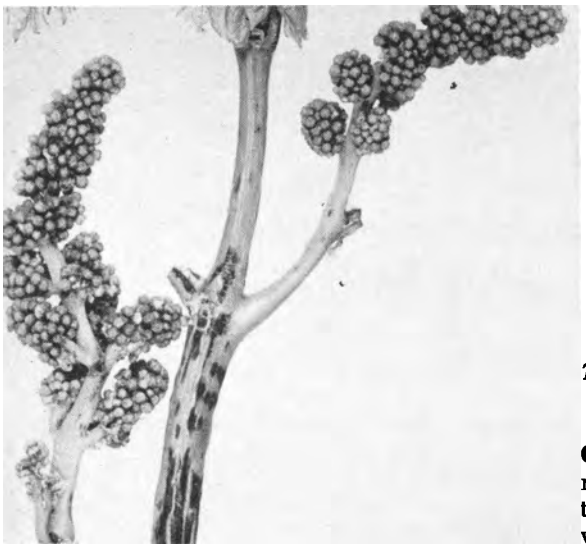

Dead-arm disease of Tokay grapevine. Materials are tested to substitute for the dormant spray of sodium arsenite which often is injurious.

Verticillium wilt in Lassen strawberry. *Left,* a healthy; *right,* an inoculated plant. An extensive program is under way to develop resistant varieties.

# Plant Pathology

## research program aims of crop plant diseases

*The following report of current research was prepared by staff members of the Division of Plant Pathology under the chairmanship of Professor Max W. Gardner, Berkeley–Davis.*

**Control of armillaria root rot,** or oak root fungus, a disease of fruit and nut trees in the coastal and cooler interior valleys is being attempted by chemical soil treatment, root exposure, and resistant rootstocks. For fig, pear, walnut and persimmon, sufficiently resistant rootstocks are now available. For apricot, plum, and prune, one of the mariannas is available as a resistant root. Some of the apple roots show some resistance.

Dematophora root rot, a fungus disease threatening the apple and pear industry of four counties and occurring in 10 others is being studied for resistance and reaction to soil treatment. Trifoliate orange, plum roots, and some lots of peach seedlings show resistance; 15 species of pear roots have proved susceptible; and 30 collections of crab apple seed, including species adaptable to this area, are being tested.

Sodium chlorophenate shows promise as a dormant spray for brown rot on almonds. Copper concentrates applied with air blast sprayers control peach leaf curl and shot hole.

Control of walnut branch wilt, a serious fungus disease in the interior valleys, is attempted by removal of diseased limbs, nitrogen fertilization, and spraying with Bordeaux in fall and midwinter.

For the control of Phomopsis canker in Kadota figs protective and eradicant sprays are being tested. Experiments are set up to determine a safe date for pruning, and a method of eradication from young plantings.

Extensive experimental planting of stone fruit trees was made in Placer County in search of a rootstock or an intermediate stock resistant to bacterial canker.

### Virus Diseases

Two experimental orchards for the study of virus diseases on stone fruit trees were established at and near Davis.

Yellow leaf roll, a destructive and apparently new virus disease of clingstone peaches has been experimentally transmitted, and numerous varieties are being tested for susceptibility.

Among the newly discovered virus diseases on California stone fruit trees is a necrotic spot disease on Gaume peach; bunch top on peach; and a rugose mosaic on sweet cherry.

Virus-free stock of Bing, Black Tartarian, Royal Ann, Deacon, and Black Republican varieties of sweet cherry were obtained for propagation, increase, and distribution. Cherry orchards free from all virus diseases, and plantings from which nurserymen can obtain virus-free scions, are being established.

### Grape Diseases

Under investigation is Botrytis bunch rot—a serious problem of the California table grape industry in years such as 1950 when rain occurs before the grapes are harvested. It was found that infection of Tokay grapes takes place through the uninjured skin and that berries with higher sugar content are more susceptible.

