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

Life cycle of Heterodera schachtii on table beet under field and greenhouse conditions. G. S. ABAWI & W. F. MAI (Cornell Univ., Geneva, Ithaca, N. Y.). In a field test, roots of table beet, *Beta vulgaris* 'Ruby Queen', were invaded by larvae of *Heterodera schachtii* 6 days after planting (19 May 1971). Size and number of larvae per root system increased with time. Immature white females (W♀) were first detected on roots after 28 days, but were abundant after 35 days. Oviferous females and brown cysts were found after 49 days. W♀ increased with time, then decreased to a low level of 11/root system after 63 days. After 83 days, however, there were 32 W♀/root system. W♀ were also found on roots of volunteer beets in October. These findings suggest that two and perhaps three generations of this nematode occur per year in New York. In a greenhouse test, no nematodes were seen in roots 4 days after seeds were planted in naturally infested soil. Three and 150 larvae/root system were found after 7 and 10 days, respectively. Males and females were distinguishable after 17 days. After 23 days, a female with 4 eggs was observed. Oviferous females and a few with their cone area darkening were detected after 29 days. Brown cysts were seen after 36 days. The shorter life cycle in the greenhouse was probably due to a temperature effect. At a depth of 15.2 cm, temperatures of field soil varied from 14.5 to 22.3 C, whereas those in the greenhouse were 21.1 to 23.9 C.

Screening grape seedlings for resistance to powdery mildew. H. S. ALDWINCKLE (New York State Agr. Exp. Sta., Geneva). Selection of new cultivars of grapes more resistant to powdery mildew (*Uncinula necator* [Schw.] Burr.) would be facilitated by a method for screening large progenies as young seedlings. Several progenies from controlled crosses involving French hybrids and American-type grapes were grown in flats in the greenhouse. At the two-leaf stage, the seedlings were inoculated by application of conidia of *U. necator* to the upper surfaces of the leaves with a camel's-hair brush. Reactions were observed 4 weeks later. Seedlings of each progeny were divided into three classes of resistance according to severity of infection: low, medium, and high. Seedlings were all potted, and after 1 month's growth in the greenhouse were lined out in the nursery. The following year they were evaluated for powdery mildew resistance under conditions of natural infection, using a scale of 0 to 4, based on the proportion of total leaf area infected. There was a positive correlation between reaction in the seedling test and infection observed in the nursery. The greenhouse inoculation technique appears promising as a means of eliminating many highly susceptible seedlings without lengthy nursery and vineyard trials.

Cell wall-degrading enzymes produced by Helminthosporium maydis (race T). D. F. BATEMAN, T. M. JONES, & O. C. YODER (Cornell Univ., Ithaca, N.Y.). *Helminthosporium maydis* produced no detectable polygalacturonase (PG) when cultured for 8 days at 23 C in liquid media containing Na pectate as the carbohydrate source; pectate lyase was produced during growth in a potato-pectate medium (broth from 200 g autoclaved potato plus 20 g Na pectate). PG and xylanase were produced by *H. maydis* when cultured in a medium containing/liter: $MgSO_4$, 181 mg; KCl, 149 mg; $(NH_4)_2NO_3$, 1,000 mg; $MnSO_4$, 0.2 mg; $FeCl_3$, 2.0 mg; $CuSO_4$, 2.0 mg; yeast extract, 2 g; and glucose, 20 g. The PG exhibited a pH optimum of 4.8, a pI of 8.3, and released di-, tri-, and tetra-galacturonides from Na pectate. This enzyme caused a 50% viscosity loss in Na pectate with about 0.1% hydrolysis. *H. maydis* PG was inactivated by $(NH_4)_2SO_4$; however, it was purified 2-fold by gel-filtration on Sephadex G-75, 10-fold by carboxymethylcellulose column chromatography, or 16-fold by isoelectric focusing. Attempts to use these procedures in series resulted in inactivation of the enzyme. Within 2 hr at 30 C, crude filtrate from *H. maydis* cultures grown in the glucose medium released 31% of the galacturonate, 45% of the xylose, and 75% of the arabinose from the trifluoroacetic acid hydrolyzable portion of cell walls from leaves of 10-day-old corn (W64A T) seedlings.

Root knot causes reduced root pressure in some tomato varieties. J. R. BLOOM & L. L. BURPEE (The Pennsylvania State Univ., University Park). Sunray and Pritchard variety tomato plants were transplanted into 4-inch plastic pots in steamed greenhouse soil mix when the first true leaves had expanded. Three days later, one group of each variety was inoculated with eggs and nemas of *Meloidogyne incognita*; another group served as healthy checks. Approximately 28 days after inoculation, plant stems were cut off about 2 inches above the soil line and affixed to a diaphragm-type pressure gauge with a section of rubber tubing. The soil was saturated with water, and the pot covered with a plastic bag. The plants were cut in late afternoon, and remained in the greenhouse overnight. Root pressure readings were taken 17 hr after cutting. The average root pressure of noninfected Sunray plants was 45 mm Hg, whereas the root knot-infected plants averaged 15 mm Hg pressure. Check plants averaged 49 mm Hg pressure and the inoculated averaged 7.3 for the variety Pritchard. All inoculated plants developed root knot, but no correlation of amount of knotting with the extend of reduction in root pressure was made. Reduced root pressure was made. Reduced root pressure may account for flagging symptoms in root knot-infected tomatoes, and may be a factor in breaking resistance to Fusarium wilt in some crops.

Sativin and vestitol: phytoalexins induced in birdsfoot trefoil. M. R. BONDE & R. L. MILLAR (Cornell Univ., Ithaca). Two isoflavanoid compounds, sativin [(-)-7-hydroxy-2',4'-dimethoxyisoflavan] and vestitol [(-)-7,2'-dihydroxy-4'-methoxyisoflavan], were isolated both from drops of a spore suspension (50,000 spores/ml 0.05% Tween 20 [polyoxyethylene sorbitan monolaurate] solution) of *Helminthosporium turcicum* incubated 48 hr on the leaves of birdsfoot trefoil (*Lotus corniculatus* L.), and from the tissues directly beneath the drops. These compounds were extracted from the drops with ethyl acetate and from the tissue with ethanol. They were purified by thin-layer chromatography (solvent system diethyl ether:hexane, 5:1, v/v), followed by column chromatography on Sephadex LH-20 (solvent 95% ethanol). Both compounds exhibit marked antifungal activity. Identification of the compounds was based on mass spectrometry data, ultraviolet absorption spectra in 95% ethanol and ethanolic NaOH, R_F values in several solvent systems, and optical rotation in absolute methanol. *H. turcicum*, a nonpathogen of trefoil, induced production by the leaves of both sativin and vestitol so that concentration of each phytoalexin in the drops was

95-110 μg/ml. Sativin accumulated in the leaf tissue under the drops to 1,500-1,900 μg/g of tissue. *Stemphylium loti*, a pathogen of trefoil, also induced production of both phytoalexins, but subsequently degraded them to noninhibitory compounds.

Epidemiological study of Phyllosticta maydis on corn. L. L. CASTOR, J. E. AYERS, & R. R. NELSON (The Pennsylvania State Univ., University Park, Pa.). Field experiments evaluated the effects of cultural practices and host resistance on the onset and severity of yellow leaf blight of corn, incited by *Phyllosticta maydis*. More lesions occurred per leaf, and more leaves were infected initially on susceptible and moderately susceptible plants, but not resistant plants, in no-till plots than in till plots. Tillage practices had no effect on later spread of disease. Lesion number, lesion size, and rate of colonization decreased with increasing levels of resistance. Disease spread during cool, rainy periods was primarily an increase in lesion number, whereas spread during hot, dry mid-season periods was largely through increase in lesion size. The relative resistance of the host is an important determinant in the ultimate amount of disease, irrespective of tillage practices.

Reaction of Allium cepa to Botrytis brown stain. C. A. CLARK & J. W. LORBEER (Cornell Univ., Ithaca, N.Y.). One red, one white, and eleven yellow cultivars of *Allium cepa* were examined at harvest and after 4 months' storage for the incidence, severity, and type of brown stain caused by *Botrytis cinerea*. The order of susceptibility (percent of bulbs infected) from least to most was: Southport White Globe, Southport Red Globe, Buccaneer, D-4351, Abundance, Summit, Spartan Banner, Downing Yellow Globe, D-1451, 622-Spartan Banner, Elite, Elba Globe, and 68-W-143. There were no significant differences between cultivars of infected yellow onions in the average amount of tissue stained. The frequency of diseased bulbs usually decreased during the storage period, due to sloughing of the affected scales. In one experiment, the amount of brown stain increased during storage, indicating the possibility of latent infections. Approximately three-fourths of all infected bulbs were stained in the neck. The percent of neck staining was not significantly correlated with disease incidence or severity.

