

Abstracts of the Fifty-fourth Annual Meeting of the Pacific Division
of The American Phytopathological Society

The influence of common root rot on the survival of winter wheat. T. G. ATKINSON & J. S. HORRICKS (Can. Dept. Agr., Res. Sta., Lethbridge, Alta.). Evidence that common root rot, caused principally by *Cochliobolus sativus*, is an important factor influencing the "winterhardiness" of fall-sown wheat was obtained under field conditions of root-rot infection and cold injury. Three winter wheat cultivars, Kharkov 22 M.C., Jones Fife, and Comanche, were sown at three dates (9, 23 Aug. and 6 Sept.) into paired plots of untreated field soil and soil that had been treated on 19 June with metam-sodium (Vapam soil fumigant) at 60 gal/acre. Both the severity of root rot in the fall and the degree of winterkill in the spring were invariably lower in the treated than in the untreated plots. The fumigant improved the winter survival of Kharkov 22 M.C. and Jones Fife most (34%) in plots sown on the third date, while for Comanche the best improvement (29%) in winter survival occurred at the second seeding date.

Effect of antitranspirants on Fusarium wilt of carnations. R. BAKER & D. SMITH (Colo. State Univ., Ft. Collins). Carnations (*Dianthus caryophyllus*) were planted in soil infested with *Fusarium oxysporum* f. *dianthi* and sprayed with phenylmercuric acetate (PMA), triazine, diuron, isocil, and swep; all are antitranspirants. PMA exerted some degree of control and was selected for further tests. It was lightly sprayed biweekly at 0, 20, and 40 ppm (active) on inoculated plants of the variety Pink Sim in a replicated experiment. Symptoms of wilt appeared in 67, 42, and 28% of these plants after 1 year. In a similar experiment in which PMA was sprayed to runoff at 0, 1, and 5 ppm, significant control was obtained at the higher rate for the susceptible var. Pink Sim but not the resistant var. Red Sim. Tissue from sprayed plants was not inhibitory to germination of conidia of the pathogen. The fungus was isolated from the same proportion of treated and non-treated plants. It is postulated that wilting was delayed in treated plants because of the maintenance of high water status due to transpiration inhibition.

Common antigen relationships among Fusarium species and wilt-susceptible and wilt-tolerant varieties of cotton. R. CHARUDATTAN & J. E. DEVAY (Univ. Calif., Davis). A comparison was made of the antigenic structures of varieties of *Gossypium hirsutum* with those of *Fusarium oxysporum* f. *vasinfectum* to determine possible common antigen relationships. Included were highly virulent strains of *F. oxysporum* and nonpathogenic variants. *F. solani* var. *phaseoli* and *F. moniliforme* were also studied. Cotton varieties Rowden and Acala 4-42 (both wilt-susceptible) and Auburn 56 and Deltapine Smoothleaf (both wilt-tolerant) showed a strong serological relationship with all the isolates of *Fusarium* except *F. moniliforme*. In agar gel double-diffusion plates, identical precipitin bands were formed in homologous and heterologous reactions when fungal and cotton antigens were reacted with fungal or host antisera. The common antigenic substance (CA) was isolated by differential centrifugation and partially purified by gel filtration and electrophoresis; it appears to be proteinaceous. The CA was apparently not a component of ribosomes or mitochondria, but was concd in the soluble fraction of fungal and host cells. It is postulated that CA quite possibly is involved in the establishment and survival of *Fusarium* isolates in host tissue.

The mechanism of photoreactivation of plant viruses. M. CHESIN (Univ. Montana, Missoula). Photoreactivation (PR) of some plant viruses was determined from survival curves of ultraviolet-irradiated virus when inoculated assay hosts were subsequently kept in light and dark. Results with viruses of different morphology were in general agree-

ment with those previously obtained for others. Viruses with rigid, rodlike particles (barley stripe mosaic and Lychnis strain of tobacco mosaic virus [TMV]) showed no PR, while those with flexible particles (potato X, clover yellow mosaic, and the infectious nucleic acid of TMV) did exhibit PR. The PR of clover yellow mosaic virus demonstrated no particular relation to temp between 15 and 25 C, in contrast to some DNA systems, suggesting the implication of indirect PR or "photoprotection". Several treatments, urea, high pH, and low temp, were used in an attempt to sufficiently weaken bonding between the nucleic acid and protein of TMV to permit photo-reversal of ultraviolet (UV) damage. None of the treatments was effective; however, high pH sensitized virus to damage in illuminated leaves, and low temp consistently reduced inactivation of virus by UV.

