporization increases so that a greater proportion of fumigant is in the air rather then the water portion of the soil. The diffusion rate of a fumigant also increases in soil as the temperature increases. Too high a soil temperature causes rapid diffusion and loss of a fumigant from the soil before its toxic vapors can affect soil organisms. Too low a soil temperature also limits diffusion and activity of a fumigant.

Nilsen (3) considered soil temperature as one of the critical factors in soil fumigation and listed 40° to 80°F at the 6 inch level as the temperature range suitable for soil fumigants in general. Powelson and Carter of Oregon (4), in their fact sheet to farmers on fumigating for Verticillium wilt control, reported that most fall and spring soil temperatures are satisfactory, but that temperatures between 45° and 60°F at the 6 inch depth are desirable.

The following is a report of a preliminary experiment on the effectiveness of certain fumigants applied at different soil temperatures for the control of Verticillium wilt in potatoes.

HISTORY OF SOIL

This experiment was conducted in Shano silt loam at the Othello Research Farm near Othello, Washington. The field was infested in 1965 with the Verticillium wilt organism by planting potato seed pieces which had been dipped into a microsclerotial and conidial suspension of the organism. Potatoes had not been grown on this land prior to 1965, but symptoms of the disease were seen by the fall of the same year. Seed pieces planted in 1966 for this experiment were not reinfested with the Verticillium wilt organism.

METHODS

The field was chisled both crosswise and lengthwise 13-15 in.

1/ This investigation was made possible through grants supplied by the Washington State Potato Commission and Dow Chemical Co.

deep and plowed 11-12 in. in depth to loosen the soil for diffusion of fumigants. The fumigation treatments of Telone PBC[R] 3/ (Telone[R] 80%, propargyl bromide-5% and chloropicrin-15% by weight) and Telone[R] + Picfume[R] (chloropicrin) (80% and 20% by weight) (Table 1) and Vorlex (20% Methylisothiocyanate and related hydrocarbons, 100% active) were applied to the plowed soil as preplant treatments with injection chisels 9 in. deep and 9 in. apart. A roller packed the soil immediately after injection.

Soil temperatures at the 6 in. depth were taken in an unfumigated plot at the Othello Research Farm during and following fumigation. Temperatures were recorded in morning and afternoon with a mercury thermometer from March 4 to March 7 and were recorded continuously from March 8 to April 10 with a Friez Model No. 1100 soil thermograph.

The first, second and third fumigations with Telone[R], Telone[R]+Picfume[R] and Vorlex[R] were to be made at soil temperatures ranging between 30°-35°F, 40°-45°F and 50°-55°F, respectively. The mean soil temperatures for the first (March 4), second (March 16) and third (March 30) fumigations were 34°F, 44°F and 52°F. The temperature variations due to weather fluctuations 10 days after the 3 fumigations ranged from 33°-47°F, 39°-50F and 47°-59°F, respectively.

The soil was relatively dry at fumigation. Soil moisture in the 2 to 8 in. layer on March 16 and March 30 was 11.4% and 10.3% (based on soil dry weight) compared to an approximate field capacity of 21% and 15-bar wilting point of about 6% 4/. Soil moisture was not determined on March 4, however, since no moisture fell from March 4 to March 16, soil moisture during this period would be close to the 11.4% determination on March 16.

EXPERIMENTAL DESIGN

Each experimental field plot was 4 rows of potatoes wide (12 Ft.) and 20 ft. in length. Ten-foot alleys at the beginning and end of each 20 ft. plot served as buffers for the treated plots. All data shown in Table 1 except for soil temperature readings are means of 6 replications. Every treatment was located in a random complete block design experiment.

STATISTICAL ANALYSIS

The data were analysed by accepted statistical procedures. Analysis of variance was used to determine if any group of data were significant. Duncan's Range Test was utilized to compare means. Means (Table 1)

3/ The trade names of chemicals are used to define specifically the products worked with in this paper. Use of the trade name does not constitute a guarantee or warrantee of the product by Washington State University or that the behavior of similar products would be the same or different from the ones used.

4/ Estimate obtained from 1965 Bureau of Reclamation records for a Shano silt loam.

associated with the same letter of the alphabet are not significantly different.