Some effects of streptomycin on Plasmopara halstedii, the downy mildew of sunflower. YIGAL COHEN & W. E. SACKSTON (Macdonald College, McGill Univ., Que., Canada). Sporangial germination of *Plasmopara halstedii* (Farl.) Berk. & de Toni was inhibited by 90% in the presence of 1 μg/ml of streptomycin-sulphate, and totally inhibited by 10 μg/ml. Infection of 3-day-old seedlings, inoculated by immersion and infection of two-leaf-stage plants inoculated via the growing point of the stem, was totally inhibited by our mixing 10 μg/ml of streptomycin with the inocula. However, administering the antibiotic (10-100 μg/ml) 24 hr subsequent to inoculation resulted in severe infection. Two sprays of streptomycin (1,000 μg/ml) had no effect on systemic spread of the mildew symptoms, nor on the sporulative potential of the fungus on the treated plants. Floating of infected leaves on streptomycin solutions (1,000 μg/ml) for 24 hr resulted in heavy sporulation. Sporangia of *P. halstedii* produced in the presence of the antibiotic were infective. Brief immersion of sporangia in streptomycin was lethal. The antibiotic was highly efficient in protecting aboveground tissues of sunflowers from mildew infection; however, no protection of underground tissues was achieved when the antibiotic was applied as a soil drench.

Comparison of salt injury to four species of coniferous tree seedlings when salt was applied to the potting medium and to the needles with or without an antitranspirant. A. COSTANTINI & A. E. RICH (Univ. of New Hampshire, Durham). Three-year-old coniferous seedlings of *Pinus strobus, Pinus sylvestris, Picea glauca,* and *Abies fraseri* were potted in Jiffy Mix and grown for 9 weeks under greenhouse conditions. Each seedling received specific treatments for 5 days, followed by tap water for 2 days each week. NaCl treatments at 1,000 and 2,000 ppm in water were administered. Saline solution was poured on the soil of some seedlings, whereas others received their salt in a mist sprayed on the foliage. An antitranspirant was applied as a spray to a group of seedlings twice during the course of the 9-week salt spray treatments. Half of the seedlings were harvested at 5 weeks, the rest at 9 weeks. Seedlings were rated for foliar damage, and chloride content of the needles was determined. Seedlings that received salt water as a foliar spray showed more severe damage and higher chloride concentrations than those that received soil treatments. Antitranspirant spray treatments proved to be ineffective in alleviating salt injury in the greenhouse. Seedlings treated with an antitranspirant in addition to salt were found to have slightly higher chloride concentrations in the needles than trees receiving comparable treatments with no antitranspirant.

Relationship of ozone injury to time of application of carboxin analogues. L. R. CURTIS, L. V. EDGINGTON, & G. HOFSTRA (Univ. of Guelph, Guelph, Ontario, Canada). The length of time between foliar applications of carboxin analogues and ozone exposure was shown to be of importance in reducing ozone injury to white beans. White beans (*Phaseolus vulgaris*) were pretreated with 1.4×10^{-2} and 4.3×10^{-2} M of the four chemicals carboxin (5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide), its sulfoxide and sulfone analogues, and *o*-toluanilide 1, 5, and 10 days prior to fumigation with ozone at 25 pphm for 4 hr. The effectiveness of the chemicals in reducing ozone injury were assessed 3 days later on a leaf area percentage. *o*-Toluanilide and untreated leaves showed 70% injury. Leaves with 1- and 5-day sulfone analogue pretreatment showed 30% injury, and 50% injury at the 10-day interval. Pretreatment 1 and 5 days with the sulfoxide analogue resulted in only 10% injury, but by 10 days, no protection was apparent. The 5- and 10-day carboxin pretreatments reduced injury to less than 25%, compared to 45% injury after the 1-day pretreatment. The increased protection with time after carboxin application may be related to the release of sulfoxide as a result of carboxin oxidation in the leaf.

Mapping of total nitrogen in decayed wood associated with Fomes connatus and Polyporus glomeratus in Acer rubrum. M. DESSUREAULT, A. E. RICH, & A. L. SHIGO (Univ. N. H., Durham). Two columns of decayed wood, one associated with *Fomes connatus* and the other with *Polyporus glomeratus,* were mapped systematically for nitrogen (N) using a micro-Kjeldahl method. Samples were taken from cross sections at 15- to 25-cm intervals from the base of the tree to a height of 1.5 m. We compared N content of decayed wood, on a volume basis, with that of adjacent healthy wood, after correcting for a normal decrease in N as wood ages. The average N content of decayed wood associated with *F.*

connatus and *P. glomeratus* was 5 and 2 times higher, respectively, than that of healthy wood. There was no difference in N content between healthy and decayed wood behind the *F. connatus* sporophore where specific gravity was lowest. Distal from the sporophore, decayed wood contained more N than healthy wood. In the *P. glomeratus* column, N content of decayed wood was slightly higher than that of healthy wood throughout the column, except near the lower distal portion, where a sharp increase was noted. The results suggest that some N had been added to the decaying wood during the discoloration and decay process, making it more susceptible to further degradation.

The response of Petunia to peroxyacetyl nitrate. D. B. DRUMMOND & F. A. WOOD (The Pennsylvania State Univ., University Park, Pa.). Twenty-eight cultivars of petunia (*Petunia hybrida* Vilm.): Snowdrift, White Cascade-1, White Sails, Popeye, Pink Cameo, White Joy, Pink Paradise, White Cascade-2, Red Cap, Pink Bountiful, Snow Magic, Blue Magic, Festival, Apollo, Black Magic, Red Joy Improved, Rose Joy, King of Diamonds, White Delight, Pink Cascade, Zig Zag, Glacier, Red and White Delight, Mariner, Coral Cascade, Happiness, Candy Apple, and Coral Magic were exposed to 15 μ liters/liter (pphm) PAN in a plant growth chamber for 1 hr at 24 C, 70% RH, and 3,400 ft-c light. The cultivars are listed in order of their sensitivity: Snowdrift, the most sensitive; and Candy Apple and Coral Magic, the least sensitive. The remaining cultivars were intermediate in sensitivity. The symptoms observed, in addition to those previously attributed to PAN, included a necrotic fleck, an upper-surface stipple, and a collapse of the upper surface. The injury was most severe on the sixth leaf down from the top of the plant. As injury increased, symptoms were noted both up and down the plant from leaf six. White Cascade petunia exposed to 10, 20, and 30 μliters/liter PAN for 30, 60, 90, and 120 min, and 5 and 40 μliters/liter for 120 and 30 min, respectively, responded in a linear fashion to both variables. A multiple regression analysis indicated that the two variables accounted for 70% of the explained variance. The partial correlation coefficients were 0.72 and 0.81 for time and concentration, respectively.

A Verticillium wilt of green and white ash. L. B. FORER & J. L. LONGENECKER (Pennsylvania Dep. Agr., Harrisburg). A microsclerotial form of *Verticillium* sp. was isolated from green ash (*Fraxinus pennsylvanica*) and white ash (*F. americana*) trees from three ornamental nurseries in south and central-eastern Pennsylvania. The trees exhibited wilting and vascular discoloration. Greenhouse-grown green and white ash seedlings were wound-inoculated with the *Verticillium* isolates. Of the green ash inoculated with the green ash isolates and white ash inoculated with the white ash isolate, 100% developed initial wilting 10 days after inoculation. Conversely, green ash inoculated with the white ash isolate and white ash inoculated with the green ash isolates showed no symptoms up to 4 weeks after inoculation. *Verticillium* sp. was reisolated from all plants exhibiting symptoms. Control plants remained healthy throughout the study. As far as can be determined, this constitutes the first proof of pathogenicity of *Verticillium* sp. on both white and green ash.

Effects of host tissue on germination and growth of Hypoxylon mammatum. JOHN R. FRENCH & PAUL D. MANION (State Univ. New York College Environ. Sci. Forestry, Syracuse, N.Y.). Observations of young, naturally occurring infections indicate that primary infection in the host (*Populus tremuloides*) by *Hypoxylon mammatum* commonly occurs in young stems near growing tips. To test the ability of young host tissue to modify germination and growth of the pathogen, 2nd- and 3rd-year bark and wood tissue were collected at monthly intervals, ground in a Wiley mill, propylene oxide-sterilized at room temperature, and suspended in 4% Bacto-agar solution which had been cooled at 50 C. Bark tissue media inhibited germination of *H. mammatum* ascospores more effectively than corresponding wood tissue. This inhibition was greatest in October and November 1971 (100%), disappeared during the winter, and became more distinct again in April 1972. The effect of the same media on surface radial growth of a colony was of a reverse nature. A direct relationship between surface radial growth rate and concentration of host tissue was found between 0.1-100 g/liter. Analysis of 4-year-old bark and wood tissue from two sources representing oppositely sexed trees, showed a greater ability of bark tissue to promote surface growth of the fungus than did wood tissue at the same concentration for both trees.

