

Abstracts of the 1969 Annual Meeting of the Northeastern Division of The American Phytopathological Society

The response of several mutants of Fusarium to benomyl and related fungicides. J. BARTELS & B. H. MACNELL. (Univ. Guelph, Ontario, Canada). The inhibition end point of each of the benzimidazole compounds, benomyl, thiabendazole, and Bay 33172 [2-(2-furyl)-benzimidazole] for a wild type isolate of *Fusarium oxysporum* f. *melonis* fell between 5 μM and 80 μM in potato-sucrose agar. Ultraviolet-induced mutants of *Fusarium* were independently selected to tolerate benomyl, thiabendazole, and Bay 33172 at 10, 30, and 80 μM , respectively. In tests employing a range of concentrations of the three compounds, the mutants showed similar dosage responses. The behavior of each mutant was independent of the benzimidazole compound originally used in its selection. These data suggest that the mechanism of fungicidal action of benomyl and thiabendazole are similar, but that this mechanism is only partially shared by the Bay compound.

Sources of resistance in Allium spp. to Botryotinia squamosa. R. R. BERGQUIST & J. W. LORBEER (Cornell Univ., Ithaca, N.Y.). A collection of *Allium* species consisting of 67 cultivars of *A. cepa*, nine F_1 interspecific hybrids of *A. cepa* \times *A. fistulosum*, and 76 combinations of advanced generation backcrosses of interspecific hybrids with *A. cepa* were tested for resistance to *Botryotinia squamosa*. Tests were conducted in the field utilizing both natural and artificial inoculum and in the greenhouse with artificial inoculum. *Allium boudhae* and *A. schoenoprasum* were immune, *A. fistulosum* was highly resistant, and *A. pskemense* and *A. galanthum* were moderately resistant. *Allium cepa* and *A. vavilovii* were susceptible. The reactions of F_1 interspecific hybrids from *A. cepa* \times *A. fistulosum* and from *A. cepa* \times *A. pskemense* or *A. galanthum* indicated that immunity and resistance are due to dominant factors. A higher degree of resistance was transferred to interspecific hybrids from *A. fistulosum* than to interspecific hybrids from *A. pskemense* or *A. galanthum*. Immune and resistant advanced backcrosses of *A. cepa* \times *A. fistulosum*, however, did not produce bulbs. Several moderately resistant plants of advanced backcrosses of *A. galanthum* or *A. pskemense* to *A. cepa* produced desirable bulbs. These advanced progenies of interspecific hybrids had moderate resistance under field conditions, but were susceptible in greenhouse tests.

Ultraviolet light stimulation of sporulation of Botryotinia (Botrytis) squamosa. R. R. BERGQUIST, J. W. LORBEER, & R. K. HORST (Cornell Univ., Ithaca, N.Y.). *Botryotinia (Botrytis) squamosa*, the causal agent of *Botrytis* leaf blight of onion, does not sporulate readily in culture. It does sporulate on dead or dying onion leaf apices in the field during mid-summer in New York. Abundant sporulation in pyrex glass petri dish culture at 20-23 C on a defined medium occurred in 5-7 days when *B. squamosa* was exposed simultaneously to near-ultraviolet (340-380 m μ) and fluorescent irradiation (425-675 m μ) at a distance of 45 cm for a photoperiod of 14 hr. The medium was adjusted to pH 4.7, and contained 250 mg NH_4Cl , 500 mg KH_2PO_4 , 500 mg $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, 1.45 mg $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$, 0.88 mg $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$, 0.41 mg $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$, 0.004 mg H_3BO_3 , 0.004 mg H_3MoO_3 , 0.004 mg CuSO_4 , 1 mg thiamine, 0.5 mg biotin, 20 g soluble starch, and 20 g agar in 1 liter of water. Sporulation did not occur in complete darkness, or when only fluorescent or fluorescent-incandescent irradiation was applied. Neither the morphology nor the pathogenicity of the fungus was altered by conditions which favored sporulation.

Protective action of benomyl against Dutch elm disease. W. L. BEHN & A. E. DIMOND (Conn. Agr. Exp. Sta., New Haven). Benomyl [50% methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate] reduced foliar symptoms of Dutch elm

disease an average of 89% on trees treated prior to inoculation. The protection lasted for at least 10 weeks. On 10 June 1969, benomyl was injected into soil in the feeding root zone (20 ft²/tree) at the rate of 4.5 gal of suspension/tree 10 to 15 ft tall. The suspension contained 21 g/gal benomyl plus 2.8 ml/gal of Surfactant F. Two branches of each tree were inoculated with *Ceratocystis ulmi* on 17 June 1969 and again on 8 July 1969. Trees treated with benomyl averaged 4%, and inoculated controls averaged 38% foliar symptoms. Of 12 trees treated with benomyl, only 2 showed more than a trace of foliar symptoms, whereas 10 of 12 inoculated control trees had foliar symptoms greater than 12%. Bioassays involving zones of inhibition of *Penicillium expansum* on agar plates revealed the presence of a fungitoxicant in small twigs from benomyl-treated trees. Similar bioassays of elm shoots could aid in determining if an adequate protective dosage is present in trees treated with benomyl to prevent Dutch elm disease.

Maize dwarf mosaic, a problem in late-planted corn in New York. C. W. BOOTHROYD & A. O. LARSEN (Cornell Univ., Ithaca, N.Y.). Maize dwarf mosaic (MDM) was found in 16 of 35 counties surveyed over the past three seasons. The disease caused little or no apparent loss in quality or yield in 1967 and 1968, but was widespread and damaging to sweet corn in the Hudson Valley in 1969. The virus was transmitted mechanically and by the corn leaf aphid (*Rhopalosiphum maidis*) to corn from corn, and to corn from three annual grasses, foxtail (*Setaria viridis*), crabgrass (*Digitaria sanguinalis*), and smooth witchgrass (*Panicum dichotomiflorum*). Two strains of the virus, MDMV-A and MDMV-B, were detected; the latter was more prevalent. These strains were serologically similar to the strains found in Ohio. Mechanical inoculation of 250 inbred and hybrid seedlings with both strains of the virus, and observations of symptoms under controlled environmental conditions, revealed little resistance to the disease. Exposure of late-planted field and sweet corn to infection in a Hudson Valley field resulted in almost 100% mosaic in all lines tested. Quality and yield reduction were observed in both types of corn, but the damage to sweet corn was substantially greater than to field corn.

Evidence that Pennsylvania tobacco mosaic virus induced internal browning and Florida graywall are the same. J. S. BOYLE (Pa. State Univ., University Park). Hall and Stahl recently presented evidence that graywall (GW) is incited by bacteria. In 1968, 17 fruit with symptoms of GW were obtained from Florida, seven which Hall had injected or infused with bacteria, and 10 selected at a tomato packing shed near Homestead. All showed symptoms considered typical of GW and which, except for three injected fruit, were typical of internal browning (IB). When assayed for bacteria and TMV, all yielded TMV. Bacteria were recovered from 10; the four injected, one infused, and five from the packing shed. To learn more about the association of bacteria with internally browned fruit, isolations were made from 200 blotchy or IB fruit from TMV-inoculated plants and 20 normal-appearing fruit from TMV-free plants. Bacteria were isolated from 95% of the affected fruit and 60% of the normal. TMV was recovered from all affected fruit. Bacteria isolated from Florida and Pennsylvania have been injected into both greenhouse and field-grown tomatoes with varying results. In some cases, striking discoloration at the site of injection occurred and the flesh remained firm. It appears that IB or GW occurs as a result of TMV infection, but that much of the dark discoloration associated with the syndrome results from bacterial invasion of the affected necrotic tissue.

Infection of sour cherry and peach with Cytospora spp. J. S. BOYLE (Pa. State Univ., University Park). A series of experiments were made in the greenhouse to study patho-

genesis in 1-year-old nursery grown peach and sour cherry trees inoculated with several isolates of *Cytospora*. Trees inoculated with necrotic ringspot virus (NRSV) at bud break and then inoculated with *Cytospora* were no more susceptible than virus-free trees. Differences in pathogenesis and tree death were noted between sour cherry and peach inoculated with the same and different *Cytospora* isolates. When dormant trees, planted in 6-inch clay pots, were inoculated by placing mycelium under a bark flap on the main stem and kept at 65 and 75 F for 12 hr dark and light, respectively, colonization with pycnidial formation but without gummosis occurred within 10-14 days. Tissue distal to the point of inoculation died. Dormant trees handled similarly but placed at a near constant temperature of 50 F, 12 hr light and 12 hr dark, were more slowly colonized with gummosis, canker, and pycnidial formation occurring over a period of many weeks. Trees moved from the lower to higher temperatures were rapidly colonized by the fungus and killed. These experiments suggest that trees in a newly planted orchard may be extremely susceptible to *Cytospora* attack, and that effective control measures at this time might reduce tree mortality.

