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

Stachybotrys atra: a cause of root disease of cotton. L. J. ASHWORTH, JR., & A. G. GEORGE (Univ. Calif., Berkeley, Agr. Ext. Serv., Tulare, Calif.). *Stachybotrys atra* Corda was associated with root disease of cotton in Tulare County, Calif., in 1969. The fungus was more prevalent in sections of necrotic roots of variety Acala SJ-1 (54% of 2,704 roots examined between 29 June and 14 September 1970) than of variety Acala 4-42(58 variety release) (25% of 3,025 roots examined during the same period). Results of pathogenicity tests show that *S. atra* inhibits the rate of emergence of seedlings, and causes severe root necrosis with collapse of the root cortex and death of emerging lateral roots. Damage was greater to Acala SJ-1 than to Acala 4-42(58) and Acala 4-42(66) in these tests, depending upon amount of inoculum in test soils. Other data suggest that the fungus causes significant depression of growth and yield of cotton, with Acala SJ-1 more susceptible than Acala 4-42(58). In a field test, scions of six cotton varieties supported by roots of Acala SJ-1 weighed 25-33% less than other scions of the same varieties supported by roots of Acala 4-42(58) and Acala 4-42(66). Similarly, intact plants of Acala SJ-1, grown in the same field, yielded 23% less lint/acre than intact plants of Acala 4-42(58).

Control of Verticillium wilt of cotton by foliar sprays with acidic solutions of benomyl and Thiabendazole. H. BUCHENAUER & D. C. ERWIN (Univ. Calif., Riverside). HCl, HNO_3, or H_2SO_4 solutions of either Thiabendazole, 1-(4-thiazolyl)-benzimidazole (TBZ) (1 g/15 ml 0.35 *N* acid), or benomyl, (1 g/30 ml 0.35 *N* acid at 75 C) were sprayed on stems, petioles, and leaves in the evening to delay drying 1 and 3 days before inoculation. Chemicals (plus 0.05% Triton X 100) at concentrations of 2,500-5,000 ppm/application prevented or delayed Verticillium wilt caused by subsequent inoculation with spores of *V. albo-atrum* by stem puncture or root drench. Benomyl was more effective than TBZ. Neither treatment was phytotoxic. The HCl salt of methyl 2-benzimidazole carbamate (MBC) (active hydrolysis product of benomyl) induced similar results to acidified benomyl. Neither nonacidified benomyl nor TBZ was effective. Bioassays and chemical analyses of the xylem tissue and leaves above the treated area indicated that TBZ and MBC moved through the cortex of the stem and translocated upward. No fungitoxic substance was detected in plants treated with nonacidified TBZ or benomyl. TBZ or benomyl in aqueous KOH or NaOH solution (pH 9-10) was less effective than in acidic solution, but more effective than in nonacidified suspension.

Determining eye spot disease reaction of sugarcane seedlings, using host-specific toxin. R. S. BYTHER & G. W. STEINER (Exp. Sta., Hawaiian Sugar Planters' Assoc., Honolulu). The host-specific toxin produced by *Helminthosporium sacchari*, the causal agent of eye spot disease, was evaluated for its use in determining the reaction of sugarcane (*Saccharum* sp. hybrids) seedlings to this disease. Four-week-old seedlings were sprayed with various concentrations of toxin and incubated at room temperature in polyethylene bags for 40 hr. Reactions of plants varied with toxin concentration, and caused either death, systemic symptoms, localized leaf spots, or no symptoms. These were classified susceptible, intermediate, and resistant, respectively. Seedlings having a known reaction to toxin were transplanted and rated for eye spot disease susceptibility when 5 months old. Progeny reactions to toxin were related to parental eye spot disease ratings; resistant parents produced toxin-resistant progeny. Seedling reaction to toxin was indicative of their adult plant reactions. It is concluded that eye spot susceptible seedlings can be eliminated from a population by spray applications of toxin.

Improved methods for estimating populations of soil-borne bacteria and fungi, including Fusarium spp. ALICE I. CHU & M. F. STONER (Calif. State Polytech. Coll., Pomona). Methods used to quantify populations of soil-borne microbes often detect only part of the viable propagules. Population determinations can be improved by treating soil with heat, cold, H_2O, or surfactants prior to dilution-plating (23 C). Tryptone-glucose-yeast extract agar (bacterial assays), potato-dextrose agar (total fungi), and peptone-PCNB agar (*Fusarium* spp.) were used. Samples consisted of 100 mg of fresh bean field soil. Controls involved dilution plating with or without prior treatment with H_2O. Treatments at 0 C of unaltered soil for 3 hr and H_2O-saturated soil for 1 hr yielded 166% and 281% more bacterial counts than in controls and the same or fewer *Fusarium* spp. counts than controls. Samples held at 0 C for 3 hr yielded 166% more fungal counts than in controls, and gave 21% more *Fusarium* counts. Samples saturated with 1% aqueous Triton X 100 1 hr before plating yielded 80% more fungal counts than did H_2O controls; *Fusarium* counts were not increased. Samples treated with 0.1% aqueous Tween 20 just prior to plating gave 63% more *Fusarium* counts. Treatment with H_2O for 1 hr before plating gave up to 66% more fungal counts than control; it did not increase *Fusarium* counts. Soil treatments before plating could help to increase the selectivity of assay systems.