Study of dead-arm, a fungus disease, on Tokay, Olivette Blanche, and Corni-

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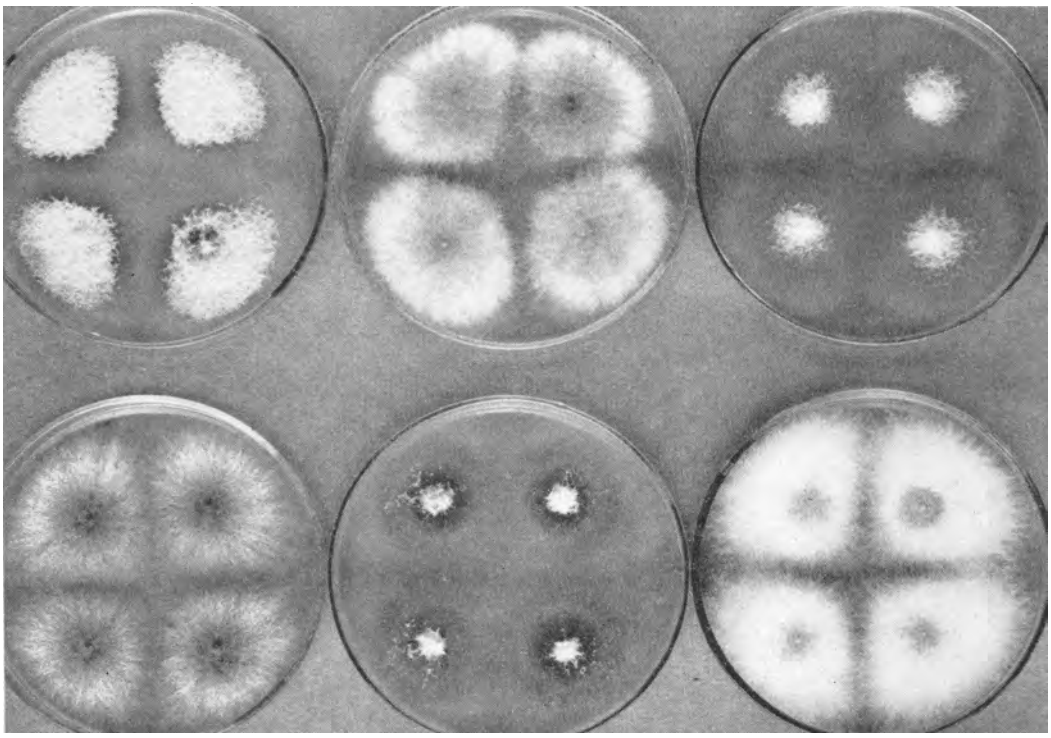

**Cultures of six different strains of the tomato wilt fungus, obtained by making cultures from single spores. These experiments on the variability in a fungus are one of many phases of basic research done at Berkeley and Davis.**

# Research Report

## at prevention and cure from seed to harvest

*The following report of current research was prepared by staff members of the Division of Plant Pathology under the chairmanship of Professor Leo J. Klotz, Riverside–Los Angeles.*

**Citrus quick decline** studies emphasize inoculation techniques, host range and symptomatology, and nature of the causal virus. At least five more years are needed to find combinations of rootstock and scion of the commercial varieties that are immune or commercially tolerant to the disease. The discovery that newly developing leaves of seedlings of Mexican lime and other citrus varieties show vein clearing within a few weeks after inoculation is greatly facilitating research on this disease.

The citrus psorosis complex—common scaly bark A, scaly bark B, concave gum disease, blind pocket, crinkleleaf, and infectious variegation—is under investigation. The chemical—dinitro—method of treating common scaly bark—Psorosis A—is being evaluated. To find sources of disease-free budwood, rapid greenhouse tests utilize citrus seedlings on which symptoms appear within two or three weeks. Experimental attempts to induce reactions similar to vaccination in animals are being made. Electrophoresis and electron microscope studies suggest that additional visible evidence of the occurrence of psorosis strains will be obtained. Continued extensive studies failed to demonstrate that any of the citrus viruses are transmitted in the seed.

The decline-collapse disease of lemon trees has been related to the gradual degeneration and necrosis of the food-conducting tubes. Six to 10 years may be required to demonstrate the cause of this disease.

### Other Citrus Diseases

Data continue to accumulate that the dry bark disease of lemon trees is a severe form of shell bark in which the shelling of the bark is inhibited probably by the invasion of secondary fungi. Investigations on the feasibility of protecting susceptible trees from these secondary invaders by fungicides are underway.