Purification of the Penicillium stoloniferum virus. R. F. BOZARTH, A. MANDELBRÖT, & A. GOENAGA (Boyce Thompson Inst., Yonkers, N.Y.). The *Penicillium stoloniferum* virus was extracted from cultures of *Penicillium stoloniferum* strain ATCC 14586 using combinations of chloroform and butanol, pH values from 5.0 to 8.0, and ionic strengths of phosphate buffer from 0.03 to 0.2 M. Analysis of the extracts on sucrose density gradients indicated that a similar multi-component nucleoprotein peak that sedimented at about 100 S was obtained regardless of the method of extraction. Best yields occurred when mycelium was blended with chloroform and .03 M phosphate buffer pH 7.6 followed by clarification at 7,000 g, two cycles of differential centrifugation, and sucrose density-gradient centrifugation. Negatively stained preparations from the sucrose density gradient contained spherical particles about 34 m μ in diam that were not penetrated by the sodium phosphotungstate and spherical particles about 29 m μ in diam that were penetrated by sodium phosphotungstate.

Effective control of four diseases of grapes using an over-the-trellis spray boom. A. J. BRAUN (N. Y. State Agr. Exp. Sta., Geneva, N.Y.). Excellent control of black rot, downy mildew, powdery mildew, and the cane and leaf spot phase of the dead-arm disease was obtained with various fungicides applied with an over-the-trellis spray boom that directed the spray to the top side of the leaves. With this boom, low-pressure (100 psi) applications of concentrate sprays at 50 gal/acre were as effective as high pressure applications of dilute sprays at proportionately higher gallonage. Spray deposit studies, using the fluorescent pigment Fire Orange A 14, indicated uniform, thorough coverage of the top sides of most leaves, but only minimal and sporadic coverage of the fruit and the undersides of the leaves. The results obtained contradict the generally accepted belief that thorough coverage of the fruit and of the undersides of leaves is essential for effective disease control in grapes. The over-the-trellis technique of application makes possible low gallonage application of fungicides with less expensive, low pressure sprayers, and obviates the necessity of using air-blast equipment. Although the boom used in these studies sprayed a single row, it could be extended and modified to spray four rows with each pass through the vineyard, thereby reducing the actual spraying time by as much as 75%.

Physical and biological activity of minimal dosages of methyl bromide in soil. B. B. BRODIE & W. A. HELBIG (ARS, USDA, Univ. Ga., Coastal Plain Exp. Sta., Tifton & Atlas Chem. Inc., Wilmington, Del.). A methyl bromide-activated carbon composition was applied (20 and 40 lb. of toxicant/acre) 15 cm deep in Tifton sandy loam contained in a plywood box (228 × 60 × 76 cm). The soil was naturally

infested with *Belonolaimus longicaudatus*, *Pratylenchus brachyurus*, and *Trichodorus christiei*. Soil samples, taken according to a predetermined time and space pattern, were assayed for methyl bromide content and nematodes. Diffusion of methyl bromide was predominantly downward. Methyl bromide was uniformly distributed within the soil mass after 48 hr, and tended to accumulate at the bottom after 72 hr. Methyl bromide sorbed by the soil particles was 10 to 20 times that amount in the soil voids. After 72 hr, methyl bromide in the soil voids had dissipated, whereas that which was sorbed by soil particles remained stable. Diffusion and sorption of methyl bromide was erratic at the lower dosage level, which resulted in lower nematocidal activity. Nematode kill was detected 48 hr after application and reached optimum after 72 hr. We conclude that the minimal dosage of methyl bromide for adequate nematode control is between 20 and 40 lb. of toxicant/acre. This conclusion was supported by pot tests in which 100% root knot (*Meloidogyne incognita acrita*) control was obtained with a 40 lb./acre dosage.

Interaction of seed piece treatments and soil treatments of aldicarb and benomyl in the control of Verticillium-nematode complex of potatoes. R. C. CETAS (Cornell Univ., Long Island Veg. Res. Farm, Riverhead, N.Y.). Field trials (split plot design) were conducted in soils naturally infested with *Pratylenchus penetrans* and *Verticillium dahliae*. Whole plots were planted with nontreated- and captan- (7.5%) and Semesan Bel WS [2-chloro-4-(hydroxymercuri)phenol + 2-chloro-4-(hydroxymercuri)nitrophenol]-treated seed pieces of the Kennebec cultivar in 1968. In 1969, the Superior cultivar was used, and 15% Difolatan [*N*-(1,1,2,2-tetrachloroethyl)sufenyl-*cis*-4-cyclohexene-1,2-dicarboximide] was substituted for captan. Sidedress applications of aldicarb (Temik, 3 lb./acre) were made to 1-row subplots at planting. One-row subplots were sidedressed with benomyl (15 lb./acre) at planting in 1968, and were given preplanting band applications of benomyl (30 lb./acre) in 1969. Aldicarb, but not benomyl or the seed piece treatments, reduced the population of *P. penetrans* in the soil and in the roots of the potato plants. Seed-piece treatments alone increased yields 18 to 25 and 9 to 10 cwt/acre in 1968 and 1969, respectively. The use of aldicarb or benomyl alone increased yields 21 to 23 cwt/acre, respectively, in 1968 and 40 and 54 cwt/acre, respectively, in 1969. The effects of the seed piece treatments and soil treatments on yield were additive, except in plots planted with captan-treated seed pieces in 1968.

Pectolytic and cellulolytic enzyme production by Sclerotium bataticola in vitro and in vivo. Y. CHAN & W. E. SACKSTON (Macdonald College of McGill Univ., Ste-Anne-de-Bellevue, Quebec, Canada). *Sclerotium bataticola* produced pectin methyl esterase (PME) in liquid medium and on sterilized sunflower stem cultures. PME activity was higher in dialyzed extracts of inoculated than noninoculated sunflower plants. It was enhanced by sodium chloride. Content of saponifiable methanol was reduced greatly in inoculated plants. Both endo- and exo-polygalacturonase activity were present in culture filtrates and in extracts of inoculated plants. Pectin *trans*-eliminase activity was present in extracts of inoculated plants, but questionable in culture filtrates. Polygalacturonate *trans*-eliminase (PGTE) activity was present in culture filtrates and in extracts of inoculated plants. Its optimum pH was about 8.5. It was not calcium-dependent. Cellulase and cellobiase activity were present both in culture filtrates and in extracts of inoculated plants. The cellulase broke down sodium carboxymethyl cellulose (sodium CMC), but not insoluble CMC. Activity of these enzymes (except PME) was not detected in extracts of noninoculated plants. Activity of all the enzymes except PGTE was detected in plants very soon after inoculation, indicating their probable involvement in pathogenesis.

Polygalacturonase production in vitro and in vivo by isolates of Sclerotium bataticola virulent and avirulent on

sunflowers. Y. CHAN & W. E. SACKSTON (Macdonald College of McGill Univ., Ste-Anne-de-Bellevue, Quebec, Canada). Dialyzed culture filtrates of four virulent isolates of *Sclerotium bataticola* and two isolates avirulent on sunflowers showed endopolygalacturonase (endo-PG) and exopolygalacturonase (exo-PG) activity. Activity was highest in filtrates from virulent isolates. Endo-PG activity was detected in dialyzed extracts from plants 12 hr after toothpick inoculation (TPI) with three of four virulent isolates (four of four after 29 hr), and 19 hr after unwounded stem base inoculation (USBI) with four virulent isolates. Exo-PG activity in extracts was detected 12 hr after TPI with two of four virulent isolates (three of four after 29 hr), and 42 hr after USBI with four virulent isolates. No PG activity was detected in extracts from plants inoculated with two avirulent isolates or in extracts from noninoculated plants, indicating that PG activity was associated with pathogenesis. Avirulent isolates survived in symptomless plants, and were recovered 30 days after inoculation. The apparent absence of PG in plants inoculated with avirulent isolates may mean either that PG was not produced or that it was inactivated by the host.

Isolation, maintenance, and infectivity studies of a plant-pathogenic mycoplasma, the causal agent of corn stunt diseases. T. A. CHEN & R. R. GRANADOS (Rutgers Univ., New Brunswick, N. J., Boyce Thompson Inst., Yonkers, N. Y.). The etiologic agent of corn stunt, a yellows type plant disease known to be transmitted by leafhoppers, was isolated from infected stem tissue of corn. Small pieces of atactosteles were transferred into culture medium consisting of amino acids, vitamins, organic acids, purines, pyrimidines, coenzymes, steroids, ATP, sugars, inorganic salts, and undefined supplemental nutrients. The plant pieces were removed later from the culture tubes that had been maintained at 25 C. Periodically, cultures were harvested by centrifugation, and the pellet was suspended in 0.2 ml of fresh medium and used as inoculum for injecting adult leafhopper vectors (*Dalbulus elimatus*). Samples from the inoculum were also examined by electron microscopy. Infectivity was obtained from cultures and subcultures 5, 8, 14, and 50 days old. All infective cultures contained pleomorphic mycoplasmal organisms (PPLO) that possessed an irregular shape with several filaments emerging from the surface. Since an extract from diseased plants kept in buffer solution at room temp becomes noninfective after 4 hr, this partially defined medium successfully maintained and probably supported growth of a plant-pathogenic mycoplasma. This study satisfied Koch's postulates, and thus proved mycoplasma etiology in corn stunt disease.

