

Abstracts of the Thirty-Third Annual Meeting of the Northeastern Division  
of The American Phytopathological Society

*Ascospores of Whetzelinia sclerotiorum as primary inoculum causing white mold of beans in New York.* G. S. ABAWI, and R. G. GROGAN. (N.Y. State Agricultural Experiment Station, Geneva; and Univ. of Calif., Davis, respectively). Sclerotia of *Whetzelinia sclerotiorum* produced abundant apothecia in unplowed bean fields and under duff in fruit orchards and uncultivated areas. Apothecia were produced in wet soils from 23 April to 15 June 1973. However, sclerotia failed to produce apothecia during dry weather in July and August. When apothecia were abundant, potted bean plants left in the field for 4 days became infected after incubation in a mist chamber. There was a positive correlation between disease incidence and plant age or injury. In laboratory and greenhouse inoculation tests, an exogenous energy source such as bean blossoms, steamed celery stems, or turnip root extract was required for ascospores to infect 1- to 5-wk-old bean plants. Infection of beans by mycelium from sclerotia was not observed in the field. After field plowing, sclerotia were absent or rare on the soil surface and no energy source was available for mycelial production. In the absence of an energy source, sclerotia are incapable of infecting bean plants even under ideal conditions in a mist chamber. Thus, it was concluded that bean white mold epidemics are initiated only by ascospores produced from apothecia under duff outside bean fields and supported nutritionally by bean blossoms or injured tissues.

*Anatomical observations on chrysanthemum plants invaded by Verticillium dahliae.* S. ALEXANDER, and R. HALL (Univ. of Guelph, Guelph, Ontario, Canada). The form and distribution of *Verticillium dahliae* within the ornamental chrysanthemum (*Chrysanthemum morifolium*) was determined from fresh and wax-embedded sections at intervals after inoculation. In roots, lignitubers and a dark pigment were produced in the outer layers of the cortex in response to invasion, and the fungus was largely restricted to these layers in the form of torulose hyphae and microsclerotia. Within root vessels, the mycelium was thin (1.3- $\mu$ m diam), relatively straight, and produced conidia on simple phialides. Colonization of vessels in the stem was initially discontinuous and appeared to be initiated by conidia produced in the vessels of the roots. Mycelium in the stem was also thin, but more sinuous than in the roots. Conidia accumulated in large numbers in vessels of the leaf, especially in the petiole and basal portions of the midrib and lateral veins. These areas were later intensively colonized by thin and thick (3.6- $\mu$ m diam) mycelium. The thick mycelium occurred in abundance in leaf vessels at the time wilt symptoms appeared. In intensively colonized areas of leaves, vessels often contained globular material which together with the abundant conidia and mycelium in leaves, appears to contribute to wilt by restricting water flow within leaf vessels.

*Phytotoxic effects of cadmium.* A. BARBER and E. BRENNAN. (Rutgers Univ., New Brunswick, N.J.). Accumulation of the heavy metal, cadmium (Cd), in the environment poses a twofold threat to agriculture. It is phytotoxic in small quantities and it also renders plants unsafe for human or animal consumption. The symptoms of Cd toxicity typically include chlorosis, leaf crinkling, red veins, and reduced growth. Bush bean (*Phaseolus vulgaris* 'Tendergreen M.R.') was the most sensitive species investigated; it showed injury when exposed to 1 ppm Cd<sup>++</sup> administered as CdCl<sub>2</sub> for 3 wk in sand culture. Lettuce (*Lactuca sativa* 'Parris Island') and tomato (*Lycopersicon esculentum* 'Rutgers') was not injured as severely as bean, even though the foliar accumulation of Cd was 1,000 and 3,000 times as great, respectively, as in bean. Since the

presence of Cd in the nutrient solution greatly increased the uptake of other mineral nutrients, it is improbable that the mode of action of the metal is simply a competitive inhibition which produces a nutrient deficiency. The observed accumulation of Cd in chloroplasts may be significant relative to interference of the metal with plant metabolism.

*Dynamics of plant cell wall breakdown and cellular injury caused by a homogeneous polygalacturonate lyase.* H. G. BASHAM and D. F. BATEMAN. (Cornell University, Ithaca, N.Y.). A homogeneous polygalacturonate lyase (PGL) from *Erwinia chrysanthemi* causes loss of electrolytes (protoplast injury) and release of unsaturated uronides (cell wall breakdown) within 5 min after potato medullary tissue is treated with the enzyme. If PGL is rinsed out of treated tissue, both rate of electrolyte loss and uronide release are reduced by more than 75%. The ratio of rate of electrolyte loss to rate of uronide release in PGL treated tissue is constant when PGL concn, substrate (tissue) concn, or temp is varied. If tissue is plasmolysed prior to PGL treatment, cell wall breakdown occurs but electrolyte loss is inhibited. When 0.1 g plasmolysed tissue/ml is treated with 0.24 units PGL/ml for 60 min, rinsed with osmoticum to remove enzyme, and then deplasmolysed, all available electrolytes are lost from tissue at a rate equivalent to electrolyte loss from free space. This rate is six times greater than rate of electrolyte loss from nonplasmolysed tissue treated with 0.24 units PGL/ml. PGL (0.24 units/ml) caused no apparent damage to isolated plant protoplasts exposed for 90 min. These data are consistent with the hypothesis that injury of cells by PGL is directly related to plant cell wall breakdown.

*Production of fire blight of apple under field conditions.* S. V. BEER. (Cornell University, Ithaca, N.Y.). Inoculation techniques destined for use in the evaluation of control measures for the fire blight of apple caused by *Erwinia amylovora* were devised and tested under field conditions. Blossom clusters of 6-yr-old *Malus sylvestris* 'Idared' were inoculated by spraying with an aqueous suspension containing 0,  $5 \times 10^2$ ,  $5 \times 10^4$ , or  $5 \times 10^7$  viable bacteria per ml at the full pink, 10% bloom, or full bloom stages of development. The number and percent of infected blossoms and blossom clusters were proportional to the inoculum dose. The highest level of infection (40% infected clusters) resulted from the inoculation made at full bloom. Infection of vegetative shoots of 6-yr-old trees (cultivar '20-Ounce') was accomplished by applying 1 liter of a suspension of *E. amylovora* and abrasives with a back pack-type gasoline-powered mist blower. The incorporation of silicon carbide (80-mesh) or glass beads (0.2-0.4 mm diam) in the mist-blown suspension did not significantly increase the mean number of infections per tree compared to the bacterial suspension alone. A 30-fold increase in bacterial concn to  $15 \times 10^8$  cells/ml doubled the number of infected shoots. Development of these techniques has made possible the efficient field evaluation of candidate fire blight control measures.

*Electrical properties of wood in progressive stages of discoloration and decay.* R. O. BLANCHARD and T. A. TATTAR. (Univ. of N. H., Durham). Electrical resistance and capacitance measurements were taken on woody tissues of several tree species. Each tissue was above the fiber saturation point. Capacitance was inversely proportional to resistance in woody tissues in progressive stages of discoloration and decay. Healthy wood measurements showed an average of 100 K $\Omega$  of resistance and 2.0 nF of capacitance. Decayed

wood measurements showed an average of 3.0 K $\Omega$  of resistance and 110 nF of capacitance. Ground woody tissues, cellulose suspensions, starch suspensions, and woody equivalent solutions of potassium chloride had resistance and capacitance properties similar to those found in intact woody tissues. Oscillometric measurements of capacitance suggested that the capacitive component of a tree is determined by the dielectric constant of the wood. The similarities between resistance and capacitance properties of woody tissues above the fiber saturation point, and the resistance and capacitance properties of dilute solutions of mobile ions, further suggest that the dielectric constant of discolored and decayed wood varies as a result of increased concns of mobile ions.

*Histological observation of corn seeds and seedlings infected with Helminthosporium maydis.* C.W. BOOTHROYD and L. W. T. HSU. (Cornell Univ., Ithaca, N.Y.). Corn seeds with blackened pedicels were selected from five commercial seed lots that exhibited 7-44% infection by *H. maydis* when germinated on moist filter paper. A total of 25 seedlings with *H. maydis* visible on the surface of the seed and shoot base were embedded in paraffin and sectioned. Mycelium was found in the pedicel, pericarp, endosperm, scutellum, mesocotyl, coleoptile, coleorhiza, and radicle. No mycelium was observed in the meristem of the plumule, although it was seen in the outer leaf tissue around the growing point. Week-old seedlings of a corn inbred, W182B<sup>tms</sup>, were inoculated by dropping a conidial suspension of *H. maydis* race T into the leaf whorl, incubated for 48 h at 100% relative humidity, and sectioned 2, 4, and 6 days after inoculation. Mycelium was present throughout the plumule 10-15 mm above the meristem and in outer plumule layers near the meristem and in the radicle; but was absent in the inner 5-7 plumule layers at the level of the growing point. *H. maydis* in infected seed of seven commercial lines stored for 3 yr reduced seed germination in the field, but the fungus was not found sporulating on seedling shoots above ground. We suggest that *H. maydis* penetrates plumule tissue with difficulty under field conditions and is confined primarily to portions of the seedling below ground.

*Some weed hosts of cucumber mosaic virus in New York.* W. L. BRUCKART and J. W. LORBEER. (Cornell University, Ithaca, N.Y.). Weed samples in and adjacent to lettuce and celery fields were collected in Orange and Oswego Counties, New York, throughout the summers of 1972 and 1973. Each sample was indexed for virus by mechanically inoculating one plant each of *Nicotiana tabacum* 'Samsun NN' and *Gomphrena globosa*. An eight-plant host range then was utilized for further screening of each sample for which a reaction was observed in the initial index pair. Based upon the host range reactions, seven of the sixty-one weed species indexed were found to be infected with cucumber mosaic virus. Weed hosts, frequencies of infection (number infected/number indexed), and dates of observation in Oswego County are given: *Rorippa islandica* (2/61, 1973), *Echinocystis lobata* (1/6, 1972 and 1/32, 1973), *Solanum dulcamara* (1/8, 1973), *Verbascum thapsus* (2/14, 1973), *Stellaria* spp. (2/13, 1973), and *Barbarea vulgaris* (3/3, 1973). The corresponding values for Orange County were: *R. islandica* (4/66, 1973), *Stellaria aquatica* (2/4, 1972 and 6/41, 1973), *B. vulgaris* (1/5, 1973), and *Phytolacca americana* (1/1, 1973).