Wood pocket of certain strains of lemons and limes appears to be an inheritable disease which can be avoided by using budwood or seeds from disease-free sources.

Rio Grande gummosis of grapefruit trees so far has not been reproduced in California by inoculation with fungi from infected trees. Various organisms are being inoculated into healthy grapefruit trees in further attempts to reproduce the trouble and find its cause.

The effect of various treatments on Rhizoctonia damping-off of citrus seedlings is being studied. Soaking the seeds in the culture filtrate of the fungus did not immunize the seedlings. Treatment of the seedbed with ethyl mercury iodide or aluminum sulfate greatly reduced the development of the trouble.

Spray plots for study of Botrytis blossom blight control were established last winter. Thus far no strikingly effective fungicide has been discovered, but sufficient evidence of partial control was found to warrant further experiments this year. Ferric ethylene bisdithiocarbamate has been the most effective material tried thus far.

Extensive trials of twig die-back lend support to the theory that it may result from a soil too dry or too cold or too salty to permit root absorption of the soil

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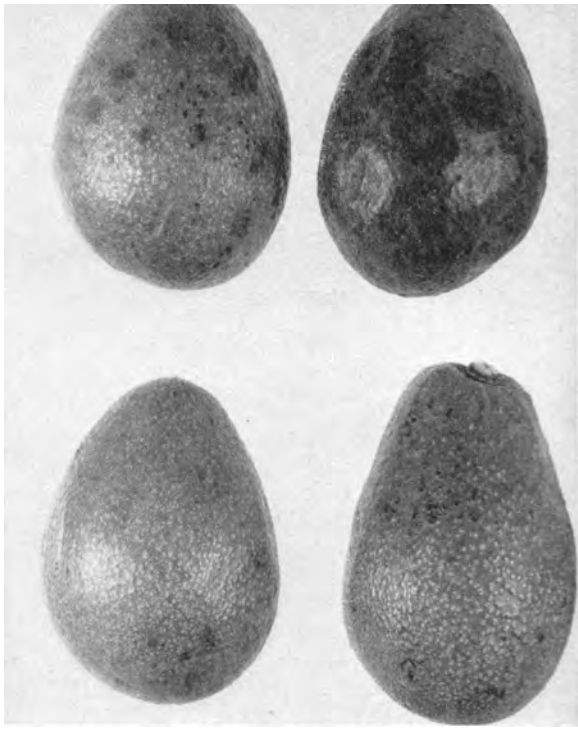
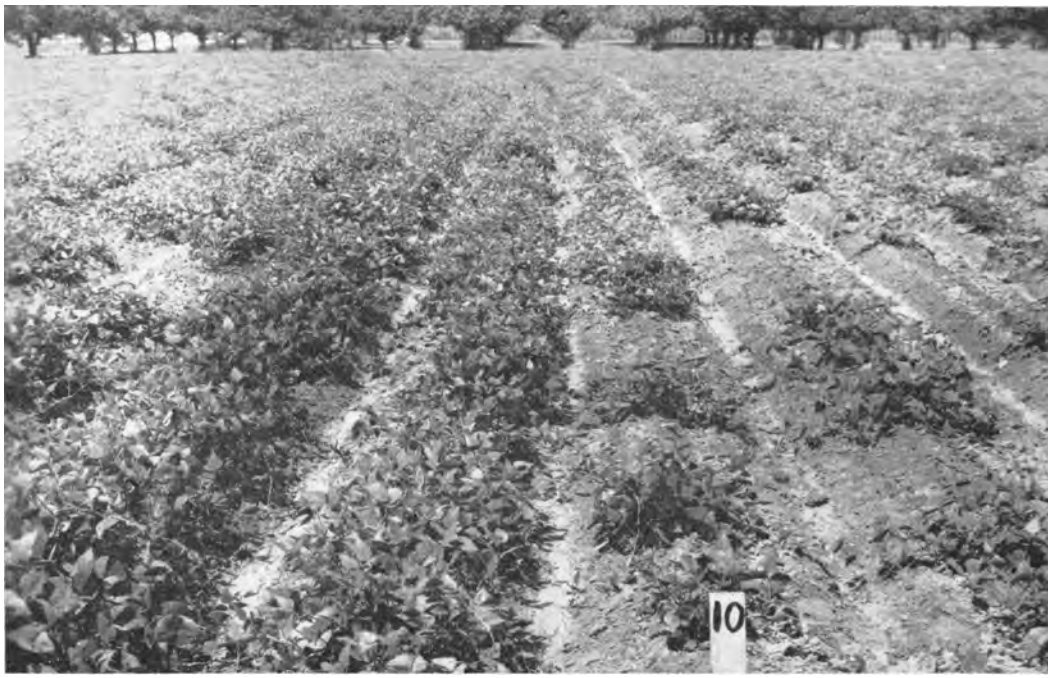