Woody gall and scaly bark of Mangifera indica in Hawaii. A. A. COOK, G. M. MILBRATH, & R. A. HAMILTON (Univ. Hawaii, Honolulu). An unreported gall and scaly bark have been observed on seedling mangoes in experimental plantings on Hawaii and Oahu. Sizeable galls may occur on main branches and/or trunks, whereas smaller galls are found on the secondary branches. When the outer bark of the gall is removed, xylem pegs 5-6 mm long are found which resemble those associated with other virus-infected woody plants. The pegs are often found in the area of leaf or twig scars on secondary branches. The scaly bark condition occurs on the trunk from the ground to the main branch axis, and results in deep cracks in the outer bark. Mangoes not affected with either of these conditions show no evidence of galling or pegging, and have smooth trunk bark. No microorganism has been isolated consistently from these plants. Mechanical transmission tests to common virus indicator plants have been negative.

Chemical control of leaf scar infection by Nectria galligena in apple. H. ENGLISH, H. J. DUBIN, F. J. SCHICK, & K. O. ROBERTS (Univ. Calif., Davis). When *Nectria galligena*, the cause of European canker, was grown on potato-dextrose agar containing various fungicides, it was possible to rank these materials in decreasing order of fungitoxicity as follows: Benlate (benomyl), Mertect (Thiabendazole), DuTer (fentin hydroxide), EL-273 [*a*-(2,4-dichlorophenyl)-*a*-phenyl-5-pyrimidinemethanol], sodium pentachlorophenate (SPCP), Difolatan, copper ammonium carbonate, copper sulfate, and TC-90 (copper salts of fatty and rosin acids). Young trees grown in soil containing 80 ppm benomyl were not resistant to infection, and bioassays showed no evidence of benomyl in host tissues. Excellent control of leaf scar infection was obtained by spraying with Bordeaux (10-10-100), basic copper sulfate (5 lb./100 gal) plus 1 gal of Niagara Supreme oil (NS), Difolatan 4 flowable (0.5 gal/100), and TC-90 (2 gal/100) at the start of leaf fall and at either mid- or late leaf fall. Benlate (1 lb./100) applied

similarly was effective in 2 of 3 years. Application of Bordeaux (15-15-100) plus 1 gal NS at early leaf fall also was highly effective. Moderately effective sprays were DuTer (1 lb./100), Actidione (2.7 oz/100), and an application of SPCP (3 lb./100) at early leaf fall plus Bordeaux (10-10-100) at late leaf fall. Mertect (1.5 lb./100) and EL-273 (20 oz/100) were ineffective.

Culture of a mycoplasmalike organism associated with stubborn disease of citrus. ABD EL-SHAFY FUDL-ALLAH, E. C. CALAVAN, & E. C. K. IGWEGBE (Univ. Calif., Riverside). A pleomorphic organism was cultured from stubborn-diseased citrus and maintained in cell-free media. Young leaves and shoots of Madam Vinous sweet orange seedlings were surface-sterilized in 0.5-1.0% NaClO, rinsed in sterile water, and placed in a special liquid medium containing horse serum, for grinding in a mortar or blender. After passage of the ground material through a 0.45-μ filter, aliquots were added to special media containing horse serum and incubated at 33 C. "Fried-egg" type colonies on agar media reached a diameter of 0.1-0.2 mm in 15 days. Cultures in liquid media containing horse serum were centrifuged at about 7,000 *g* for 10 min, 7-15 days after inoculation. Electron micrographs of negatively stained material from the pellets showed round, ovoid, or irregular-shaped main bodies, 0.5-2 μ across, connected to slender filaments 60-100 nm wide and up to 7μ long. Ultrathin sections revealed that these bodies and filaments had unit membranes about 10 nm thick. Growth was as good or better in liquid media containing ascitic fluid or cholesterol instead of horse serum. Some spherical cells of undetermined relationship, averaging 0.6 μ diam and enclosed temporarily in wall-like coatings 55-90 nm thick, were also present in the cultures.

Cultural differentiation between races T and O of Helminthosporium maydis. KATE A. FUKUKI & M. ARAGAKI (Univ. Hawaii, Honolulu). Four-day-old cultures of *Helminthosporium maydis* race T, grown on vegetable juice agar (10% V-8 juice, 0.2% $CaCO_3$) at 28 C under continuous fluorescent irradiation, were light cinnamon rufous to russet in color, in contrast to dark olive gray of race O cultures. These cultural distinctions were further reflected by significant differences in sporulation. At 28 C with continuous light, isolates of race O obtained from Hawaii and Indiana produced 3-80 times more spores than did race T isolates. There was little observable difference in sporulation between isolates of races O and T under continuous light at 16 C and 20 C or continuous dark at 16 C, 20 C, and 28 C. Sporulation of race O was considerably better at 28 C than at 20 C in continuous darkness. On the other hand, sporulation of race T cultures under continuous irradiation was 10-30 times higher at 20 C than at 28 C, indicative of sporulation inhibition at higher temperatures with light.