*Interaction of Verticillium albo-atrum and Pratylenchus penetrans on potato.* L. L. BURPEE and J. R. BLOOM. (Pa. State Univ., University Park). Single-stemmed potato plants were used to test the interaction of *Pratylenchus penetrans* and *Verticillium albo-atrum* on the development of potato wilt. Pots containing the cultivar 'Katahdin' were placed in

Esco temperature tanks at a constant water temp of 22  $\pm$  1.0 C. Treatments included: soil infestations of nematodes, the fungus, nematodes ten days prior to the fungus, and uninfested controls. A symptom and senility index was used to rate the treatments at weekly intervals. Initial symptom development in the fungus and the nematode-plus-fungus treatments appeared 1 wk and 2 wk, respectively, prior to the development of natural senescence in the control treatment group. By the 3rd wk, indices for the nematode-plus-fungus and fungus treatments were comparable. This suggests that infection of potato roots by *P. penetrans* and *V. albo-atrum* may result in a decreased incubation period for the fungus. Occurrence of chlorosis in the nematode and control treatment groups was noticed three weeks after infestation, implying that infection by *P. penetrans* does not affect the onset of senescence in Katahdin potatoes under this experimental system.

*Orientation of epidermal cell nuclei toward site of penetration of corn leaves by Helminthosporium maydis race T.* M. R. CONTRERAS and C. W. BOOTHROYD. (Cornell Univ., Ithaca, N.Y.). Light microscopy of leaf tissue from corn seedlings susceptible (W64A<sup>tms</sup> and M017<sup>tms</sup>) or resistant (W64A and M017) to *Helminthosporium maydis* race T, revealed no differences in the preparation and penetration activities of the pathogen on susceptible or resistant plants. The first detectable difference in host response occurred in resistant plants. Nuclei in all epidermal cells surrounding the penetrated cell were positioned at the points closest of the penetration site. This apparent movement of nuclei occurred simultaneously with penetration and formation of a primary hypha 6-9 h after inoculation. Inoculation of leaves of W64A<sup>tms</sup> or M017 with *H. carbonum* race II (a nonpathogen of these inbreds) caused orientation of nuclei. *H. victoriae* (nonpathogenic to corn) caused orientation of nuclei in leaves of M017, but results with W64A<sup>tms</sup> were too variable to be conclusive. There was no apparent orientation of nuclei when susceptible epidermal cells were penetrated by *H. maydis* race T. This phenomenon may be associated with incompatible corn-fungus interactions.

*Characteristics of a previously unknown cucurbit virus in New Hampshire.* W. S. CONWAY, A. E. RICH and W. E. MAC HARDY. (Univ. of N.H., Durham). A mosaic-type virus has been observed during the past several years in plantings of several varieties of *Cucurbita* spp. in New Hampshire. Each year the virus appears to become more widespread. Symptoms include typical mosaic mottling, leaf distortion, and stunting of the entire plant. For tentative identification of the virus by host range, plants in the families Chenopodiaceae, Cucurbitaceae, Leguminosae, and Solanaceae were inoculated with sap from infected plants. Only plants in the Cucurbitaceae became infected and exhibited typical symptoms. Attempts to recover the virus from symptomless plants were unsuccessful. Seed-transmission tests indicated that this virus, unlike squash mosaic virus, is probably not transmitted through squash seeds. Infected leaves were homogenized in both 0.5 M and 0.05 M phosphate buffer at pH 7.0. The resulting virus suspensions were subjected to three cycles of low- and high-speed centrifugation, and infectivity was tested after each cycle. The virus remained infectious in both buffer concns. However, results indicated that the virus is somewhat more infective in the weaker buffer. Results to date indicate that the virus is related to, but not identical with, squash mosaic virus.

*Effectiveness of benomyl and oxathiin analogs in reducing bronzing on white beans under field conditions.* L. R.

CURTIS, D. A. LITTLEJOHNS, and L. V. EDGINGTON. (Univ. of Guelph, Guelph, Ontario, Canada). Foliar sprays of chemicals were applied to white beans (*Phaseolus vulgaris*) in field trials to prevent ozone injury and yield loss caused by atmospheric ozone. The chemicals, carboxin, F-831 (5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide-4-oxide), pyracarbolid 50 W, benomyl, and a combination of carboxin and abscisic acid were applied on August 2 and 15 or on August 8 at a rate of 2.2 kg/ha. Ozone injury was assessed August 20 and beans were harvested on September 5 for yield data. Atmospheric ozone concns between August 4-7 ranged from 7-10 ppm for a duration of 12 h each day. White beans sprayed with carboxin or its sulfoxide analog (F-831) prior to the ozone exposure showed less premature senescence and they yielded 13% more than unsprayed plots. Although benomyl prevented premature senescence, yields were slightly lower than unsprayed plots. Pyracarbolid was ineffective in protecting the white beans from ozone injury. All plots sprayed on August 8, after the ozone episode, had reduced yields, which indicated that damage had already occurred. Since carboxin is readily oxidized to the sulfoxide in leaves, we hypothesize that the active antiozonant is the sulfoxide form.

*Effect of growth substances and other compounds on callus formation and discoloration following wounding of red maples.* M. DESSUREAULT and A. E. RICH. (Univ. of N.H., Durham). This study consisted of 16 treatments repeated on four red maple (*Acer rubrum*) trees. Treatments included an untreated control, lanolin, three auxins, gibberellic acid, a cytokinin, cysteine and zinc oxide, alone and in various combinations. All compounds were incorporated in lanolin. The trees were wounded at the time of leafing out by boring a hole, 1.5 cm diam to a depth of approximately 1 cm. These wounds were treated immediately after wounding by filling the holes with the lanolin paste. The trees were harvested 3 mo later. Only one auxin in combination with either gibberellic acid or zinc oxide, or both, stimulated callus formation. However, there was at least as much discoloration associated with these treatments as with lanolin alone. Zinc oxide, gibberellic acid, and cysteine had no effect on callus formation but slightly reduced the amount of discoloration. Lanolin itself greatly helped callus formation and reduced the amount of discoloration by 50% compared to the untreated control. Better healing or less discoloration did not affect invasion by microorganisms.

*Anatomy of leaf abscission of azalea infected by Cylindrocladium spp.* A. DONNAN, JR. and P. E. NELSON. (Pa. State Univ., University Park). Leaf abscission of *Rhododendron obtusum* 'Chickadee' occurred 4-5 days following leaf inoculation with spore suspensions of *Cylindrocladium scoparium* and *C. theae*. The abscission zone was examined histologically. Isolation techniques, and examination of anatomical sections, showed that the pathogen was not present in the tissue between the lesion and the petiole base. The abscission zone developed in the shoot tip prior to inoculation and consisted of a separation layer, one to three cells thick, and a heavily suberized protection layer, three to five cells thick, proximal to the separation layer. The cells of the separation layer were smaller than the surrounding parenchyma cells and rectangular in shape with the radial walls being the longest. No proliferation of the protection layer during or following abscission was observed. Separation occurred due to partial lysis of the cell walls followed by mechanical breakage. Ethylene was produced as a result of the host-pathogen interaction and appeared to accelerate the normal abscission process.

*Control of Ustilago maydis with systemic fungicides.* T. ENYINNIA and P. M. HALISKY. (Rutgers Univ., New Brunswick, N. J.). Systemic fungicides were applied as seed treatments, soil drenches, or both, to cultivar 'Spring White' sweet corn. In greenhouse and field trials, treated and nontreated seedlings were injected with sporidial suspensions of *Ustilago maydis* and scored for the presence or absence of smut galls. Seed treatment with carboxin (5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide) (Vitavax 34F) at 10 ml/125 seeds gave 78% and 72% smut control, respectively, in greenhouse and field trials. Similarly, carboxin seed treatment plus one soil drench with benomyl [methyl 1-(butyl carbamoyl)-2-benzimidazole carbamate] (Benlate 50W) at 2.0 g/2.5 liter/100 seedlings resulted in 97% and 81% control, respectively. A single benomyl drench produced 66% smut control in both trials whereas two drenches resulted in 88% and 84% control, respectively. Similarly, a single drench of thiophanate methyl [dimethyl 4,4-O-phenylenebis(3-thioallophanate)] (Topsin M 70W) gave 85% and 69% control, whereas two drenches produced 86% and 80% control, respectively. In contrast, 10% of the greenhouse-grown and 16% of the field-grown check plants (untreated, but inoculated) remained smut-free. In summary, 30 greenhouse trials resulted in an average smut control of 83.3% as compared with 75.3% control in 30 field trials with systemic fungicides.

*Effect of fungicidal seed treatment on emergence of Diaporthe-infected soybeans.* T. ENYINNIA and J. K. SPRINGER. (Rutgers Univ., New Brunswick, N.J.). Soybeans (cultivar 'Clark 63') infected with *Diaporthe phaseolorum* var *sojae* were treated with benomyl [methyl 1-(butyl carbamoyl)-2-benzimidazolecarbonate] (Benlate 50WP), [diethyl 4,4-O-phenylenebis(3-thioallophanate)] Cleary 3336 50WP, Mertect 360 [2-(4-thiazolyl-benzimidazole)] (TBZ 60WP), thylate (tetramethylthiuramdisulfide) (Arasan 65 WP) each at 2 oz/bushel of seed, or 5% Clorox (NaOCl). Also Thylate was combined with each chemical. Greenhouse and field plantings were made and the percentage of seedling emergence recorded. Benlate produced 78% and 91% healthy seedlings in the greenhouse and field, respectively. Similarly, Cleary 3336 produced 76% and 87%; Mertect, 78% and 79%; Thylate, 81% and 90%; Clorox, 74% and 74%; Benlate plus Thylate, 80% and 88%; Cleary 3336 plus Thylate, 79% and 87%; Mertect plus Thylate, 75% and 94%; and Clorox plus Thylate, 78% and 90%. However, only 67% and 70% of control plants emerged in the greenhouse and field respectively. Seedling emergence was generally higher where Thylate was used. The systemic fungicides were not better than the standard protectant Thylate, and the Clorox dip was found unsatisfactory. Seedling emergence in the field was consistently higher than in the greenhouse.