Disease problems in coastal vegetation in New Jersey. L. B. GLOVER & P. M. HALISKY (Rutgers Univ., New Brunswick, N.J.). Several diseases unreported from New Jersey were studied in coastal plant species. The root-gall nematode, *Subanguina radicicola,* was found in galls attached to lateral roots of living and dead beachgrass, *Ammophila breviligulata.* No aboveground symptoms were apparent. A gall midge, identified as *Rhopalomyia* sp., was found repeatedly in stems of *A. breviligulata.* As many as 47 pupae (1.5-2.0 × 4.0-7.0 mm) were observed within a single culm. In the laboratory, adult flies were reared from pupae. In sand dune areas, both actively growing and dead beachgrass harbored pupal cases. Black root and stem cankers were observed on sea rocket, *Cakile edentula.* Pycnidia developed in canker areas of dead stems during August-September. Isolations yielded pure cultures of *Phoma.* Extensive defoliation of sea rocket occurred in early summer due to infection by *Peronospora* sp. On seaside goldenrod, *Solidago sempervirens,* both leaf rust, *Coleosporium delicatulum,* and a leaf beetle, *Trirhabda canadensis,* were common. An unidentified virus producing yellow line and ring patterns was occasionally observed on *S. sempervirens.* Seaside beardgrass, *Andropogon littoralis,* was infected by *Puccinia andropogonis.*

In vitro study of benomyl tolerance exhibited by Sclerotinia homoeocarpa. C. W. GOLDENBERG & H. COLE (The Pennsylvania State Univ., University Park, Pa.). During the 1972 growing season, the first instance of lack of control of Sclerotinia dollar spot with benomyl was reported from an Akron, Ohio, golf course in early July. This followed with similar reports from locations in Illinois, New Jersey, and Pennsylvania. Isolates representative of *Sclerotinia homoeocarpa,* on the basis of morphological characteristics, were obtained from diseased grass samples from these sites. When grown on autoclaved rye grain and inoculated on bluegrass and bentgrass varieties in the greenhouse, typical dollar spot lesions appeared from which isolates similar to the originals could be obtained. Tolerance was measured by amount of radial growth on benomyl-amended agar. Isolates from the control failure locations were 100 times as tolerant as isolates from areas where no control difficulties had been experienced. Usually, benomyl concentrations of 1 μg/ml of agar completely inhibited

growth of *S. homoeocarpa*. All tolerant isolates exhibited growth at 100 μg/ml, but all were totally suppressed at the next increment of 1,000 μg/ml.

Mitochondrial dysfunction–an important event in pea seed deterioration by Aspergillus ruber. G. E. HARMAN, R. E. DRURY, & A. L. GRANETT (N. Y. State Agr. Exp. Sta., Geneva). Pea seeds infected with *Aspergillus ruber* (NRRL 52) lose their ability to germinate normally before invasion of their embryonic axes. In previous ultrastructural studies, severe damage to mitochondria in axis tissue was observed. Experiments were carried out to determine whether mitochondrial dysfunction was a primary factor in pea seed deterioration by *A. ruber*. Respiratory activity of mitochondria isolated from axes of infected peas was significantly less than from similarly stored uninfected seed, which, in turn, was less than from unstored seeds. Respiratory activity of embryonic axes, which is correlated with mitochondrial activity, decreased as early as infection could be detected. With increasing time of imbibition of whole seeds, respiratory activity of tissue from infected peas increased much less than that of tissue from uninfected peas. This evidence for mitochondrial dysfunction supports the hypothesis that damage to mitochondria induced by *A. ruber* plays a major role in the deterioration of infected pea seeds.

Virulence of the ash strain of tobacco ringspot virus. C. R. HIBBEN (Kitchawan Research Lab., Brooklyn Botanic Garden, Ossining, N. Y.). Previous studies identified the ash strain of tobacco ringspot virus (TRSV-A) in leaves of *Fraxinus americana* L. Isolation of TRSV-A from ash exhibiting dieback both in situ and in the greenhouse suggested transmission tests to determine its virulence in ash. Mechanical inoculation of mature leaves with crude sap containing TRSV-A appeared to cause gradual, localized twig dieback. Cotyledons and young leaves of ash seedlings were rubbed with purified TRSV-A in 0.01 M Tris [tris (hydroxymethyl) amino methane] buffer (pH 7.0) containing 0.1 N NaCl. Local lesions and symptoms of systemic infection began developing 1 week after inoculation. Line patterns, chlorotic mottle, and dwarfing occurred on new leaves of the same trees the following year. Most symptoms resembled those seen on ash in the field. TRSV-A was recovered from six of 16 inoculated trees, and identified by the Ouchterlony agar double-diffusion test. Eight of eleven TRSV-A-treated trees apparently recovered the following year, based on internode measurements and leaf fresh weights. The growth of three trees was severely reduced in both the year of inoculation and the following year. These early results suggest that the virulence of TRSV-A in ash is generally, but not always, low.

Rhabdovirus and mycoplasmalike organism: natural dual infection of Cajanus cajan. H. HIRUMI, K. MARAMOROSCH, & E. HICHEZ (Boyce Thompson Inst., Yonkers, N. Y., Centro Nacional de Investigaciones Agropecuarias, San Cristobal, R. D.). *Cajanus cajan* plants with a proliferation disease were observed growing wild on the north shore of Hispaniola Island in the Dominican Republic near the border of Haiti. Plants often had portions that were pale green and showed symptoms of witches'-broom. Leaves and petioles with symptoms of proliferation were fixed in the field in 1-1.5% cacodylate buffered glutaraldehyde and further processed for electron microscopy according to standard procedures. Electron micrographs of thin sections revealed the presence of mycoplasmalike organisms (MLO) as well as bullet-shaped (rhabdo) virus particles in the phloem. The rhabdovirus particles were 45-55 nm in diam and 240-260 nm in length. This is believed to be the first report of a natural, dual infection of a plant by a rhabdovirus and MLO.

Pathogenicity of old cultures of Ceratocystis ulmi and their ability to mate before and after re-passage through elm trees. F. W. HOLMES (Shade Tree Laboratories, Univ. of Massachusetts, Amherst, and Phytopathologisch Laboratorium "Willie Commelin Scholten", Baarn, The Netherlands). Dutch isolates (TX-series), stored in test tubes 8 years or more on cherry agar slants under mineral oil, and fresh isolates were transferred side-by-side onto peeled, split, autoclaved, moist elm twigs in test tubes. Each old culture was paired with two fresh cultures of compatibility type "A" and two of type "B". Only four of 24 old cultures formed perithecia. The same 24 were inoculated into greenhouse-forced *Ulmus hollandica* 'Belgica' (1.5 m tall). After 1 month, two had caused moderate wilt; five, slight wilt; and 17, no wilt; but 21 discolored the xylem and 22 could be reisolated. After reisolation, the same four plus two others formed perithecia when mated; all six were of type "A". Retention of pathogenicity and retention of compatibility were not related. Ten freshly isolated Dutch cultures of *Ceratocystis ulmi* were crossed with each other by the same method, and all 10 repeatedly mated, either with all "A" cultures or with all "B" cultures, but not with both. The fresh isolates caused typical disease symptoms in the greenhouse-forced trees. Old cultures should not be used to test resistance of elms to *C. ulmi*.

Association of Lophodermium pinastri with eastern white pine. J. J. JAEGER & W. M. BANFIELD (Univ. Mass., Amherst). *Lophodermium pinastri* was found to be weakly parasitic on *Pinus strobus*. Seedlings exposed to ascospores in a chamber open to outside air developed silver-cream spots on their new needles. *L. pinastri* was cultured from these needles; pycnidia and apothecia formed after the needles fell. Needles in which *L. pinastri* was present were examined histologically until apothecia formed. Mycelium, first seen at the time of needle abscission, mostly intercellularly in mesophyll tissue, continued to increase in quantity until apothecia matured. Insignificant quantities of mycelium found at the time of needle abscission and the absence of lesion intensification during the 3 years these needles were retained in carbon-filtered air suggest an unlikely relationship to severe needle pathology. Seedlings exposed to ascospores in closed chambers developed no spots, but *L. pinastri* was cultured from their needles. Seedlings on which symptoms of SO_2-O_3 injury were present after fumigation in 1971 were exposed to ascospores in July 1972. Their new needles have remained unblemished, although *L. pinastri* was recovered from them and from SO_2-O_3 lesions on the old needles. There has been no symptom intensification on these needles that can be attributed to *L. pinastri* as of September 1972.

Transmission of tomato ringspot virus to raspberry by Xiphinema americanum. J. A. KEPLINGER & A. J. BRAUN (New York State Agr. Exp. Sta., Geneva). Tomato ringspot virus (TomRSV) was transmitted by *Xiphinema americanum* from infected cucumber seedlings to red raspberry plants grown at 21 C in a temperature tank in the greenhouse. Raspberry plants propagated from root cuttings of an indexed clone of the cultivar Hilton were planted in 6-inch plastic pots containing nematode-free soil. When the plants were well established,

cucumber seeds (cultivar Marketmore) were planted in 16 of these pots. After the seedlings emerged, 100 active *X. americanum* were introduced into each of eight of these pots. Within 1 week, the cucumber seedlings in four of the nematode-infested pots and in four of the nematode-free pots were inoculated with an isolate of tomato ringspot virus (TomRSV) from Hilton raspberry. When indexed 6 weeks after inoculation, no virus reaction was obtained on *Chenopodium quinoa* from any of the 16 raspberry plants. After 20 weeks, TomRSV was recovered from three of the four plants in the nematode-infested, virus-inoculated series. The identify of the virus was confirmed by host range and serological tests. Virus was not recovered from any of the plants in the "virus-inoculated only" or "nematode-infested only" series, nor from the controls. *X. americanum* was present in low numbers in the nematode-infested series after 13 weeks.

Application and implementation of computerized forecasts of potato late blight. R. A. KRAUSE & L. B. MASSIE (The Pennsylvania State Univ., University Park). Computerized analyses of local weather data are currently used in Pennsylvania to predict potato late blight occurrence and make spray recommendations. Regional forecasts, based on weather gathered at one location, have predicted epidemics for the past 20 years. However, for effective disease control, excessive sprays may have been applied. Today's concern over excess pesticide use suggests that regional forecasts should be improved. Microclimatological conditions monitored at stations separated by less than 6 miles give drastically different blight forecasts and spray recommendations. Therefore, establishment of localized weather monitoring stations have provided more accurate blight forecasts and spray recommendations. Each local blight station in Pennsylvania is linked to the computer via telephone. Growers receive daily or weekly forecasts during a 3-min telephone call. Contrary to the past practice of spraying at 10-day intervals, the present system results in judicious use of fungicides and excellent blight control. The system is modest in cost, can handle an enormous number of stations, and gives immediate and accurate forecasts.

