Potato Scab Control

applications of sulfur to increase soil acidity effective in reducing disease in experiments in Kern County

John W. Oswald and David N. Wright

The most promising approach in the prevention of potato scab development has been to increase the acidity of the soil by the addition of sulfur.

The scab fungi in the soil—*Actinomyces fungi*—are intolerant of high soil acidity and their activity is reduced when soil pH—measurable acidity-alkalinity—is 5.0 or below, with pH7 representing neutral.

Potato scab is one of the most widespread and serious of potato diseases in the California spring crop, centering in and around Kern County, where it is estimated 10,000 acres are now out of production due to severe scab infestation.

From the middle of May to the middle of June in 1948, 23% of all potatoes examined in this area had at least a trace of scab as compared to 3.5% for the comparable period in 1939.

Scabs in most cases are normally superficial and do not affect the quality or edibility of the potato. The unsightly appearance, however, renders infected tubers unmarketable.

Scab is caused by a minute fungus, known as *Actinomyces*, which is capable of living for long periods in the soil. The fungus attacks the potatoes as they develop causing corky open pustules or scabs to form on the surface of the skin. In cases of severe infection individual scabs coalesce to form large corky areas covering most of the potato's surface.

The growth of the *Actinomyces fungi* is favored by warm weather. As a result, the scab disease generally becomes serious each year around the middle of May and the severity increases during June and July. Under California irrigated conditions soil moisture does not appear to have any appreciable effect on the development of scab.

The disease is carried on the tubers. Planting of scab-infested tubers will result in a scabby crop of potatoes. The use of diseased potatoes for seed will also result in infesting clean land.

Once the fungus becomes established in the soil each subsequent crop of potatoes will increase the concentration of *Actinomyces* in the soil. After five or six continuous croppings of potatoes, the land usually becomes so badly diseased it is no longer fit for potato production.

Scab resistant potato varieties have been used successfully in scab-infested fields in the eastern United States. Tests have shown that none of these varieties is resistant to scab in Kern County. Whether this is due to a different variety or strain of the scab organism or some other factor is being investigated.

In the control of potato scab there are two general problems: *1*, how to keep the land from becoming infested or from increasing in severity of infection by such practices as seed treatment, rotation, cover cropping, and sanitation; and *2*, what to do with scab-infested soils.

Treatment of potato seed for scab control with mercury or formaldehyde formulations is effective in killing the scab fungus in the tubers but if treated seed is planted in scab-infested soil, a scabby crop of potatoes will result in spite of the treatment. Seed treatment is of value in avoiding the introduction of scab into soil, but will not prevent the development of scab once the fungus has been established.

Sulfur has been used as a soil treatment for scab for years in many potato areas. Results have been conflicting; usually the incidence of scab has been reduced but often the soil has become so acid that potatoes do poorly. It has generally been considered that a pH of 4.8 or lower markedly reduces the yield.

In February of 1948, 12 acres of scab-infested land were selected for investigations on soil acidity and scab control. The soil type was Delano fine sandy loam with an initial pH of about 7.5.

The first year an attempt was made to establish permanent strips of pH 6.0, 5.5 and 5.0, by the application of 1,000, 1,500, and 2,500 pounds of sulfur per acre respectively. A fourth strip received sulfuric acid at the rate of 2,000 pounds per acre. The strip receiving 1,500 pounds of sulfur received an additional 1,000 pounds per acre in September 1948.

Each strip was 800 feet long by 20 feet wide and contained eight rows of which the center two were used for the results.