*Effect of combining horizontal resistance and protective fungicide treatment on rate of epidemic development* W. E. FRY and D. C. MUNCH. (Cornell Univ., Ithaca, N.Y.). Protective fungicides and horizontal (field) resistance (HR), each of which reduced the rate of epidemic development, were tested in combination for additive effects using late blight of potatoes as a model system. Plots of *Solanum tuberosum* 'Russet Rural' (low level of HR) or *S. tuberosum* 'Sebago' (moderate level of HR) were sprayed weekly with a coordination product of zinc ion and manganese ethylenebisdithiocarbamate at 0.89 kg (2 lb)/4,047m<sup>2</sup> (acre) (x), at 0.44 kg (1 lb)/4,047m<sup>2</sup> (acre) (x/2) or with water. The center plant in each plot was artificially inoculated and sprinkler irrigation was applied in the morning and evening to create conditions conducive to late blight. At the termination of this experiment (vine killing) the amount of late blight in plots of Russet Rural and Sebago, respectively, was 100% and



80.2% for the water treatment, 43.1% and 15.4% for the  $x/2$  fungicide treatment and 12.5% and 3.15% for the  $x$  fungicide treatment. Rate of epidemic development ("r") for Russet Rural and Sebago, respectively, was 0.6674 and 0.3994 in plots sprayed with water, 0.2316 and 0.2261 for the  $x/2$  fungicide treatment, and 0.1661 and 0.1505 for the  $x$  fungicide treatment. Apparently the fungicide dosages used in this test masked the differences in rates of disease development which are due to horizontal resistance.

*Absence of interaction between systemic fungicides and nematocides for the control of Fusarium blight in Merion Kentucky bluegrass.* C. W. GOLDBERG, H. COLE and L. BURPEE. (Pa. State Univ., University Park). It has been suggested that nematodes play a major role in Fusarium blight development. To test this hypothesis, fungicide and nematocidal combinations were evaluated on a nematode-infested Merion Kentucky bluegrass fairway during 1973. Benomyl, thioallophanate ethyl and methyl, thiabendazole, and CL 1881 fungicides were applied at the rate of 113 g actual ingredient (AI) per 93 centares across untreated turfgrass areas, or areas previously treated with Dasanit or carbofuran at the rate of 204 g per 93 centares. The nematocides were applied 24 May. Fungicides were applied 18 June, with half the fungicide plots receiving a second 113 g application on 2 July. Plots were irrigated with 12.7 mm (0.5 inch) of water after each fungicide treatment. In an adjacent experiment, Dasanit, oxamyl, Nema-cur, carbofuran, and leptophos were applied on 11 June at 102 g or 204 g AI and irrigated with 12.7 mm of water. Benomyl and the thioallophanates provided 4-8 wk control with benomyl and thioallophanate-methyl being most effective. No nematocidal alone, in spite of nematode population reduction, provided any measure of Fusarium blight control and no improvement in control was detectable from any of the nematocidal-fungicide combination treatments.

*Electron microscope observations of apple scab.* A. L. GRANETT. (N.Y. State Agric. Exp. Stn., Geneva). Little use has been made of the electron microscope in studying apple scab, even though it is one of the historically classic plant diseases. The incitant, *Venturia inaequalis*, has a typical ascomycete life cycle. Several electron microscopic techniques were utilized to observe and study various structures in this cycle. After being subjected to glutaraldehyde and osmium fixation, critical-point drying, and platinum coating; the ascospores, conidia, and conidiophores were observed in a scanning electron microscope. Replicas of the two forms were also visualized in a transmission electron microscope. Thirdly, thin-sections were cut of perithecia, scab-infected apple leaves, and isolated conidia after they had been fixed and embedded in plastic. Besides typical fungal ultrastructure, there were several points of particular interest. A septal pore separates the ascospore cells. The surface of the conidium is coarser than that of the ascospore. Concentric bodies, 300 nm in diameter were found in the hyphae of both the perithecia and conidiophores. These bodies have a unique structure, but their origin and function is unknown, and they were not observed in either ascospores or conidia. They seem identical to the concentric bodies reported in the mycobionts of many lichens.

*Germination and germ tube growth of Verticillium malthousei phialospores as influenced by substrate and duration of aerated steam treatment.* A. C. HAPP and P. J. WUEST. (Pa. State Univ., University Park). Mushroom casing, loam soil, peatmoss, and spent compost were treated with aerated steam at 60 C for 30, 90, and 240 min. Phialospore germination and germ tube growth of *Verticillium malthousei*

were ascertained from spore-coated water agar slides buried in treated substrates for 24 h. Germination was inhibited and percent germination reduced when casing was treated at 60 C for 30 min vs. treatments of 90 and 240 min. Significant differences in germination occurred between each of the treatment times. Least phialospore germination occurred in loam soil treated for 30 min, and the 240-min treatment of peatmoss was similarly inhibitory. No significant germination difference was found between controls and 240-min treatment with loam soil and spent compost. Treatment for 30 min showed a substrate effect since spore germination on compost, peatmoss, and loam soil occurred in decreasing magnitude. Spores in contact with peatmoss treated for 30 min, produced longer germ tubes compared with loam soil and spent compost. Germ tube length decreased when peat or soil were treated for 90 min at 60 C. These observations indicated that aerated steam treatment time and casing substrate influence germination of *V. malthousei* spores, and length of germ tubes.

*Ecological races within Helminthosporium maydis race T.* J. P. HILL and R. R. NELSON. (Pa. State Univ., University Park). Certain biological fitness attributes of two populations of race T of *Helminthosporium maydis*, one collected from the cool environment of Northern Europe (CEP) and the other from warm, tropical areas (WEP), were evaluated under cool and warm temp regimes. The inoculum for each population consisted of an equal amount of similarly calibrated spore suspensions from 11 selected isolates. Infection efficiency (IE) recorded after a standardized inoculation as the number of lesions per plant, sporulation in terms of conidia per mm<sup>2</sup> of lesion (SP), and lesion size (LS) were measured on plants of P-A-G hybrid 15029T. IE at 28 C infection and 31 C colonization was 117 for the WEP and 66 for the CEP while IE at 16 C and 20 C was 68 for the WEP and 84 for the CEP. SP for the WEP and CEP at 28 C was 179 and 95 respectively and at 16 C SP was 28 for the WEP and 49 for the CEP. All differences were statistically significant (ANOVA,  $P = 0.05$ , except SP under cool environment, which was significantly different between  $P = 0.10$  and  $0.05$ ). LS was comparable for both populations under both temp regimes. Similar differences were observed when individual isolates of the two populations were evaluated separately under the warm regime and their performances expressed collectively as population means. The collectively expressed means of individual mycelial growth rates of the WEP were significantly greater at 35 C and comparable to the CEP at 18 C.

*Rickettsialike organisms in the phloem of little leaf-diseased Sida cordifolia.* H. HIRUMI, M. KIMURA and K. MARAMOROSCH (Boyce Thompson Inst., Yonkers, N.Y.); J. BIRD and R. WOODBURY. (Univ. of Puerto Rico, Rio Piedras, P.R.). *Sida cordifolia* plants with a previously underscribed little leaf disease were observed growing wild at Lagos de Vega Baja, Puerto Rico. The diseased plants were characterized by dwarfed leaves, reduction in internode length, and suppression of flowering. Occasionally leaves on several branches were severely dwarfed, while leaves on other branches of the same plant appeared normal. To elucidate the etiology of the disease, portions of leaves and petioles were excised in the field, fixed with 1.5% glutaraldehyde in 0.1M sodium cacodylate buffer (pH 7.2), and further processed for electron microscopy using standard procedures. Examination of thin-sections revealed the presence of pleomorphic microorganisms, resembling Rickettsiae (RLO), in the sieve tube elements, but not in the xylem, of diseased as well as healthy-appearing *S. cordifolia* collected in the same area. The RLO were either spherical or filamentous and had thin cell walls that distinguished them from mycoplasma-like

organisms (MLO). Healthy *S. cordifolia* from a location 2 kilometers away contained no microorganisms. Presumably RLO represent a group of plant pathogens, distinct from MLO and from bacteria.

*Basal canker disease of white pine: ecological comparisons between disease development in New York and Maine.* D. R. HOUSTON. (U.S. Dep. Agric., For. Serv., NE For. Exp. Stn., Hamden, Conn.). Basal canker on white pines planted along Route I-95 in central Maine was noted in 1972. Study revealed marked ecological similarities between this situation and that on Tug Hill in north-central New York. In New York, pines were planted to reforest abandoned farms; young trees injured by ants, *Formica fusca*, or by snow or ice were invaded by canker fungi; and damage was associated with site features that influenced occurrence of ant mounds or accumulation of ice and snow (swales, rock piles, hedgerows). In Maine, pines were planted as natural snow fences on farm lands taken by the highway; injuries caused by snow or ice or by *F. fusca* were invaded by canker fungi; and, as in New York, disease incidence and severity were related to features influencing distribution of ants and snow and ice (drainage patterns, snow fences). Damage ranged from 3% in rows oriented parallel with prevailing wind to 59% in rows oriented perpendicular to wind. Greenhouse inoculation trials confirmed pathogenicity of several fungal isolates from Maine cankers, including a *Fusarium* sp., one of the several previously associated with the disease in New York. Results indicate that conditions contributing to the disease complex are much more common than previously realized.

*Effect of relative humidity on sporulation of Helminthosporium maydis on corn (Zea mays).* R. A. HYRE. (Agric. Res. Serv., U.S. Dep. Agric., Pa. State Univ., University Park). Potted corn plants with nonsporulating 4-day-old leaf lesions of *Helminthosporium maydis* race T on Texas male-sterile hybrid P-A-G 15029<sup>T</sup> were placed in an insulated box with moving, humidity-controlled air. The box and control apparatus were located in a darkened environmental chamber. Relative humidity (RH) was continuously monitored with a hygrosensor which was calibrated with wet- and dry-bulb mercury thermometers. After 16 h at 24 C conidia were collected and counted. Conidia were formed at high RH in the absence of water. Virtually no spores were formed at less than 93% RH. As RH increased, more spores were formed until as many were present at 97½% RH as have been reported when dew was present. Similar results were obtained using humidity-controlled air flowing over leaf lesions sealed in a 1.3-cm diam Lucite tube.