Extraction and identification of some phenols from tomato stems infected with Verticillium albo-atrum Reinke & Berth. K. KUMAR & G. MC INTYRE (Univ. of Maine, Orono, Maine). Six-week-old Bonny Best and Loran Blood tomato plants were inoculated by immersion of the roots for 30 sec in 10^7 bud cells/ml of *Verticillium albo-atrum* Reinke & Berth. Plants were harvested 1, 2, 3, 4, 5, and 6 weeks after inoculation. Freeze-cut cross and longitudinal sections (30 to 40 μ) of stems and petioles were stained with 2% aniline, aniline-$K10_3$, 2% $FeCl_3$, nitrous acid, or Hoepfner-Vorsatz reagents. Phenols were extracted from stems using 80% ethanol and ethyl acetate. Paper chromatography of extracts were carried out using butanol, acetic acid, and water (4:1:5). Phenols observed in diseased Bonny Best and Loran Blood stems were localized in scattered cells external to the conducting elements of the phloem. Histochemical and chromatographic data indicate that pyrogallic acid, cinnamic acid, and caffeic acid were major phenols in these cells. Phenols were first detected 2 weeks after inoculation, and no phenols were detected after 4 weeks. With one exception, phenols were not found in healthy tomato stems. Chlorogenic acid was detected in both inoculated and healthy tomato stems of Loran Blood. Differences in phenol content found in resistant versus susceptible diseased tomato stems suggest that phenols play a role in the vascular discoloration of susceptible diseased tomato stems.

Tolerance of Verticillium malthousei isolates to benomyl in relation to linear growth, geographical origin, spore volume, or zineb tolerance. D. H. LAMBERT & P. J. WUEST (The Pennsylvania State Univ., University Park). Thirty single-spore cultures of *Verticillium malthousei* from Korea, England, South Africa, Europe, the United States, and one culture of *V. psalliotae* were grown on potato-dextrose agar (PDA) at 12, 21, and 30 C, and on 1 μg/ml benomyl-amended PDA at 21 C. Both *Verticillium* species are pathogens of the commercial mushroom, *Agaricus bisporus*. Fifteen isolates demonstrated benomyl tolerance in addition to lower growth rates on unamended PDA as contrasted with 15 of the remaining 16 isolates, which were benomyl-sensitive. Relative growth rates of the 30 isolates at 21 and 30 C suggested groupings that may be referred to as ecological or geographical races. The mean summer temperature within the area of an isolates' origin was directly related to its growth at 30 C. Growth of isolates from areas with mean July temperatures (MJT) of 16 to 20 C was minimal; where MJT was 21 to 23 C, more growth occurred. Two Korean isolates demonstrated the greatest growth of all isolates at 30 C; MJT ca. 24 C. Spore volume of isolates was not clearly related to benomyl tolerance, growth rate, or culture origin. In vitro tolerance to benomyl and to zineb was not related.

A disease of white ash caused by tobacco mosaic virus. A. O. LANA & G. N. AGRIOS (Univ. Mass., Amherst). White ash (*Fraxinus americana*) trees in several locations in Massachusetts were found showing ring and line pattern mosaic symptoms. The virus causing these symptoms was transmitted by grafting to white ash and green ash (*F. pennsylvanica*) and through sap to several varieties of *Nicotiana tabacum, N. glutinosa, Gomphrena, Petunia,* Pinto bean, *Chenopodium amaranticolor*, and *C. quinoa*. The symptoms produced in these hosts paralleled in most respects the symptoms produced by a known tobacco mosaic virus (TMV) isolate. In crude *Chenopodium* and tobacco sap, the virus has a dilution end point of 10^{-6}-10^{-7} and a thermal inactivation point between 96 and 98 C, and is still infective after 9 months at room temperature. Partially purified preparations of the virus from ash reacted positively with TMV antiserum in gel double-diffusion tests. Electron micrographs of partially purified virus from infected ash and tobacco revealed that the size and shape of the virus particle are similar to those of TMV. This is the first case in which TMV has been found to actually cause disease symptoms on a tree.

Reducing the amount of infectious Fusarial propagules on surface of certified seed potatoes. S. S. LEACH & L. W. NIELSEN (USDA, ARS, Orono, Me., North Carolina State Univ., Raleigh). Certified seed potatoes from Maine received in North Carolina have been reported as having the highest amount of *Fusarium* tuber contamination when compared to seed grown in other areas. A cooperative study was initiated in 1971 with North Carolina State University to determine methods of reducing tuber contamination. A seed source of highly contaminated Pungo potatoes was used in this study. Physical and chemical treatments were applied to test seed potatoes. Physical treatments were: check, brushed and washed, chemical treatments were: check, TBZ

[2-(4-Thiazolyl) benzimidazole]; M-45 [zinc ion + (manganous ethylenebis [dithiocarbamate])], and Polyram at 2 lb/100 gal. All combinations of physical and chemical treatments were made. Precut seed with the same treatments was also included in the tests. One-half the treated seed was sent to North Carolina, and one-half was tested in Maine for surface contamination and effects of treatments on stand, disease incidence, and yield. Results revealed that TBZ reduced the number of infectious propagules to less than 0.05/seed piece, as compared to 15.5 for untreated checks. TBZ-treated precut seed also had the least contamination. TBZ-treated seed produced highest stand counts and yields, in North Carolina tests. In Maine tests, stands were best with TBZ-treated seed although emergence was delayed.

Growth responses of alfalfa pathogens to saponin extracts from alfalfa. K. T. LEATH (ARS, USDA, U.S. Regional Pasture Res. Lab., University Park, Pa.). Saponin fractions extracted from DuPuits and Lahontan alfalfas were assayed for stimulation or inhibition of the vegetative growth of *Rhizobium meliloti, Trichoderma viride*, and 15 fungi pathogenic to alfalfa. The saponins were obtained as four mixtures from each variety; the proportions of individual saponin components within each mixture varied. Fractions of greater purity were assayed for inhibition of *T. viride*. All test concentrations were below those that occur naturally in alfalfa. Growth responses of the test organisms varied with the organism, the saponin mixture, the concentration, and the source variety. The responses of test organisms ranged from significant stimulation to complete inhibition. In general, the activity of the four saponin mixtures from the same variety varied only in degree; saponins from DuPuits exhibited more activity than did those from Lahontan. Fungicidal, as well as fungistatic, properties of the saponins were demonstrated. *Pythium debaryanum, P. irregulare*, and *P. ultimum* were completely inhibited by most of the saponin mixtures, as was *R. meliloti*. Purified saponins containing medicagenic acid were the most toxic to growth of *T. viride*. This compound was found only in some of the saponins from the DuPuits alfalfa.

Electron microscopy of purple-top wilt of potato in relation to the suspected mycoplasmalike pathogen. T. C. C. LI & R. C. MC CRUM (Univ. of Maine, Orono, Maine). Six-spotted leafhoppers (*Macrosteles fascifrons* Stål) were used to transfer two isolates of the aster yellows agent from infected asters to healthy potatoes. Out of 26 potatoes inoculated, three developed typical purple-top wilt symptoms. The incubation period in potato varied from 28-45 days. After the onset of symptoms and within 1 week of developing wilt, all plants exhibited severe root necrosis. No secondary organisms were observed in or around these roots. Extensive electron microscope studies of phloem tissues from leaves, stems, and roots of infected potatoes exhibiting purple-top wilt as well as healthy checks were carried out to locate suspected mycoplasmas. No such bodies were found. Phloem cells from potatoes showing purple-top wilt did not differ appreciably from normal phloem cells. No virus particles were observed in the cells examined. Mycoplasmalike bodies were found in asters used for inoculum sources, and in asters used as checks for vector transmission. Leaf cuttings taken from affected potato shoots produced roots and new, healthy shoot growth. It is suggested that symptoms result from toxic substances produced during limited infection or from lysis of the short-lived suspected pathogen.

Injury to turf grasses by Tylenchorhynchus dubius and Hopolaimus spp. R. J. LUKENS & P. M. MILLER (The Conn. Agr. Exp. Station, New Haven). Plugs of Kentucky bluegrass (*Poa pratensis* L.), Hyland, Astoria, and Penncross bentgrass (*Agrostis* spp.), and perennial ryegrass (*Lolium perenne* L.) were grown in soil infested with the nematodes *Tylenchorhynchus dubius* and *Hoplolaimus* spp. Under greenhouse conditions, bluegrass roots were discolored and top growth was decreased slightly. Roots of all the bentgrasses were brown and stunted severely, and top growth was chlorotic and stunted. Growth and vigor of ryegrass was unaffected by the nematodes. Application of aldicarb, DuPont 1410 [S-methyl-1-(dimethylcarbamoyl)-N-([methylcarbamoyl] oxy)thioformimidate] and benomyl to infected turf improved the growth of bentgrass but not that of bluegrass or ryegrass. Bluegrass sod in the field containing high natural populations of *T. dubius* and *H.* spp. showed no improvement when treated with the nematicides. Evidently, under conditions in Connecticut, turf grasses can tolerate high populations of pathogenic nematodes with little adverse effects.