Survival of Phytophthora parasitica in soils. B. F. HOLDAWAY & P. H. TSAO (Univ. Calif., Riverside). Survival and population of *Phytophthora parasitica* (citrus isolate) in artificially infested, nonsterilized soils as influenced by ecological factors were determined by periodic soil dilution assays on a selective antibiotic medium. After 180 days at 24 C, 62% of the initial population was recovered from soil maintained at 25% moisture-holding capacity (MHC), and 11-21% recovery from soils at 50, 75, and 100% MHC. Drying of moist soils for 24 hr at 24 C to about 2% MHC reduced recovery to below 12% of that from nondried soils. Recovery increased if soils dried for extended periods were remoistened. At either 50 or 75% MHC, survival after 180 days was greater in soil incubated at 12 C than at 24 or 30 C. The fungus was rarely recovered from those moist soils maintained at 1 C after 14 days, and at 39 C after 30 days. Recovery was greater from infested, sterilized soil than from nonsterilized soil. The population of the fungus increased in most nonsterilized soils amended (2%) with leaves and/or stems of alfalfa, beet, corn, cotton, or various crucifers. Chlamydospores did not germinate in soil at pH 3.8, but germinated in soils at pH 4.8, 6.0, and 6.6, accompanied by increases in recovery of the fungus. Examination of soil dilution plates revealed chlamydospores and sporangia as colony origins.

Effect of temperature on the interrelationship of Pratylenchus zeae and Pythium gramminicola on sugarcane. V. HOLTZMANN & G. S. SANTO (Univ. Hawaii, Honolulu, Univ. Calif., Davis). In previous tests when *Pratylenchus zeae* and *Pythium graminicola* were inoculated simultaneously to sugarcane (var. 37-1933), the pathogenic effect of the two was independent and additive. *Pratylenchus zeae* reproduces better at 30 C than at 24 C, and little at 18 C. The pathogenicity of *P. graminicola* on sugarcane is favored by lower temperatures (16-18 C). When the two pathogens were inoculated to sugarcane in combination and grown at a constant soil temperature of 30 C for 6 weeks, the pathogenic effect appeared to be synergistic. However, when sugarcane was similarly inoculated and grown at 30 C for 12 weeks, the pathogenic effect of the nematode and fungus was independent and additive. *Pratylenchus zeae* increased 220-fold at 30 C in 12 weeks when inoculated alone to sugarcane; when inoculated in combination with *P. graminicola*, the increase was 8-fold.

Interactions between Xanthomonas oryzae and saprophytic bacteria isolated from rice leaves. SHIH-PAN-YU HSIEH & I. W. BUDDENHAGEN (Univ. Hawaii, Honolulu). Several cultures of saprophytic bacteria were isolated from bacterial leaf blight-infected leaves and the surface of healthy rice leaves collected in Asian countries. Inhibition of leaf blight symptom development and prolongation of incubation period were observed when *Xanthomonas oryzae* was mixed with saprophytic bacteria and inoculated on rice plants by either the needle-prick or root-dip inoculation method. Most symptom development was retarded when low concentrations of *X. oryzae* (10^6/ml) were combined with high concentrations of saprophytic bacteria (10^8 or more/ml). Using streptomycin mutants of *X. oryzae* (resistant to more than 20,000 ppm) we found that: (i) Saprophytic bacteria, both in vitro and in vivo, have a shorter lag phase and shorter average generation time than does *X. oryzae*; (ii) no delay in symptom development was observed when growth of saprophytic bacteria was completely inhibited, rate of multiplication of saprophytic bacteria was reduced by streptomycin, heat-killed saprophytic bacteria were used, and *X. oryzae* was mixed with bacteria having a similar growth rate, such as *X. translucens*, or combined with bacteria with rapid growth rate but which failed to multiply in rice plant; and (iii) growth of *X. oryzae* in mixed culture with saprophytic bacteria was considered circumstantial evidence against the production of antagonistic materials by the saprophytes.

Inclusions in a mycoplasmalike organism associated with stubborn disease of citrus. E. C. K. IGWEGBE, E. C. CALAVAN, & ABD EL-SHAFY FUDL-ALLAH (Univ. Calif., Riverside). Five types of mycoplasmalike bodies (MLB) were found in ultrathin sections of leaf veins of stubborn-diseased citrus seedling: spherical particles, 50-100 nm; spherical to ovoid bodies, 200-500 nm; irregular bodies, 600-800 nm diam; filaments about 100 nm wide and up to 1.5 μ long; and spherical, ovoid, or angular cells (packets), 1.0-1.8 μ x 1.9-3.5 μ, containing MLB of the other types and embedded in cytoplasm of young differentiated sieve elements. MLB that appeared to be budding or undergoing fission were seen in

the packets and in cytoplasm of sieve elements. MLB of all types had unit membranes 9-10 nm thick, and lacked cell walls. Pleomorphism of the packets, their apparent restriction to young sieve elements, and thickness of their unit membranes suggest they are enlarged mature forms of MLB. If the different forms of MLB, including packets, have a common origin, one could conclude that this mycoplasmalike organism probably multiplies or reproduces in vivo by budding, by fission, and by forming inclusions.