*Leptosphaerulina briosiana on alfalfa: relation of lesion size to leaf age and light intensity.* K. T. LEATH and R. R. HILL, JR. (USDA, ARS, Reg. Past. Res. Lab., University Park, Pa.). The size of lesions caused by *Leptosphaerulina briosiana* varied with the age of alfalfa leaves in greenhouse and growth chamber tests. Lesions on the youngest (top) leaves were the largest and decreased in size on the next three successively older leaves of three susceptible clones; small lesions formed on all leaves of two resistant clones. The gradient in lesion size was greater under high (21,528 lumens/m<sup>2</sup>) than under low (9,688 lumens/m<sup>2</sup>) postinoculative light. The large, susceptible-type lesions formed only under the high light condition. A lesion size gradient occurred in high light even when all leaves received essentially the same amount of light energy. Plants that did not have a gradient in lesion size also did not produce pale green, succulent leaves at the top of the stem. Postinoculative light of sufficient intensity and vigorously growing plants are prerequisite to selection for resistance to *L. briosiana*.

*The relationship between foliar wilt symptoms, leaf colonization, relative water content, and protein, RNA and chlorophyll levels of Verticillium-infected chrysanthemum leaves.* W. E. MAC HARDY. (Univ. of N.H., Durham). Shifts in host metabolism during early stages of foliar infection and symptom development were examined. The first visible evidence of water imbalance within a chrysanthemum leaf infected with *Verticillium dahliae* was a slight flaccidity of one or more lobe apices, followed by wilting which progressed basipetally along each lobe. Extensive fungal colonization of leaf vascular tissue occurred prior to initial flaccid symptoms, but similar numbers of fungal propagules were recovered from nonsymptomatic and symptomatic parts of a leaf lobe. Chlorophyll, RNA, and protein levels in apical tissue were not altered until wilt symptoms were clearly visible. Chlorophyll, RNA, and protein levels of adjacent symptomless leaf tissue remained comparable to check values. Similarly, relative water content decreased in lobe apices as wilt became visible, but remained unchanged in adjacent symptomless tissue. Dye distribution patterns within the xylem elements of infected plants and checks were similar within all tissues except flaccid or wilted lobes where dye distribution was interrupted. Data support the concept that the appearance of foliar wilt symptoms is associated with a water imbalance initiated in the apical leaf tissue where wilt symptoms appear.

*Benzimidazoles as haploidizing agents in Penicillium expansum.* B. H. MAC NEILL. (University of Guelph, Guelph, Ontario, Canada). Linkage studies with synthetic diploids of *P. expansum*, a pathogen of apple fruit, have been limited by the infrequency of spontaneous haploidization. However, when synthetic diploids heterozygous for markers governing color, nutrition, and virulence were exposed to sublethal concns of either benomyl [1-(butylcarbamoyl)-2-benzimidazole carbamic acid], thiabendazole [2-(4'-thiazolyl)-benzimidazole] or furidazole [2-(2'-furyl)-benzimidazole] incorporated into complete medium, haploidization was increased approximately 100-fold without any evidence of accompanying toxicity or atypical genetic effects.

*Ozone and Pyrenochaeta lycopersici: effects on growth and development of tomato plants.* W. J. MANNING, and P. M. VARDARO. (Univ. Mass., Waltham). Tomato plants (*Lycopersicon esculentum* 'Tiny Tim') were grown in two paired greenhouses for 60 days in 22-cm diam pots of either steam-sterilized fine sandy loam or nonsterilized fine sandy loam naturally infested with the brown root rot fungus *Pyrenochaeta lycopersici*. One greenhouse contained charcoal-filtered, ozone-free air and the other filtered air plus ozone at 8-10 ppm for 8 h/day, 5 days/wk. Five replications of three plants each were used for each soil system in each air regime. Moderate injury was observed throughout the experiment on older leaves of plants exposed to ozone. Significant differences ( $P = 0.05$ ) in root dry weights were noted between plants grown in steamed and infested soil in filtered air. Root dry weight differences were significant when comparisons were made between plants grown in infested soil in ozone and filtered air and when plants grown in steamed soil in ozone and filtered air were compared. Ozone and *P. lycopersici* both significantly reduced the number and weight of fruit. Top dry weights were not affected by ozone, but were affected by *P. lycopersici* within either ozone or filtered air. Only plants grown in steamed soil in filtered air were significantly taller than any others.

*Pigeon pea witches' broom disease.* K. MARAMOROSCH, H. HIRUMI, and M. KIMURA (Boyce Thompson Inst., Yonkers); J. BIRD, and N. G. VAKILI (Univ. of Puerto Rico, Rio Piedras and Mayaguez, P. R., respectively). Pigeon pea

(*Cajanus cajan*) plants with a witches' broom disease of unknown etiology were collected at Rio Piedras and Mayaguez, Puerto Rico. At the time of collection, plants in both localities were heavily infested by *Empoasca* sp. leafhoppers. Diseased and healthy material was fixed and processed for electron microscopy using standard methods. Thin-sections of diseased plants from Mayaguez contained large accumulations of mycoplasma-like organisms (MLO) in the sieve tube elements, while similar sections from distorted plants collected at Rio Piedras were free from MLO. Rhabdovirus particles were also detected in the Mayaguez material. All healthy plants were free of MLO and viruses. These findings indicate that the leaf distortion at Rio Piedras may have been caused solely by leafhopper burn, whereas the witches' broom disease at Mayaguez, apparently associated with MLO and a virus, might conceivably be the result of the combined action of *Empoasca* toxin, MLO, and virus. This working hypothesis will be tested by graft transmission and *Empoasca* feeding tests at both locations. The MLO-associated pigeon pea disease of Puerto Rico resembles the MLO and rhabdovirus associated pigeon pea disease described earlier from the Dominican Republic.

*Modeling and simulation of southern corn leaf blight caused by race T of Helminthosporium maydis.* L. B. MASSIE and R. R. NELSON. (Pa. State University, University Park). Controlled environment, greenhouse, and field experiments evaluated the effects of environmental factors on the development of southern corn leaf blight caused by a highly virulent isolate of race T of *Helminthosporium maydis* on moderately susceptible varieties of corn containing Texas male-sterile cytoplasm. Models were developed for several segments of the disease development and pathogen life cycles. Through the use of regression analysis and other statistical procedures, these experimentally obtained data (and data from the literature) were utilized to test the models and develop satisfactory predictive equations for each of the cycle segments studied. These equations were logically integrated in a Fortran IV computer program to produce a model for the disease. Simulations of disease development were made using environmental data acquired from four field plots during the summer of 1972. Accuracy of the model was verified by comparing predicted disease development with actual disease development observed in the four field plots from which the environmental data were obtained.

*Geographical distribution of fluoride in relation to a primary aluminum smelter.* J. R. MC CLENAHEN, and T. C. WEIDENSAUL. (Ohio Agr. Res. and Dev. Center, Wooster). The purpose of the study was to determine the area of influence of an aluminum smelter located in the Ohio River Valley. Hay and pasture vegetation were sampled periodically on 200 farms along 20 radii, each 10 miles long and spaced at 18-degree intervals around the F source. Linear regression based on a significant correlation ( $r = 0.89$ ) indicated 1972 second-cutting hay averaged 1.8 times the F content of first-cutting hay. Computer-generated isofluoric maps provided a basis for graphical comparison of the F distribution in a  $7.77 \times 10^8$  m<sup>2</sup> (300 square-mile) area around the source. These maps were used to identify zones of varying F accumulation in hay and pasture plants. The concn of F in hay generally did not fall below 10 ppm even at 10 miles from the source in the prevailing downwind direction (NE), whereas levels decreased below 10 ppm within 11.26 km (7 miles) southwest of the source.

*The effect of cadmium, nickel, and lead on the growth of ectomycorrhizal fungi.* J. D. MC CREIGHT, and D. B. SCHROEDER. (Univ. of Conn., Storrs). To ascertain whether or not cadmium, nickel, and lead are detrimental to ectomycorrhizae, nine ectomycorrhizal fungi were tested. The fungi tested were: *Amanita muscaria*, *Cenococcum graniforme*, *Laccaria laccata*, *Pisolithus tinctorius*, *Rhizopogon roseolus*,

*Suillus brevipes*, *S. grevillei*, *S. luteus*, and *Thelephora terrestris*. Various concns of cadmium sulfate, nickel sulfate, and lead acetate were used in each test. The metals were incorporated into Hagem Nutrient agar as modified by Modess with a pH of 4.6. Each test was conducted for 28 days at 20 C. Growth was determined by measuring colony diam. Ammonium sulfate and ammonium acetate were used as anion controls. Cadmium was completely inhibitory to all fungi at 200 µg/ml except for *T. terrestris* which was completely inhibited at 350 µg/ml. Nickel inhibited all fungi at 225 µg/ml. Lead inhibited six fungi at 250 µg/ml. *C. graniforme*, *L. laccata* and *S. luteus* were completely inhibited at 2,000 µg/ml of lead. Ectomycorrhizal fungi varied in sensitivity with each of the metals tested. Variation in sensitivity to each metal was also found among the seven genera and among the three species of one genus.

*Influence of heavy metals on nodulation of red clover.* W. D. MC ILVEEN, and H. COLE, JR. (Pa. State Univ., University Park). The effect of cadmium, cobalt, copper, and zinc on nodulation red clover (*Trifolium pratense* Pennscoot) was investigated. Germinated seedlings at the primary leaf stage were transplanted into soils of three different types, each of which had been amended with the chloride salt of one of the metals. The soil amendments provided additions ranging from 15 to 195 ppm metal expressed on an oven-dry soil weight basis. Plants were harvested after 6 wk. Direct nodule counts made on individual root systems revealed that nodulation was slightly stimulated by low concns of metal in some soils, but at higher concns, the number of nodules per plant and the number of nodules per g fresh root tissue was reduced. In some soils, the highest metal concns were sufficient to kill the plants and no nodulation occurred. The apparent toxicity of the metals to nodule formation was ranked in the order: Cd > Co > Cu > Zn. Lowering of the soil pH or cation exchange capacity of the soil increased the toxicity of all four metals to the nodulation process and to the plants themselves. Toxicity of the metals to the plants was evident as a reduction in root weight, number of leaves, and shoot weight with or without marginal chlorosis, anthocyanosis, or necrosis of the foliage.