Control of stripe smut in Merion Kentucky bluegrass turf areas with a single application of benomyl. H. COLE, L. B. MASSIE, & J. M. DUICH (Pa. State Univ., University Park). The systemic fungicide benomyl was employed in a series of four stripe smut control experiments on Merion Kentucky bluegrass fairways of two southeastern Pennsylvania golf courses during 1968 and 1969. Benomyl was applied as a 50% WP formulation in 1.5 gal of water/1,000 ft² of turf with a wheel-mounted CO₂ powered boom sprayer. Dosages ranged from 3 to 24 oz of the 50% formulation/1,000 ft². The 1968 treatments provided a range of application dates and intervals from 22 April through 7 October. Single as well as multiple applications were included. The 1968 treatments were irrigated with 0.5 inch of water after spraying. The 1969 treatments applied on 24 March consisted of two experiments, one irrigated and one not irrigated after a single spray application. Dosages ranged from 3 to 24 oz of the wettable powder formulation. Any treatment sequence in any experiment which included 6 oz or more of benomyl 50% WP applied in either October or during the March dormant season resulted in almost complete suppression of spring and summer smut symptom development. However, benomyl treatments applied during the spring and summer periods of active grass growth did not result in satisfactory control.

Establishment of Fusarium oxysporum in small grain seeds. W. F. CROSIER, S. W. BRAVERMAN, & D. C. CROSIER (N. Y. State Agr. Exp. Sta., Geneva; USDA, Geneva, N.Y.; N. Y. State Agr. Exp. Sta., Geneva). *Fusarium oxysporum* was isolated from seeds of apple, barley, sorghum, woolly marigold, and wheat and its formae speciales, *conglutinans*, *lycopersici*, *perniciosum*, and *pisi*, from their host plants, and cultured on PDA. The cultures were blended with starch and talc and pressed into florets of 19 grain cultivars. The inoculated plants were incubated at 20-27 C under mist for 2 days and matured in dry air. Ripened seeds were surface-sterilized in sodium hypochlorite and plated directly on PDA. Each isolate was recovered from seeds of barley, oat, rye, sorghum, and wheat. Percentage recoveries of *F. oxysporum* f. sp. *conglutinans* varied from 16 to 76 for barley and 40 to 68 for wheat, and of *F. oxysporum* f. sp. *pisi* from 2 to 43 for barley, 2 to 40 for oat, 22 to 30 for rye, 2 to 18 for sorghum, and 4 to 72 for wheat seed lots. None of 13 fungi, when individually mixed with *F. oxysporum*, prevented the latter from establishment in grains. *F. oxysporum* f. sp. *perniciosum* and *Rhizoctonia solani* were co-inoculated into florets, and both became established in 1, 3, and 5% of barley, sorghum, and wheat seeds, respectively, while the former alone grew from 64, 11, and 57% and the latter alone from 1, 1, and 7% of these seeds. *Fusarium oxysporum* remained alive in grain seeds for 6 years.

The influence of age on the susceptibility of Virginia pine to ozone. D. D. DAVIS (Pa. State Univ., University Park). The susceptibility of Virginia pine cotyledons, juvenile needles, and secondary needles to O₃ was determined by exposing seedlings at various stages of growth to 25 pphm O₃ for 1 to 8 hr. Temperature during exposure was maintained at 24 C, RH at 75%, and light intensity at approximately 1,400 ft-c. Plants used in the exposure studies were either grown from seed or obtained from a nursery. Plants in all three stages of growth showed maximum susceptibility after 4 to 5 weeks of growth. Beyond this point, the resistance of the cotyledons increased until 12 weeks, when they were not injured. Injury was most severe on the basal portion of the cotyledon. Juvenile and secondary needles became resistant at about 16 weeks of age. Older juvenile needles were more susceptible than younger juvenile needles on the same plant. Only the tips of the youngest juvenile needles were severely injured; most injury occurred near the bases of the oldest juvenile needles. During the latter part of the growing season, secondary needles on lammas shoots of 2-year-old plants were much more susceptible than were the current needles on the original shoot.

Viability of the aster yellows agent in cell-free media. R. E. DAVIS, R. F. WHITCOMB & R. PURCELL (USDA, Crops and Entomol. Res. Div., Beltsville, Md., NIH Public Health Serv., Bethesda, Md.). As a first step in an attempt to cultivate the aster yellows (AY) agent in vitro, an effort was made to develop a cell-free medium favorable for survival of the agent. Longevity of the agent, suspected to be a mycoplasma, was determined by bioassay of aliquots of media at intervals after seeding with filtered (650 mμ) extracts from AY-infected insects or plants. In a simple buffer (0.3 M glycine, 0.03 M MgCl₂, pH 8.0), infectivity decreased rapidly at 22 C, and was completely lost in less than 3 hr. In a medium containing amino acids, vitamins, inorganic salts, sucrose, and cholesterol, AY infectivity could be detected after 6-hr, but not after 12-hr incubation at 22 C under ordinary atmosphere. Addition of horse serum (5%) improved survival of the agent to 24 hr. Incubation under N₂ or CO₂-N₂ extended AY agent survival to 48 hr. In the absence of horse serum (20% sucrose present) or sucrose (5% horse serum present), AY infectivity could be detected, respectively, after 4 but not after 12 hr, and after 12 but not 24 hr at 22 C under N₂. AY agent was viable after storage under liquid N₂ for 2 days in Grace's medium supplemented with sucrose and

horse serum. The results indicate feasibility of storage of viable AY agent, and suggest a possible basal medium that might be enriched for eventual cultivation of the agent.

The sensitivity of twenty-nine northeastern tree species to PAN. D. B. DRUMMOND & F. A. WOOD (Pa. State Univ., University Park). Twenty-nine tree species that occur in northeastern USA were fumigated with peroxyacetyl nitrate (PAN) to determine their susceptibility to this pollutant. The species tested were *Abies balsamea*, *A. concolor*, *Acer platanoides*, *A. saccharum*, *Betula pendula*, *Cornus racemosa*, *Fraxinus americana*, *F. pennsylvanica*, *Larix decidua*, *L. leptolepis*, *Liquidambar styraciflua*, *Picea abies*, *P. glauca*, *P. glauca* var. *densata*, *P. pungens*, *Pinus nigra*, *P. resinosa*, *P. rigida*, *P. strobus*, *P. sylvestris*, *P. virginiana*, *Pseudotsuga menziesii*, *Quercus alba*, *Q. palustris*, *Q. robur*, *Q. rubra*, *Thuja occidentalis*, *Tilia cordata*, and *Tsuga canadensis*. Each species was fumigated five times throughout the growing season at 24 C, 70% RH, and 2,500 ft-c of light. PAN was generated in a photoreactor, purified, and metered into the fumigation chamber at a rate necessary to maintain the concentration between 10 and 20 ppm for 8 hr. The concentration was checked periodically with a Panalyzer. None of the species tested developed symptoms. The concentrations used are well above those usually found in ambient air.

Similarity of fungitoxic spectrum of benzimidazole fungicides. L. V. EDGINGTON & K. L. KHEW (Univ. Guelph, Guelph, Ontario, Canada). Benomyl was found to be extremely toxic to a wide spectrum of fungi, inhibiting mycelial growth by 50% with less than 1 ppm of benomyl in agar. Benomyl was quite nontoxic to certain taxonomic groups, however, requiring over 100 ppm to inhibit growth by 50%. Amongst the Deuteromycetes, the sensitive groups were Phialosporae, Arthrospora, Symptodulosporeae, and Aleurospora, while only some genera of the Blastosporae were sensitive and all Porosporae were insensitive. Within the Blastosporae, only those genera having perfect stages in the Sclerotiniaceae of the Euscomycetes were sensitive to benomyl, while the yeast, *Candida*, with a perfect stage in the Hemiascomycetes, was resistant. Within the Porosporae, benomyl was nontoxic to such important pathogens as *Alternaria*, *Dreschlera*, *Bipolaris*, *Stemphylium*, and *Curvularia*. A comparison of benomyl with thiabendazole and Bay 33172 [2-(2-furyl)-benzimidazole] revealed an identical pattern of selective fungitoxicity. Consequently, the selective toxicity of all three compounds depends on the benzimidazole moiety.