Botrytis cinerea protects broad beans against visible ozone injury. W. P. MAGDYCZ & W. J. MANNING (Univ. Massachusetts, Amherst, and Waltham). The first two sets of bifoliate leaves of broad beans (*Vicia faba*) were inoculated with a spore suspension of *Botrytis cinerea* at 100,000 spores/ml and incubated at 20 C for 48 hr. The plants were then exposed to 20 pphm ozone for 8 hr. Ozone injury on broad bean is characterized by large, tan-black-colored bifacial necrotic areas generally covering a major portion of the leaf surface. Plants that were infected with *Botrytis* were less injured by exposure to ozone than noninoculated exposed plants. Where infection was well established, distinct haloes surrounding the points of infection were consistently found. The width of the haloes varied depending upon the size of the lesion, and were apparent immediately after exposure. These observations suggest that the apparent protection may be due to some diffusible substance emanating from the point of infection.

Suppression of oxidant air pollution injury on bean plants by systemic fungicides under field conditions. W. J. MANNING & P. M. VARDARO (Univ. Massachusetts, Waltham). Field plots of bean plants [*Phaseolus vulgaris* 'Pinto 111' and 'Tempo'] were used to determine the effectiveness of benomyl [Benlate], carboxin [Vitavax], and triarimol [EL-273] in the suppression of foliar oxidant injury under natural conditions in Waltham in June-August. Benomyl, at 0.5, 1, 2, and 3 lb./100 gal, carboxin, at 8 and 24 ppm, and triarimol, at 50, 75, and 100 ppm, were applied once a week for 4 weeks as foliar sprays, beginning 5 days after seedling emergence. Benomyl sprays, at 2 and 3 lb./100 gal once a week, provided 70-80% suppression of oxidant injury. All other foliar sprays were ineffective. Triarimol sprays, at 75 and 100 ppm, resulted in cupping, dwarfing, and greening of leaves. Carboxin 10% granular, at 2.7, 5.3, and 7.9 g/15-ft row, was applied over seed at planting. The 7.9-g rate provided complete suppression of oxidant injury. This effect lasted 40 days and broke down at flowering and pod set. The use of carboxin at this rate also resulted in yellowing and burning of primary leaves. Carboxin 75% WP seed treatments, at 2, 4, 6, and 8 oz/100 lb. seed, were ineffective in suppressing oxidant injury. All experiments were repeated twice during the June-August period.

A computer program for the forecasting of late blight of potato. L. B. MASSIE & R. A. KRAUSE (The Pennsylvania State Univ., University Park). Techniques for forecasting initial occurrence and subsequent development of late blight of potato caused by *Phytophthora infestans* were developed by Hyre and Wallin more than a decade ago. Although continued testing of these techniques confirmed their reliability, their use has not been widespread, perhaps due to uncertainty of their application or difficulty of their implementation. A Fortran IV computer program has been written that incorporates modifications of both forecasting methods and forecasts late blight occurrence, and produces a day-to-day synopsis of late blight favorability and fungicide spray application recommendations based on daily weather data. Utilization of the telephone to transmit weather data, and of the computer to calculate the late blight favorability, enables virtually instantaneous dissemination of late blight forecasting information. Results of testing this procedure in twelve locations throughout the state of Pennsylvania during the summer of 1972 have been highly encouraging.

The use of regression analysis in epidemiological studies of southern corn leaf blight. L. B. MASSIE & R. R. NELSON (The Pennsylvania State Univ., University Park). In epidemiological studies, the effect of an environmental factor upon a given process in a disease cycle too often is measured without regard to the interactive effects of other such factors upon the process. Such an approach identifies, usually by analysis of variance, general response trends, but fails to reveal adequately the over-all response of a given process to the combined effects of several factors. Mathematical models for each of several processes in the disease cycle of southern corn leaf blight, caused by race T of *Helminthosporium maydis*, have been constructed by use of linear least squares multiple regression analysis. These models can predict accurately the results of each process when given the level of each factor significant to the process. Models have been developed for sporulation, spore take-off, spore germination, and infection from data obtained from laboratory, greenhouse, controlled environment, and field experiments, and result in R^2 values ranging from 82.1 to 99.9.

Scanning electron microscopy of sporophores of Streptomyces spp. causing potato scab. G. A. MC INTYRE & CAROLEE RUSANOWSKI (Univ. of Maine, Orono). Sporophores from 5- to 14-day-old cultures of strains of *Streptomyces globisporus* (ATCC 15864 and 19906), three strains of *S. griseus* (ATCC 10137, 3352, and 10246), two pathogenic strains of *S. scabies* (ATCC 15485 and a field isolate), and a pathogenic strain of *Streptomyces* sp. were examined with the light microscope (×400) and a Cambridge Stereoscan S4 scanning electron microscope (×500-10,000) to compare morphology of spores and sporophores. Whereas the light microscope proved satisfactory for comparisons of general sporophore configuration, the scanning electron microscope proved superior in establishing spore size and absence of markings on the walls of individual spores. Comparisons of fresh material versus material fixed in osmium tetroxide in either phosphate (pH 7.0) or sodium cacodylate (pH 6.5) buffers indicate superior preservation of sporophores and spores from fixed material, although sporechains were more fragmented by fixation. Scanning electron microscopy is superior to light microscopy for elucidation of morphological similarities and differences between strains and species of *Streptomyces*.

Suppression of Physalospora obtusa by Trichoderma sp. P. M. MILLER & S. L. ANAGNOSTOKIS (The Conn. Agr. Exp. Sta., New Haven). *Trichoderma* sp. was tested as a biological antagonist for *Physalospora obtusa*, the cause of apple black rot. A spore suspension of *Trichoderma* suppressed the growth of *P. obtusa* on agar. On autoclaved apple twigs, *P. obtusa* alone grew well, but was suppressed when it was inoculated together with *Trichoderma*. When *P. obtusa* was inoculated into the ends of nonsterile, freshly cut apple twigs, only *Trichoderma* could be isolated 3 weeks later. When apple twigs with black rot cankers were inoculated with *Trichoderma*, the production of *P. obtusa* conidia from these cankers was suppressed 4 weeks later. Drenching apple twigs and branches with a solution (1 g/liter) of a complete fertilizer (23-19-17) increased the suppression of *P. obtusa* by *Trichoderma*.

Survival and spore dissemination of Mycosphaerella zeae-maydis. D. M. MUKUNYA & C. W. BOOTHROYD (Cornell Univ., Ithaca). *Mycosphaerella zeae-maydis*, the cause of yellow leaf blight of corn, survived adverse winter conditions in pycnidial and ascigerous stages in corn debris. The fungus was cultured from surface debris, but it did not survive more than 1 month in debris buried in soil or as spores mixed with soil. The conidia were infectious and were probably splashed by rain to corn seedlings in the field. Ascospores from pseudothecia formed on sterile corn tissue in the laboratory were discharged to a height of at least 1.6 cm. Ascospores in the field were wind-borne, and were recovered readily by a Hirst spore trap. Pycnidia formed in most leaf lesions that developed throughout the growing season; pseudothecia with mature ascospores were occasionally found. Discharge of ascospores in the field was influenced by time of day, temperature, and relative humidity. Discharge occurred primarily at night from 12 June to 10 July, with a peak between 6 and 8 AM. The number of ascospores recovered was inversely related to temperature and directly related to relative humidity, 50-60 F and 80-100% RH being associated with greatest spore recovery. Ascospores were discharged immediately after a rainfall; however, more spores were recovered during intervals of low rainfall (<13 mm) than of high rainfall (>13 mm).

The effect of leaf age and leaf position on the development of southern corn leaf blight. R. R. NELSON & GABRIELLE TUNG (The Pennsylvania State Univ., University Park, Pa.) Controlled environment and field experiments evaluated the effect of leaf age and position on colonization and sporulation of race T of *Helminthosporium maydis* on a susceptible male-sterile corn hybrid. The extent and rate of colonization are greatest on lower leaves, and both decrease proportionately to increasing leaf height. Similarly, sporulation per given area of diseased tissue is maximum on lower leaves and decreases with increasing leaf height. Physiological age of the leaf may be an important factor, as colonization and sporulation are less, for example, on the sixth leaf of a six-leaf plant than on the sixth leaf of a twelve-leaf plant. Sporulation increases with successive sporulation periods at a greater rate on lower leaves, and is maximum on dead leaves. The fact that maximum disease and sporulation occurs on lower leaves within the

canopy of the field may account, in part, for the greater spread of disease from plant to plant rather than from one point to another.

Comparisons of DNA-dependent RNA polymerase from a virulent and an avirulent strain of Agrobacterium tumefaciens. R. M. NILES & M. S. MOUNT (Univ. Mass., Amherst). RNA polymerase from virulent and avirulent isolates of *Agrobacterium tumefaciens* (strain 806) were partially purified through DEAE cellulose chromatography. The activity of both polymerases was stimulated by 0.2 M KCl and inhibited by rifamycin. The DNA from virulent *A. tumefaciens* was the best template for the polymerase from the virulent strain, whereas the DNA from the avirulent strain was the best template for the polymerase from the avirulent strain. Chromatin from healthy *Vicia faba* was transcribed effectively by the RNA polymerase from the virulent strain, but poorly by the polymerase from the avirulent strain. Chromatin from tumorous tissue was utilized effectively as a template by polymerases from both strains. Maximum activity of both bacterial polymerases was attained in the presence of both Mg^{++} and Mn^{++}. Optimal concentration of Mn^{++} was 10 mM, and 25 mM for the RNA polymerases from the virulent and avirulent strain, respectively, whereas the optimal concentration of Mg^{++} was 20 mM for both enzymes.