*Possible serological relationship between two strains of Spiroplasma citri and the corn stunt spiroplasma.* A. H. MC INTOSH, B. S. SKOWRONSKI, and K. MARAMOROSCH. (Boyce Thompson Inst., Yonkers). Antisera to the semipurified Rio Grande strain of corn stunt spiroplasma and *Spiroplasma citri* (California, ATCC 27563) were prepared in New Zealand white rabbits. A rapid serological slide test, based upon the reduction of spiral forms as viewed by dark field microscopy, was developed for detecting the presence of antibodies. When *S. citri* antiserum was tested against *S. citri* there was a 100% reduction in spiral forms at a serum dilution of 1:8, whereas normal rabbit serum did not result in any reduction. A second strain, *S. citri* (Morocco, ATCC 27556) was also shown to be related to *S. citri* (California). More important, both strains were found to be antigenically related to the corn stunt spiroplasma. Additional serological tests have confirmed the finding of the slide test that *S. citri* and the corn stunt spiroplasma are antigenically related.

*Effects of hydrolytic enzymes on plant parasitic nematodes.* P. M. MILLER, and D. C. SANDS. (Conn. Agric. Exp. Stn. New Haven). Plant-parasitic *Tylenchorhynchus* sp. nematodes are killed when they are immersed in dilute solutions of commercial preparations of papain, chitinase, and lipase. Papain is the most toxic of the three. The preparations lose their toxicity when they are heated to 80 C for 10 min. Bromelain, erepsin, and pronase are not toxic. Scanning electron micrographs show that papain preparations apparently produce structural changes in the epidermis of treated nematodes. Papain, lipase, or chitinase mixed with nematode-infested soil reduce nematode populations by 50 to 75% after 3 wk. Pentachloronitrobenzene, a papain inhibitor, eliminates the toxicity of papain to nematodes.



*Reduction of ozone injury on Poa annua by benomyl and thioallophanate-ethyl.* J. W. MOYER, H. COLE, JR., and N. L. LACASSE. (Pa. State University, University Park). Three systemic benzimidazole derivative compounds were evaluated for control of ozone injury to annual bluegrass sod induced by growth chamber fumigation with 25 pphm ozone. Samples of annual bluegrass sod obtained from a golf course fairway were transferred to pots and maintained in a greenhouse. Compounds tested were benomyl, thioallophanate-ethyl, and thioallophanate-methyl. The materials were tested as soil drenches and soil amendments. Dosages tested varied from 20 µg active ingredient per cc soil to 200 µg/cc soil depending on chemical and treatment method. Ozone injury was expressed as yellow to tan necrotic flecks and varying degrees of chlorosis. Ozone injury appeared to predispose the plants to increased drought damage under dry soil conditions. Benomyl and thioallophanate-ethyl provided a high level of reduction in ozone injury when applied as a soil amendment and a consistent trend in injury reduction when applied as a soil drench as well as minimizing possible ozone-induced drought stress.

*Electron microscope observations of turf grasses showing symptoms of yellow tuft.* W. C. MUELLER, N. JACKSON, and J. M. FENSTERMACHER. (Univ. of Rhode Island, Kingston). Yellow tuft has become increasingly prevalent on blue grass in sod culture in Rhode Island in the last few years. The disease, characterized by the proliferation of yellowed tillers from the same region of a stem, is of unknown etiology, but the symptoms suggest mycoplasma involvement. Accordingly, tissues from diseased bluegrass and bent grass were fixed in glutaraldehyde/osmium and embedded in epoxy resin for sectioning and examination in the electron microscope. Mycoplasma could not be found in the phloem, but the vascular bundles of the leaf tissue are distorted by large thick-walled cells occurring in the mesophyll and surrounding the bundles. These large cells appear multinucleate and possess a dense cytoplasm with abundant ribosomes, a well-developed system of endoplasmic reticulum and numerous organelles. Prominent among these organelles are mitochondria, dictyosomes, lipid bodies, uniformly-stained spherical bodies of unknown function with a densely staining bounding membrane, and vacuoles with granular contents and amorphous deposits of electron-dense material. When seen in longitudinal sections, these cells branch and ramify through the leaf tissue, but there was no indication of where they originate or how they develop.

*Environmental factors affecting the germination of conidia of Alternaria alternata, the cause of blackmold of tomato fruit in California.* R. C. PEARSON AND D. H. HALL. (Univ. Calif., Davis). Infection by *Alternaria alternata*, in the absence of rain, is restricted to the upper surface of tomato fruit not covered by a canopy of leaves. The effect of moisture, temp, and fruit surface nutrients on germination of conidia were investigated. At 98.5% relative humidity (RH) and 20 C, conidia germinated in 6-9 h but required longer than 9 h at 15 C. Germination occurred between 3 and 6 h at 100% RH and 15 C. Free moisture was essential for spore germination at temp below 15 C. Relative humidities greater than 95% seldom occur at temp above 15 C in the semiarid central valleys of California during the summer. Dew deposition occurred at ambient temp at or below 15 C and only on the upper surface of fruit exposed to the sky, providing the moisture necessary for germination of conidia. Water-soluble nutrients in dew deposits, principally glucose and fructose, collected from the surface of tomato fruit, stimulated germination of conidia between 6-15 C.

*The economic impact of air pollutants on vegetation in New Jersey based on the 1972-73 survey.* E. J. PELL, and E. BRENNAN (Rutgers Univ., New Brunswick). In 1972-73, a survey was conducted to determine the economic impact of air pollutants on vegetation in New Jersey. We were informed of

potential air pollution episodes through the cooperative efforts of the New Jersey Extension Service, the Christmas Tree Growers Association, and the Flower Growers Association. In addition, spot checks were made where damage was not reported in order to avoid overlooking any air pollution episodes. Causes of damage were identified by consideration of source, symptoms, spectrum of species sensitivity, and (when meaningful) by chemical analyses of plant tissue for pollutant residues. Total crop loss was expressed as the cost of replacement based on current market values. Partial losses were calculated according to a rule of thumb utilized in previous air pollution surveys. According to the 1972-73 survey, air pollution damage to vegetation in New Jersey totaled \$128,019. Ozone caused 27% of the damage; peroxyacetylnitrate, 20%; hydrogen fluoride, 18%; ethylene, 16%; sulfur dioxide, 4%; and ammonia, 1%. The remaining damage was attributed to unknown pollutants. Vegetable crops were the most severely affected, sustaining 46% of the total loss, followed by nursery and cut flowers at 39%, fruit crops at 8%, Christmas trees at 5%, and field crops at 2%.

*Histopathology of chrysanthemum artificially inoculated with Erwinia chrysanthemi.* B. W. PENNYPACKER, P. E. NELSON, and R. S. DICKEY. (Pa. State Univ., University Park; and Cornell Univ., Ithaca, N.Y.). Rooted cuttings of *Chrysanthemum morifolium* 'Giant #4 Indianapolis White' were grown in pots of a mixture of peat, perlite, and soil (1:1:1, v/v) for 2 wk before being inoculated in a young leaf midrib with a chrysanthemum isolate of *Erwinia chrysanthemi*. Following inoculation, the plants were placed in a mist chamber, sampled, and examined histologically at selected intervals during disease development. *Erwinia chrysanthemi* entered the main stem through the leaf trace of the inoculated leaf, colonized the vascular bundle from which the leaf trace emerged, and eventually moved out of that bundle into the pith. Pith colonization and the resultant separation of cells, gave the pathogen access to other vascular bundles of the stem. The bacteria, once in the xylem vessel elements of the bundles, moved vertically in the stem. Some vertical movement may also occur in the pith tissue. In addition to pith cell separation, *E. chrysanthemi* caused extensive xylem parenchyma and phloem breakdown, and occasional plugs of pectic substances in the lumens of xylem vessel elements. The characteristic wilt symptom of bacterial blight probably results from the disruptive action of the pathogen on the xylem, phloem, and pith tissue of the chrysanthemum.

*Validity of quantitative ambient temperature-response relationships of organism cultures as derived from controlled environmental chamber investigations.* S. P. PENNYPACKER. (Pa. State Univ., University Park). Temperature and radiation measurements were made at various distances from the light barrier in an ISCO Model E-3A environmental chamber. The lighting system consisted of twelve 1.22 m (4-ft) General Electric cool-white, Power Groove, fluorescent lamps and three General Electric 100 W, 120 V incandescent lamps. Temperature and its vertical gradient in the interior of covered Pyrex petri dishes containing potato-dextrose agar were monitored with thermocouples. Radiant intensity as measured with an Eppley Pyranometer was found to increase from 9.4 to 27.6 m W/cm<sup>2</sup> as the distance to the thermopane barrier was decreased from 135 to 25 cm. The significance of this varying heat load on the microenvironment in petri dishes was illustrated by corresponding increased temp differences between the agar and ambient air. Temperature near the media surface ranged from 2.5 to 5.2 C higher than the chamber mean ambient air temp. Errors of significant magnitude may thus easily be introduced into laboratory investigations by failing to consider that organisms are not exchanging heat to the same sources and sinks of radiation as they would under natural conditions. Therefore, quantitative expressions may be invalid if the response was correlated to the ambient air temp in an environmental chamber.

*Inhibition of sporulation of Alternaria alternata by a substance(s) from dry pea seeds.* F. L. PFLEGER, and G. E. HARMAN. (ARS, USDA and N.Y. State Agric. Exp. Stn., Geneva). Alaska pea seeds exhibit natural resistance to hyphal invasion of storage fungi suggesting possible involvement of a chemical substance(s) in resistance. Ethanol:water (80:20) extracts from dry whole pea seeds inhibited sporulation, but not linear growth of the bioassay organism *Alternaria alternata*. Extracts were coned in a rotary evaporator, brought to 0.4 M NaCl and partitioned against petroleum ether. The active substance(s) was (were) contained in the petroleum ether phase which was applied to a silicic acid column. Pigments were removed by elution with hexane:ethyl acetate:methanol (60:40:1, v/v) followed by elution of the active substance(s) with butanol:acetic acid:water (25:4:10, v/v). Bioassays indicated the substance(s) was (were) labile in solution at 4 C under N<sub>2</sub> since activity was not detectable after approximately 7 days of storage. The role of this (these) substance(s) in resistance to storage fungi and other pathogens is being investigated. Pisatin was not found in any extracts from challenged or unchallenged dry whole pea seeds.