Seed and cone mortality of coast redwood. J. G. N. DAVIDSON (Univ. Calif., Berkeley). Pathological aspects of low viability in *Sequoia sempervirens* seed were investigated by isolating fungi from ovules or seeds and cone scales collected from two widely separated localities at regular intervals from June until October. Few ovules, but most scales, were invaded by the time of fertilization. Necrosis of scales and cone peduncles began early in July and increased until maturity when few cones were healthy. Ovule and seed infection also increased, but their mortality was mostly associated with scale mortality. Individual tree and regional variations existed in the mycoflora isolated. Sound seed, selected by X-radiography and incubated at 5, 15, and 25 C, were inoculated with the more common fungi isolated. An unidentified fungus, isolated only from seed, reduced germination significantly at all temp; *Pestalotia* sp. reduced germination at 25 and 15 C, and frequently destroyed emerged radicles at all temp; *Phoma* sp. and *Penicillium* sp. reduced germination only at 5 C after prolonged incubation. *Pestalotia* sp., *Coniothyrium* sp., *Phomopsis* sp. and a second unknown fungus, when present in the seed coat, destroyed embryos or emergent radicles. These fungi, when present in the seed coat, comprise a component distinct from the usual damping-off mycoflora.

Evaluation of several fungicides in Idaho for control of Rhizoctonia on potato. J. R. DAVIS & R. H. CALLIHAN (Univ. Idaho, Moscow). Seed-piece treatments with chloroneb (1,4-dichloro-2,5-dimethoxybenzene, 2.5-5.0% active ingredient) applied as a dust to provide max coverage of fresh-cut seed, showed a significant reduction of stolon infection. Although yield was not significantly reduced, the 5% chloroneb dust treatment was phytotoxic. Seed-piece treatments with benomyl [methyl-1-(butylcarbamoyl)-2-benzimidazolecarbamate] applied as a dust at 1-5% active ingredient showed a significant increase of healthy stolons per stem; however, *Rhizoctonia* was not significantly reduced. In-furrow treatments of benomyl applied to soil to provide 25-30 ppm of active ingredient significantly reduced stolon infection in potato caused by *Rhizoctonia*. Soil treatment at 12.5 ppm, however, provided no significant control. For 2 consecutive years, potassium azide (KN₃) has shown promise for *Rhizoctonia* control. Following soil incorporation, potassium azide demonstrated a significant reduction of stem cankering and stolon infection at concn of 50-150 lb./acre.

Fungistatic activity of nonaromatic amines. J. W. ECKERT, M. L. RAHM, & M. J. KOLBEZEN (Univ. Calif., Riverside). 3-Methylpyrrolidine and 2-aminobutane were the most active of 50 nonaromatic amines tested in their cationic form for inhibition of germination of *Penicillium digitatum* spores. Pyrrolidine, 2-methylpyrrolidine, isopropylamine, and 1-methylpropenylamine showed lesser activity, but all other simple amines tested were not inhibitory. Replace-

ment of either the C-1 or C-4 methyl group of 2-aminobutane with CF_3 , CCl_3 , COOH , OCH_3 , CH_2OH , Cl , NH_2 , or OH resulted in compounds which were not active. (—) 2-Aminobutane was considerably more active than the (+) enantiomer, both in preventing spore germination and in inhibiting mycelial growth of three species of fungi which were sensitive to racemic 2-aminobutane. (—) 2-Aminobutane and 3-methylpyrrolidine were uniquely effective in preventing infection of citrus fruits by *P. digitatum*. The receptor site for inhibitory amines on the fungus cell appears to consist of an anionic component, which binds the $-\text{NH}^+$ group, and a hydrophobic area, which is complementary to the *sec*-butyl radical as spatially oriented in (—) 2-aminobutane.

Electron microscopy of Datura stramonium leaf cells infected with tomato spotted wilt virus. R. I. B. FRANCKI (Waite Agr. Res. Inst., Univ. Adelaide, S. Australia). Spherical particles, about 85 m μ in diam, were observed in leaf cells of *Datura stramonium* infected with tomato spotted wilt virus (TSWV), but not in those of noninfected plants. These particles consist of an inner core and an envelope with uniformly arranged projections; it is concluded that they are the virus particles. Two additional cytoplasmic inclusions were observed in TSWV-infected cells: osmiophilic granular inclusions and long filaments. All the inclusions associated with TSWV infection were confined to the cytoplasm and were never observed inside nuclei, chloroplasts, or mitochondria. The distribution of TSWV in systemically infected leaves is very similar to that of several other viruses causing mosaic symptoms, but its large size raises interesting questions regarding its spread from cell to cell.