Virus particle numbers in relation to aphid transmissibility and mechanical infectivity of bean yellow mosaic virus isolates. I. R. EVANS & F. W. ZETTLER (Univ. Fla., Gainesville). A comparison was made between pea leaves (*Pisum sativum* 'Alaska'), each with four leaflets, infected with either a Wisconsin isolate (WV) or Florida isolate (FV) of bean yellow mosaic virus. Aphid transmissibility was determined by allowing five aphids (*Aphis craccivora*) 3-min access periods to each leaflet before transfer to healthy bean (*Phaseolus vulgaris* 'Red Kidney'). Virus particle numbers were assayed by excising and quartering 3-mm discs from each pea leaflet, placing this tissue in 3 drops of 1% phosphotungstic acid (PTA), and transferring the PTA suspension to a 400-mesh grid for electron microscope examination. All particles present in 36 grid squares in comparable pre-selected zones on each grid were counted. The remainder of each leaf was triturated in 2 ml of water and mechanically inoculated onto 10 leaves of a local lesion host, *Chenopodium amaranticolor*. This procedure was repeated eight times for each isolate. Particle counts from leaf dip extracts of the nonaphid-transmissible WV averaged four times that of readily aphid-transmissible FV-infected tissue ($P < .001$). This related positively to a 4:1 ratio in the number of local lesions induced on *C. amaranticolor* by the WV and FV isolates, respectively ($P < .01$).

Factors influencing ingress of Xanthomonas pruni through peach leaf scars, tissues invaded, and subsequent development of spring cankers. A. FELICIANO & R. H. DAINES (Rutgers Univ., New Brunswick, N.J.). To study the ingress of *Xanthomonas pruni*, leaf scars were obtained by the forcible removal of the entire leaf or by delaminating the petioles 7 days prior to inoculation. Inoculations were made bi-monthly from 15 July to 1 November. The scars were located either at the tip of the twig or one-third the way down. Summer cankers were produced from inoculations performed on 15 July to 1 October, whereas spring cankers resulted from inoculations made on 17 September to 1 November. Ingress through leaf scars decreased as the time interval between removal of leaves and inoculation increased. Location of the scar on the twigs also affected the occurrence of spring cankers, as inoculated scars at the tip of twigs developed many more cankers than those one-third the way down. Histopathological investigations disclosed that *X. pruni* can enter through xylem vessels and intercellular spaces of the leaf trace. Entrance through xylem vessels, however, appeared to be of no pathological importance since the bacteria, once inside, could not move out to infect neighboring cells. Bacteria surviving the winter in the intercellular spaces of the cortical, phloem, and xylem parenchyma initiated cankers the following spring.

Tobacco ringspot virus infection of grapevine. R. M. GILMER & J. K. UYEMOTO (N. Y. Agr. Exp. Sta., Geneva). A new disease of European grape (*Vitis vinifera*) was discovered at Geneva in 1968 and at two other locations in New York in 1969. Infected vines were stunted and had chlorotic rings or watermarks on the foliage. Leaves later became mottled and malformed, with irregular serrations and broad petiolar sinuses. Infected vines were severely injured by cold winter temp. The disease spread rapidly in European grape cultivars at Geneva: 41/228 vines were infected in 1968 and an additional 11 vines in 1969. No infections occurred in any of 336 *V. labrusca* vines in the vineyard. The causal virus was easily transmitted to herbaceous indicators from leaves or roots of infected vines. It was identified by serology, electron microscopy, and host range as tobacco ringspot virus (TRSV) not previously reported from grape. Single-lesion TRSV isolates from grape were transmitted to young grape seedlings. Many infected seedlings died; survivors were extremely stunted with malformed leaves, partially duplicating the original syndrome. TRSV was recovered from vineyard soil by baiting with cucumber or snapdragon seedlings, a fact suggesting soil transmission of the virus. The nematode *Xiphinema americanum*, a vector of TRSV, was abundant in vineyard soil.

Unusual after-infection control of apple scab with a (2,4-dichlorophenyl) α phenyl-5-pyrimidinemethanol. J. D. GILPATRICK & M. SZKOLNIK (N. Y. State Agr. Exp. Sta., Geneva). In an orchard spray test, a new experimental fungicide, a (2,4-dichlorophenyl) α phenyl-5-pyrimidinemethanol (Eli Lilly, EL-273) prevented apple scab (*Venturia inaequalis*) in cluster leaves of mature orchard trees when applied dilute at 40 or 80 ppm 8 days after the start of an infection period. Dodine at 290 ppm and the mixture of captan and phenylmercuric acetate (PMA) at 600 and 30 ppm did not control this cluster leaf scab. In a continuation of this program with sprays applied weekly (some after infection), EL-273 at 40 and 80 ppm also gave excellent control of scab on terminal leaves and fruit through the season. Control of powdery mildew (*Podosphaera leucotricha*) was also excellent. In greenhouse tests on potted apple trees, one spray with 50 ppm of EL-273 applied 24 to 72 hr after inoculation with conidia controlled scab; however, chlorotic nonsporulating leaf lesions developed with a spray applied 5 to 9 days after inoculation in sharp contrast to normal sporulating lesions on unsprayed trees. PMA at 23 ppm prevented scab when applied 24 to 48 hr after inoculation, but with a spray at 72 hr, normal sporulating lesions developed. An application of EL-273 24 hr before

inoculation gave partial control of scab, but allowed the development of normal sporulating lesions.

Effect of hydrogen chloride gas on photosynthesis pigments in tomato plants. T. J. GODISH & N. L. LACASSE (Pa. State Univ., University Park). Preliminary investigations showed that tomato plants exposed to hydrogen chloride (HCl) gas at 70 ppm for 10 hr/day for 2 days developed a general interveinal chlorosis. The cause of chlorosis was unknown. It is generally recognized that chlorophyll may be converted to pheophytin at low acid levels. Therefore, this investigation was conducted to determine if chlorosis was due to HCl-induced conversion of chlorophyll to pheophytin. Pigment concentrations were determined by a spectrophotometric method. Total chlorophyll and pheophytin, chlorophyll a, chlorophyll b, pheophytin a, and pheophytin b were significantly reduced in exposed plants. Ratios of chlorophyll to pheophytin in fumigated plants, however, did not differ from those of controls. These results indicated that the effect of HCl gas on chlorophyll was not a direct acid-induced conversion to pheophytin.

Effects of chronic levels of hydrogen chloride gas on respiration, photosynthesis, and transpiration of tomato. T. J. GODISH & N. L. LACASSE (Pa. State Univ., University Park). Tomato plants were subjected to hydrogen chloride gas at 70 ppm for 10 hr/day for 2 days or 40 ppm for 8 hr/day for 6 days. Respiration and photosynthesis were measured manometrically. Transpiration was measured indirectly by wt loss of plants enclosed in transpirometers. At 70 ppm, respiration was significantly stimulated (15% over controls) during fumigation; this stimulation was still evident 48 hr following fumigation. No symptoms were visible after fumigation at 40 ppm for 8 hr/day for 6 days, but respiration was significantly reduced (18-20% of the controls) during fumigation and 24 hr following fumigation. True photosynthesis was significantly inhibited (16% of controls on a leaf area basis) during fumigation and prior to symptom expression; based on total chlorophyll there was no change. Inhibition of photosynthesis, based on leaf area, was not evident 24 hr after fumigation; however, based on total chlorophyll, photosynthesis was 25% higher than the controls. Inhibition of transpiration was significant at 70 ppm exposures for 8 hr, but not at 4 hr.

Identification of a ringspot virus from white ash. C. R. HIBBEN (Brooklyn Bot. Garden, Kitchawan, N.Y.). Previous studies demonstrated the presence of a sap- and graft-transmissible virus from leaves and buds of declining white ash (*Fraxinus americana*). Host range tests with 20 herbaceous plants showed local and systemic symptoms similar to those caused by tobacco ringspot virus. Thermal inactivation (56-59 C), dilution end point (between 10^{-2} and 10^{-3}), and other physical properties, with crude juice of virus-infected cowpea (*Vigna sinensis* 'Early Ramshorn') revealed similarities between the ash isolate and known properties of tobacco ringspot virus. Purified and crude juice preparations of the ash isolate gave positive reactions with tobacco ringspot virus antisera in the Ouchterlony agar double diffusion test. Electron micrographs of purified preparations, negatively stained with phosphotungstic acid, showed hexagonal particles with diam of about 25 m μ . The ash isolate was further characterized by sucrose density gradient centrifugation and sedimentation coefficients.

Body wall ultrastructure of two plant-parasitic nematodes, Trichodorus christiei and Pratylenchus penetrans. H. HIRUMI, C. L. HUNG, & K. MARAMOROSCH (Boyce Thompson Inst., Yonkers, N.Y.). The structural reason for the characteristic swelling occurring in *Trichodorus* spp., but not in other plant-parasitic nematodes, was studied by comparing the cuticular wall of *T. christiei*, an ecto-parasite, and of *Pratylenchus penetrans*, an endoparasite, using cinematography and electron microscopy. Reversible annulations on the cuticle, absent in *P. penetrans*, were demonstrated in living *T. christiei* by time lapse photography. The wall

cuticle of *P. penetrans* was found to consist of a marginal osmiophilic layer and two homogeneous cortex layers. The body wall of *T. christiei* consisted of five layers: a marginal layer, followed by an outer cortex layer, a loose fibrous matrix, and two inner cortex layers. Numerous transversal micropores were detected in the cortex of the fourth and fifth layers that were loosely connected by osmiophilic substances. The fibrous matrix of the third layer and the loose connection between the fourth and fifth layers of *T. christiei* can account for the wall flexibility and the reversible annulations. The swelling of the cuticle appears to be caused by the separation of the fourth and fifth layers.