**Top, Dothiorella fruit rot caused by *Botryosphaeria ribis*; bottom, fruit protected by spray of 6-6-100 Bordeaux mixture.**

**Shell bark of lemon, one of the many citrus diseases investigated at Riverside.**




**Comparative stand and size of Baby Lima beans, variety Westan, grown in non-infested soil—to left of row 10—and soil infested with *Rhizoctonia solani*, incitant of Rhizoctonia root rot—row 10 to the right.**

## SOUTH

Continued from page 9

solution sufficiently rapid to keep pace with transpiration of the foliage. The organisms isolated from diseased trees are probably secondary.

The long search for fungicides effective against brown rot, Septoria spot, Botrytis blossom blight and bacterial blast, and also non-injurious to citrus, has yielded some copper-zinc chromates, a copper-aluminum-iron compound, and ferric ethylene bisdithiocarbamate of considerable promise.

Studies aim at controlling fruit troubles in the packing house by preventing or retarding various types of decay, physical and chemical injuries, and physiological breakdowns. Observations and experiments on brown rot of lemons have revealed conditions under which this important storage decay can be decreased.

Temperature-growth studies are made of various fungi causing decay of citrus fruits.

Investigations of disease resistance and susceptibility include attempts to immunize citrus seedlings from attacks of fungi by soaking the seeds in the culture filtrates of the microorganisms. To immunize citrus against virulent strains of quick decline, pre-inoculation with mild strains of the virus are made. The interference between different strains of citrus psorosis viruses is studied. Search for rootstocks resistant to the brown rot gummosis fungi, avocado root rot fungus, dry root rot of citrus, and quick decline continues.

A study of the effect of temperature on infection and development of the citrus root nematode reveals that soil temperatures between 77° F and 88° F are favorable, while temperatures below 59° F and above 95° F permit little or no infection.

A number of chemicals for control of the nematode on the roots of living orange trees are being tested under greenhouse and field conditions. Chemicals tested so far have been ineffective or resulted in serious injury to the roots.

Orange and lemon trees replanted on fumigated soil in the field have improved growth over trees on untreated soil. Some of the changes induced by soil fumigation are being studied further.

Immersion of the roots of bare-root nursery trees in water at 113° F for 25 minutes eradicated the nematode. The fumigation of balled nursery trees with methyl bromide is being studied with promising results.

The susceptibility to nematode of 14 species of citrus, comprising 136 varieties has been tested. All were infected. But selections of a near-citrus relative, the trifoliate orange—*Poncirus trifoliata*—appear promising for developing nematode-resistant rootstocks. The development of satisfactory nematode-resistant rootstocks for citrus by selection and breeding are being investigated.

### Avocado Studies

Several means have been found to kill or reduce in the soil *Phytophthora cinnamomi*, the fungus causing avocado root rot. Successful methods include use of soil fumigants, soil fungicides, organic matter applications—such as alfalfa meal—and drying the soil to a low moisture content. Application of these methods to control of the disease in the field is underway and promising results have been obtained in some cases. Other factors being investigated include: effect of various fertilizers, natural distribution of the fungus in southern California soils, and the biology of the fungus.

**Elberta peach tree affected with peach mosaic showing retarded foliation contrasted to normal foliation on an escape unaffected arm.**

Tests of possible resistant rootstock sources are underway but results are not yet available. The resistance of other subtropical plants to *P. cinnamomi* is being investigated. According to present data, macadamia nut, persimmon, and cherimoya are very resistant to the fungus.