Susceptibility of cultured tissues from Pinus albicaulis, Pinus flexilis, and Pseudotsuga menziesii to invasion by Cronartium ribicola. A. E. HARVEY & J. L. GRASHAM (USDA, Intermountain Forest Range Exp. Sta., Moscow, Idaho). Sixty-day-old tissue cultures from *Pinus albicaulis*, *Pinus flexilis*, and *Pseudotsuga menziesii* were invaded by *Cronartium ribicola* when grown for 60-90 days adjacent to heavily infected cultures from *Pinus monticola*. Typical intracellular haustoria were formed in all cases. Invasions of *P. albicaulis* and *P. flexilis* resulted in self-sustaining infections (i.e., when the inoculum tissue was removed the infection continued to propagate). Invasions of *P. menziesii* did not result in self-sustaining infections. Invaded calluses of the latter became necrotic within 60 days; within 90 days, both organisms were moribund. All tissues successfully invaded, regardless of origin, had an attractant effect on rust mycelia. This effect was noted on mycelia within the substrate and on aerial mycelia from inoculum calluses. These results confirm the practicability of using any host species as a source of tissue cultures on which to carry out in vitro studies of the *Cronartium-Pinus* system. Invasion of callus tissue from a nonhost species suggests that the nutritional requirements of this rust may not be host-specific. The attractant effects suggest production of diffusible, possibly volatile, growth factors.

Transmission of rice transitory yellowing virus by Nephotettix impicticeps. SHIH-PAN-YU HSIEH, REN-JONG CHIU, & CHUN-CHUNG CHEN (Univ. Hawaii, Honolulu, Provincial Chung-hsing Univ., Taichung Agr. Improvement Sta., Taichung, Taiwan). Two of the three species of *Nephotettix* occurring in Taiwan are known to transmit rice transitory yellowing virus (RTYV). The third species, *N. impicticeps*, occurs rarely in Taiwan and has not been tested as a RTYV vector. Transmission studies of RTYV by *N. impicticeps* were carried out in an air-conditioned greenhouse at 24-28 C at Provincial Chung-hsing University, Taiwan, during the winter season, 1969. Results showed that efficiency of transmission by *N. impicticeps* was almost the same as with the other two known vectors, *N. apicalis* and *N. cincticeps*. Twenty-eight of 60 insects

which fed for 2 days on diseased plants became infective. These insects showed an incubation period of 4-20 days (usually 10-12 days). All infective insects retained the virus up to their death. Preliminary studies on transovarial transmission indicated that RTYV was not passed through the eggs of infected *N. impicticeps*. Mechanical transmission of RTYV into *N. impicticeps* by microinjection was successful. More than 90% of insects became infective after receiving the virus by injection.

The morphology of a mycoplasma associated with peach X-disease. JENIFER HUANG & G. NYLAND (Univ. Calif., Davis). Midrib tissues of leaves of peach with and without symptoms of peach X-disease were collected in late summer for study by electron microscopy. Tissues were fixed by standard methods and embedded in Spurr's medium. Cross and longitudinal serial sections about 100 m μ thick were mounted on bar grids for examination. Mycoplasma-like bodies were seen only in mature sieve tubes of the leaves that had symptoms of X-disease but not in healthy leaves. In longitudinal sections, the mycoplasma bodies were straight or undulating, cylindrical tubules up to 5,400 m μ long and 120-360 m μ in diam. Most were oriented parallel to the tangential walls of the sieve elements. Some tubules were oriented perpendicular or at angles to the long axis, perhaps because of stream flow in the sieve tubes. Cross sections through sieve tubes showed spherical, ovate, or elongate discrete mycoplasma bodies. Serial sections showed that some individual spherical or short cylindrical mycoplasma elements in certain sections were portions of the same curved or undulating tubule. Movement from cell to cell probably occurs through the pores in the sieve plates, since some mycoplasmas were seen extending through pores of adjacent sieve tubes.

Identification of plant-pathogenic bacteria using aminopeptidase profiles. D. M. HUBER, J. W. GUTHRIE, & OLGA BURNOVIC (Univ. Idaho, Moscow). Two ml of 22 different amino acid beta-naphthylamide substrates (10^{-4} M in 0.1 M Tris [tris (hydroxymethyl) aminomethane] pH 8.0) were each separately combined with 0.1 ml of inoculum (10^8 cells/ml) and incubated for 6 hr at 25 C. Released beta-naphthylamine was determined with a fluorimicrophotometer (Corning 7-60 primary filter and Wratten 2A secondary filter). *Pseudomonas syringae*, *P. pisi*, *P. solanacearum*, *P. lachrymans*, *P. phaseolicola*, *Xanthomonas phaseoli*, *X. phaseoli* var. *fuscans*, and *Agrobacterium tumefaciens* all had distinct aminopeptidase profiles characteristic of the species. *Pseudomonas phaseolicola* isolates could be grouped into two categories depending on the per cent hydrolysis of lysine, methionine, and phenylalanine. *Pseudomonas syringae* isolates could be grouped into one of three profiles, depending on the host of origin. Isolates of *X. phaseoli* hydrolyzed 3 times as much lysine, 8 times as much methionine, and 2 times as much phenylalanine as that hydrolyzed by *X. phaseoli* var. *fuscans*. Standardization of incubation time and inoculum concn resulted in a rapid, reproducible means of identifying these bacteria.