Electrophoretic strains of Cymbidium mosaic virus. M. ISHII & R. F. BOZARTH (Univ. Hawaii, Honolulu, & Boyce Thompson Inst., Yonkers). Cymbidium mosaic virus is widespread in Hawaii. Many commercial Vanda Miss Joaquim plantings are uniformly infected; however, Vanda Miss Joaquim shows no symptoms and is productive under field conditions. Density-gradient centrifugation indicates closely related but heterogenous components. Sucrose density-gradient electrophoresis shows two electrophoretic components, a fast-moving major component and a slow-moving minor component. Both components produce local lesions on *Cassia occidentalis* and positive serological reaction to Cymbidium mosaic virus antisera. Protein subunits from both isolates were homogeneous by polyacrylamide gel electrophoresis, and a value of 24,000 mol wt was obtained for both subunits. Mean particle lengths of the fast component were 482 nm, and for the slow component, 456 nm.

Some metabolic changes in Lycopersicon esculentum plants infected with potato spindle tuber virus. S. P. KAPUR & L. G. WEATHERS (Univ. Calif., Riverside). Changes in respiration rate, nitrogen metabolism, and peroxidase and catalase activities were determined at 2-day intervals over a period of 16 days in tomato leaf tissue infected with potato spindle tuber virus. Three- to four-leaf stage Pearson tomato plants grown in U.C. mix in 4-inch pots in the greenhouse were inoculated by rubbing virus extract, prepared by homogenizing infected tomato leaves in 0.03 M phosphate-buffer pH 7.0, on leaf surfaces previously dusted with 400-mesh Carborundum. Buffer was substituted for the virus inoculum in control plants. Discs 1 cm in diam were cut from all the leaflets of the second leaf from the apex (at the time of sampling) with a sharp cork-borer. The composite sample of leaflet tissue was used for tests. Oxygen uptake, total nitrogen, and activity of both perioxidase and catalase increased as compared to controls, starting at the time of symptom appearance (4-6 days after inoculation). Peroxidase and catalase activity reached their maxima at 8 and 10 days after inoculation, respectively, then declined. Increase in both oxygen uptake and total nitrogen was uniform throughout the investigation.

Chemotactic response of zoospores of five species of Phytophthora. K. L. KHEW & G. A. ZENTMYER (Univ. Calif., Riverside). Aspartic and glutamic acids, arginine, and methionine were selected for quantitative comparison of their chemotactic activity on five *Phytophthora* spp. A chemotactic index (ratio of number of zoospores attracted to an area near the end of a capillary tube to an equal area beyond its influence) was used to evaluate the response. Zoospores of *P. capsici, P. palmivora*, and *P. cactorum* were attracted to the four amino acids (at pH 3) at a lower threshold concentration (concentration causing a chemotactic index of 1.5) than zoospores of *P. cinnamomi* and *P. citrophthora*. Zoospores of methionine- and arginine-deficient mutants of *P. capsici* were also attracted to methionine and arginine, but at a higher threshold value than that for their wild type. Zoospores of *P. capsici* and *P. palmivora* suspended in 10^{-3} M aspartic or glutamic acid solution were attracted to capillary tubes with aspartic acid and with glutamic acid. This indicates that if any "chemoreceptor(s)" is present on the zoospore membrane, it is likely to be nonspecific. Several metabolic inhibitors, antibiotics, membrane-active agents, protein and DNA, or RNA synthesis inhibitors were used in attempts to interfere with the chemotactic response. None of them completely inhibited chemotaxis at a concentration that did not affect motility of zoospores.

Biological control of root rot of papaya seedling caused by Phtyophthora palmivora. W. H. KO (Univ. Hawaii, Honolulu). Greenhouse tests confirmed the field observation that resistance of papaya roots to *Phytophthora palmivora* was directly correlated with plant age. Two weeks after inoculation of soil, percentages of 1- and 2-month-old plants killed by *P. palmivora* were 94 and 47, respectively. However, all plants 3 months of age or older at the time of inoculation survived. Excellent field control was obtained by planting seeds in small quantities of pathogen-free virgin soil placed in the planting holes (30 cm diam and 10 or 20 cm depth). Three months after planting, 21-42% of the papaya trees were killed in control plots, whereas all trees growing in small islands of virgin soil survived. One year after planting, all the trees in the "virgin islands" were healthy and producing fruits. The principle involved in this biological control method is to protect young seedlings by planting seeds in small quantities of pathogen-free soil placed in the pathogen-infested fields. This approach may be useful for controlling other unspecialized parasites which are characterized by their destructiveness to juvenile host tissues and restriction by mature tissues.