Histopathology of scar skin disease of apple. P. E. PARKER & G. N. AGRIOS (Univ. Mass., Amherst). The first symptoms of Red Delicious apples infected with scar skin virus (SSV) are small, red protuberances on the skin. Later, reddish-brown streaks form that radiate from the calyx. The streaks coalesce into large blotches, and small, brown, scablike tissue forms in them. Subsequently, the scabs enlarge to cover most of the blotch area. Small fissures develop in the centers of the scabs which later become deep cracks. Apple fruit tissue fixed in FAA or Acrolein and embedded in Tissuemat was sectioned at 10 μ and stained with safranin and fast green. Epidermal cells in affected areas first appear reddish, but soon turn a necrotic brown. At the same time, a few hypertrophic and hyperplastic cells appear at the base of these areas which push the outer cells upward, forming a protuberance at the surface. As the raised areas enlarge, layers of meristematic tissue, probably phellogen, separate the affected area from the underlying tissue. Cells within the affected area are deeply stained and distorted. As a result of excessive cell division and enlargement at the base of these areas, the cuticle erupts and a fissure in the epidermal layer appears. This fissure enlarges until a large crack is formed and the exposed cells become distorted and necrotic.

Cassava mosaic virus. BILJANA PLAVSIC-BANJAC & K. MARAMOROSCH (Univ. of Sarajevo, Yugoslavia, Boyce Thompson Institute, Yonkers, N.Y.). Cassava mosaic disease, widespread in East and West Africa, Southeast Asia, and tropical America, affects the yield of manihot (tapioca), an important staple food. The causative agent, transmitted by *Bemisia* sp., has not been isolated or characterized morphologically. Diseased *Manihot utilissima* material was collected in Ibadan, Nigeria. Portions of leaves were immersed in 3% glutaraldehyde and dissected in the fixative. Further processing as well as light and electron microscopy observations were carried out in Yonkers, N.Y. Light microscopy revealed inclusions in parenchyma cells, and electron micrographs showed large accumulations of rigid rods, often in bundles that appeared hexagonal in cross sections. No suitable control material was available as most, if not all, cassava plants in the field seemed to be infected. However, healthy-appearing plants, from a screened greenhouse of the International Institute for Tropical Agriculture in Ibadan, were examined and no inclusions or viruslike particles were found. It is assumed that the rigid rods represent the causative agent of cassava mosaic. If confirmed, this represents the first visualization of a white fly-transmitted virus.

Growth response of genetically different Coprinus lagopus isolates to various temperature regimes. P. E. REYNOLDS, W. H. SMITH, & K. F. JENSEN (Yale Univ., New Haven, Conn., U.S. Forest Service, Delaware, Ohio). The effect of constant and fluctuating temperature regimes on in vitro growth of eight genetically different isolates of *Coprinus lagopus*, varying in nuclear and cytoplasmic composition, was investigated. A range of constant temperature (20-44 C) was used, with optimal growth (linear expansion on plates) occurring at 37 C for both homo- and reciprocally constituted dikaryons. When ranges of fluctation consisting of ±3, 6, and 9 C around means of 32 and 37 C were employed, marked differences in growth pattern, not observed with constant temperatures, were observed among isolates differing in cytoplasmic composition. These differences appeared when the isolates were grown at pH 5.5 and 7.0. Invariably, initial temperature fluctuations reduced growth. In some cases, however, subsequent larger fluctuations enhanced it. In no case was the enhancement greater than growth at the constant mean temperature. Since isolates with the same nuclear constitution, but varying cytoplasmic composition, reacted differently to the various fluctuating temperature regimes, it is thought that growth response to temperature variations may be cytoplasmically inherited.

Effect of ozone on phosphorus levels of Pinto bean stems and foliage. C. P. RIPALDI & EILEEN BRENNAN (Rutgers Univ., New Brunswick, N.J.). Phosphorus levels of young mature (11- to 14-day-old) Pinto beans (*Phaseolus vulgaris* 'Pinto') were examined after ozonation (0.20-0.25 ppm/1.5-3 hr). The plants had been grown in sand culture and supplied with a standard nutrient solution having a phosphorus concentration of 15.5 ppm. Phosphorus determinations were carried out on three fractions from each plant: stem, primary leaves, buds, and trifoliate leaves. Determinations included both standard phosphorus analyses (J. Official Agr. Chemists Assoc.) and radiotracer techniques using liquid scintillation counting. Samples for phosphorus determinations were harvested at 0, 6, 24, and 48 hr after ozonation. A significant increase of phosphorus levels in the primary leaves occurred in ozonated bean plants. This increase was sometimes evident immediately after ozonation, but always within 48 hr after ozonation when characteristic ozone-induced bleaching and stipple had developed on primary leaves. Experiments conducted on plants grown in nutrient solution culture and soil showed no significant increases in phosphorus levels of ozonated plants.

Graft transmission of ash witches'-broom to ash. R. A. SCHALL & G. N. AGRIOS (Univ. Mass., Amherst). A considerable number of white ash (*Fraxinus americana*) trees located in a wooded area in Massachusetts were found to be dead, dying, or having sparse foliage. Several of these trees also had abnormal basal sprouts exhibiting: a compact upright growth; small, simple rather than large,

compound leaves; bud-break from axillary buds that are normally dormant; and a yellowish rather than a dark-green color. In the summer of 1971, eleven groups of white ash and green ash (*F. pennsylvanica* var. *lanceolata*) seedlings were grafted with buds or bark patches obtained from trees showing witches'-broom symptoms. In one of three experiments using green ash, a new host of ash witches'-broom, four of seven inoculated plants developed witches'-broom by the fall of 1972. In eight experiments using white ash, four gave positive results with five of 12, three of nine, two of seven, and four of 10 plants showing symptoms. Of 20 apparently healthy ash seedlings gathered in the same area where the witches'-broom was found and transplanted to another area and left noninoculated, one is showing symptoms. It appears that, in the above wooded area at least, witches'-broom may be an important factor in the decline and death of white ash trees.

Nondegradation of cell wall polysaccharides by Erwinia amylovora. E. A. SEEMULLER, S. V. BEER, T. M. JONES, & D. F. BATEMAN (Cornell Univ., Ithaca, N.Y.). Shoot tips of *Cotoneaster pannosa*, highly susceptible to fire blight, were inoculated with *E. amylovora* and maintained in the greenhouse at 24 ± 3 C for 9 days. Cell wall polysaccharides were prepared by grinding stem tissue in liquid N_2 and washing with buffer, water, chloroform/methanol, and acetone. The composition of the hemicellulosic and pectic substances was determined by gas-liquid chromatography of the alditol acetate derivatives after hydrolysis of the polysaccharides with trifluoroacetic acid and a crude enzyme preparation from *Sclerotium rolfsii*. Cellulose was determined after destruction of noncellulosic polysaccharides with acetic and nitric acids. Cell wall polysaccharides from healthy and infected stem tissue had, respectively, the following percentage compositions: cellulose, 30.6, 27.8; xylose, 11.0, 9.7; galacturonic acid, 8.0, 7.9; arabinose, 4.7, 4.6; galactose, 2.4, 2.5; mannose, 1.7, 1.7; glucose, 1.5, 1.3; and rhamnose, 0.7, 0.7. No pectolytic, cellulolytic, or xylolytic activity was detected either in extracts of infected shoots or in the ooze produced during infection of immature pear fruit. Maceration of infected pear fruit tissue was not observed. These observations indicate that cell wall degradation may not be an important factor in the development of fire blight.

Isolation and characterization of bacteria associated with root rot and wilt of alfalfa. P. A. SHINDE & F. L. LUKEZIC (The Pennsylvania State Univ., University Park, Pa.). Isolations from discolored roots of stunted plants with small, pale green leaves consistently yielded green-fluorescent pseudomonads and Erwinia bacteria; the former were more prevalent. Phenotypic characterizations of representative pseudomonads are: oxidase and catalase-positive, produce laven, lipase, and acid from sucrose. These isolates were unable to hydrolize starch, liquefied gelatin, and produced pectolytic enzymes and a green diffusible pigment on King's B medium that fluoresced blue. These tests indicated that the isolates were close to the *Pseudomonas marginalis* group. The Erwinias were straight rods, motile with peritrichous flagella, catalse-positive, oxidase-negative, did not hydrolyse starch or produce lipase or levan; acid was produced from glucose, sucrose, xylose, sorbitol, but not from lactose or rhamnose; metabolism of glucose was fermentative. They reduced NO_3 to NO_2, liquefied gelatin, and produced pink, diffusible pigment on special media. They are facultative anaerobes and did not produce pectolytic enzymes. These tests suggest that the bacteria belong to Dye's *E. amylovora* group. Laboratory and greenhouse tests indicate that the bacteria contribute to plant decline.

