EFFECTS OF SOIL FUMIGATION ON YIELD AND QUALITY OF RUSSET BURBANK POTATOES IN THE COLUMBIA BASIN OF WASHINGTON

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During the past six years, the number and the size of soil spots wherein potato plants die prematurely has been increasing. In some of these areas the plants have died because of a soil-borne disease known as Verticillium wilt. This organism is prevalent in virgin soils in the Columbia Basin and throughout most cultivated areas of the United States. The plants seemingly grow normally until hot weather occurs, at which time the plants begin to turn yellow and die before a satisfactory yield of potatoes has been produced. More recently, the premature death of the plants in many of these soil spots in potato fields has been associated with potash deficiency. Potash deficiency occurs primarily on leveled areas and cut spots within a field. The plant symptoms for Verticillium wilt and potash deficiency may appear similar but differ enough so the two causes can be distinguished. A definite diagnosis can be made by the use of soil and tissue tests to determine whether or not potash is limited. The Verticillium organism is so generally prevalent that its isolation still leaves the question unanswered whether it was primary or secondary. It can be primary.

Preliminary studies to test the effect of soil fumigation on the yield and quality of the potato crop were begun in 1958. Increased plant growth and improvement of the root systems as well as increased yield were observed, but no attempt was made to obtain quantitative differences.

An experiment was conducted on the Percy Driggs farm in 1960 to test the effect of soil fumigation on yield, grade and blackspot susceptibility of the potatoes. The field used was known to produce plants which died early. The cropping history was beans in 1959, beets in 1958, potatoes in 1957, corn in 1956, and peas and clover in 1955. The plots were uniformly fertilized. The fertilizer was banded through the planter at planting time.

The chemical used to fumigate the soil was chloropicrin, which is also known as tear-gas, and by the trade name of Picfume. To treat an acre of ground with 35 gallons of this chemical would cost about $400. The chemical nevertheless was used in this experiment because it was believed to be the most effective chemical against soil-borne organisms. If a major problem could be demonstrated by the use of this chemical, additional studies to find chemicals which would be effective and cheap enough to be used by growers would seem warranted. The results of the 1960 fumigation experiment are shown in Table 1.

Table 1: Results of the 1960 Soil Fumigation Experiment

	Total Yield CWT/Acre	No. 1 grade CWT/Acre	No. 1 grade Per cent
Picfume 35 gal./A	479	353	73
Picfume 35 gal./A + tarp	478	359	75
Picfume 12 gal./A	496	352	71
Picfume 12 gal./A + tarp	494	356	72
Check	326	213	65

It can be seen that treating the soil with chloropicrin at the rates used greatly increased the total yield, the yield of No. 1 grade potatoes and the percentage of No. 1's. The 12 gallon rate of application appears to be slightly better than the 35 gallon rate per acre, but these results may have been influenced by planting too soon after the application of the chemical. The plants in the plots where the high rate of application was used took almost three weeks longer to break through the soil than was the case in the check plot and where the 12 gallon per acre rate was used.

Soil fumigants require a minimum soil temperature of about 60 degrees Fahrenheit to be most effective, and a waiting period of at least two weeks after application before potatoes can be planted. These requirements delay planting in the spring until about the first of May, which is much too late for a large portion of the Washington crop, often planted as early as the last week of March and the first week of April.

Experiments with fall applications of fumigants began in 1961. Fall applications would allow ample time between the time of fumigation and the time of planting for the chemical to be completely dissipated from the soil. The experiment was conducted in the same field as the 1960 experiment, the history of the land being the same except that it now had grown one additional crop of potatoes. The land was irrigated and deep disked and in a good moist, friable condition at the time the treatments were applied. The field was pre-marked to make sure of where each row of potatoes would be located when they were planted the following spring. The chemicals were applied as recommended by the manufacturers, except that a band application was also used to reduce the cost. The band application consisted of applying half of the amount of chemical used for complete coverage in two bands twelve inches apart. The field having been pre-marked, it was then possible to plant between these two bands of chemical. The potatoes were planted on April 13 with a press wheel potato planter. One hundred and fifty-two pounds of nitrogen and 190 pounds of P_2O_5 were applied in bands at planting time. No potash was used. Zinc was mixed with the fertilizer. As far as possible, cultural practices were uniform throughout.

The results of this experiment are shown in Table 2.

Table 2: Results of the 1961 - 62 Soil Fumigation Experiment

		Rate/A		CWT/A	Rate/A		CWT/A
1.	Picfume	9 gal	complete coverage	413	9 gal	banded	338
2.	Picfume	7.3 gal	" "	231	7.3 gal	"	294
3.	Picfume	5.4 gal	" "	257	5.4 gal	"	250
4.	Pic + Telone	5.4 + 20	" "	478	5.4 + 20	"	444
5.	Telone	20 gal	" "	373	10 gal	"	377
6.	Telone	40 gal	" "	352	20 gal	"	315
7.	Vapam	40 gal	" "	426	20 gal	"	232
8.	Vapam	80 gal	" "	496	40 gal	"	422
9.	Vorlex	20 gal	" "	454	10 gal	"	333
10.	Vorlex	40 gal	" "	458	20 gal	"	417
11.	Check		soil left loose	240	soil left loose		244
12.	Check		soil left loose	258	soil left loose		255
13.	Terraclor	40 lbs./A	tilled once	254	tilled twice		245
14.	Terraclor	80 lbs./A	tilled once	216	tilled twice		224
15.	Check		soil left loose	273	soil rolled		263

Several check plots were included because Verticillium frequently does not occur uniformly throughout a given field. It can be seen that the yield of the check plots was generally low, in fact, lower than the check plots in 1960. It may be that the lower yield of the check plots in 1962 was the result of one additional year of cropping the land to potatoes. This would seem reasonable, since the top yields were identical to those of the previous experiment. It can be seen that a number of the soil treatments produced yields substantially greater than those which occurred on the check plots. The top yield was produced by the 80 gallon per acre rate of Vapam. This chemical, like Picfume, is too expensive to be used for potatoes on a commercial scale. It can be seen that the compound Telone at the 20 gallon per acre rate produced a yield of 373 CWT per acre. When half of this rate, or 10 gallons per acre was applied in two bands and the planting was done between these bands, the yield produced was equal to that produced by double the amount of chemical used over the entire area. Telone is a relatively cheap chemical and can be applied at a cost of $40 to $50 per acre.

One of the most interesting aspects of the experiment was that Picfume, which is primarily a fungicide at the rates used, gave substantial increases in yield, but Telone, which is strictly a nematocide, also gives substantial increases in yield. This poses a question as to the type of problem with which we are dealing. Is it primarily Verticillium, or is it a combination of both? Nematode counts were made in samples of soil taken from this field several years back, and it was concluded on the basis of these counts that nematodes were not a major problem.

An additional experiment was put out the fall of 1962 and will be planted to potatoes in 1963. The purpose of this experiment is to use combinations of a fungicide and a nematocide at rates which would be economically feasible for the grower, and to determine whether or not the effect of a fumigation will last for two years. Much is yet to be learned about this problem.