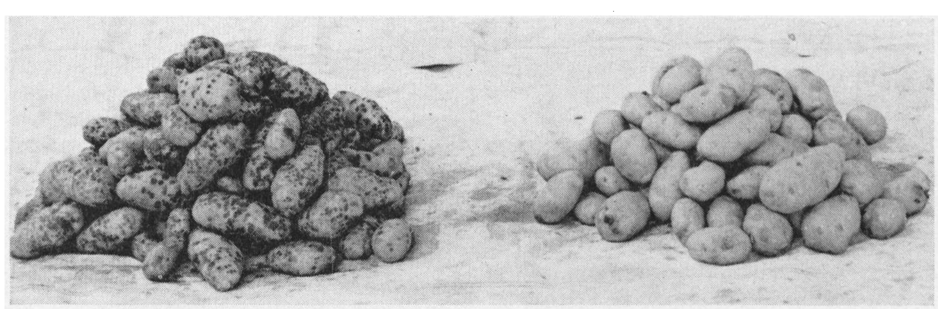
The soil sulfur was broadcast on and disked in to the top eight inches of the soil. The acid was sprayed on the surface from a tank truck and similarly disked.

Two successive crops, 1948 and 1949, have been grown since the original treatments. pH readings have been made regularly at 80-foot intervals in each treated and check strip. At each harvest, yield and scab data were recorded. The degree of scab was measured by the percentage of tubers marketable. Any tuber with over 5% of its tuber surface covered with scab is not marketable by U. S. No. 1 grade standards. The results indicate:

1. A remarkable control was attained in the heavy sulfur plot in the second crop after application. In the 2,500-pound application in 1948, only 29% of the potatoes were marketable whereas 90.4% were marketable in 1949. This control was obtained even though diseased potatoes in the checks had gone from 23% marketable in 1948 to only 11.8% in 1949. These results indicated that scab can be reduced by increasing soil acidity in the first year but is not effectively controlled until the second year. Future data will determine how long the control attained in the 2,500-pound sulfur treatment will last.

2. A pH of 4.5 or below was necessary for any appreciable effect on the disease.

Continued on next page



Left are the scabby tubers from the nontreated strip adjacent to the sulfured strip. ***Right*** are potatoes harvested in June, 1949 from scab-infested soil treated with 2,500 pounds of sulfur per acre in February, 1948. In the nontreated soil potato scab reduced the percentage of marketable tubers to under 10%; in the treated strip over 95% of the tubers were marketable.

3. Most striking is the fact that yield was not significantly reduced at pH's as low as 3.5. The pH of the heavy sulfur strip averaged 3.7 at harvest in 1949 and total yield was no different from the checks on either side at pH 7.0.

The effect of pH on potatoes is now being studied to determine whether sulfur toxicity, rather than low pH, is responsible for some of the crop failure after sulfur applications.

A second set of sulfur soil trials in September 1948—at rates of application similar to those of the February 1948 experiments—brought out the fact that oxidation of elemental sulfur in the soil by the sulfur bacteria is dependent upon abundant soil moisture.

In the absence of any appreciable rainfall, the soil remained dry until the preplanting irrigation in February. The pH of all treatments remained neutral until February and then dropped abruptly. The strips receiving the 2,500-pound application dropped from pH 6.8 to 4.5 in 40 days.

Many older potato fields have a reaction of about pH 6.0—due to the application of ammonium sulfate fertilizers which tend to change the soil reaction to the acid side. In the experimental field initial pH was 7.5 and 2,500 pounds of sulfur were effective on scab with no harmful effects on potato yields. It is not likely that 2,500 pounds of sulfur per acre could be safely applied to fields with pH 6.0. Many instances of poor stands and yields have been reported where sulfur applications have been too great.

Since it apparently takes two years to renovate scabby land with sulfur, it seems advisable not to crop the land to potatoes the first year after the treatment. No control of scab could be expected and the infestation of the fungus would be building up in the soil. The danger of encountering sulfur damage on the potatoes would also be eliminated.

A rotation program of potatoes with cotton as a first year crop after soil treatment is being studied but is not recommended as a control until experiments show its effectiveness.

As the potato scab problem is studied further, it may be possible with knowledge of a field's soil type and reaction to prescribe an amount of sulfur necessary to cope with scab but without affecting a field's productiveness.

John W. Oswald is Assistant Professor of Plant Pathology and Assistant Plant Pathologist in the Experiment Station, Davis.

David N. Wright is Farm Advisor, Kern County.

The tests on scab resistant varieties in Kern County were conducted by G. N. Davis, Associate Professor of Truck Crops, Davis.