*Microorganisms associated with bottom rot of lettuce grown on organic soils in New York.* D. J. PIECZARKA, and J. W. LORBEER. (Cornell Univ., Ithaca). *Rhizoctonia solani*, *Fusarium oxysporum*, *Mucor* sp., *Trichoderma* sp., and *Alternaria* sp. frequently were isolated from leaves and heads of lettuce which exhibited bottom rot when grown on organic soil. *R. solani* was consistently isolated, and it was the only fungus of the group found to be pathogenic, when inoculated to detached leaves and heads of lettuce. Soft rot bacteria frequently were present, in addition to *R. solani*, on plants which exhibited extensive maceration and vein-browning of heads under field conditions. Representative isolates were identified as *Erwinia carotovora*, *Pseudomonas marginalis*, and *P. fluorescens*. In pathogenicity tests using detached lettuce leaves, all bacterial isolates required a wound before infection occurred. When excised leaves with lesions formed by *R. solani* were inoculated with soft rot bacteria, the resulting rate of decay was greater than on leaves infected with only *R. solani*. *R. solani* may provide a mode of entry for the bacteria under field conditions. To determine if pectolytic bacteria are resident on the lower healthy and senescing leaves under field conditions, the mineral pectin medium of Hawkin, Zucker, and Sands was used for sampling. Populations of pectolytic bacteria were 10<sup>2</sup>/cm<sup>2</sup> on healthy and 10<sup>3</sup>/cm<sup>2</sup> on senescing leaves under dry conditions. After rainy periods populations reached 10<sup>3</sup>/cm<sup>2</sup> on both healthy and senescing leaves. Up to 50% of the pectolytic bacteria isolated from leaves produced soft rot symptoms within 48 h on wounded detached leaves.

*Absorption of gaseous pollutants by individual leaves: sulfur dioxide.* B. R. ROBERTS. (ARS, USDA, Delaware, Ohio). Foliar uptake of sulfur dioxide (SO<sub>2</sub>) was measured in an open-fumigation system at 1.0 ppm. Container-grown seedlings of white birch (*Betula papyrifera*); red maple (*Acer rubrum*); white ash (*Fraxinus americana*); sweetgum (*Liquidambar styraciflua*); rosebay rhododendron (*Rhododendron maximum*); kurkume azalea (*Rhododendron obtusum japonicum*; "Venus"); privet (*Ligustrum vulgare*); and firethorn (*Pyracantha angustifolia*) were used in this study. Maple, birch, and sweetgum showed appreciably greater vegetative uptake of SO<sub>2</sub> on a unit area or unit weight basis than did comparable species of rhododendron, ash, and azalea. Privet and firethorn showed an intermediate response. Under controlled environmental conditions, depletion of SO<sub>2</sub> by foliage of firethorn remained relatively constant for periods up to 6 h. There was no significant difference in the capacity of foliage from white ash and azalea to remove SO<sub>2</sub> from the air at pollutant concns of 1.0, 0.5, and 0.2 ppm. However, leaves of birch and firethorn showed significantly less SO<sub>2</sub> uptake at 0.2 ppm compared with uptake at the higher concns.

*Tetracycline concentrate treatment for X disease of peach.* D. C. SANDS. (Conn. Agric. Exp. Stn., New Haven). X disease of peach in the eastern United States is caused by a mycoplasma-like organism. Remission of western X disease symptoms after injecting such trees with several liters of dilute tetracyclines has been reported. We find that injecting small amounts of concd (7.5%, w/v) tetracycline-HCl can cause the remission of symptoms of eastern X disease. The tetracycline, stabilized and solubilized with 2% citric acid, is injected into holes 5.5 mm in diam and about 40-mm deep. The holes are then sealed with modeling clay. Five filled holes, or about 10 ml, are used per mature tree. Fall treatments were most effective and although temporary chlorosis appeared on some of the treated trees in the spring, they recovered to a normal appearance. This single treatment can return a tree to production, but is not sufficient to eradicate the disease. Tetracycline was detected by bioassay in the roots, stems, and leaves for a few months after injection, but none was detected in the fruit.

*Variability in pathogenicity and cultural characteristics of geographically diverse isolates of Ceratocystis ulmi.* L. R. SCHREIBER and A. M. TOWNSEND. (ARS, USDA, Delaware, Ohio). Inoculations with 12 isolates of *C. ulmi* from various geographic areas in the United States were made into 10-yr-old *Ulmus americana* and *U. pumila* seedlings. Significant differences in percentage of foliar symptoms occurred among isolates and in the same relative order of magnitude in both species. The most aggressive isolates were recovered with greater frequency than the less aggressive ones from Siberian elms and all were recovered with equal frequency from American elms. Moderately- and highly-aggressive isolates grew more rapidly on potato-dextrose agar (PDA) and malt extract agar (MEA) than less aggressive ones. Pigmentation was unrelated to pathogenicity. Most isolates were intermediate in mycelial habit between aerial and appressed on PDA and a range of mycelial growth types appeared among the least pathogenic ones. Mycelia of all isolates grown on MEA were appressed. Generally, aggressive isolates produced more conidia than nonaggressive ones on wood disks of American and Siberian elms.

*Anaerobic environment enhances the detection of bacteria in tissues associated with wounds in living trees.* E. M. SHARON. (Northeastern Forest Exp. Stn., USDA, Durham, N.H.). The number of wood chips cut from living trees that yielded bacteria increased when chips were incubated anaerobically. A total of 581 chips approximately 2 × 2 × 5 mm were cut from discolored tissues associated with natural wounds on three *Quercus alba*, three *Q. rubra* and three *Acer rubrum* trees, and 324 chips were cut from clear tissues in nine nonwounded control trees of the same species. Sample points were selected randomly, and three chips were removed sequentially from each point. One-third of the total chips were incubated aerobically in a 2% agar medium composed of 10 g malt extract and 2 g yeast extract/liter of distilled water. The remaining chips were incubated under anaerobic conditions; one-half in the 2% agar medium, the other half in anaerobic agar (BBL). All chips were incubated for 5 days at 30 C. Only 8% of the chips from control trees yielded bacteria. From wounded trees the number of chips yielding bacteria was doubled in each medium under the anaerobic environment. Forty-six percent of the positive samples yielded bacteria under both environments. The results suggest that facultative anaerobes are abundant in wound-discolored tissues of living trees, and that greater consideration should be given to the environment in which sample materials are incubated.

*Rooting of geranium meristem-tip cultures reduced by virus infection.* S. H. SMITH, R. K. HORST, and W. A. OGLEVEE. (Pa. State University, University Park, and Cornell University, Ithaca, N.Y.). Heat treatment at 35 C and 38 C for 21 to 27 days increased rooting of geranium meristem-tip cultures derived from 11 of 18 commercial cultivars. To determine if increased



rooting might be associated with removal of virus by heat therapy, seedlings of cultivar 'Nittany Lion Red' were inoculated with tobacco ringspot (TRSV) or tomato ringspot (TomRSV) viruses. The percentage of 2- to 3-mm-long meristem-tips derived from noninoculated and TRSV-infected geranium seedlings which developed roots were 60.0 and 46.3, respectively. Comparable noninoculated and TomRSV-infected meristem-tips which developed roots were 71.0% and 58.0%, respectively. In all cases, roots started appearing earlier with the noninoculated material than with either the TRSV- or the TomRSV-infected material. To assure that the meristem-tip cultures derived from the TRSV and the TomRSV infected geraniums contained virus, the plantlets which developed were indexed by mechanical inoculation to cucumber.

*The effect of cholesterol and a steroid inhibitor on the resistance of pinto bean to ozone.* R. A. SPOTTS, F. L. LUKEZIC, and N. L. LACASSE (Pa. State Univ., University Park). The hypothesis that ozone damages plants by altering membrane permeability has been recognized. Because free sterols are closely associated with membrane permeability, an experiment was designed to determine if alterations in leaf sterol content could be correlated with ozone resistance. Bean plants (*Phaseolus vulgaris* L. 'Pinto 111') treated with 20 µg/ml of tris-(2-diethylaminoethyl)-phosphate trihydrochloride (TDPT), a steroid inhibitor applied as a foliar spray were less resistant to ozone than were untreated plants. TDPT decreased the amount of several free sterols in leaf tissue. Plants treated with an aqueous suspension of cholesterol applied to the root solution (103 mg in 400 ml of complete nutrient solution applied to two plants) were more resistant to ozone than untreated plants. Increased cholesterol and campesterol levels were significantly correlated with decreased leaf damage. This evidence suggests that ozone resistance in bean is related to free sterol content of the leaf tissue.

*Protection of Douglas-fir seedlings against Fusarium root rot by a mycorrhizal fungus.* R. W. STACK and W. A. SINCLAIR. (Cornell Univ., Ithaca, N.Y.). *Fusarium oxysporum* causes root rot, stunting, and death of Douglas-fir (*Pseudotsuga menziesii*) seedlings in forest nurseries. Under experimental conditions, losses were reduced by adding *Laccaria laccata*, an ectomycorrhizal symbiont with Douglas-fir, to soil infested with *F. oxysporum*. When pasteurized soil was infested with mycelium of *L. laccata* as seeds were sown and/or with grain spawn of *F. oxysporum* 3 wk later, dry wt of seedlings 13 wk after sowing were reduced 52% with *F. oxysporum* alone and 15% with *F. oxysporum* + *L. laccata*. When 10-day-old seedlings were planted in pasteurized soil infested by layering grain spawn of *F. oxysporum* or basidiospores of *L. laccata* at 5 and/or 10 cm below the soil surface, *F. oxysporum* alone at either depth caused stunting or death of most seedlings within 3 wk; if *L. laccata* was added at 3 cm and *F. oxysporum* at 6 cm, the proportion of seedlings which remained healthy was equal to that for seedlings in noninfested soil; protection did not occur when *F. oxysporum* was at 3 cm and *L. laccata* at 6 cm depth. Addition of *L. laccata* spores to *F. oxysporum*-infested nursery soil when seeds were sown, reduced seedling mortality during the first growing season from 5.6% to 2.4%. The protective influence of *L. laccata* occurred before mycorrhiza formation.

*Synthesis of DNA by bean rust uredospores.* R. A. STAPLES. (Boyce Thompson Inst., Yonkers, N.Y.). When uredospores of the bean rust fungus (*Uromyces phaseoli*) were induced to form infection structures, adenosine (2,8-<sup>3</sup>H) was incorporated into nuclear deoxyribonucleic acid (DNA) which had a density ( $\rho$ ) of 1.695 g/cm<sup>3</sup>. The studies were carried out using isopycnic gradients of CsCl. Buoyant densities of purified DNA were determined in the analytical ultracentrifuge using DNA from *Micrococcus lysodeikticus* ( $\rho = 1.731$  g/cm<sup>3</sup>) as a standard.