The mode of action of pentachloronitrobenzene in soil. W. H. KO & M. K. ODA (Univ. Hawaii, Honolulu). At 100 ppm pentachloronitrobenzene (PCNB) in soil inoculated with *Rhizoctonia solani* completely prevented pre-emergence damping-off of germinating beet seeds. However, at the end of the experiment the population of *R. solani* as determined by Ko and Hora's selective medium method was similar in treated and untreated soil. Preincubation of beet seeds for 12 hr in soil containing PCNB did not protect them from infection by *R. solani* when they were subsequently transferred to inoculated soil without PCNB. Shaking *R. solani* mycelia for 1 hr in a PCNB suspension also did not decrease the pathogenicity of this fungus when they were subsequently inoculated in virgin soil. A vertical-illumination microscopic technique recently developed by Ko was used to observe directly the effect of PCNB on the growth of *R. solani* in soil. After 24 hr, the average diameter of *R. solani* colonies growing on the soil surface from sclerotia embedded in soil with and without PCNB was 0.6 and 12 mm, respectively. These data indicate that control of *R. solani* by PCNB in soil is due to strong suppression of the growth of this fungus.

A collar rot of Acacia koa caused by Calonectria sp. F. F. LAEMMLEN (Univ. Hawaii, Honolulu). *Acacia koa* seedlings 8 to 12 months old, which were naturally reforesting a burned area on the island of Oahu in Hawaii, were severely thinned by the attack of *Calonectria* sp. Symptoms were early senescence and dropping of the older leaves, accompanied by bronzing and epinasty of apical leaves. Severely affected trees collapsed and died without showing intermediate symptoms. Examination of the base of these plants revealed a white band, 2 to 5 cm in width and 2 to 5 cm above the soil line, consisting of a *Cylindrocladium* sp. Below this, a band of bright orange-red perithecia of *Calonectria* sp., extending to the soil line and slightly below, was clearly visible. The cambial region in the affected collar area was also discolored. Glasshouse inoculations produced typical collar

rot symptoms. This appears to be the first report of *Calonectria* sp. causing disease on *Acacia koa*.

Effect of copper on the activity of benomyl. B. T. MANJI, ELAINE BOSE, J. M. OGAWA, & K. URIU (Univ. Calif., Davis). The activity of benomyl and MBC (methyl 2-benzimidazole-carbamate) was reduced in potato-dextrose agar (PDA) medium containing heavy metal ions such as Cu, Zn, and Fe. *Monilinia fructicola* grew 82 mm (colony diameter) on PDA and 83 mm on medium incorporated with 200 ppm Cu as $CuSO_4$. With 0.1 ppm benomyl and a mixture of Cu and benomyl, growth was 18 mm and 76 mm, respectively. Substitution of MBC for benomyl in the mixture resulted in 70 mm growth, whereas with 0.1 ppm MBC there was only 1 mm. Detached almond blossoms sprayed with 1,280 ppm Cu (53% proprietary basic $CuSO_4$), 300 ppm benomyl, and the mixture resulted in *Botrytis* blight of 28, 5, and 1 blossoms, respectively, while all 30 inoculated control blossoms blighted. This test showed no reduction in benomyl activity. Field tests on apricot trees at the red-bud stage of bloom using 2,800 ppm Cu (in standard 10-10-100 Bordeaux mixture), 300 ppm benomyl, the mixture, and a nonsprayed control showed an average of 74, 18, 38, and 193 *Monilinia laxa*-blighted twigs/tree, respectively, suggesting partial inactivation of benomyl by Bordeaux mixture.

Identification and distribution of pores in apricot and citrus leaf cuticles. J. C. MCFARLANE, W. L. BERRY, & B. F. HOLDAWAY (Univ. Calif., Riverside). Cuticles were isolated from orange (*Citrus sinensis* 'Washington Navel') and apricot *(Prunus ameniaca)* leaves. By using a diffusion cell, especially constructed to yield steady state data and reduce the interference of boundary layer resistance, the penetration rates of various plant nutrients were studied. These kinetic data give added evidence for the existence of pores through the cuticle. We precipitated AgCl in the cuticle by allowing $AgNO_3$ to penetrate in one direction, at the same time allowing KCl to penetrate in the opposite direction. Pore closure by precipitation was confirmed by K^+ measurements. Electron micrographs show that pores are most concentrated adjacent to anticlinal cell walls, and are 10-40 nm in diam. These are too small to accommodate the penetration of hyphae, but could be the site of nutrient or hormone loss from the host plant that could stimulate hyphal penetration. This knowledge of pore existence and of their characteristics gives additional theoretical basis for formulating foliar applied sprays.

Host range studies of spotted wilt virus isolates from Hawaii. G. M. MILBRATH & A. A. COOK (Univ. Hawaii, Honolulu). Twelve isolates of spotted wilt virus were collected from vegetable and weed hosts on Hawaii, Kauai, and Oahu. Isolates originally obtained from naturally infected *Chrysanthemum morifolium, Lilium longiflorum, Emilia sonchifolia, Lactuca sativa, Capsicum annuum, and Lycopersicon esculentum* were included. All inoculations were accomplished from leaf tissue triturated in cold 0.1 *M* phosphate buffer (pH 7.0) with 0.01 *M* sodium diethyldithiocarbamate. To detect virus strains, herbaceous plants from several plant families were inoculated including the diagnostic hosts *Nicotiana glutinosa, N. tabacum* L. 'Blue Pryor', and *Lycopersicon esculentum* 'Dwarf Champion'. Subsequently, twelve varieties of tomato, some of which presumably carried heritable resistance to particular strains of the virus, were inoculated. Variation in susceptibility of some host plants in successive inoculations may have resulted from differences in virus titer in the plant material used for inoculum. All tomato varieties tested were susceptible to at least one isolate of the virus. There was no indication of host resistance or difference in virus isolate pathogenicity in 57 cultivars of pepper inoculated with three virus isolates.