Localization of infection in American elms resistant to Ceratocystis ulmi. W. A. SINCLAIR, J. P. ZAHAND, & J. B. MELCHING (Cornell Univ., Ithaca, N.Y.). Species of *Ulmus* resistant to *Ceratocystis ulmi* are known to possess mechanisms for limiting the size of lesions in the xylem. Evidence for such localization of infection was sought in trees of *U. americana* L. susceptible (S) or putatively resistant (R) to *C. ulmi*. Internal spread of the pathogen from points of artificial inoculation was traced by culturing xylem tissue systematically. Inferences about multiplication of *C. ulmi* were based on numbers of colonies from propagules of the fungus flushed with sterile water out of stem segments cut 2-11 days after inoculation. On average, *C. ulmi* was cultured from tissue of 38 and 16% of shoots from inoculated branches of S and R trees, respectively, 4 days after inoculation. Propagules recovered per 10-cm segment from inoculated branches of S and R trees averaged 1,525 and 47, respectively. Corresponding figures for inoculated main stems of young clonal stock were 1,961 and 636 propagules. The cross-sectional area of current-season xylem discolored in inoculated branches and stems was also greater in S than in R trees and clones. These data corroborate the report of resistance in the R trees and support the hypothesis that multiplication and/or spread of the pathogen is inhibited within such trees.

Synthesis of DNA in differentiating bean rust uredospores. R. C. STAPLES & Z. YANIV (Boyce Thompson Institute, Yonkers, N.Y.). Although several nuclear divisions occur during formation of infection structures, bean rust uredospores germinate and differentiate in the absence of a net synthesis of nucleic acids. Nevertheless, uredospores incubated with uridine-5-^{3}H-incorporated tritium into all classes of RNA. Synthesis of DNA was detected in the first 4 hr in both differentiated and nondifferentiated spores, but by 12 hr, synthesis of DNA occurred only in differentiated spores. Detection of DNA synthesis with ^{3}H-uridine is possible because uridine is readily converted to adenine by the spore. Three species of DNA have been resolved in equilibrium centrifugation in cesium chloride. Their buoyant densities were 1.723 g/cm^3, 1.698 g/cm^3, and 1.665 g/cm^3, respectively, and their identities are being determined. Synthesis of ribosomes apparently is not mediated by formation of infection structures.

After infection control of apple scab with fungicides applied at different intervals. M. SZKOLNIK (New York State Agr. Exp. Sta., Geneva). Rome Beauty apple trees in the greenhouse were inoculated with 65,000 conidia/ml of *Venturia inaequalis* and held until sprayed in a moist chamber at 18 C. Trees removed at 14, 16, 18, 20, 22, and 24 hr and left unsprayed developed 36, 53, 60, 77, 72, and 91 scab lesions/leaf (LPL), respectively. A dilute spray of phenylmercuric acetate, 15 ppm (Tag 10%, 2 oz/100 gal) allowed only 0, 0, 1, 1, 1, and 2 LPL. Dodine, 293 ppm (Cyprex 65W, 6 oz/100 gal) allowed 1, 1, 9, 19, 25, and 29 LPL. Benomyl, 225 ppm (Benlate 50W, 6 oz/100 gal) allowed 10, 18, 33, 42, 56, and 50 LPL. Captan, 1,200 ppm (Captan 50W, 2 lb./100 gal) allowed 14, 33, 42, 47, 66, and 62 LPL. Zinc-maneb, 1,440 ppm (Dithane M-45 80W, 1.5 lb./100 gal) allowed 11, 23, 45, 44, 77, and 69 LPL. True after-infection control occurs only after a fungus completes the infection process. No

finite time for infection can be declared because considerable physiological variability among the conidia in the suspension allows infection with some spores during only 6 hr of wetting at 18 C, whereas the majority of conidia need more than 10 hr. Consequently, it is not possible to assign an accurate effective after-infection time value for each fungicide.

Fungicidal inhibition of production of new conidia from established foliar apple scab lesions. M. SZKOLNIK, J. R. NEVILL, & L. M. HENECKE (New York State Agr. Exp. Sta., Geneva). Three weeks after greenhouse inoculation of Rome Beauty foliage with *Venturia inaequalis*, all existing conidia were removed from the scab lesions by atomization with water, and the trees sprayed the same day with dilute fungicides. A week later, all spores were harvested from the leaves and the conidial concentration of the suspensions was determined by haemocytometer count. This, together with known counts of scab lesions per leaf, provided data on production of new spores per lesion (SPL). Unsprayed atomized leaves produced 51,000 new SPL; those sprayed with water, 55,000. Dodine, 390 ppm (Cyprex 65W, 8 oz/100 gal) was the most effective fungicide, allowing only 2,000 new SPL. Benomyl, 300 ppm (Benlate 50W, 8 oz/100 gal) and 150 ppm allowed 10,000 and 15,000 new SPL, respectively. New SPL production with other fungicides was: 36,000 with zinc-maneb, 1,440 ppm (Dithane M-45 80W, 1.5 lb/100 gal); 46,000 with triarimol, 40 ppm (Eli Lilly EL-273 25W, 2.2 oz/100 gal); and 100,000 with captan, 1,200 ppm (Captan 50W, 2 lb./100 gal). In these tests involving no removal of fungicide by rain, two applications 1 week apart of these fungicides to the same leaves did not materially alter the level of new spore production from that after a single spray.

Ozone fleck on tobacco reduced by benomyl and carboxin in soil. G. S. TAYLOR & S. RICH (The Conn. Agr. Exp. Sta., New Haven). Field plots on Merrimac fine sandy loam under a shade tent were amended in five replications by raking in benomyl 25 ppm (w/w of soil) or carboxin at 5 and 10 ppm just before setting tobacco, *Nicotiana tabacum* '7272' susceptible to ozone fleck, on 6 June 1972. The amount of fleck rated on 17 July on the first six leaves was reduced 61, 33, and 32%, respectively, by benomyl, carboxin, 5 ppm, and 10 ppm. On leaves three-six, benomyl had the least fleck. On leaves 6-11, rated 12 August, benomyl reduced fleck by 63%, but carboxin 10 ppm increased fleck 58%. By 7 September, there was no observable difference in the amount of fleck on leaves 9-20. Plants in the benomyl plots grew taller and wilted less than plants in the check or carboxin plots. Carboxin at 10 ppm decreased growth, increased wilting, and produced marginal yellowing and cupping on leaves 1-10. Plants in the benomyl plots had many more fine roots and harbored fewer cyst nematodes (*Heterodera tabacum*) than did plants in the check or carboxin plots. Soil applications of benomyl appear useful for increasing plant growth on nematode-infested soil while reducing air pollution injury on early season leaves.

Relating ozone resistance to antisenescence in beans treated with benzimidazole. H. TOMLINSON & S. RICH (The Conn. Agr. Exp. Sta., New Haven). Pinto bean plants (*Phaseolus vulgaris*) treated with concentrations of benzimidazole (Bd) that make them resistant to ozone were tested for rate of senescence. Root drenches of Bd at 10 and 20 ppm (w/w of sand) were applied to 14-day-old seedlings which were then kept in the dark 7-10 days before measuring their chlorophyll content. Those plants treated with either concentration of Bd retained 2 to 4 times more chlorophyll than the plants without Bd. In other experiments, bean leaf discs floated for 7-10 days in the dark on solutions of Bd at 50, 100, and 200 ppm contained 3 to 5 times more chlorophyll than did discs floated on water. During ozonation and senescence, there is normally a significant loss of free sterol in plant cell membranes. Bd inhibited the loss of free sterol, suggesting that it may act by protecting the membranes. This is the first report that Bd inhibits senescence in beans.

Effect of an ethanol-enriched medium on Gibberella zeae. A. T. TSCHANZ & R. K. HORST (Cornell Univ., Ithaca, N.Y.). Production of perithecia of *Gibberella zeae* on various natural and synthetic media was sporadic, required a prohibitive length of time (30 days or longer), or resulted in an aggregation of perithecia that were difficult to count. Two media were developed to stimulate uniform production of perithecia within 21 days. Live carnation leaf tissue discs (5 mm diam) were dipped in 70% ethanol (ETOH) for 5 min, then immersed 12 hr in sterile distilled water, and finally placed on solidified 1.5% water agar (WA). A suspension of macroconidia or ascospores (ca. 500 spores) was applied to each disc. Perithecia actively releasing ascospores were observed in 10-14 days; hyphal growth and asexual reproduction were minimal. Perithecia were usually scattered on the disc and easily counted. Perithecial development was delayed when leaf discs were soaked 12 hr in 70% ETOH, then placed on WA; however, sporodochia and conidia developed profusely. The numbers of perithecia produced in 14 days, using a medium of dried carnation leaf discs on 1.5% WA, decreased as ETOH concentrations in the WA increased over the range 0.5 to 2.0%.

Effect of extracellular enzymes from Erwinia carotovora on cucumber protoplasts. T. C. TSENG & M. S. MOUNT (Univ. Mass., Amherst). Three extracellular enzymes – endopolygalacturonate *trans*-eliminase (PGTE), phosphatidase C, and protease – produced by *Erwinia carotovora* (EC_{14}) were purified and tested for their ability to cause bursting of isolated cucumber protoplasts. The crude enzymes were purified by $(NH_4)_2SO_4$ fractionation, DEAE cellulose column chromatography, and isoelectric focusing. The isoelectric points of the enzymes were: phosphatidase C, 7.5; protease, 8.3; and PGTE, 9.4. Both purified phosphatidase C and protease caused lysis of the protoplasts (25-50%/hr), whereas purified PGTE did not. Leakage of neutral red from the protoplasts was evident before bursting of phosphatidase C and protease-treated protoplasts, indicating a modification of cellular membranes of host tissue. PGTE had no apparent effect on the protoplasts, suggesting that its pathological contribution to the soft rot disease is restricted to the cell wall.