Incorporation of isotope into nuclear DNA of uredospores occurred between 4 and 12 h following initiation of germination when the nuclei divided during formation of appressoria and vesicles. Nuclear DNA was not synthesized if germ tubes were not induced to differentiate. Mitochondrial DNA was obtained from DNase-treated mitochondria purified on sucrose gradients. Both differentiated and nondifferentiated spores synthesized mitochondrial DNA ( $\rho = 1.718$  g/cm<sup>3</sup>) during germination, but this synthesis ceased with appearance of the appressoria.

*Degradation of medicarpin and sativan by Stemphylium botryosum.* P. W. STEINER and R. L. MILLAR (Cornell Univ., Ithaca, N.Y.). *Stemphylium botryosum*, a foliar pathogen of alfalfa, degrades both alfalfa phytoalexins, medicarpin [(+)-3-hydroxy-9-methoxypterocarpan] and sativan [(+)-7-hydroxy-2',4'-dimethoxyisoflavan] in vitro. The first product of medicarpin breakdown was isolated and characterized as vestitol (7,2'-dihydroxy-4'-methoxyisoflavan), a phytoalexin previously associated with birdsfoot trefoil. The identity of vestitol was established in comparisons with authentic vestitol using thin-layer chromatography, ultraviolet absorption spectra, mass spectrometry, and gas liquid chromatography. Vestitol has also been isolated from alfalfa infected with *S. botryosum*, but not from alfalfa inoculated with the corn pathogen, *Helminthosporium turcicum*. Vestitol at high concns, like medicarpin, inhibits mycelial growth of *S. botryosum*; however, at low concns vestitol is further degraded by the pathogen to at least two other phenolic compounds. *S. botryosum* also degrades sativan in vitro, but apparently more slowly than medicarpin and to products that are nonphenolic.

*Two charge isomers endopolygalacturonase from Fusarium oxysporum.* L. L. STRAND, M. E. CORDEN, and D. L. MAC DONALD. (Ore. State Univ., Corvallis). Polygalacturonase produced by *Fusarium oxysporum* f. sp. *lycopersici* was purified by chromatography on DEAE cellulose, CM cellulose, and hydroxylapatite. The purified enzyme consisted of two electrophoretically distinct "isozymes". The two had similar "endo" modes of action on polygalacturonic acid, as determined by comparison of viscosity reduction, reducing-group release, and thin-layer chromatography of oligomeric hydrolysis products. Both isozymes hydrolyzed 5% of the substrate bonds in reaching 50% viscosity reduction. The amino acid compositions of the isozymes were similar and their molecular weights were about 37,000 as determined by sedimentation equilibrium. Electrophoresis in several different concns of polyacrylamide gel indicated the two isozymes are charge isomers.

*Model of a forest root pathogen for classroom use.* M. A. STRAND. (Oregon State University, Corvallis). The computer model presented is intended for use in teaching forest pathology. It demonstrates the relationship between forest management decisions and the spread of a root pathogen. The student is presented with a hypothetical, healthy stand that requires precommercial thinning. The time of cutting and the subsequent stocking level are determined by the student. The stand initially becomes infected by aerial invasion of cut stump surfaces and later by root contact. The model predicts the number of trees infected for each year after thinning.

*Rapid detection of the fungus Monilinia fructicola in plant tissues.* M. SZKOLNIK. (N.Y. State Agric. Exp. Stn., Geneva). A technique was developed for the rapid detection of the brown rot fungus, *Monilinia fructicola*, in flowers, stems, fruit, and mummies of stone fruits. A suitable liquid substrate was poured into a plastic box with lid forming a film on the bottom into which was placed an aluminum mesh screen that was wetted but not submerged by the substrate. Plant tissues were spaced on this screen. A prior dip of the tissues for 5 min in 0.5% sodium

hypochlorite (10% Clorox) without rinsing did not adversely affect recovery of the brown rot fungus from the tissue but did reduce germination of surface spores and markedly restricted aerial mycelial growth of other fungi. *M. fructicola* conidiophores grew luxuriantly at 22 C from tissues on syrup of canned peach diluted 1:3, 10% sucrose, and 10% dextrose. Sucrose supported better growth than did dextrose. Good growth occurred with peach syrup diluted 1:10 and in 1% sucrose. Fair to good growth occurred with 1% dextrose, undiluted syrup of canned sweet cherry, and V8 juice, with only fair growth on distilled water. Often *M. fructicola* conidiophores could be detected within 6 h with best readings at about 24 h. To avoid confounding of data due to conidiophores produced at room temp from germinated brown rot spores on the tissue surface it was necessary to refrigerate samples held for reading beyond 24 h.

*Postinfection fungicidal inhibition of Venturia inaequalis sporulation for apple scab control.* M. SZKOLNIK, L. M. HENECKE, and J. R. NEVILL. (N.Y. State Agric. Exp. Stn., Geneva). Production of apple scab, *Venturia inaequalis*, conidia from leaf lesions was greatly reduced by postinfection spray with fungicides. Potted greenhouse-grown apple trees (cultivar 'Rome Beauty') inoculated with 70,000 conidia/ml and given an infection period of 48 h at 18 C developed 70 scab lesions per leaf with 131,000 spores per lesion (SPL). Benomyl (Benlate), dodine (Cyprex), captan, and piperazin-1,4-diyl-bis-[1-(2,2,2-trichloroethyl)formamide] (Cela-Merck W 524 20EC) applied 5 or 7 days after inoculation allowed 61 lesions per leaf. At orchard spray rates, benomyl at 300 ppm, allowed fewer than 500 SPL with a spray at 5 or 7 days compared with 3,000 and 2,000 SPL, respectively, for dodine at 390 ppm, 2,000 and 1,000 SPL for W 524 at 360 ppm, and 124,000 and 100,000 SPL for captan at 1,200 ppm. At one-eighth the above rates at 5 or 7 days, the respective SPL production was: benomyl at 38 ppm, 15,000 and 6,000, dodine at 49 ppm, 40,000 and 50,000, and W 524 at 45 ppm, 81,000 and 26,000. Spore inhibition aids greatly in containing spread of secondary scab, but is possible only with adequate levels of effective fungicide on infected leaves during the incubation period.

*Growth response of peas when inoculated with single females of two morphological variants of Pratylenchus penetrans.* R. TARTE, and W. F. MAI. (Cornell Univ., Ithaca, N.Y.). Two morphological variants of *Pratylenchus penetrans* females, characterized by having either a smooth or a crenate tail terminus, occurred in a population maintained for several years in alfalfa callus tissue culture. Well-developed females of each tail type were inoculated, one per plant, to Wando pea seedlings. When the pea plants were kept under shade 3,874 lx (360 f.c.) in two separate growth chamber experiments, it was noticed that those inoculated with a crenate-tailed female were smaller in size than those inoculated with a smooth-tailed female. The differences were first noticed 3 wk after inoculation. In many cases, those seedlings inoculated with a smooth-tailed female attained twice the height of their counterpart 6 wk after inoculation. The size of leaves and internode length accounted for the observed differences. In another experiment under shade, noninoculated plants had a greater dry weight than plants inoculated with either type of variant 3 wk after inoculation. The differences were highly significant between the control and the crenate tail treatments. In a similar greenhouse experiment, however, no differences occurred when plants were kept at high light intensities.

*Electrical resistance and impedance of wood in progressive stages of discoloration and decay.* T. A. TATTAR, and G. C. SAUFLEY. (Univ. of N.H., Durham). Electrical resistance and impedance measurements were taken on clear, discolored, and decayed wood of red maple, *Acer rubrum*, and red oak, *Quercus rubra*. Pulsed currents and direct currents were used to measure

electrical resistance, and sine-wave alternating currents were used to measure electrical impedance. Degree of electrical resistance and impedance were both measured in wood above the fiber saturation point that was in progressive stages of deterioration. Clear wood had the highest electrical resistance and impedance. Results with pulsed, direct, and sine-wave alternating currents for clear red maple were 72, 94, and 102 K $\Omega$ , respectively; and 65, 65, and 72 K $\Omega$  for clear red oak heartwood. Discolored wood gave significantly lower results with 29, 36, and 32 K $\Omega$  for red maple and 50, 44, and 48 K $\Omega$  for red oak. Decayed wood gave the lowest results with 11, 16, and 11 K $\Omega$  for red maple and 8, 10, and 10 K $\Omega$  for red oak. Results of pulsed, direct, and sine-wave alternating current measurements were comparable; no significant differences were found between them after standard correction of the means. These results indicate that any of the three types of electrical measurements could be used to detect and quantify progressive stages of deterioration in wood.

*The effect of aqueous extracts of blue spruce leaves on seed germination and seedling growth of several plant species.* A. S. THOMAS, JR. (Merrimack College, N. Andover, Mass.). Aqueous extracts of needles of blue spruce (*Picea pungens*) retarded or prevented seed germination or seedling growth of timothy, oats, wheat, barley, lettuce, and some lawn grasses. Two grams of fresh needles from tips of branches were homogenized in a Sorvall Omni-mixer in 20 ml distilled water at maximum speed for 2 min. The extract, filtered through Whatman No. 1 filter paper, was used to prepare a dilution series in the ratios of 0:4, 1:3, 2:2, 3:1, and 4:0 (extract to water, v/v). Four ml of each of the dilutions was used to moisten filter paper on which seeds were placed in petri dishes and allowed to germinate. Increased concns of extract, decreased shoot and/or root growth and increased evidence of histological pathology such as lack of root hair development, malformed roots, and blackened root tips. The degree of suppression at a given dilution of extract varied with the test species. Barley and timothy were most susceptible to damage. These results suggest that one or more components of blue spruce needles inhibit seed germination and seedling growth of some desirable field and yard plants.