Characterization and pathogenicity of Calonectria sp. causing collar rot of papaya. W. T. NISHIJIMA & M. ARAGAKI (Univ. Hawaii, Honolulu). *Calonectria* sp. which causes papaya collar rot is similar to *C. crotalariae*, although it also resembles *C. ilicicola*. Perithecia of the papaya fungus are orange to red, subglobose to ovate, 266-532 μ wide, and 323-570 μ high. Ascospores are hyaline, curved, fusoid with mostly rounded ends, 1- to 3-septate, and measuring 31.0-59.0 μ x 3.6-7.1 μ. The imperfect stage is a *Cylindrocladium*; conidia are hyaline, cylindrical, 1- to 3-septate, and 46.4-89.0 μ x 4.7-7.6 μ. The main axis of the conidiophore is a long, unbranched stipe terminating in a hyaline, globose vesicle, 6.4-17.2 μ in diam, with a lateral, penicillate, spore-bearing head. Frequently the main axis is the spore-bearing structure, and 1-4 smaller vesicles are borne either laterally or on secondary and tertiary conidiophore branches. *Calonectria* collar rot of papaya is frequently associated with *Pythium splendens* root rot. Mortality of inoculated papaya seedlings is much higher with both organisms than with either alone. *Calonectria* sp. also causes collar rot and eventual death of *Acacia koa* and *A. melanoxylon* seedlings.

Effectiveness of soil fungicide mixtures added prior to planting as compared with those added as drenches. R. D. RAABE & J. H. HURLIMANN (Univ. Calif., Berkeley). Mixtures of fungicides give good control of root rot complexes in various container-grown plants. To determine the most effective method of application, the fungicides were added as drenches or mixed in the soil prior to planting. Fungicide mixes used included benomyl or Thiabendazole and 35% *p*-(dimeethylamino) benzediazo sodium sulfonate (Dexon^R) or 30% 5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole (Truban^R). As soil mixes, they were added mostly at the rate of 25 ppm, though concentrations as high as 100 ppm were used. As drenches, most were added at the rate of 100 ppm, but lower concentrations were also used. The drenches were added between 2 and 4 times during the growing season. Poinsettia *(Euphorbia pulcherrima)* plants were grown in soil infested with *Pythium ultimum, Thielaviopsis basicola*, and *Rhizoctonia solani* prior to treatment. Easter lilies *(Lilium longiflorum)*, the bulbs of which are frequently infected with *Rhizoctonia solani, Pythium splendens*, and/or *Fusarium oxysporum* f. *lilii*, were planted in noninfested soil. With few exceptions, the total amount of fungicide added was similar whether mixed or drenched in the soil. Control was excellent with either method, but generally was better when fungicides were added as drenches.

Field control of Ceratocystis paradoxa on pineapple asexual propagative parts. K. G. ROHRBACH & W. J. APT (Pineapple Res. Inst. Hawaii, Wahiawa). *Ceratocystis paradoxa* causes butt rot of pineapple planting material (crowns, slips, and suckers). In the past, control was obtained by partially drying (curing) the planting material, but mechanization of handling has made curing impractical. At several locations in Hawaii, whole and one-quarter crowns were dipped into various fungicides and inoculated with *C. paradoxa*. Fungicides were benomyl, Difolatan (*N*-[(1, 1, 2, 2-tetrachloroethyl) sulfenyl]-*cis*-4-cyclohexene-1, 2-dicarboximide) and captan. Data were taken on mortality, and plant and root weights at six months. Benomyl at 0.63 lb. active/acre, and Difolatan at 12 lb. active/acre, resulted in excellent control of butt rot in all tests when compared to the inoculated check. The noninoculated check had significantly less disease than the inoculated check in most tests, but not all. Surviving plants in the inoculated checks had significantly lower plant weights than those in the

benomyl treatments, indicating a severe reduction in plant growth not recognized in the past with this disease.