Field spray trials to reduce incidence of Dothiorella fruit rot of Fuerte avocados in coastal San Diego County have shown that copper 8-quinolinate, a copper-zinc-chromate, or Bordeaux, give excellent control. The soil fungus, *Verticillium albo-atrum* was recently determined to be the cause of an avocado disease known for many years as collapse. It causes a vascular or wilt disease similar to that on many other hosts.

The virus disease of avocados known as sunblotch is being studied chiefly with the aim of developing techniques to aid in the production of virus-free nursery stock.

The effect of plant nutrition on virus diseases is under study. These experiments should yield information on how viruses behave in the infected plant, and how their detrimental effects may be eliminated.

### Vegetable Diseases

Root rot of lima beans, caused principally by *Rhizoctonia solani*, is being investigated on soil treatment plots, and in a study of the influence of soil temperature on the incidence of the disease.

A breeding program has revealed the possibility of incorporating root rot resistance into commercial varieties. A source of resistance was uncovered in 1950, and is now included as parent material in this program.

The effect of a satisfactory crop rotation program on the severity of Pythium root rot, injurious to various vegetables, is under investigation. The relation of Pythium wilt on bean, pea and cowpea to root rot of legumes is under study.

Study of soil microflora and resultant incidence of disease is likely to lead to recommendations in cropping procedures which will cut down the annual loss caused by root rot of various legumes.

A program for developing resistance to Verticillium wilt in peppers is underway. A study is devoted to the control of pepper viruses, particularly tobacco mosaic, and spotted wilt. A continued study will determine the effectiveness of control through a virus susceptible weed-host eradication program.

Alternaria fruit rots of fall tomatoes have been greatly reduced in the south coastal counties by field sprays with one pound of 2,3 dichlor 1,4 naphthoquinone in 100 gallons water applied every two weeks throughout the fruit bearing season.

Recent investigations have shown that organic peroxides, formed when unsaturated hydrocarbons—petroleum products—are in the presence of ozone or nitrogen oxides and sunlight, are responsible for air pollution or smog damage to spinach, endive, lettuce, and other herbaceous crops grown in the Los Angeles area.

### Other Crops

Observations of 18 varieties of date palm indicate that only the Deglet Noor variety is appreciably susceptible to omphalia root rot. Attempts are being made to determine the role of this root rot, of culture conditions, and other factors to decline of commercial plantings of the Deglet Noor variety. The pathogenicity of fungi obtained from roots affected by rhizosis—rapid decline—is being investigated.

Continued on next page

## NORTH

Continued from page 12

field selection of resistant plants, is now available.

No wilt-resistant California Common plants have been found; but by crossing, the wilt resistance of the Turkestan variety, and the resistance to leaf spot and downy mildew obtained by selection in California Common, have been incorporated into a new variety, Caliverde.

Large numbers of Caliverde plants are exposed in the greenhouse to high populations of the sharpshooter leafhoppers carrying the dwarf virus, to discover dwarf-resistant plants. This work should yield a variety of alfalfa resistant to all four diseases.

### Ornamentals

Among the diseases of ornamentals which have been investigated are powdery mildew, downy mildew, Verticillium wilt and virus diseases of rose; root rot and Fusarium wilt of carnations; powdery mildew of heather; stem rot of peperomia; Verticillium wilt of chrysanthemum; Septoria leaf spot of Esther Read daisy; powdery mildew of snapdragon; root rot of poinsettia; rhizome rot and spotted wilt of calla; flower blight of camellia; and bacterial and virus diseases of orchids.

Botrytis infection has been studied on Bouvardia, Stephanotis, cyclamen and tuberous begonia and other bulbs; virus diseases on primula, annual stock, sweet pea, and freesia and other bulbs.

### Basic Research

Experiments using radioactive sulphur as a tracer, explain how sulphur kills the rust or powdery mildew fungus without injuring the leaf tissue.

Other tests show that sulphur vapor is more effective as a fungicide at higher temperatures.