Uptake of benomyl fungicide by American elm seedlings. W. K. HOCK, L. R. SCHREIBER, & B. R. ROBERTS (USDA, ARS, Delaware, Ohio). Benomyl fungicide [methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate], applied to 4-month-old container-grown American elm seedlings as a biweekly drench (200 ml of a 500 ppm suspension/treatment), was absorbed by the roots and translocated throughout the plants. Leaf, wood, and bark sections were placed in petri plates containing potato-dextrose agar seeded with *Ceratocystis ulmi* conidia. The sizes of the zones of inhibition around the tissue sections were considered representative of the relative concentration of inhibitor in the plants. These bioassays indicated that the concentration of inhibitor in seedlings grown in silica sand did not increase greatly after the third treatment. Sections from seedlings treated three times with benomyl still contained a high concentration of inhibitor after 110 days. The level of inhibitor in seedlings similarly treated and then transplanted to clean sand, however, dropped off sharply between 20 and 40 days. The composition of the potting medium greatly influenced uptake of the fungicide. Plants grown in sand contained about twice the concentration of inhibitor as plants grown in a silt loam, and about three to four times as much as plants grown in a greenhouse potting mixture.

Response of eastern white pine to prolonged exposure to atmospheric levels of ozone, sulfur dioxide, or mixtures of these pollutants. J. JAEGER & W. BANFIELD (Univ. of Mass., Amherst). Three-year-old diseased plants selected from the forest nursery were grown for 2 years in carbon-filtered air. Their new foliage remained healthy until exposed for up to 1 month to one or both gases, each at 5 ppm. Fumigation was limited to 12 daylight hr/day. All 33 plants exposed to SO₂ remained healthy. Four of 26 plants exposed to O₃ for 10 or more days developed needle-spotting. All 47 plants exposed for 10 or more days to the mixed gases developed profuse spotting of new and 1-year needles, plus traces of, or extensive, blight (red-orange necrosis). All lesions centered on stomata. The spots were white or cream colored, often with red-orange centers surrounded by lighter yellow-green halos. These lesions usually developed first in the semi-mature tissue, then in the mature tissue, rarely in immature tissue. The most spectacular damage developed after exposure during a succession of 3 days of high humidity. In fair weather, some of the plants did not show symptoms until exposure was continued for 18 days.

Studies on yellow leaf blight of corn caused by Phyllosticta zeae. C. E. KOONS, J. E. AYERS, & R. R. NELSON (Pa. State Univ., University Park). Yellow leaf blight initially occurs in the seedling stage, but the disease can occur and spread rapidly on mature plants under appropriate environmental conditions. Most lines were equally susceptible in the seedling and in the mature plant stage. Field and greenhouse studies demonstrated marked differences in pathogenicity and virulence among 20 isolates of *Phyllosticta zeae* from several states. Blighting symptoms suggested toxin involvement. A nonspecific toxin was identified by corn root inhibition bioassay. Differences in toxin production were correlated with differences in pathogenicity; however, culture filtrates did not induce disease symptoms and the toxin was not recovered from diseased tissue. Field studies with

corn lines in both normal and male-sterile cytoplasm background confirm preliminary greenhouse findings that susceptibility is governed cytoplasmically. Differences among inbreds in normal cytoplasm backgrounds suggest that nuclear factors also govern host response.

Content of reducing sugar in host, and melting-out of Kentucky bluegrass. R. J. LUKENS (Conn. Agr. Exp. Sta., New Haven). *Helminthosporium vagans*, the cause of melting-out of Kentucky bluegrass, behaves as a low sugar pathogen, like other species of *Helminthosporium*. Thus, where turf of Merion, Windsor, Newport, Common, and Park cultivars was mowed to 1-inch height, leaves contained 8.3, 6.8, 6.7, 6.2, and 6.3 meq of reducing sugars/g dry wt, respectively, and the corresponding disease levels were 10, 20, 28, 41, and 46% based on browned area. At a mowing height of 2 inches, sugar levels were approximately 1.2 greater and disease was one-half as severe. Glucose sprayed weekly on common Kentucky bluegrass turf reduced the rate of disease development for 3 weeks. The reduction in disease was proportional to the log concentration of glucose in the spray. However, by 5 weeks, the sugar treatments caused an increase in disease, presumably by inducing *H. vagans* to grow saprophytically. Apparently, *H. vagans* growing on glucose in the sod produced abundant inoculum to attack the grass. Conceivably, bluegrass turf is normally resistant to melting-out. The grass succumbs to the disease when its tissue is depleted of sugars.

Comparisons between pigments produced by Cercospora kikuchii and C. hayi. F. L. LUKEZIC (Pa. State Univ., University Park). A purple pigment isolated from cultures of *Cercospora kikuchii* has been shown to cause the disease, purple stain of soybean. *Cercospora hayi*, which causes brown spot on banana fruit, can produce a purple pigment in culture and also induce a purple stain of soybean seed, which suggests that the two pigments are similar if not the same. Purification and preliminary characterization showed that both pigments have identical infra-red spectra and melting points, thus proving they are identical. Precursor studies have shown the nitrogen source to be important in pigment production by both species. Both species produced the pigment while using acetamide and potato broth as a N source. *Cercospora kikuchii*, however, uses alanine, ammonium chloride, potassium nitrate, and DL-phenylalanine, while *C. hayi* did not. Diethylamine and potassium nitrite were not used by either species. The fact that certain precursors were used by *C. kikuchii* and not by *C. hayi* suggests that different metabolic pathways may be involved in pigment production.

Sites of water transport interference contributing to elm wilt caused by Ceratocystis ulmi. W. E. MAC HARDY (Univ. Rhode Island, Kingston). The wilt syndrome of Dutch elm disease is associated with reduction of water available to the leaves. The critical sites for vascular tissue occlusion and tissue lysis are in 1-year-old twigs and green shoots. Studies were made on healthy and *C. ulmi*-inoculated twigs using 0.1% light-green SF stain. Dye distribution is uniform in noninfected twigs, but diminishes progressively towards the shoot tips in infected branches. Vascular occlusion and lysis of tissue at leaf and shoot nodes as well as internodal vessel plugging are responsible. The pathogenic propagules produced by "bud cells" are carried vertically and laterally in the cylinder of newly formed large-diam spring vessels. Agents that inhibit budding and germination in vitro at nonphytotoxic levels have been found, and formulations for leaf and twig absorption following surface application are under test. The type of foliar symptom expression, i.e., yellowing, blotch, or marginal necrosis, abscission, and wilt, depends upon the rapidity and extent of tissue lysis and vascular occlusion. Hence, checking fungal cell multiplication until pathogen occlusion by summer-wood formation may mitigate or avoid susceptible host cell necrosis and consequent disease development.

Influence of previous exposure to ozone on infection of geranium leaves by Botrytis cinerea. W. J. MANNING, W. A. FEDER, & I. PERKINS (Univ. Mass., Waltham). Upper surface flecking on lower and middle leaves of cultivar Enchantress and marginal burning on lower and middle leaves of cultivar White Mountain were observed on plants exposed to ± 0.1 ppm ozone in a greenhouse chamber for 15 and 30 days, respectively, in May 1969. Ozone-damaged and undamaged leaves from the lower, middle, and terminal parts of exposed and nonexposed plants were detached, dipped in sterile distilled water, and placed in moist chambers with petioles in sterile distilled water. Half of the leaves were sprayed with a spore suspension of *Botrytis cinerea*, and half were not. Leaves were incubated at 22 C for 96 hr. Infection of inoculated, ozone-damaged lower and middle leaves of both cultivars frequently originated in flecked or burned areas after 24 hr and resulted in 80-100% infection after 96 hr. Infection of inoculated exposed and nonexposed, nondamaged leaves of both cultivars occurred after 48-72 hr and resulted in 5-25% infection after 96 hr. Natural infection of ozone-damaged lower and middle leaves of both cultivars originated in flecked or burned areas after 48 hr, and resulted in 30-60% infection after 96 hr. Natural infection did not occur on nonexposed lower and middle leaves. Terminal leaves from any source were not infected.