Infectivity of stem scions versus root scions from pear decline-infected Pyrus sp. 'Variolosa' trees following dormancy chilling. H. SCHNEIDER (Univ. Calif., Riverside). Small, chronically infected pear trees grown in pots from infected cuttings were placed in a 40-F cold room from 4 March to 3 June 1969. On 3 June, the following plant parts were taken from these donor trees for use as inoculating side grafts: recent 1968 stem growth; older stem growth with spur buds; and pioneer roots. Mycoplasmalike bodies, which presumably cause pear decline, were observed in sections of newly growing root tissue collected on 3 June from one donor tree. For test trees, Variolosa cuttings were used in two experiments, and *Pyrus communis* 'Comice' with *P. serotina* 'Chojuro' sealings as rootstocks in a third. In each experiment, two test trees were used to test each scion type. Two scions were used/tree and one donor tree/experiment. Trees developing symptoms were: two out of six trees receiving 1968 stem scions, two out of five trees receiving older stem scions (one tree died from water-logging), and four out of four trees receiving root scions. Root tests exclude the experiment using Comice trees, because the roots of the Variolosa donor tree were stunted and weak, and scions from them died. Results confirm earlier reports that dormant Variolosa stems do not make good inoculum, but indicate that roots are infectious when grafted into stems.

Induction of bacterial seed piece decay of potatoes by various soil-borne fungi. M. E. STANGHELLINI & J. D. RUSSELL (Univ. Ariz., Tucson). Certified potato tubers of the Norgold variety from four sources were screened for seed-borne soft rot bacteria. Ten surface-sterilized tubers from each source were individually cut into 20- to 30-g pieces and dipped in either sterile distilled water or a spore suspension of *Fusarium roseum* cultivar 'Sambucinum'. Each treatment, replicated 10 times, was placed in a separate moist chamber and incubated for 10 days at 10, 15, 20, 25, 30, and 37 C. Soft rot was induced only in the *Fusarium*-inoculated potatoes at all incubation temperatures, and in the controls incubated at 37 C. A bacterium, capable of producing typical blackleg stem symptoms when inoculated into seedling potatoes, was isolated from 30-60% of the decayed seed pieces. Another bacterium, probably *Erwinia carotovora*, and a soft rotting *Pseudomonas* sp. were isolated from the remainder. Soft rot was prevented by seed piece treatment with Dithane M-45, Polyram, and benomyl after inoculation with *Fusarium*. All three chemicals were fungicidal, but not bactericidal, at 200 μg/g. Bacterial soft rot also was induced by *Pythium aphanidermatum, Fusarium solani* f. *pisi, F. solani* f. *phaseoli, F. oxysporum* f. *vasinfectum*, and *Verticillium albo-atrum.*

Survival and germination of oospores of Pythium aphanidermatum. M. E. STANGHELLINI & J. D. RUSSELL (Univ. Ariz., Tucson). Oospores of *Pythium aphanidermatum*, collected monthly over a 1-yr period from infected oat root segments buried at 5- and 20-cm depths in fallow field soil, germinated when placed on water agar. Soil temperatures at the 5-cm depth ranged from 52 C in July to −4 C in January. Laboratory studies showed that oospores survived for 12 months in saturated and air-dried field soil at 4 C, and air-dried soil at 40 C, but failed to survive more than 1 month in saturated soil at 40 C. Oospores obtained from 2-month-old V-8 agar cultures began to germinate in 3-4 hr, and reached a maximum germination of 20% after 24-hr incubation at 32 C on cornmeal agar. Percentage germination was increased to 94% on cornmeal agar by passage of oospores through live water snails. Cardinal temperatures for oospore germination, 15, 35, and 45 C, coincided with those for linear growth.

Pseudomonas phaseolicola toxin: chemical groups involved in binding to ornithine carbamyl transferase. L. Q. TAM & S. S. PATIL (Univ. Hawaii, Honolulu). We have previously shown that *Pseudomonas phaseolicola* toxin inhibits ornithine carbamyl transferase. Here we assign binding areas P_1, P_2, and P_3 to the composite substrate, carbamyl phosphate-ornithine. P_1 and P_2 are assigned to the phosphate group and carbamyl group respectively, while P_3 is assigned to ornithine. Anti-P_1, anti-P_2, and anti-P_3 correspond to complementary binding areas in the enzyme active site. Lineweaver-Burk plots of the OCT-catalyzed forward reaction indicate competitive and noncompetitive inhibition by the toxin for carbamyl phosphate (P_1 and P_2) and ornithine (P_3), respectively. Similar plots of the OCT catalyzed reverse reaction indicate competitive inhibition for both phosphate (P_1) and citrulline (P_2 and P_3). When either anti-P_1 or anti-P_2 is occupied by high substrate concentrations, toxin binding is diminished. We conclude that the toxic moiety probably possesses chemical groups corresponding to P_1 (electronegative) and P_2 (electronegative at pH 8.5).

Internal rib necrosis of lettuce associated with ammonium ion concentration. J. L. TROUTMAN, B. R. GARDNER & W. D. PEW (Ariz. Agr. Exp. Sta., Yuma). Severe incidence of internal rib necrosis (IRN) occurred in Climax variety lettuce at Yuma in the winter, 1969-70. Attempts to isolate a pathogen or transmit a virus from affected plants to greenhouse-grown seedlings were unsuccessful. Symptoms like those described for IRN of lettuce were induced by sidedress applications of NH_4OH to nearly mature field-grown plants. Rates inducing positive symptoms included 50, 100, and 150 ml each of 0.75, 1.5, and 3.0 *N* solutions of NH_4OH. Sixty-seven per cent of treated plants developed typical IRN; untreated controls and those receiving only distilled water remained negative in three different experiments. Severity ratings of IRN symptoms were directly correlated with concentrations of NH_4OH applied.