Dissemination of Phytophthora palmivora sporangia from papaya fruits. J. E. HUNTER (Univ. Hawaii, Hilo). *Phytophthora palmivora* causes devastating aerial attacks on papaya during rainy periods on the Island of Hawaii. Diseased fruits are covered with masses of sporangia which are not liberated in dry air. Water drops impacting on diseased fruits dislodge numerous sporangia in large splash droplets, a few in very small droplets, and others without any coating of water. Detached sporangia free of water did not survive more than 4-8 min at relative humidities below 90% at 24 C. Thus, windblown rain is concluded to be the important means of dissemination. When diseased and healthy fruits were enclosed in beakers covered with cheesecloth, *Drosophila* sp. were attracted only to the containers with diseased fruit, suggesting that volatile attractant(s) may be produced. Evidence has been obtained that these insects can disseminate *P. palmivora*.

Association of mycoplasma-like bodies with stubborn disease of citrus. E. C. K. IGWEGBE & E. C. CALAVAN (Univ. Calif., Riverside). Tissues from the midvein of fully expanded young leaves of Madam Vinous sweet orange seedlings, showing characteristic stubborn symptoms, were fixed in glutaraldehyde and osmium tetroxide, embedded in Epon, and sectioned with glass knives for electron microscopic examination. No viruslike particles were seen. Some of the mature sieve tubes of infected plants, however, contained pleomorphic bodies which were absent in comparable tissues from leaves of healthy seedlings. These bodies ranged from 50 to 500 m μ in diam and lacked a definite cell wall. A triple-layered unit membrane was evident in some bodies. The larger bodies contained ribosome-like granules and fibrils not apparent in the smaller, more electron-dense bodies. In size and morphology, these bodies are similar to mycoplasma-like structures reported to occur in phloem cells of plants affected by yellows-type diseases. It is suggested that these mycoplasma-like bodies rather than a virus may be the causal agent of stubborn disease.

Studies on the mechanical transmission, extraction, and assay of citrus exocortis virus in Gynura aurantiaca. S. P. KAPUR, L. G. WEATHERS, & E. C. CALAVAN (Univ. Calif., Riverside). Buffers of varying pH and ionic strength were evaluated for efficiency in extraction and mechanical transmission of exocortis virus of citrus from *Gynura* to *Gynura*. Low ionic strength buffers in the basic range were preferable to acid buffers and buffers of higher ionic strength. Almost 100% transmission was obtained with low ionic strength Tris [tris(hydroxymethyl) amino methane] buffer and sodium sulfite, both pH 9.0. Exocortis virus in crude extract was more infectious for a longer period of time at room temp in Tris buffer than in sodium sulfite. Partially purified preparations of the virus were more infectious when initially extracted in Tris buffer vs. extraction in sodium sulfite. Extraction with 0.1M Tris buffer was adopted as a procedure in purification and mechanical transmission. Optimum temp for development of symptoms was 24-30 C, with an incubation period of approximately 12 days. Above 30 C growth of the plants was retarded. The incubation period of the virus was extended when plants were grown at temp below 24 C with masking of symptoms at 15 C. When plants at 15 C were transferred to 24 C, symptoms appeared in 10 days. Light intensities of 500, 1,000, 1,500, and 2,000 ft-c had no effect on development and severity of symptoms.

A method for enumeration and isolation of phospholipase-producing microorganisms from soil. WEN-HSIUNG KO & FRANCES K. HORA (Univ. Hawaii, Honolulu). Lecithin (0.1%) was incorporated into water agar, soil-extract agar + 50 ppm PCNB, and soil-extract agar + 50 ppm chloramphenicol and 50 ppm streptomycin for use as selective media for the enumeration and isolation from soil of phospholipase-producing actinomycetes, bacteria, and fungi, respectively. The relative amount of phospholipase activity was indicated by the comparative sizes of the white zones surrounding the colonies. Most soil actinomycetes and a few bacteria and fungi were able to produce phospholipases. Production of phospholipases by actinomycetes appeared to be widespread, since more than 60% of them, from the five soils tested, produced this group of enzymes. Actinomycetes, therefore, may be responsible for decomposition of phospholipids in the organic matter in soil. The method employed in this study may be used to detect and compare phospholipase production by plant pathogens and other microorganisms. Simplicity and quickness are two important advantages of this method over the 'cup plate' procedure.