Fungicidal and nematocidal effectiveness of three chemicals on bluegrass and bentgrass turf areas. L. B. MASSIE, J. R. BLOOM, & H. COLE (Pa. State Univ., University Park). Field tests of fungicidal and nematocidal effectiveness of ethyl 4-methylthio-m-tolyl isopropyl-phosphoramidate (Chemagro, Bay 68138), *O,O*-diethyl *o*-[*p*-(methylsulfinyl)phenyl] phosphorothioate (Dasanit), and disulfoton (Di-Syston) were performed on Seaside bentgrass (*Agrostis palustris*) and a mixture of Pennstar and Fylking Kentucky bluegrasses (*Poa pratensis*). Formulations and rates (active material) used were: Bay 68138 (3 lb/gal LC) 5, 10, and 20 lb/acre; Dasanit (6 lb/gal LC) 10 and 20 lb/acre; Dasanit (15% granular) 10 and 20 lb/acre; and disulfoton (15% granular) 5, 10, and 20 lb/acre. All treatments, replicated four times, were applied once. Nematode counts after 5 and 10 weeks showed that the 20 lb/acre rate of each chemical significantly decreased the levels of *Paratylenchus*, spirals, and other plant parasitic nematodes. Disulfoton at 20 lb/acre significantly reduced the number of Sclerotinia dollarspot infection centers in the treated plots. Further field studies indicated that disulfoton at 15 lb/acre controlled dollarspot for at least 6 weeks. Preliminary greenhouse studies using mature Merion and Park Kentucky bluegrass in pots also indicated that control of *Helminthosporium* leaf spot was obtained with 10, 15, or 20 lb/acre rates of disulfoton.

Response of Chrysanthemum to infection by Mycosphaerella ligulicola. R. E. MCCOY & A. W. DIMOCK (Cornell Univ., Ithaca, N.Y.). Stem inoculation of *Chrysanthemum morifolium* 'Iceberg' with *Mycosphaerella ligulicola* caused dark, necrotic lesions at the inoculation site and leaf spotting, wilting, and necrosis in noninfected portions of the plant. Diseased plants exhibit a one-sided distribution of foliar symptoms associated with the discoloration of vascular traces within the main stem. Infected plants are seldom killed, lesion development becoming arrested 1 to 2 weeks after inoculation. New apical growth occurring after lesion delimitation appears normal in all respects, even though the fungus can still be isolated from the inoculation site. Further inoculations of recovered plants result in the repetition of the entire symptom complex. Sterile culture filtrates of *M. ligulicola* injected into the stems of healthy plants produce the same symptoms as fungal inoculation, except for the necrotic region of fungal invasion. Toxicity of the culture filtrates is retained after autoclaving, drying, or pH adjustment from 3.5 to 10.0, but is lost after dialysis, indicating that the toxic principle is a relatively stable low molecular wt compound.

The antagonistic effect of some soil bacteria on Fusarium roseum 'Culmorum' isolated from carnation. A. H. MICHAEL & P. E. NELSON (Pa. State Univ., University Park). Bacteria isolated from several soil samples differed in their antagonistic effect toward *F. roseum* 'Culmorum'. Antagonism was determined by growing *Culmorum* and each bacterial isolate in dual culture. Isolates causing the greatest inhibition of fungal growth were selected for further testing. The cutting-rot phase of *Fusarium* stem rot of carnation (*Dianthus caryophyllus*) was reduced when the bases of unrooted cuttings were soaked in a cell suspension of an antagonistic bacterium for 24 hr prior to inoculation with the pathogen. In each of the tests, bacterial isolates reduced the amount of disease in comparison to the inoculated checks. Bacteria antagonistic to *Culmorum* could be isolated from cuttings for 4 weeks after treatment. Tests in which cell suspensions of antagonistic bacteria and macroconidia of *Culmorum* were mixed in the rooting medium prior to cutting placement indicate that bacterial isolates were slightly effective in reducing disease under these conditions. No reduction in rooting occurred when carnation cuttings were rooted in the presence of the antagonistic bacteria.

Cellular injury caused by an endopolygalacturonate trans-eliminase from Erwinia carotovora. M. S. MOUNT & D. F. BATEMAN (Univ. Mass., Amherst, Cornell Univ., Ithaca, N.Y.). Endopolygalacturonate trans-eliminase (PGTE), proteinase, and phosphatidase C were produced by *Erwinia carotovora*. Crude enzymes caused electrolyte loss, tissue maceration, and death of potato tissue. The three enzymes were resolved by $(\text{NH}_4)_2\text{SO}_4$ fractionation, DEAE cellulose chromatography, and isoelectric focusing. Phosphatidase and most of the proteinase activities were detected in the 40-60% $(\text{NH}_4)_2\text{SO}_4$ fraction; maximum PGTE activity was obtained in the 60-80% fraction. The PGTE was dissolved in water, dialyzed, and chromatographed on a DEAE cellulose column prepared in 0.05 M Tris[tris (hydroxymethyl) amino methane]-HCl buffer at pH 8. The column was eluted with buffer followed by a salt gradient at pH 8. PGTE was eluted in the void volume; proteinase was eluted in fractions containing 0.3-0.4 M NaCl. Fractions that contained PGTE were pooled and subjected to isoelectric focusing. A 295-fold purification of the PGTE was achieved. The molecular wt of the PGTE was determined by gel filtration (Sephadex G-75) and by ultra centrifugation to be 31,000 and 31,700, respectively. Purified PGTE effected electrolyte loss, maceration, and death of potato tissue. Electrolyte loss preceded maceration and cellular death; the latter two processes occurred simultaneously.

Phyllosticta leaf spot of corn and tests for resistance to this disease. D. MUKUNYA & C. W. BOOTHROYD (Cornell Univ., Ithaca, N.Y.). *Phyllosticta* leaf spot of corn was first observed in New York in 1968 and found in 21 of 33 surveyed counties in 1969. In most fields there was no economic loss, but in a few localities there was a loss of stover and grain. The disease was first seen on the lower leaves of young seedlings, and became progressively worse on all foliage as the plants developed. Small, light-green spots developed first, and these elongated and became yellowish-brown with dark-brown margins. The spots enlarged and coalesced, and the leaves became prematurely yellow and dry. Pycnidia developed in many of the larger lesions and extruded conidia when placed under moist conditions. A fungus was isolated consistently from diseased material, and it produced pycnidia on potato-dextrose agar at 22-25 C under fluorescent light. All isolates resembled each other in cultural morphology and in size of pycnidia and conidia. The fungus resembled that identified by Stout in Illinois in 1930 as *Phyllosticta zeae* Stout. Forty-five corn lines were tested for resistance to *Phyllosticta* in the greenhouse and in the field. Many of these lines contained cytoplasmic male sterility, and such lines were found to be more susceptible than their normal counterparts. There was considerable resistance, however, between lines that were produced from

a common cytoplasmic male sterile source, indicating the importance of nuclear gene(s) in determining response to *Phyllosticta*.

Bean seed orientation and performance of fungicide treatment of seed. J. J. NATTI (N.Y. State Agr. Exp. Sta., Geneva). Oriented placement of bean seeds treated with benomyl had a significant influence on the incidence of powdery mildew (*Erysiphe polygoni*) and hypocotyl rot (*Rhizoctonia solani*) in greenhouse plantings of Red Kidney bean (*Phaseolus vulgaris*). In tests in which treated seeds were planted hilum-down, 80% of the plants were infected with powdery mildew and 82% with hypocotyl rot. In tests in which the seeds were planted hilum-up, 11% of the plants were infected with powdery mildew and 13% with hypocotyl rot. These differences in disease incidence appeared to be due to the adherence of the fungicide to the seed coats and to the location of the seed coats after seedling emergence. With seeds planted hilum-down, seed coats remained attached to the cotyledons of emerged seedlings, and the fungicide adhering to the seed coats was removed from the soil. With seeds planted hilum-up, the cotyledons slipped from the seed coats before the seedlings emerged so that the seed coats and the fungicide remained in the soil. Similar control of hypocotyl rot resulted from oriented plantings of bean seeds treated with thiram.

Apple chat fruit symptoms produced by green mottle virus infection. D. H. PALMITER (N.Y. State Agr. Exp. Sta., Geneva). Several virus free apple cultivars planted in 1963 reacted differently to graft inoculations made in 1964 with scions that carried the green mottle virus. Lord Lambourne fruit showed typical green mottle and russet, but little reduction in size in 1967. In 1968 and 1969, 51% and 93%, respectively, of the crop were chat fruit. Most of these small fruits showed typical green mottle symptoms, but some of the normal-sized fruit on the same tree were free of these symptoms. Green mottle developed on Duchess fruit, and some ring russet developed on Golden Delicious, but there was little effect on fruit size. McIntosh and Baldwin trees showed no reaction to the inoculation. Spy 227 and R12740-7A indicators were severely stunted or killed, and *Malus platycarpa* fruit were marked by ring russet. Scions from a Delicious tree showing "flat apple" symptoms produced green mottle on Duchess fruit 2 years after graft inoculation. Thus, Duchess green mottle, Lord Lambourne chat fruit, and Delicious "flat apple" may be different host reactions to the same virus.

