panied the use of these sulphurs. The groves where these tests were conducted are located in the San Joaquin Valley—one of the hotter regions of California.

Dusting citrus trees with sulphur has been practiced for a number of years in southern California against the citrus mite, but evidently no records of scale control by this method are to be found. The daily maximum temperatures for southern California are decidedly lower, as a rule, than is the case in central California where our tests were made. At Lindsay, for example, where most of our data were secured, the mean maximum temperature for June is 94.9° and for July is 101.4° Fahrenheit (U. S. Weather Bureau). These high temperatures probably constitute the factor which causes the scale mortality through the accelerated sublimation of the sulphur particles.

The above table briefly summarizes our data bearing on the subject of scale mortality induced by applications of sulphur dust to citrus trees.

In further explanation of the table it should be recorded that all the dustings were applied between April 15 and June 14, inclusive. The period during which the scale hatched was from May 12 to about July 15, so that the sulphur applications were effective against the "crawlers" throughout most of the hatching period.

The gas-purification sulphur consisted of a mixture of 20 per cent. of sulphur recovered in the process of purifying city illuminating gas and 80 per cent. commercial yellow sulphur. In all cases the sulphurs employed were ground to the point where a high percentage of the material would pass through a 200-mesh-per-inch screen, and the majority of the particles through a 300-mesh screen.

The mortality percentages listed in the table do not include natural mortality from climatic or other causes. Each of the groves had an untreated check which provides the basis for the mortality computation.

It is planned to prepare a more complete manuscript to be submitted at some future time dealing with this highly interesting new method of scale control.

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TABLE I

MORTALITY OF CITRICOLA SCALE BY DUSTING WITH VERY FINELY DIVIDED SULPHURS

Grove	Type of sulphur	Number of applications	Date of scoring grove	Net scale mortality
Montague White	Gas-purification	2	June 14*	100.0 per cent.**
H. A. Campbell	Commercial yellow	2	" 15	90.1 "
A. T. Margo	"	2	July 7	97.5 "
"	Gas-purification	2	" 7	91.6 "
C. C. Chapman	"	2	" 24	96.1 "
I. A. Baldwin	"	3	" 25	100.0 " **
Frank Kennedy	"	3	Aug. 8	98.3 "
Paul Gramm	"	2	Sept. 11	97.2 "
"	Commercial yellow	2	" 11	96.5 "
"	"	3	" 13	96.7 "
Montague White	Gas-purification	3	" 20	96.7 "
E. I. Brown	"	3	" 23	98.6 "

* All dates are of 1929.

** Had larger series been employed these values no doubt would have dropped below 100.0 per cent.

Average mortality for 3 dustings ..... 98.1 per cent.
" " " 2 " ..... 95.6 "
" " " all jobs ..... 96.6 "

CULTIVATION OF BACTERIUM TULARENSE

THE literature contains numerous references to the difficulty encountered in the cultivation of *Bacterium tularense*. Francis has shown that this organism grows well on serum dextrose cystin agar. This medium may be prepared by a process simpler than the somewhat complicated method used by Francis. Medium prepared by the process given below produces abundant growths of *Bact. tularense*, even with primary isolations.

Dissolve 0.05 per cent. cystin in water containing 0.2 per cent. Na_2HPO_4, with the aid of heat; add this to dehydrated heart infusion agar to which 1 per cent. dextrose has been added; heat the whole in the water bath to dissolve the agar. If cystin dextrose agar is

desired, tube and sterilize at fifteen pounds steam pressure for fifteen minutes. Should serum cystin dextrose agar be desired, sterilize the medium in a flask at the above pressure for the same time, then cool to 50° C., add 5 per cent. sterile rabbit's blood serum, tube and slant.

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SPECIAL ARTICLES

THE EFFECTS OF INFRA-RED, VISIBLE AND ULTRA-VIOLET IRRADIATION ON CHANGES IN ELECTRICAL POTENTIALS AND CURRENTS IN PLANTS

MANY theories have been developed to account for the effects of ultra-violet and infra-red radiations on tissues. We cite: (1) the activation of cholesterol in the skin, (2) the ionization of calcium and phosphorus in superficial tissues, (3) the electrical modifications produced in the proteins of the skin and consequent changes in hydrogen-ion concentration and (4) the presence of fluorescing materials in the skin which may act as absorbers of energy of short wave-length with reemission in the form of energy of longer wave-length which, in turn, is utilized by the tissues either as heat or in chemical changes.

The skin is the medium which separates the organism, whether it be an animal or a plant, from its environment. The skin, therefore, is the medium of reception of radiant energy and the seat of transformation or utilization of the incident energy. Since no changes of a physical or chemical character are produced in cells, tissues or organisms unless there is an absorption of energy, and since protoplasm exercises a pronounced absorption of energy of short wave-lengths (such as ultra-violet rays) and of the shorter infra-red radiations which lie close to the region of the visible spectrum, we have felt that an investigation of the electrical changes produced in the leaves of living plants under various types of selective radiation might give some information regarding the physical and chemical changes taking place in plant tissues when exposed to these various kinds of energy.

Potentiometric changes produced by artificial sources of radiant energy.—Sunflowers were used in general for experimental purposes outdoors during the summer; poinsettias were found satisfactory for indoor investigation during the autumn and winter months. Ordinarily electrodes of thin tinfoil were used and attached to the leaves or stems of plants by means of acid-free kaolin after the method of Sen. In investigating potentiometric changes in leaves, both before and after irradiation, one electrode was fastened near the base of the leaf and the other one was placed at or near the tip of the leaf. Leads were then carried to a Leeds and Northrup potentiometer, using a high sensitivity galvanometer. Various spectral filters, such as Corning Glass Company filters of special make and transmitting only infra-red, red, green, blue and ultra-violet rays and so forth, respectively, were employed. Infra-red energy of long and relatively short wave-lengths could be removed from the sources of illumination by water chambers of sufficient depth and possessing quartz bottoms. The visible and infra-red portions could be removed by water cells and solutions of certain substances or by special mediums transmitting selected portions of the ultra-violet light only. The artificial sources of energy used were infra-red generators and arcs rich in ultra-violet irradiation.

The data obtained during the last three years definitely show that marked changes in electromotive forces in leaves are produced by irradiation with infra-red and ultra-violet rays. The potential changes under heat rays from an infra-red generator are usually rapid and values as high as 0.3 volt change in potential have been obtained. The potential changes produced by irradiation with an air-cooled quartz-mercury lamp have been similar to and in the same direction as those produced with infra-red irradiation. The visible portions of the line spectrum of air-cooled quartz-mercury arcs operated at 90 volts did not produce changes, except possibly small changes in the region of the short visible waves (violet end of spectrum). Irradiation with quartz-mercury arcs from which the infra-red energy had been removed by suitable water filters, hence allowing the incidence of visible and ultra-violet rays only, produced potential changes in the same direction as those produced by infra-red rays and of an order ranging from 0.005 to 0.10 volts. These data show that potentiometric changes are produced by infra-red and ultra-violet irradiation.

Potentiometric changes produced by ionized gases near arcs.—Ozone and oxides of nitrogen produced by the quartz-mercury arc or by other metallic arcs, operating at high voltages, through which air was drawn, the ionized or nascent gases then being conducted through suitable channels to the container surrounding the leaf under test, showed marked potentiometric changes and in the same direction as the changes produced by infra-red or ultra-violet irradiation. These observations lend support to the theory which we are advancing that ionization, due directly to ultra-violet light or indirectly to the ionized con-