Loquat canker incited by Pseudomonas sp. in California. MINGTAN LAI, W. O. MCCARTNEY, & C. MORIN (Calif. Dept. Agr., Sacramento). The loquat (*Eriobotrya japonica*) canker disease in California is characterized by numerous

stem cankers of various sizes. As these cankers enlarge, callus tissue forms a tan to brown border which eventually develops an irregular-shaped "lip" around the canker edges. Finally, the exposed and infected wood within the cankers becomes a charcoal black, concentrically depressed cavity. Isolations of the causal organism, *Pseudomonas* sp., were made from cankered branches in late fall and mid-winter. The isolate induced symptoms on young seedlings 3 to 4 weeks after inoculation similar to those on the naturally infected tree. Morphological, physiological, and serological studies indicate that *Pseudomonas* sp. isolated from the infected loquat tree is similar to *Pseudomonas eriobotryae*. This is the first report of a bacterial canker disease on loquat in California.

Trehalose utilization and sclerotium formation in Sclerotinia sclerotiorum. SU-CHIN LIU & D. LETOURNEAU (Univ. Idaho, Moscow). Trehalose is the major sugar found in sclerotia of *Sclerotinia sclerotiorum*, but few, if any, sclerotia were produced on a trehalose-salts medium. Sclerotia, however, began to form about 5 days after seeding a glucose-salts medium. When the fungus was grown in still culture on a liquid trehalose medium, sclerotia were produced when glucose-U¹⁴C was added before the 5th day after seeding. On the basis of ¹⁴C distribution, 20% of the carbon in the mycelium and 65% of the sclerotial carbon came from glucose. This indicates a selective utilization of glucose for sclerotial formation. When the fungus was grown continuously on glucose-U¹⁴C or trehalose-U¹⁴C and fractionated, mycelia grown on glucose contained a large amt of ¹⁴C in a starchlike fraction, while mycelia produced on trehalose contained considerable ¹⁴C in an S-glucan fraction. Four to 5 days after seeding, mycelia grown on glucose contained up to 20 times more trehalose than that grown on trehalose. We suggest that on trehalose medium, most of the trehalose is directed to other products in the cells and never accumulates to the level necessary for the formation of sclerotia.

Role of phenolics in a virus disease of hops. H. A. MELOUK & C. B. SKOTLAND (Irrigated Agr. Res. Ext. Center, Wash. State Univ., Prosser). Prunus necrotic ringspot virus is latent in many hop varieties; in others it produces ring-spots, line patterns, and various types of mottling. Leaf symptoms usually appear during cool weather that follows periods of warm temp (27-30 C). Peroxidase (PER) activity in the susceptible variety Early Prolific (EP) was higher than in the susceptible variety Petham Golding (PG) and the less susceptible Late Cluster selections L₁, L₈, L₁₆, and Early Cluster (E₂). Polyphenol oxidase (PPO) activity in the variety PG was higher than in the Cluster selections and EP. EP and PG had a low phenolic content as compared with the Clusters. Varieties with high phenolic content showed a higher activity of phenylalanine ammonia-lyase than those with low phenolic content. PER activity in hops grown at 18-20 C was higher than in those grown at 27-30 C. Total phenolic content, PER, and PPO activities in necrotic and line-patterned areas of the leaves were higher than those in the surrounding tissue. Paper chromatography separation showed that the number of phenols in necrotic tissue was higher than in the surrounding tissue. These data suggest that phenol metabolism in virus-infected hops may play a role in symptom expression and disease tolerance.

A rapid serological detection method for Pseudomonas phaseolicola infected bean tissues. T. D. MILLER (Utah State Univ., Logan). A simple, rapid serological test for *Pseudomonas phaseolicola* was developed which utilizes the pathogen population present within the plant. This eliminates the difficult process of isolating the bacterial pathogens from the many contaminants encountered in nutrient culture techniques, thus shortening and simplifying the identification-detection procedure. The entire test requires less than 30 min to complete. The juices are extracted from

portions of the suspected plant with a hand press. The exudate is centrifuged at 3,000 g for 5 min, after which 0.025 ml of the supernatant is mixed with 0.025 ml of the appropriate antiserum on a serological ceramic ring slide. This mixture is rotated for a min of 2,100 revolutions. Agglutination will occur if the pathogen is present in numbers greater than 10^4 . Of 146 plants inoculated with *P. phaseolicola*, all tested serologically positive. Symptoms on the inoculated plants ranged from apparently none through localized water-soaking to systemic chlorosis and deformity.

Duration of apricot pruning wound susceptibility to Eutypha armeniaca and protective action of benomyl. W. J. MOLLER & M. V. CARTER (Univ. Calif., Davis, Waite Agr. Res. Inst., Univ. Adelaide, S. Australia). Apricot dieback, caused by the vascular pathogen *Eutypha armeniaca* (imperfect state *Cytosporina* sp.), is the most serious disease affecting apricot trees in South Australia. Infection is caused by airborne ascospores which gain entry into the tree via pruning wounds. Duration of wound susceptibility has recently been studied using trees grown beneath a rainproof shelter. While trees are dormant, wound susceptibility declines rapidly during the first 2 weeks after pruning. The decline in susceptibility is less rapid in sheltered trees, where a small proportion of wounds could still be infected by inoculation 8 weeks after pruning. The difference in rate of decline of susceptibility between sheltered and unsheltered trees may well be the result of differences in the rate of movement of other microorganisms into the wounded tissues. High-volume sprays of 0.025% (active ingredient) benomyl [methyl-1-(butylcarbamoyl)-2-benzimidazole-carbamate] immediately after pruning reduced infection in inoculated wounds by more than 50%.