RESULTS AND DISCUSSION

The interval in time between the last fumigation (March 30) and planting (May31) was over 6 weeks. The time interval generally recommended for fumigation is 10 days to 2 weeks before planting; therefore, it is unlikely that toxic amounts of fumigants remained in the soil to affect germination or growth of the potato crop.

Compared to the control, Telone^{R} alone did not increase yield regardless of the soil temperature range after application (Table 1). However, the Telone^{R} + Picfume^{R} (chloropicrin) combination gave significant increases in yield at all of the soil temperature ranges tested. Telone PBC^{R} contains the same amount of Telone^{R} as the Telone^{R} + Picfume^{R} combination, but 5% less chloropicrin (by weight). Telone PBC^{R} also contains propargyl bromide (5% by weight). This Telone^{R} + Propargyl bromide + chloropicrin mixture produced significant yield increases when applied in the temperature ranges of 39°-50°F and 47°-59°F but not at the 33°-47°F range. Actually, there was little difference in temperature between the 33°-47°F and 39°-50°F range; therefore, it is not possible to determine if these differences in yield are due to composition of chemicals in Telone^{R} + Picfume^{R} and Telone PBC^{R} or due to soil temperature. Significant yield responses occurred when Vorlex^{R} was applied at soil temperatures of 33°-47°F and 39°F-50°F but not at 47°-49°F. Representatives 5/ of the Morton Chemical Company report that other experiments indicate Vorlex^{R} to be effective in cooler soil temperatures.

Verticillium wilt generally was delayed in treatments which produced significant yield increases.

The percent of U.S. No.1 grade tubers was not significantly affected by any fumigation treatment or temperature following application.

SUMMARY

Preliminary results from this experiment indicated that yield response may be obtained in Verticillium infested soil by application of fumigants at soil temperatures which ranged from 33°-59°F during the 10-day period following fumigation. Lower or higher soil temperatures were not tested. There was some indication that some fumigants may not be as effective when soil temperatures are near the lower and higher portion of this range.

At this time Washington State University does not recommend fumigation for control or delay of Verticillium wilt. This study will continue.

5/ Personal communication

LITERATURE CITED

1. Fisher, J. R. 1965. Principles of soil fumigation. 5th Annual Washington State Potato Conference Proceedings., Moses Lake, Washington 19-24.

2. Goring, C.A.I. 1957. Factors influencing diffusion and nematode control by soil fumigants; ACD Information Bull. 110. The Dow Chemical Co., Midland, Michigan. 53 pp.

3. Nilsen, A. 1965. Critical factors for successful soil fumigation. 5th Annual Washington State Potato Conference Proceedings, Moses Lake, Washington. 25-30

4. Powelson, R. L. and G. C. Carter. 1964. Use of soil fumigation for control of Verticillium wilt of potato. Fact Sheet 77. Oregon State University.

Table 1. The effect of fumigation and soil temperature following fumigation on Verticillium wilt and yield.

Fertilizer: 300 N, 150P, 150 K, 10 Zn. Planted: May 13
Harvested: October 14

Fumigant & Gals./A.	Soil Temp. (°F) 1/	Mean Vert. wilt 2/	Mean %U.S. No. 1 3/	Mean yield cwt./A.
Telone, 30	33-47	17 d	89	465 c
Telone, 30	39-50	13 cd	88	479 bc
Telone, 30	47-59	18 d	90	465 c
Telone PBC, 30	33-47	8 abc	88	545 ab
Telone PBC, 30	39-50	5 ab 4/	88	581 a 4/
Telone PBC, 30	47-59	3 a 4/	87	624 a 4/
Telone + Picfume, 20+5	33-47	2 a 4/	85	624 a 4/
Telone + Pic fume, 20+5	39-50	4 a 4/	90	595 a 4/
Telone + Picfume, 20+5	47-59	6 abc	86	595 a 4/
Vorlex, 30	33-47	4 a 4/	91	574 a 4/
Vorlex, 30	39-50	5 ab 4/	91	610 a 4/
Vorlex, 30	47-59	6 abc	89	545 ab
Control	---	14 cd	87	479 bc

1/ Temperature variation during the 10-day period following fumigation at the 6" soil level.
2/ Number of plants showing Verticillium wilt symptoms out of approximately 23 plants per 20 ft. plot row.
3/ Data not significant according to the F test at the 5% level.
4/ Values significantly different from the control according to Duncan's Multiple Range Test at the 5% level.