The February 1948 investigations on 12 acres of scab infested land were made possible by the cooperation of the S. A. Camp Co., Shafter.

HYBRIDS

Continued from page 7

proximately equal numbers of fertile and sterile plants.

By backcrossing in this manner, male-sterile plants can be propagated indefinitely and in as large numbers as desired. It is also expedient for special purposes to propagate the male-sterile mutant as a clone by rooting cuttings.

One curious and exceptional mutant—designated as ms_5—produces small quantities of fertile pollen in occasional flowers and can therefore be propagated by self-pollination to produce 100% male-sterile progenies.

Male-sterile mutants are useful for any project that demands large-scale cross-pollination. Their use eliminates not only the need for costly emasculation but also the possibility that contamination by self-pollination might occur if flowers of fertile plants were not properly emasculated.

Hybrid seed production is being facilitated also by the invention by an Australian worker of a simple mechanical pollen collector.

Certain hybrids are very difficult to obtain and may require the pollination of great numbers of flowers. In transferring desired characters from species of wild forms to cultivated tomatoes, it is important that accidental self-pollination of fertile plants be avoided. The contamination of such crosses is misleading and can be prevented by utilizing, as female parents, male-sterile plants planted together in a plot well isolated from other tomatoes.

Male-sterile mutants also serve efficiently to measure rates of natural cross-pollination because all fruits and seeds that they produce must issue from pollen transferred to them from surrounding plants.

Tests in progress show that rates vary to a great extent from one locality to another and are influenced by the distance between parent plants and by the varieties used as parents. These studies suggest that natural cross-pollination itself—chiefly by wild solitary bees—might be utilized in combination with male-sterile plants to supplant, or at least supplement, hand pollination as well as hand emasculation.

Differences in size and color of anthers affect the usefulness of many mutants. In hybrid seed production utilizing natural cross-pollination, those mutants with anthers most closely resembling the normal type are most desirable because they enjoy the highest rates of cross-pollination. In regard to ease of identification and pollination, mutants whose anthers are most reduced are preferable.

Mutants of intermediate effect—those designated ms_6 and ms_7—might satisfy both requirements because they are subject to relatively high rates of cross-pollination and at the same time, are readily identified and pollinated.

Charles M. Rick is Associate Professor of Truck Crops and Associate Geneticist in the Experiment Station, Davis.

OLIVES

Continued from page 4

duced total yield and at the same time pay for the cost of thinning, the income per tree was calculated from the yield records and size grades.

After thinning and harvesting costs the early-thinned trees gave a return of $11.56 per tree in comparison with $7.06 per tree from the check trees, an increase of $4.50 per tree or approximately $225 an acre.

The trees that were thinned later in the summer, on July 19th and August 16th, failed to show any appreciable benefits. While fruit sizes in the later thinned trees were greater than in the unthinned trees, apparently the yield was reduced to such an extent by the later thinning that the increased fruit sizes failed to offset this reduced yield.

Another fruit thinning experiment with olives was conducted in an orchard near Davis in 1949.

Two Mission variety trees were used, about 25 years old and of moderate size, growing in a border row. Both trees were heavily loaded with fruit, and the thinning was performed on June 30th.

Individual branches on the same tree were given different amounts of thinning to determine how localized the thinning effect was. Fruits and leaves were counted following thinning to obtain a leaf-fruit ratio. Each treatment was given to three branches. The figures given in the table on page 4 are the averages for the three branches used. The thinned branches of one of the trees were girdled to see if girdling is necesary to localize the thinning effect.

The thinning effect was quite pronounced even when single branches on the same tree were used as the units for thinning and regardless of whether the branches were girdled.

All trees in these experiments were of moderate size with the fruiting area well distributed around the tree. In extremely large trees, especially those planted close together, where the fruiting areas are in the upper parts hand-thinning may not be feasible. It is likely that only those trees which show a very heavy fruit set by about June 25th will respond to thinning—it probably would not pay to thin the trees unless they are definitely overloaded.

The thinning operation is most important when it can lift fruit from the Sub-

Continued on page 14