A possible mechanism for honeydew production and carbohydrate assimilation by Claviceps species. R. L. MOWER (Univ. Calif., Berkeley). A mechanism is described for the production of honeydew by *Claviceps* species infecting sedge and grass flowers. Each species produces a distinct group of sugars and corresponding wall-bound β -D-fructosidase and transfructosidases, which effect conversion of sucrose to mono-, di-, and oligosaccharides. Glucose and fructose are found in varying concn in honeydew during pathogenesis by all species tested except *C. gigantia*. Evidence for the flow of sucrose from the host to the parasite is based primarily on two findings: (i) sucrose is transformed into one or more other species of sugars during honeydew formation; and (ii) the high threshold of glucose repression of fungal β -D-fructosidase. Mass flow of translocant from high osmotic to low osmotic concn, and diffusion of sucrose from an area of high to an area of low concn, probably constitute the biophysical basis for this mechanism. Evidence to support this hypothesis is based on cultural and host-parasite studies using histochemical and biochemical methods.

Macerating enzymes associated with Typhula idahoensis. M. W. MULANAX & D. M. HUBER (Univ. Idaho, Moscow). Snowmold of winter wheat incited by *Typhula idahoensis* is characterized by tissue maceration. Czapek's solution containing 0.5% carbon was inoculated with 0.3 ml *T. idahoensis* inoculum and incubated for 4 weeks at 0-5 C. Viscometric and colorimetric (DNS) assays were used to determine cellulase and pectinase activity. Substrates for enzyme assays were 1% (w/v) sodium carboxymethyl cellulose or 1% (w/v) sodium polypectate in 0.1 M sodium citrate-citric acid buffer pH 5.0. Both cellulase and pectinase were present in culture filtrates when wheat, barley, oat, or alfalfa residues were the carbon source. Sodium polypectate and pectin also induced pectinase production. Pectinase was not produced when glucose, sucrose, galactose, galacturonic acid, or polygalacturonic acid were carbon sources.

Uptake and translocation of inorganic elements in healthy and curly-top virus-infected tomatoes. N. J.

PANOPOULOS, G. FACCIOLI, & A. H. GOLD (Univ. Calif., Berkeley). The effect of CTV infection on the uptake and translocation of calcium, phosphorus, and sulfur was studied using ^{45}Ca , ^{32}P , and ^{35}S as tracers. In both short-term (1.5-2.5 hr) and long-term (7-9 hr) experiments with plants grown in a fog nutrient atmosphere or with excised roots, the uptake of the two anions was reduced to one-half or more, but that of calcium was enhanced in diseased plants. Translocation to the tops was lower for all three ions. Efflux experiments with excised roots did not reveal strong differences between healthy and diseased plants. It appears that compartment analytical estimation of cell membrane and tonoplast fluxes requires a modification of the classical two-compartment model in order to deal with calcium.

Kinetic studies on curly-top virus-infected tomatoes. N. J. PANOPOULOS, G. FACCIOLI, & A. H. GOLD (Univ. Calif., Berkeley). Photosynthate translocation and foliar carbohydrate turnover in healthy and CTV-infected tomatoes were studied using methods based on short-time labeling of single leaves with $^{14}\text{CO}_2$. The results showed that infection reduced the velocity of basipetal photosynthate transport 4-7 times, decreased the rate of turnover of transient petiolar pools of translocated photosynthate by half, and suppressed the turnover of foliar sucrose, glucose, and fructose by a factor of 2 or 3. Profile analysis of the kinetic data gave further support of the idea that compartment analysis may be applicable in the study of disease-induced metabolic aberrations, in addition to normal leaf carbohydrate turnover in plants.

Mode of action of Pseudomonas phaseolicola toxin: Mechanism of ornithine accumulation. S. S. PATIL & L. Q. TAM (Univ. Hawaii, Honolulu). A toxin from culture filtrates of *Pseudomonas phaseolicola*, purified by gel filtration and ion exchange chromatography, causes chlorotic halos accompanied by accumulation of ornithine in bean leaves. Ornithine carbamyl transferase (OCT) extracted from bean leaves was examined for toxin inhibition in both forward (ornithine \rightarrow citrulline) and reverse reactions. Studies of the reverse reaction showed that the toxin had a high affinity for the enzyme relative to its substrate with a semicompetitive mode of inhibition. No inhibition of the forward reaction was observed at opt pH (8.45), but comparable inhibition kinetics were observed at lower pH values. Pilot experiments showed that carbamyl phosphate synthetase was also inhibited. Inhibition of either enzyme could be responsible for ornithine accumulation. The cause and effect relationship between ornithine accumulation, presumed lowering of citrulline levels, and chlorosis was strongly suggested by the finding that no chlorosis developed when leaves were treated with citrulline prior to toxin.

