THREE YEAR SUMMARY OF SOIL FUMIGATION STUDIES

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In 1957 it was discovered that blackspot susceptibility and resistance could be achieved by dehydrating and rehydrating potatoes. It was learned also that if insufficient water was available in the soil to meet the needs of the transpiring plant, water would be withdrawn from the tubers to the extent that the tubers would live in small caverns in the soil, the size and shape of the caverns being that of the tubers before dehydration began. Fields of potatoes were observed in which the tubers seemingly failed to grow even though the foliage was somewhat green. It is not uncommon to pull relatively green potato plants only to find that most of the roots are diseased. The occurrence of tubers lying in the soil and completely detached from the plant is also quite common.

For these reasons it was thought that soil fumigation to improve the root systems of the plants might lead to some of the reasons why potato soils appear to "run out" with time. Most newly farmed soils produce large yields of well formed tubers, but as the years pass the yields get lower and the tuber types poorer. The use of soil fumigants for the control of root diseases and soil insects is not new but has been too expensive for crops of low economic value.

Exploratory work with soil fumigants began as far back as 1958. The work was limited to treating small plots in different parts of the Basin, washing out the roots, and observing the differences between the root systems on the plants which were grown on the treated and the non-treated soils. During this period it was observed that many fields or parts of fields were dying prematurely, but growers and shippers generally thought this was good rather than bad because the skins would "set" sooner and maturity regulations could be met earlier in the season.

Enough observational data on roots and tuber growth were obtained by 1959 to justify and extensive study of soil fumigation effects on yield, grade, specific gravity and blackspot. A farmer-cooperator who was considered to be a good farmer was chosen. His potato yields nevertheless had slipped to about 300 CWT per acre in a 20-acre field. The cropping history was: dry beans, 1959; sugar beets, 1958; potatoes, 1957; corn, 1956; field peas, 1955; and was not farmed before 1955. It was planted to potatoes again in 1960.

Soil fumigants are chemicals which when applied to the soil kill or inactivate disease-producing fungi, nematodes and soil insects. Some chemicals even inactivate weed seeds. Some fumigants are quite specific in their action, whereas others are effective on a large number of different organisms. The degree of effectiveness depends to a great extent on the dosage applied and the conditions in the soil at the time of application. All of the fumigants used in this study are corrosive when in

contact with metal, and range from lethal to hazardous in their toxicity to humans, and require special precautions to keep the chemicals from getting on the clothes or in contact with the skin. The manufacturer's directions should be followed explicitly.

The cost of the materials is relatively high and must be evaluated on the basis of the amount of good they will do, rather than on the cost per gallon. Some are of course prohibitive in cost for use on potatoes. One of the most promising combinations of chemicals found so far costs about $90.00 per acre.

The conditions required before fumigants should be applied are a minimum soil temperature of 50° F. and a temperature of 60° F. is better. The soil temperature is not likely to get too high because the soils are relatively cool during early spring and late fall when most of the fumigation for potatoes is likely to be done. Too low a soil temperature is more likely to be a problem, because the soil temperature is seldom above 50° F. before the middle of April. Therefore, spring fumigation for early market potatoes is not possible at this time.

Before fumigation, the soil should be in an excellent state of tilth. This may require pre-irrigation and working the soil to a depth of nine to ten inches to eliminate clods and provide pore space for the diffusion of the fumigant. Some fumigants diffuse readily and can be infected eight inches deep in bands twelve inches apart, but others must be injected six inches deep in bands only five inches apart.

A waiting period of one to three weeks after fumigation is necessary before potatoes are planted if spring fumigation is used. Working the soil after two weeks would also be efficacious in removing the remaining fumes from the soil. When fall fumigation is used, spring planting can be done as early as the weather permits and possibly without any more land preparation than was used to prepare the land for fumigation the previous fall, depending of course on the particular soil type and the effect of weather conditions on soil compaction. In our studies the soil was not reworked after the fumigants were applied, neither in the case of the spring nor the fall applied fumigants.

In 1960 the fumigants were applied in the spring. The untreated check plots yielded at the rate of 326 CWT per acre and the best treatment yielded at the rate of 496 CWT per acre, an increase in total yield of 51 per per cent. The yield of No. 1 grade potatoes was increased by 65 per cent. On September 14 when the last of the experiment was harvested, the specific gravity of the potatoes from the check plot was 1.077, whereas those from the treated plots was 1.083 or above. This is not only a statistically significant difference but one of practical importance. To the chipper it would mean an extra pound of potato chips per 100 pounds of potatoes, other factors being equal. The blackspot index was lower by about 20 per cent in the potatoes from the fumigated plots than in the potatoes from the

check plots. The reduction in black spot was much smaller than had been hoped for, but on the other hand, the increase in the yield of No. 1 grade potatoes was much larger.

A second experiment was put in the fall of 1961 on land with a cropping history the same as that used for the 1960 trials. The untreated check plot yielded at the rate of 254 CWT per acre and the best treatment yielded at the rate of 496 CWT per acre, an increase in yield of 95 per cent. These same plots were again planted to potatoes in 1963 to determine the residual effect of the treatments. In 1963 the check plots yielded at the rate of 314 CWT per acre, and the highest yielding treatment yielded at the rate of 437 CWT per acre. Thus the residual effect from the best treatments would have produced over an hundred CWT of potatoes more than the checks. In a two year period the increase in yield resulting from fumigation would have been equal to the yield on non-fumigated land in any one of the two years of the experiment.

A third experiment was established in the fall of 1962 and planted to potatoes in the spring of 1963. The treatments in this experiment were developed around the findings of the previous year. A combination of Chloropicrin and Telone seemed to have a synergistic effect when used in combination with each other. The plots were eight rows wide and 40 feet long and each treatment was replicated four times. The check plot yielded at the rate of 379 CWT per acre and the highest yielding treatment produced potatoes at the rate of 576 CWT per acre, an increase of about 200 CWT per acre. The treatment which seems promising is a combination of 20 gallons of Telone plus 5 gallons of Picfume when applied at the rate of 25 gallons per acre. This treatment produced a yield increase of 88 per cent the first season after fumigation in 1962; a yield increase of 36 per cent as a residual effect the second year after fumigation, and a 52 per cent yield increase the first season after fumigation in 1963. The material alone would cost about $90.00 per acre.

There is still much more to be learned before a recommendation can be made, but the future looks promising.