The effect of temperature on germination and germ tube elongation of aeciospores and urediospores of Melamporella caryophyllacearum. W. H. PAWUK (Univ. N.H., Durham). Aeciospores and urediospores were placed on 2% water agar (pH 5.5) and incubated at 5, 10, 15, 20, 25, and 30 C. Plates containing the spores were removed every 2 hr for 24 hr and treated with 5% $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ to stop germination. Percent spore germination at each temp was determined by counting 300 spores, and germ tube length was determined by measuring 30 germ tubes. Germination of both spore types was highest between 10-25 C. At these temps, maximum aeciospore germination of 60-70% was reached in 10, 12, 16, and 18 hr at 20, 25, 15, and 10 C, respectively. Maximum urediospore germination of 70-85% occurred in 8, 12, 14, and 16 hr at 20, 25, 15, and 10 C, respectively. At 5 and 30 C, germination of both spore types was reduced, reaching a maximum of 25 to 30%. Using germ tube length as an indicator of vigor aeciospores were most vigorous from 15-25 C, intermediate at 5-10 C, and least vigorous at 30 C. Urediospores were most vigorous at 15-25 C, somewhat less vigorous at 10 C, intermediate at 5 C, and least vigorous at 30 C. After 24 hr, germ tubes of both spore types were still growing vigorously at temp from 15-25 C.

Calyx-end rot of apples. A. E. RICH (Univ. N.H., Durham). Calyx-end rot of apples was a problem in New Hampshire orchards in 1968 and 1969. McIntosh appeared

to be most susceptible. *Alternaria* sp. was isolated most frequently in 1968 from small, dark-brown-to-black corky lesions on green fruit. Two distinct types of symptoms were observed on small green fruits in 1969. One was similar to that observed in 1968, while the other was lighter brown in color and the affected tissue was softer. *Alternaria* was again isolated from the dark corky lesions, and *Sclerotinia sclerotiorum* was isolated from the lighter brown soft rot tissue. Both fungi caused fruit rot after inoculation into green Early McIntosh apples. *Alternaria* produced a dark brown rot that developed slowly; *Sclerotinia* produced an extensive watery soft rot, followed by formation of black sclerotia. Neither rot formed a zonate ring pattern characteristic of *Physalospora obtusa* infection.

A newly recognized disorder of Pelargonium hortorum. D. SEAVEY & L. A. MCFADDEN (Univ. N.H., Durham). An unknown disorder of the greenhouse geranium was observed in New Hampshire in 1964, and has caused economic losses each year since. Symptoms include an over-all reduction in top and root growth, shortened internodes, and brittleness. Leaf veins develop necrotic brown areas; the blades turn shades of yellow and red. Cuttings taken from affected stock plants often exhibit chlorotic veins. Internal stem breakdown precedes visible external symptoms, as evidenced by the development of dark necrotic areas in the pith parenchyma. All attempts to isolate a biotic agent from affected plants have failed. Geraniums which were grown in a nutrient-sand culture void of, or low in, boron developed typical symptoms in 4 to 6 weeks. Foliar symptoms became evident when plants received less than 0.23 ppm boron in the nutrient solution or when young leaves accumulated less than 26.6 ppm boron. Toxicity symptoms occurred as marginal necrosis when plants received in excess of 6.46 ppm boron in the nutrient solution, or when leaves accumulated 325-410 ppm boron. When affected plants were supplied with boron, the new growth which resumed appeared normal.

Concentration of manganese in discolored and decayed wood of sugar maple, Acer saccharum. W. C. SHORTLE (Univ. N. H., Durham). Columns of discolored and decayed wood associated with 8-year-old inoculation wounds and contiguous clear wood were analyzed for total mineral content and manganese. The mineral content, calculated as ash/4 cc of wood, increased as the wound was approached longitudinally from the distal margins of the columns. In columns that contained little or no decay, the concentration of manganese, calculated as $\mu\text{g}/4$ cc of wood, was not significantly different from that in the contiguous clear wood. In columns that did contain decay, the concentration of manganese in the discolored wood surrounding the decay was significantly greater than the clear wood, and the decayed wood contained significantly less manganese than the clear wood. The mean values for manganese concentration as $\mu\text{g}/4$ cc of wood were: clear wood, 170; discolored wood, 220; and decayed wood, 130. These data indicated that manganese is redistributed somehow as discolored tissues are decayed.

Utilization of levopimaric acid by representative wood-inhabiting fungi. C. R. SHRINER & W. MERRILL (Pa. State Univ., University Park). Bases of dead coniferous branch stubs, principal infection courts for many heart-rotting fungi, usually are impregnated with oleoresin and are decay-resistant. Resin acids form a major portion of the oleoresin. Therefore, we determined the effect of levopimaric acid (L), a major component of the resin acid fraction in *Pinus strobus*, upon growth (mycelial dry wt) of *Fomes pinicola* and *Haplosporella* sp. The fungi were grown on 0.001, 0.01, 0.1, and 1.0% (v/v) L incorporated into an aqueous nutrient salts-thiamine medium (S) with or without glucose (G), asparagine (A), or both. Growth of both fungi was significantly greater in SL and SAL than in S or SA, respectively, thus indicating utilization of L as a sole carbon source. There were no significant differences between

growth in SG or SGL or in SAG or SAGL. These and our previous results demonstrate that although wood-inhabiting fungi cannot utilize monocyclic or bicyclic monoterpenoids, they can utilize diterpenoids. Reasons for these differences are unknown. To our knowledge, this is the first report of the utilization of resin acids by wood-inhabiting fungi.

Reversal of germination inhibition of sclerotia of Macrophomina phaseoli by Pinus lambertiana root exudate. W. H. SMITH (Yale Univ., New Haven, Conn.). The germination of sclerotia of *Macrophomina phaseoli* in soil, as determined by the spot plate and buried membrane filter methods, was found to be less than 5%. The germination of sclerotia in vitro on silica gel, silica gel plus soil leachate, and potato-dextrose agar was found to be in excess of 90%. Germination in soil could be increased to over 50% by the addition of natural or synthetically prepared sugar pine root exudate. The natural root exudate collected from 18-day-old seedlings contained carbohydrate, amino acid, and organic acid fractions. When prepared artificially and added to the soil, the amino-acid fraction was the most effective in increasing sclerotial germination.

Apparent resistance of Venturia inaequalis to the fungicide n-dodecylguanidine acetate. M. SZKOLNIK & J. D. GILPATRICK (N.Y. State Agr. Exp. Sta., Geneva). Control of apple scab (*Venturia inaequalis*) with *n*-dodecylguanidine acetate (dodine) has been outstanding since its approval for grower use in 1959. In some western New York State orchards where formulations of dodine (Cyprex) have been used for 5 to 10 years, the control has diminished since 1967. In one orchard where the Geneva Station has conducted aerial application tests for 9 consecutive years, dodine controlled scab satisfactorily through 1967. In 1968, 5% of the terminal leaves on trees sprayed with dodine were infected with scab as compared with 1% for the captan treatment. In 1969, scab developed on 66% of the leaves of dodine-sprayed trees as compared to about 3% with captan or maneb and 100% on unsprayed trees. Dodine applied by ground equipment allowed 72% leaf scab. These observations and laboratory and greenhouse tests indicate that lines of *V. inaequalis* have developed resistance to dodine. In slide tests, conidia of the scab fungus collected from orchards where dodine failed germinated at a higher concentration of the fungicide than did those from other sources. In greenhouse tests with potted apple trees sprayed with dodine before inoculation, more scab lesions developed from suspected dodine-resistant inoculum than from nonresistant.

Tobacco protected against fleck by benomyl and other fungicides. G. S. TAYLOR (Conn. Agr. Exp. Sta., Windsor). Field plots of tobacco *Nicotiana tabacum* 'Connecticut Broadleaf' were sprayed weekly during May with several fungicides at X (1.5 to 2.0 lb. formulation/100 gal) and 3X rates. Weather fleck first appeared on the plants following a period of air pollution on 4 June. The plants were rated for weather fleck damage 1 week later. The plots sprayed with benomyl at both rates had 80% less fleck than the unsprayed plots. Plots sprayed with Polyram (complex of ethylenebisdithiocarbamic acid, zinc salts, and sulfides), zineb, and maneb all at 3X had respectively 69, 53, and 52% less fleck than the unsprayed plots. In another experiment, using tobacco plants of a fleck-susceptible breeding line growing under shade cloth, benomyl spray at 2 lb./acre, benomyl dust at 3 lb./acre, and the antiozonant diphenyl-*p*-phenylenediamine (DPPD) dust at 8 lb. per acre were applied to the foliage weekly from 27 June to 30 July. All three treatments gave significant protection against fleck throughout the season. Neither benomyl or DPPD reduced fleck on two fleck-resistant lines of tobacco that were only slightly flecked, even in the untreated plots.