Yield increase in Baccara roses as a result of heat treatment to remove viruses. R. A. F. POOL, J. A. TRAYLOR, & H. E. WILLIAMS (Calif. Dept. Agr., Sacramento). The rose Baccara was hot-air heat-treated 6 weeks to remove viruses. After heat treatment, the absence of the common rose viruses was determined by bud inoculation tests to known indicator plants, including the rose cultivars, Condesa de Sastago and LD-1, and Shirofugen flowering cherry. The heat-treated clone was expanded in the field on heat-treated virus-indexed Manetti rootstock. Cut flower yield comparisons were made between the heat-treated and nonheat-treated roses. The tests were conducted in a commercial greenhouse as part of the normal cut flower production. The heat-treated roses yielded 14% more salable blooms than the nonheat-treated plants.

Control of nematode populations with a sporozoan endoparasite. N. PRASAD & R. MANKAU (Univ. Calif., Riverside). A sporozoan parasite of nematodes found attacking the root-knot nematode has proved highly effective in

controlling populations of *Pratylenchus scribneri* and *Meloidogyne incognita* in greenhouse tests. Tomatoes planted in soil containing the parasite showed significantly better growth, as compared to those planted in sterilized soil, when both were inoculated with 10,000 *M. incognita* larvae. The electron microscope showed that the mature spore becomes cuplike, with a central sporoplasm. Soon after the adhesive spores attach to a nematode, the sporoplasm penetrates the cuticle and multiplies by schizogony and sporogony until the nematode is filled with spores. Infected nematodes are incapable of reproduction and eventually die, releasing the spores upon disintegration. The spores exhibit great specificity in host selection. Only certain nematode species were infected when subjected to the spores. Passage of approximately 5,000 *M. incognita* larvae through 50 g of soil was a reliable method for determining the presence of viable spores, and the percentage of infected nematodes recovered gave a rough indication of the population of the parasite. The spores withstood drying for up to 6 months, as well as nematocidal dosages of 1,2-dibromo-3-chloropropane (DBCP). Other nematocides tested gave varying degrees of kill of the parasite.

Interrelationships of Pratylenchus zae and Pythium graminicola on sugarcane. G. S. SANTO & O. V. HOLTZMANN (Univ. Calif., Davis, Univ. Hawaii, Honolulu). The lesion nematode, *Pratylenchus zae*, and the root-rot fungus, *Pythium graminicola*, are pathogenic on sugarcane. Greenhouse studies showed that when the sugarcane variety 37-1933 was simultaneously inoculated with both pathogens, the reduction of root and top growth was greater than when each was inoculated separately. Although the nematode and fungus were found together in the same lesion, their effect appeared to be independent and additive. Sugarcane seedlings which were inoculated with *P. zae* 7 days prior to inoculation with *P. graminicola* were more severely affected than when the two pathogens were inoculated simultaneously. The effect of *P. graminicola* was more devastating to the sugarcane root system than that of *P. zae*. Nematode population increases were much less when sugarcane roots were inoculated with the nematodes in the presence of the fungus than when the fungus was absent.

Evidence for involvement of a systemic factor in the cross-protection response in cotton plants infected with Verticillium wilt. W. C. SCHNATHORST (USDA, Univ. Calif., Davis). When Acala 4-42 cotton (*Gossypium hirsutum*) was root-inoculated in the greenhouse with a mild form (SS-4) of *Verticillium albo-atrum* and similarly challenged 7 days later with a severe form (T-1), a high percentage of the plants did not become severely wilted. To determine if locally and/or systemically formed inhibitors could account for cross protection, a conidial suspension of the mild SS-4 strain was sprayed on the root ball of 4- to 6-week-old Acala 4-42 plants as before. When symptoms appeared, the upper stems were inoculated with conidia of T-1 by means of a syringe, in order to bypass possible vascular occlusion caused by SS-4. Control plants received only single inoculations of each strain. Protection of plants varied from partial to complete. Although the protective response was not as pronounced as that obtained earlier, when T-1 was applied to roots, the data indicated that a systemic factor was involved. The indications are that the systemic factor may be the water-soluble inhibitor(s) that I reported earlier only in xylem fluid from tolerant cotton varieties infected with SS-4. Thus, cross protection and tolerance appear to be related to the same inhibitory response.