To safeguard the high reputation of California seeds and to aid growers, pure culture procedures have been developed to detect plant pathogenes on seeds. This makes it possible to analyze any seed lot for its disease-freedom or disease-potential, and inform seedsmen or growers if they need to take precautions against any particular fungus.

Chemical activities and responses of plant pathogenic bacteria are under study.

Some strains of the potato scab organism, *Streptomyces scabies*, were found to produce an antibiotic that is active against Verticillium and Fusarium wilt fungi.

The antibiotics, penicillin, streptomycin, bacitricin, aureomycin, and circulin killed pathogenic bacteria on tomato seed, so that healthy seedlings were produced while 30% of the seedlings from untreated seed were infected.

Sodium salt of o-hydroxydiphenyl—natriphene—at dilutions of 1:2000 has been found effective as a plant dip against a bacterial disease of orchids.

When cultures of two species of pathogenic bacteria, those causing tomato canker and walnut blight, were treated with certain chemicals of the naphthalene group or with certain uranium salts, mutations were induced which resulted in strains with greatly reduced virulence.

The size and shape of plant virus particles are being studied by means of the electron microscope. Methods of extracting virus from diseased tissues have been improved and two spectrophotometric methods for measuring virus concentration in plant tissues developed.

Many compounds are applied to living infected tissue to determine their effect on virus multiplication. This is done with entire plants, detached leaves, and tissue cultures. Any compound that will inhibit virus multiplication may find important applications in medicine as well as agriculture.

## SOUTH

Continued from preceding page

Experiments on date fruit spoliage reveal that wet weather, microorganisms, insects, and mites are responsible, and that commercial control can be effected by covering the fruit bunches with strong paper bags, inserting wire rings in the bunch to separate the fruit strands, and dusting the fruit with various fungicides and insecticides.

The role of the fungus *Trichoderma lignorum* in the control of Armillaria mellea, a fungus causing root rot of various trees, is being studied.

Ninety-six of the most promising and important peach varieties have been tested for tolerance to the peach mosaic virus. Most of the clingstone varieties fall in the tolerant or little damaged class, and most of the freestone are in the severely damaged class.

Work on diseases of commercial floricultural seed, nursery, bulb, and ornamental crops aims at obtaining disease-free seed or planting stock, and at methods for keeping them healthy. Some of the studies attempt to control established diseases of a wide variety of commercially important ornamentals of California.

## ANTS

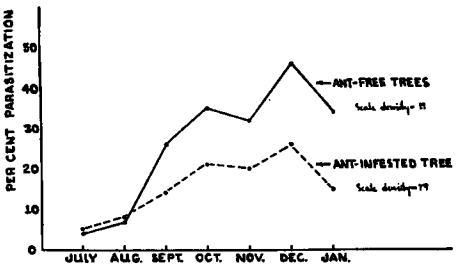
Continued from page 7

do not distinguish between the natural enemies of these and other pests. The ants seem to be particularly effective in capturing or disturbing the principal red scale parasite, the golden chalcid. Thus the red scale increases in ant-infested groves where this parasite is prevalent.

The citrus red mite, too, increased sharply on ant-infested trees. The ants show no particular interest in the mites but attack their natural enemies. In a lemon grove at Montecito there was an average of 1,437 citrus red mites on 1,000 leaves taken from ant-infested trees, while the same number of leaves from ant-free trees averaged only 66 mites.

It is evident from this experiment that in an untreated grove having efficient citrus red mite predators present, the effectiveness of the predators may be nullified by the adverse activities of ants to such an extent that mite populations may increase 20-fold.

Data from the Montecito tests show that on ant-infested trees 63% of the leaves suffered medium to very heavy feeding damage. On ant-free trees only 32% of the leaves suffered medium to heavy feeding damage, and none suffered very heavy feeding damage.




**Per cent parasitization of California red scale by *Aphytis* during a period of heavy ant infestation on ant-infested and ant-free lemon trees.**

The gray field ant or crazy ant, individual for individual, is much more destructive of natural enemies of citrus pests than the Argentine ant. But the Argentine ant is most generally distributed and occurs in larger colonies, so its over-all effect is greater.

Pest populations increase during and shortly after the season of greatest ant activity. Their relative increase, with respect to ants, is greatest in years of ant abundance.

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