Host range and serological properties of a seed-borne cowpea virus. J. K. UYEMOTO, R. PROVVIDENTI, & D. E. PURCIFULL (Dep. Plant Pathology, Geneva, N.Y., Gainesville, Fla.). A seed-borne virus (approx 28% seed transmission) was recovered from cowpea seedlings (*Vigna unguiculata* 'Knuckle Purple Hull') by mechanical transmissions to cultivars of *Phaseolus vulgaris, P. limensis, P. lathyroides, V. unguiculata* 'Ramshorn Cowpea', *V. cyclindrica, Vicia faba, Chenopodium amaranticolor*, and *C. quinoa*. Immune hosts included

Cucumis melo, C. sativus, Cucurbita pepo, Citrullus lanatus, Pisum sativum, and *Nicotiana tabacum.* Host range response of cowpea virus (CV) and bean common mosaic virus (BCMV) were similar, but differed from infections induced by watermelon mosaic virus (WMV-type 2), which also infected pea, squash, cucumber, and watermelon. Virus particles of CV were filamentous, with particle length of 750 nm. In immunodiffusion tests, partially purified virus preparations degraded in ethanolamine (0.5 M, pH 10.5) or pyrrolidine (2.5%) were tested with antisera of BCMV and WMV-2. Each serum cross-reacted with heterologous virus and CV. CV and BCMV were identical, but distinct from WMV-2, with homologous antibody-antigen precipitin line spurring over the heterologous virus reaction.

Fate of the fungicide 2,6-dichloro-4-nitroaniline in soil. N. K. VAN ALFEN & T. KOSUGE (Univ. Calif., Davis). The fate of the fungicide 2,6-dichloro-4-nitroaniline (DCNA, Botran) in sterile and nonsterile Yolo loam soil amended with 1% (w/w) D-glucose and flooded with water was studied using ^{14}C-DCNA. The DCNA was rapidly metabolized in the nonsterile soil, with only 7% being recovered after 3 days. No $^{14}CO_2$ was detected during the 9-day experimental period. The largest fraction of radioactivity (up to 65%) could not be extracted from the nonsterile soil using an acetone-water extraction process. The major metabolite of DCNA that could be extracted from nonsterile soil was identified as 4-amino-3,5-dichloroacetanilide (ADCAA). The expected intermediate in the conversion of DCNA to ADCAA, 2,6-dichloro-*p*-phenylenediamine (DCPD), was also recovered from the soil. It was found that in addition to being acetylated, DCPD is also oxidatively dimerized to the corresponding azine in nonsterile soil. After 9 days in sterile coil, ca. 70% of the added DCNA could be recovered by extraction with acetone-water. DCNA was thus rapidly metabolized in nonsterile soil, whereas in sterile soil nearly all extractable radioactivity remained as ^{14}C-DCNA. The growth of six fungi inhibited by DCNA was found to be unaffected by ADCAA and DCPD.

Infection of defoliated sugar/maple trees by Armillaria mellea. P. M. WARGO & D. R. HOUSTON (USDA, Forest Service, Northeastern Forest Exp. Sta., Hamden, Conn.). The attack of defoliated trees by *Armillaria mellea* may be influenced by time of season and frequency of defoliation. Sugar maple trees (*Acer saccharum*) defoliated by the saddled prominent, *Heterocampa guttivitta,* and artificially defoliated trees were inoculated with *A. mellea* to determine the relationship of these factors to infection by the fungus. Insect populations collapsed, and resulted in a low incidence of infection and mortality of trees by *A. mellea.* In the artificial defoliation series, defoliation in June or July resulted in higher mortality and more infections than that in August, and defoliation for 2 consecutive years resulted in a higher percentage of infection than single defoliations. Not all dead trees were infected by *A. mellea*, and observations indicated that *Stegonosporium ovatum* may be involved in the death of severely stressed tissues.

Comparative study of the cuticle ultrastructures of Criconema and Criconemoides. GUANG-YEONG WEN & TSEH AN CHEN (Rutgers Univ., New Brunswick, N.J.). The cuticles of both *Criconema* and *Criconemoides* consist of at least five major layers in their thick annule regions. In addition to the cortex, matrix, striated layer, and the basal lamella, the spine of *Criconema* is observed to be a homogenous and rigid structure with fiberlike materials firmly attaching to the outer corticle surface. In *Criconemoides,* however, only multilaminated thin cap instead of spine is observed in the corresponding area. The cortices of both nematodes are similar. The outer cortex is composed of three sublayers: an outer and an inner osmiophilic layer and a median electron-transparent layer. The inner cortex is a multiple-layered structure alternating with electron-dense and transparent strata. In *Criconema* as many as 20-24 layers are observed, whereas only 10-14 are found in *Criconemoides*. The matrix is triangular beneath the cortex within each annule, and reduced to a very thin layer at the level of groove between two annules in longitudinal section. In oblique section it is composed of loosely packed fibrils arranged in right angles. The center portion of the matrix of both nematodes is oval in shape, and it is probably filled with fluid. The striated layer is about 0.1 μ in thickness, and is relatively uniform throughout the nematode cuticle.

Effect of oxidized phenolic compounds on the infectivity of cowpea chlorotic mottle virus ribonucleic acid. T. L. WOODS & G. N. AGRIOS (Univ. Mass., Amherst). Solutions of enzymatically oxidized L-dihydroxyphenylalanine (L-DOPA), chlorogenic acid, and catechol reduced the infectivity of cowpea chlorotic mottle virus ribonucleic acid (CCMV-RNA) as compared with the unoxidized phenolics, polyphenoloxidase only, and buffer controls. RNA infectivity decreased as the length of time the RNA was exposed to the oxidized phenolics increased from 0 to 60 min, and as the temperature of the reaction mixture increased from 0 to 35 C. Oxidized chlorogenic acid was more effective in reducing infectivity than either oxidized catechol or oxidized L-DOPA. Polyphenoloxidase (PPO) at 0.05 mg/ml reduced the infectivity of CCMV-RNA by nearly 70% in 20 min at 23 C, whereas boiled PPO reduced infectivity by 11%. Treatment of PPO with bentonite did not restore infectivity to the level of the buffer control. When PPO and RNA were incubated together for 12 hr at 23 C, the ribonuclease activity in the PPO, as measured by the amount of acid-soluble nucleotides produced, was very low.

Development and pathogenesis of Verticillium malthousei as influenced by benomyl. P. J. WUEST & H. COLE, JR. (The Pennsylvania State Univ., University Park). Linear growth of three *Verticillium malthousei* isolates was measured after 14 days at ca. 20 C on potato-dextrose agar infused with 0, 1, and 10 ppm benomyl. Isolate ML2 was benomyl-tolerant, whereas ML4 and BC69 were benomyl-sensitive. At the same benomyl concentrations, sporulation of ML2 grown at 20 C for 7 days was not reduced by the order of magnitude noted with BC69. Spores of ML2, ML4, and BC69 were harvested from such plates, atomized onto water agar, and incubated at 12 C for 18 hr. Germination of ML4 and BC69 spores from cultures grown on 1 ppm was reduced as compared with spores from ML2. Pathogenicity of isolates was measured following aqueous inoculation of phialospores onto sporocarps of *Agaricus bisporus,* PSU 310, and incubation in moist chambers at 18 C for 72 hr; ML4 and BC69 were more pathogenic than ML2. Signs of ML2 were similar to controls on sporocarps dipped into 0 and 100 ppm benomyl for 5 min before inoculation; however, signs of ML4 and BC69 decreased with increasing benomyl concentration. ML2 is benomyl-tolerant as measured by the above parameters. ML2 is not as pathogenic as ML4 or BC69. Registration of benomyl for *V. malthousei* control is pending. Whether an

isolate similar to ML2 may predominate in the natural population is yet to be evaluated.

Variation in virulence of Botrytis cinerea isolates to stored cabbage. O. C. YODER & M. L. WHALEN (Cornell Univ., Ithaca, N.Y.). Excised cabbage leaves (cultivars Green Winter) were inoculated with actively growing mycelial plugs (4 mm diam) or spore suspensions (10^6/ml, 10 days old) and incubated in darkness 5 days at 20 C. Virulence was estimated from the area of disintegrated tissue. When wounded or nonwounded leaves were inoculated with mycelium of 11 single spore isolates from cabbage, five groups which caused significantly different ($P \leq .05$) rates of tissue breakdown were identified. Differences in germinability and virulence between representatives of the most (A) and least (E) virulent groups were compared. Spores of either group suspended in water on glass slides or on nonwounded tissue did not germinate, and caused no tissue breakdown. Spores of A had 95% germination, and caused extensive tissue breakdown when suspended in nutrient solution (sterilized 25% cabbage juice) on nonwounded tissue or when suspended in water on wounded tissue. Both spores and mycelium of A caused extensive damage to surface-sterilized leaves and leaves of different ages. Spores of E had 95% germination, but neither spores nor mycelium caused appreciable tissue breakdown under any condition used. In culture, both groups grew and sporulated equally well. Group E caused no more damage to cabbage tissue than did *B. allii*, a pathogen of onion.

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