Comparison of virulence of Xanthomonas oryzae from tropical and temperate Asian countries on different rice varieties. J. P. SILVA, I. W. BUDDENHAGEN, & S. H. OU (Univ. Hawaii, Honolulu, Int. Rice Res. Inst., Philippines). Twenty-seven greenhouse-grown rice varieties, representing 13 Japonica and 14 Indica types, were used to differentiate

virulence among isolates of *Xanthomonas oryzae* from seven Asian countries. Five 30-day-old seedlings were inoculated by a single needle-prick method, using 4-day-old cultures grown on a modified glucose-peptone agar. The most virulent isolates were from Indonesia and India. In general, tropical isolates were more virulent than those from Japan, and were equally virulent on both groups of varieties. Japanese isolates, however, were more virulent on the Japonica than on the Indica varieties, indicating a slight specialization to the plant type on which they probably had evolved. Twelve of 27 rice varieties were selected as the most promising for use as differential hosts.

The effect of zinc on the formation of sclerotia by Sclerotinia sclerotiorum. R. R. VEGA & D. LETOURNEAU (Univ. Idaho, Moscow). Isolates of *Sclerotinia sclerotiorum* were grown in a medium containing 30 g glucose, 1.5 g KH_2PO_4 , 1 g NaNO_3 , and 0.5 g $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ /liter of glass-distilled water. One ml of minor element solution providing 0.2 mg Fe, 0.1 mg Cu and Zn, and 0.02 mg Mo and Mn/liter was added to the medium. Analytical grade chemicals were used; all glassware and equipment were acid-washed and rinsed with glass-distilled water. The medium was dispensed into polypropylene flasks which were plugged with plastic foam. Mycelia grown in basal medium without minor elements were used to seed the medium. All isolates produced less mycelia and no sclerotia in the absence of minor elements. Sclerotia formed only in the presence of Zn, alone or in combination with other minor elements. Addition of L-asparagine (750 mg/liter) to the medium increased the number of sclerotia formed, but none occurred in this enriched medium in the absence of Zn. Zn was effective as a sulfate, acetate, or chloride when added as many as 3-10 days after seeding. A few sclerotia formed in the presence of 0.03 mg Zn/liter. The dry wt of mycelia increased when Zn was increased to 10 mg/liter, but there was no change in numbers or dry wt of sclerotia. The increased quantity of Zn caused formation of atypical sclerotia.

The effect of cover crops incorporated into field soil on Pythium ultimum populations and inoculum potentials. A. G. WATSON (Univ. Calif., Berkeley). Each week, following incorporation of cover or rotation crops of barley, rye, or broccoli into Salinas Valley fields, the numbers of sporangia and oospores of *Pythium ultimum* were determined by Stanghellini's method. Simultaneously, the inoculum potentials of these populations were determined by bioassays with lettuce seedlings. For the first 4 days following incorporation, populations of *P. ultimum* in amended soils were less than those in the nonamended controls, but after 1 week, populations in these soils were consistently higher than the control populations. This increase reached a peak about 3 weeks after incorporation and subsequently decreased slowly, reaching the control level 2-3 months later. Damage by *Pythium* to lettuce seedlings was directly proportional to the population counts during the first 2 weeks. Subsequently, less damage to plants was observed in the amended soils even though they contained higher populations of *P. ultimum* than the control soils. Incorporation of immature crops resulted in greater *P. ultimum* population increases than when mature crops were used. Lettuce seed, planted the same day that immature crops were incorporated, exhibited damage after 24 hr in the soil; this was attributed to constitutive toxin(s) in the crop.

Proteins in tobacco mosaic virus- and potato spindle tuber virus-infected plants. M. ZAITLIN & V. HARIHARASUBRAMANIAN (Univ. Ariz., Tucson). Virus-infected leaf tissue was incubated with actinomycin D and was then allowed to incorporate ^3H -leucine. Comparable uninfected tissue was allowed to incorporate ^{14}C -leucine. Extracts of the two tissues were combined and analyzed by electrophoresis in sodium dodecyl sulfate-containing polyacrylamide gels. This procedure enabled a direct comparison of the incorporation of leucine into the proteins of diseased vs. healthy tissue.

When this type of analysis was applied to tobacco plants infected with either the common tobacco mosaic virus (TMV) strain or a strain with a defective coat protein, it was found that incorporation into three protein components and the coat protein was stimulated in diseased tissue. With PSTV infection, no component was found which could be

construed as a coat protein, suggesting that this unusual virus engenders no coat protein. Incorporation into two components was stimulated, however; these proteins had about the same molecular wt as those found to be stimulated in TMV-infected tissue. With both diseases, incorporation into several proteins was depressed.

The 1970 Annual Meeting of the Pacific Division of The American Phytopathological Society was held 23-25 June in Berkeley, California.