Factors affecting control of Verticillium wilt of cotton by preplant soil fumigation with chloropicrin and methyl bromide. S. WILHELM & J. E. SAGEN (Univ. Calif., Berkeley). Preplant soil fumigation for control of Verticillium wilt with chloropicrin and methyl bromide with machinery that applies the fumigant and covers the soil simultaneously with polyethylene sheeting began commercially about 1957. The practice increased steadily to a maximum of 12,000-15,000 acres fumigated annually in California for strawberries, tomatoes, ornamentals, and nursery crops. Favorable plant growth responses and improved yields paralleled disease control. For Acala cotton, 5 years of studies have shown that chloropicrin or the combination of chloropicrin (1 part) and methyl bromide (1 part) at rates of 489 and 325 lb./acre, respectively, controlled Verticillium wilt but effected little improvement in yields the 1st year. The low percentage, 1-3%, of diseased plants after fumigation increased to 12-15% of infected plants by the end of the first cotton season, and delay of maturity offset advantages of disease control. Due primarily to delaying infection, yield increases of 0.5 to 1 bale of lint/acre were realized in the 2nd year, and the percentage of infected plants at the end of the season rose to 50 or more. Early season infection, as determined by leaf cultures, caused severe reduction in yields and affected primarily the number of bolls per plant, not the weight.

Distribution of three species of dwarf mistletoe on their principal pine hosts in the Colorado Rocky Mountain Front

Range. W. T. WILLIAMS (Calif. State Polytechnic College, San Luis Obispo). Surveys of occurrence, possible slope preference, and severity of the dwarf mistletoe species *Arceuthobium vaginatum, A. americanum,* and *A. campylopodum* parasitizing *Pinus ponderosa, P. contorta,* and *P. flexilis*, respectively, in Boulder County, Colo., revealed distinct altitudinal zones of parasitism specific for each host-parasite interaction. *Arceuthobium vaginatum* is present to the upper range of its host (9,200 ft), but is absent below 6,100 ft. Below 7,000 ft, ponderosa pine is vigorous and may be resistant to mistletoe, with temperature possibly being important. *Arceuthobium americanum* on lodgepole pine was observed to the lower, but not to upper elevational limits of host growth. *Arceuthobium americanum* is restricted to elevations of 8,700 to 9,600 ft. *Pinus flexilis* grows at altitudes of 8,500 to 9,400 ft, and its principle parasite, *A. campylopodum*, is present between 8,600 and 9,200 ft. *Pinus ponderosa* was 38% infected, with 37% infection on ridge sites, 41% on north-facing slopes, and 38% on south-facing slopes. *Pinus contorta* was 22% infected with 19% diseased trees on ridges, 25% on north-facing slopes, and 21% on south-facing slopes, whereas *P. flexilis* showed 26% infection over-all with mistletoe most severe on ridges.

Regression analysis of dwarf mistletoe infection in relation to basal area and relative density of pine host stands. W. T. WILLIAMS (Calif. State Polytechnic College, San Luis Obispo). Basal area and stand density were employed as screening modes to relate intensity of dwarf mistletoe infection of pines to various site characteristics on the Colorado Front Range. Uni- and multivariate analyses of these two measurements showed no significant regression when they were chosen as independent variables on *Pinus ponderosa-Arceuthobium vaginatum* interactions. Mean infection increased, however, as basal area increased, with *A. americanum* parasitizing *P. contorta* on north-facing slopes, but when slope aspects were combined, disease ratings displayed inverse relationships to relative density in all infected plots. There appeared to be a direct relationship between greater basal area, relative density, and increasing mistletoe infection on *P. flexilis-A. campylopodum* combinations on ridge study plots.

Virus transmission by powdery mildews and rusts. C. E. YARWOOD (Univ. Calif., Berkeley). When conidia of *Sphaerotheca lanestris, Erysiphe polygoni*, and *Erysiphe graminis,* or uredospores of *Uromyces phaseoli, Coleosporium asterum*, and *Phragmidium* sp., from hosts which were not known to be infected with virus, were dust- or spray-inoculated to *Chenopodium quinoa*, the visible viruslike or hypersensitivelike lesions which formed on *C. quinoa* were larger than those formed on other nonhosts of these fungi. Epinasty of lower *C. quinoa* leaves was a common response to inoculations with powdery mildews. Systemic viruslike symptoms commonly developed following inoculation with rusts, but virus usually could not be recovered from this tissue. When lesion tissue from *C. quinoa* was inoculated to further *quinoa* plants, viruslike lesions developed in 19 out of 55 trials. On the basis of host range and symptoms, these viruslike infections were different from any known virus maintained in the greenhouse, and viruslike infections from different fungi were different from each other. The isolates which became systemic in tobacco protected tobacco from systemic infection by ordinary tobacco mosaic virus. Old infections of *Uromyces* on bean commonly showed internal necrosis of petioles, and virus was recovered from these petioles. TMV-like rods were present in some infections.

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