Weather fleck on tobacco made worse by certain nematocides. G. S. TAYLOR & P. M. MILLER (Conn. Agr. Exp. Sta., Windsor & New Haven, Conn.). The following rates per acre of nematocides were applied to soil in replicated plots in late

April or early May: Dasanit [*o,o*-diethyl-*o*-(*p*-methylsulfinyl)phenyl phosphorodithioate], 10 and 15 lb; Vorlex (80% mixed dichloropropenes and 20% methylisothiocyanate), 7.5 and 20 gal; Telone (mixed dichloropropenes), 20 gal; and Chemagro 68138 [ethyl-4-(methylthio)-*n*-tolyl isopropyl phosphoramidate], 10 and 20 lb. In separate experiments, *Nicotiana tabacum* 'Conn. 49' was planted in plots under shade cloth, and Conn. 49 and fleck-resistant cultivar 2238 were planted in unshaded plots. After periods of air pollution in June, July, and August, weather-fleck damage was rated early in July and again early in August. Under shade, fleck-susceptible Conn. 49 tobacco plants had more fleck in Dasanit plots than in untreated plots. Twenty gal of Vorlex applied in April increased fleck on 15 Aug. On Conn. 49 plants in unshaded plots, 10 lb. of Dasanit increased fleck by July; 20 gal of Telone, 10 and 20 lb of Chemagro 68138, and 7.5 gal of Vorlex increased fleck by August. On fleck resistant cultivar 2238, 10 and 20 lb of 68138, 20 gal of Vorlex, and 20 gal of Telone increased fleck rated in August. The amount of damage was not consistently related to plant vigor.

A vein chlorosis or yellow-net disease of Forsythia caused by tobacco ringspot virus. E. S. TIANGCO & E. H. VARNEY (Rutgers Univ., New Brunswick, N. J.). A virus transmitted mechanically from *Forsythia* showing vein chlorosis or yellow-net symptoms was identified as tobacco ringspot virus (TRSV). It infected 45 out of 64 species or cultivars in 14 families. Symptoms in commonly used indicator plants were like those caused by TRSV. Healthy *Forsythia* cuttings mechanically inoculated with sap from infected cowpea developed typical vein chlorosis symptoms. The virus was dodder- and graft-transmissible. Thermal inactivation was between 65 and 70 C; dilution end point was between 1:10⁴ and 1:10⁹; and longevity in vitro at 20 C was 4-16 days, depending on the source host. Virus purified by the chloroform-butanol method was used in the production of an antiserum. In reciprocal cross-protection tests with recovered *Nicotiana tabacum* 'Bel-W3', the *Forsythia* virus and TRSV protected against each other but not against tomato ringspot virus. Electron micrographs showed polyhedrons characteristic of TRSV. Schmelzer concluded that a similar if not identical disease of *Forsythia* in Germany is caused by a strain of arabis mosaic virus (AMV). Although host range and properties of our virus are similar to those reported by Schmelzer for AMV, gel-precipitin tests indicated that all of our isolates were serologically indistinguishable from common TRSV.

Sexual induction in Cochliobolus carbonum by gaseous products of methionine and related compounds. A. TIJERINA-MENCHACA & R. R. NELSON (Pa. State Univ., University Park). Perithecial production (PP) in *Cochliobolus carbonum* occurred when crosses were made on Sachs agar on filter paper discs supplemented with 0.03-0.5 mg/mating of methionine (M), homocysteine, M sulfone, homocystine, methional (MT), cystathionine, S-methyl-cysteine (SMC), M sulfoxide, N-acetyl M, M-OH analogue, or vitamin U, but did not occur when similar amount of homoserine (H), cysteine (CY), cystine, propionic acid, M sulfoximine, and ketobutyric acid were applied. Molecular similarities, the C-S-C moiety of active compounds, and the instability of S linkages suggested gaseous involvement in sexual induction. M, MT, SMC, H, CY and uniformly labeled ¹⁴C M were fed to crosses placed in airtight syringes, and the gases trapped for gas chromatographic and tracer studies. Mercaptan, methyl disulfide, and ethylene were detected only in crosses treated with active compounds. Crosses on deficient substrates were fertile when placed in sealed containers with chemically induced fertile crosses. PP occurred in crosses fed with pure gases, but less than when treated with active compounds. Studies with ¹⁴C M suggest that gases are natural breakdown products of the metabolism of M. It is possible that the active compounds activate fungal processes, which in turn liberate gases.

Influence of rhizosphere pH on alfalfa root exudate composition and resulting effect on growth of Rhizobium. H. E. VOEGELI, JR. (Univ. Rhode Island, Kingston). Rhizobia have been found to reduce fusarial root rot of alfalfa. Hence, stimulation of rhizobial growth increases the potential for disease control. Root exudate was collected from alfalfa seedlings aseptically grown for 14 days at 32.2 C in a sand/nutrient substrate adjusted to increments of 1 pH from pH 4 to 9. Aliquots of the composite exudate from 30 seedlings at each pH level were adjusted to pH7, added to a minimal nutrient medium, inoculated with *Rhizobium meliloti*, and incubated at 35 C for 24 hr. Culture growth was determined by spectrophotometer absorbance at 470 mμ. Exudate produced by two seedlings (2 ml) caused a 4 to 5 times growth stimulation at pH 4, 6, 7, 8, and 9, and 3 times at pH 5. Components of exudate from seedlings grown at pH 4, 5, and 6 were separated by ion-exchange resin (Amberlite IR 120) using acetic acid, water, and triethylamine (TEA) sequential elution. The TEA eluant caused stimulation similar to that of the whole exudate. The combined acetic acid-water eluant inhibited rhizobial growth. In the TEA fraction of the pH 4, 5, and 6 exudates, the amount of α-amino N present and *Rhizobium* growth were positively associated. Technicon auto-analysis of ninhydrin-positive substances in the TEA fractions showed four or five compounds present.

Relationship of temperature to the development of Fusarium cankers of sugar maple. T. C. WEIDENSAUL (Pa. State Univ., University Park). *Fusarium solani*, a cause of an annual canker of sugar maple, develops during the dormant season. Studies of the temp response of the organism indicated that the threshold temperature for linear growth was about 6 C, and that an average of 100 effective day-degrees was necessary for 20 mm of linear mycelial growth. Fungal growth was greater in a fluctuating temp regime than at the constant median about which temp fluctuated. During the spring and fall of 1968, temp beneath the bark of sugar maples was recorded at three heights on four tree faces. Approximately 600 effective day-degrees were available for fungus growth during this period. Although there were differences in temp among faces and heights, there were no differences in total effective day-degrees during this period. If the rate of mycelial growth in vitro is extrapolated for 600 day-degrees, the amount of linear growth closely approximates the average length of cankers observed in nature. Canker incidence has been reported to be greater on some tree faces than on others, and to vary inversely with height. Results indicate that although temp is a limiting factor, it is not the only factor responsible for distribution of cankers on tree stems.

The influence of temperature and relative humidity on the response of white ash to ozone. R. G. WILHOOR (Pa. State Univ., University Park). White ash (*Fraxinus americana*) seedlings were reared in a growth chamber at constant 27 C, 80% relative humidity (RH), and 2,200 ft-c for a 12-hr photoperiod. All combinations of pre-, during, and post-fumigation temp of 16 and 27 C and relative humidities of 65 and 85% were used to determine the influence of these factors on seedling response to 25 pphm ozone. The pre-, during, and postfumigation treatment periods were 2-3 weeks, 4 hr, and 4 days, respectively. A pre- and post-fumigation temp of 27 C and a fumigation of 16 C resulted in the greatest injury. The response was similar for seedlings 4, 6, and 10 weeks of age. Pre-, during, and postfumigation relative humidity regimes of 85% resulted in the most severe injury on plants 4, 12, and 14 weeks of age. The influence of RH was greatest on the youngest plants.

The relative sensitivity of sixteen deciduous tree species to ozone. F. A. WOOD (Pa. State Univ., University Park). Two to 5-year-old seedlings of 16 species of deciduous trees commonly found in northeastern USA were exposed to 25 pphm ozone for 8 hr at 21 C, a relative humidity of about 75%, and 1,400 ft-c of light. All plants were exposed to 1 hr

of darkness prior to fumigation. Symptoms developed on green ash, white ash, sweet gum, pin oak, scarlet oak, white oak, and tulip poplar. The most common symptoms observed were stipple of the upper leaf surface, necrotic areas, over-all leaf chlorosis, and tissue collapse. Exposure of these species to 25 ppm ozone for 4 hr injured green ash, white ash, white oak, and tulip poplar. Exposures at 10 ppm ozone of 8 hr injured white ash. Symptoms failed to develop

on European white birch, grey dogwood, flowering white dogwood, little leaf linden, Norway maple, sugar maple, English oak, red oak, and shingle oak exposed to 25 ppm for 8 hr. The incidence of sensitive plants within seedling populations of each species ranged from 19 to 92%; with the exception of white ash, all species were resistant during the first 2 weeks of growth following bud break in the spring.

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