*Ozone injury and senescence of bean leaves inhibited by phenylurea.* H. TOMLINSON, and S. RICH. (Conn. Agric. Exp. Stn., New Haven). Bean plants (*Phaseolus vulgaris* 'Pinto') treated with phenylurea became highly resistant to ozone injury within 24 h and remained resistant for 1 wk. Twelve-day-old seedlings in sand were either treated with soil drenches to give 0, 1, 2, and 4  $\mu$ g phenylurea/g of dry sand, or they were sprayed with water solutions of 0, 60, 125, 250, or 500  $\mu$ g/ml (500 ppm) of phenylurea, each containing 0.2% Tween 85. Control plants were consistently and severely injured by ozone (0.5  $\mu$ liters/liter for 1 h). Plants grown in soil drenched with phenylurea at all concns applied were completely resistant to the ozone treatment. Plants sprayed with 250  $\mu$ g/ml (250 ppm) or less developed slight or moderate ozone injury. Phenylurea was phytotoxic when sprayed at concns exceeding 500  $\mu$ g/ml or as a soil drench exceeding 2 ppm. Like some other compounds known to inhibit ozone injury in plants, phenylurea also delayed dark-induced senescence. Disks of primary bean leaves floated on a solution of 100  $\mu$ g/ml phenylurea in the dark for 7 days contained twice as much chlorophyll as did disks floating on water in the dark for the same period. Furthermore, disks on the phenylurea solution became highly resistant to ozone.

*Nitrogen nutrition as it affects total nitrogen content of Nicotiana glutinosa plants following nitrogen dioxide fumigation.* J. TROIANO, and I. A. LEONE. (Rutgers Univ., New Brunswick, N.J.) *Nicotiana glutinosa* plants were grown in sand culture under three different levels of nitrogen nutrition

(14, 140, and 280  $\mu\text{g N/g}$  of sand). One month after the start of the treatments, one group of plants was fumigated with 0.30  $\mu\text{liters}$  of nitrogen dioxide ( $\text{NO}_2$ ) per liter of air for a period of 52 h. The other group received charcoal-filtered air. The leaves, stems and roots were harvested immediately, 24 h and 1 wk after fumigation. Total nitrogen analysis (Kjeldahl method) of the leaves in the 280- $\mu\text{g N}$  nitrogen treatment indicated a trend toward an increase in total nitrogen content. After 24 h, however, the total nitrogen content returned to normal. No nitrogen dioxide injury was observed on any of the fumigated plants. In a similar experiment in which the  $\text{NO}_2$  concn was 1.0-1.5  $\mu\text{liters/liter}$ , administered for 3 h, the plants exposed to 140  $\mu\text{g N/g}$  sand and the 280  $\mu\text{g N/g}$  sand were severely damaged; whereas, those which received 14  $\mu\text{g N/g}$  sand escaped injury.

*An association of phloem necrosis and stem-pitting symptoms in grapevines infected with tomato ringspot virus.* J. K. UYEMOTO. (N.Y. State Agric. Exp. Stn., Geneva). The French hybrid grape cultivar, 'Cascade', was found to be a sensitive indicator for tomato and tobacco ringspot viruses. Four of five vineyards—[4,046-12,138  $\text{m}^2$  (1-3 acre) in size] which were surveyed in the Finger Lakes region of upstate New York, revealed that an average of 50% of the grapevines were showing small-sized leaves with general chlorosis, ringspot, and oak-leaf patterns. Shoots and canes displayed shortened internodes and abnormal shoot clustering. Tomato ringspot virus was easily recovered from infected leaves and berries by assaying extracts on *Chenopodium quinoa*. Several of the diseased vines were stripped of their bark and the exposed phloem tissue layer showed necrotic pits and a generally spongy texture. The stem portion contained pits and grooves. These latter disease symptoms resemble those described for *Prunus* stem-pitting disease.

*The effectiveness of road dust as a protective agent on buckwheat and pinto bean against sulfur dioxide and ozone.* G. N. VASILOFF, and D. B. DRUMMOND. (Ontario Ministry of Environment, Toronto, Canada). The effectiveness of road dust as a protective agent in reducing sulfur dioxide injury to buckwheat and ozone injury to pinto bean was investigated. Road dust was obtained from a lightly gravelled earthen road and processed so that the resulting dust closely approximated that found on roadside vegetation. Buckwheat was exposed to  $\text{SO}_2$  concns ranging from 25-75  $\mu\text{liters/liter}$  (pphm). The pinto beans were exposed to ozone concns ranging from 25-50  $\mu\text{liters/liter}$ . All exposures were for a 6-h period and the temp and relative humidity were maintained 26 C and 70%, respectively. In both series of exposures, the road dust was applied to only the upper leaf surface at a rate sufficient to cover completely. The  $\text{SO}_2$  exposures resulted in a correlation between severity of injury and dosage on both dusted and undusted buckwheat plants. A significant reduction in symptoms was noted on dusted (as opposed to undusted) plants, particularly at the higher dosages. Ozone exposures revealed a similar significant reduction in symptoms on dusted pinto bean plants when compared to undusted plants.

*Factors influencing symptom expression and recovery of tobacco ringspot virus from geranium.* D. M. WALSH, R. K. HORST, and S. H. SMITH (Cornell University, Ithaca, N.Y.; and Pa. State Univ., University Park). Geranium seedlings (cultivar 'Nittany Lion Red') were inoculated with tobacco ringspot virus ca 4 wk after germination and maintained under constant temp and light conditions with a 14-h photoperiod to find optimum conditions for symptom expression and recovery of the virus. Symptoms were more rapidly and clearly expressed when plants were grown at 27 C than at 24 or 21 C. Symptom expression was more intense at light intensity of 4,304 than at 25,824 lx (400 than at 2,400 ft.-c.). Upper leaves were harvested from geraniums at 4-day intervals to test for recovery of virus by

inoculating *Nicotiana tabacum* 'Samsun NN'. Use of 4% polyethylene glycol (6,000) in 0.33 M phosphate buffer pH 7.0 and shading of the assay plant 24 h before inoculation greatly increased recovery. Virus recovery was best from geraniums grown at 27 C sampled 4-12 days after inoculation with TRSV. Geraniums sampled 16-24 days after inoculation showed more virus recovered from plants maintained at 21 C. This study showed symptoms were best in geraniums maintained at high temp under low light, and that recovery of the virus closely paralleled symptom development.

*Lysis of the cell wall of Armillaria mellea by enzymes from forest trees.* P. M. WARGO (U.S. Dep. Agric., For. Serv., N.E. For. Exp. Stn., Hamden, Conn.). Chitinase and  $\beta$ -1,3-glucanase, enzymes shown to be lytic to *Armillaria mellea* and other fungi, were extracted from healthy tissue of both stem and root of the following trees: sugar maple (*Acer saccharum*), red oak (*Quercus rubra*), black oak (*Q. velutina*), and white oak (*Q. alba*). The enzymes were extracted from both inner bark and outer wood of the stem and root, but yields were higher from the inner bark. Enzyme concns, especially of chitinase, were usually higher in stem tissues. Enzyme activity also varied among and within tree species. Enzyme extracts, concd by ammonium sulfate precipitation, dissolved the cell wall of *A. mellea*. The presence of these enzymes in trees, and their ability to lyse the cell wall of *A. mellea*, suggest a system in trees that may account for the resistance of healthy tissues to invasion by *A. mellea* and possibly other organisms.

*Copper accumulation by trees and soil.* T. C. WEIDENSAUL. (Ohio Agric. Res. and Dev. Center, Wooster). During 1971 and 1972, the accumulation of airborne Cu was studied in soil, Scotch and white pines, and red maple. Plants were potted in uncontaminated soil and placed in the field for 6 or 12 mo at different distances from a source of airborne Cu. Both exchangeable and total Cu contents of soils were determined at 2.54- and 7.62-cm (1- and 3-inch) depths. Only 1.7% of the total Cu was available to plants and more Cu was found at 2.54 cm than at 7.62 cm. Native soil in the study area contained 1,120 ppm exchangeable Cu as compared to 0.5 ppm in uncontaminated Wooster silt loam. The greatest Cu accumulation in trees was in the stems, followed by foliage and roots. Eighty times as much copper was observed in stems of exposed trees (1,100 ppm) as in controls (15 ppm) and 17 times as much in the roots. Scotch pine seems to accumulate more Cu than white pine or red maple. Surviving native vegetation includes red maple, slippery elm, white ash, and poison ivy. Conifers are in a steady state of decline and 3-yr-old seedlings of red, white, and Scotch pines died as soon as growth was initiated in contaminated native soil.

*"Virus-related" cytoplasmic inclusions and morphogenesis in cultured healthy carrot cells.* H. J. WILSON, H. W. ISRAEL, and F. C. STEWARD. (Cornell Univ., Ithaca, N.Y.). A study has been made of cultured explants from secondary phloem parenchyma of *Daucus carota* roots sampled at defined stages between the quiescent source tissue of the storage organ and the derived globular embryos known to produce plants. The fine-structure of the cells along this progressive morphogenetic route has been investigated and related to the causal and controlled conditions by which the transition stages in question were achieved. A range of distinctive cytoplasmic inclusions that occur in cells at these specified stages has been described. Although some of these inclusions resemble those attributable to the presence of certain viruses, they are not virus particles per se, and their occurrence and form is an obvious function of the cultural conditions. The morphogenetic propensity of the cells that give rise directly to embryos is associated with cytoplasm that is rich in microtubules but, like the initial quiescent cells of the root, is notably free of the identified inclusions that are otherwise so conspicuous.



*Reaction of orchardgrass cultivars to purple leaf spot caused by Stagonospora arenaria.* K. E. ZEIDERS, R. T. SHERWOOD, and C. C. BERG. (ARS, U.S. Dep. Agric., U.S. Reg. Past. Res. Lab., University Park, Pa.). Twenty-eight cultivars of orchardgrass (*Dactylis glomerata*) were screened for their reaction to a single isolate of *Stagonospora arenaria* in two inoculation tests. None of the cultivars exhibited a high level of resistance to purple leafspot. On a scale of 1=(no disease) to 8=(very severely diseased), the overall disease means of cultivars ranged from 3.97 to 5.90. Differences among cultivars were highly significant for both inoculations. The inoculation ×

cultivar interaction was not significant. No plants were disease-free, but there was considerable variation among cultivars in percentage of apparently resistant plants with low disease ratings of 2 or 3 in both tests. Plants selected for low ratings were compared with randomly selected plants within each cultivar in a third inoculation. Within each cultivar, the mean rating of the selected group was lower than the random group, thus confirming the resistance of the selected plants. The best plants are being intercrossed in an attempt to develop lines of orchardgrass with resistance to purple leaf spot.

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