

Abstracts of the 1970 Annual Meeting of the Northeastern Division
of The American Phytopathological Society

Pathological histology of four onion varieties infected by Fusarium oxysporum f. sp. cepae. G. S. ABAWI & J. W. LORBEER (Cornell Univ., Ithaca, N.Y.). Onion (*Allium cepa*) cultivars differently susceptible to basal rot caused by *Fusarium oxysporum f. sp. cepae* were equally susceptible to root and stem plate infection by the pathogen. Anatomical differences between the cultivars Treasure, Autumn Spice Improved, Grandee, and Elba Globe were not detected. The pathogen invaded roots by both direct penetration and/or through wounds. Invasion of the stem plate was by growth of the pathogen from infected roots and/or through natural wounds in the lower portion of the stem plate area. Invasion of the fleshy leaf bases of the bulb in either tolerant or susceptible cultivars usually was from the stem plate, but occasionally it occurred through the lower portions of leaf bases below the soil surface when propagule loads in the soil were high. In the root or the stem plate, the pathogen at first grew in the intercellular spaces but soon invaded cells. Tylose formation and occlusion of xylem vessels were observed equally in the stem plate tissues of the four varieties. Chlamydospores formed in the cortex and vascular tissues of the root, but not in the stem plate.

Correlation of chemically induced root injury with a reduction of Fusarium wilt of tomato. W. L. BIEHN & A. E. DIMOND (Conn. Agr. Exp. Sta., New Haven). Tomato plants were less susceptible to *Fusarium* wilt when compounds that injure roots were applied before root inoculation with *Fusarium oxysporum f. sp. lycopersici*. Compounds were applied by subirrigation continuously to potted tomato plants for 6-12 days before inoculation. Tests involving 272 compounds showed that the severity of *Fusarium* wilt and root injury were negatively correlated to a highly significant degree. The correlation coefficient for 270 degrees of freedom was -0.61 . Ratings of the severity of root injury were as follows: 1 = 0%; 2 = 1-33%; 3 = 33-66%; and 4 = 66-100%. The ratio of compounds rate 1, 2, 3, and 4 that reduced *Fusarium* wilt symptoms greater than 50% were 0.08, 0.28, 0.55, and 0.83, respectively. Studies using a split root technique indicated that disease reduction generally occurs only when both chemical application and inoculation with *F. oxysporum f. sp. lycopersici* are carried out on the same root system. This suggests that the compounds causing root injury generally have a localized effect.

Internal browning and abnormal ripening in field-grown tomato inoculated with 16 tobacco mosaic virus isolates. J. S. BOYLE (Pa. State Univ., University Park). Internal browning (IB) in tomato fruit is readily produced by inoculating large-fruited, virus-free plants with tobacco mosaic virus (TMV). Brown, necrotic tissue is discernible through the pericarp in severely affected, immature fruit, and this symptom is often referred to as graywall. While many IB-affected fruit will be "off-color" when ripe and hence "blotchy-ripened", IB and blotchy-ripening (BR) are not considered synonymous. Yet the fact that BR is significantly reduced by the inoculation of young plants before fruit set with TMV suggests a relationship with this virus. Southern-grown plants of the cultivar Campbell 17 were transplanted on 26 May. On 11 August, 20 plants were inoculated with each of 16 TMV isolates (11 green and 5 yellow). Incidence of IB was determined by individually harvesting and cutting the fruit from each plant. The incidence of IB ranged from 100 to 20%, with a total incidence of 82% in all inoculate plots. Several isolates induced abnormal russet, roughness, and blotch to the fruit finish. The incidence and severity of IB was less with these isolates. IB and BR were not observed in the controls. It now appears that some TMV isolates are more effective in inducing IB, and some are more effective in inducing surface abnormalities which in some cases are characteristic of BR.

Properties of a peach isolate of necrotic ringspot virus.

R. F. BOZARTH (Boyce Thompson Inst., Yonkers, N.Y.). A seed-transmitted virus isolated from peach seedlings was identified as a strain of necrotic ringspot virus on the basis of herbaceous host range, biophysical properties, and serological reaction with a cherry isolate of the necrotic ringspot virus. The virus had sedimenting components of 70 and 102 S, and a particle diam of 28 m μ . Only the fastest sedimenting component was infectious.

Myrothecium leaf spot of birdsfoot trefoil. S. W. BRAVERMAN (ARS, USDA, & N.Y. State Agr. Exp. Sta., Geneva). A leaf spotting of birdsfoot trefoil (*Lotus corniculatus*) was prevalent during the 1968 and 1969 growing seasons. Random isolations from affected trefoil leaf tissue revealed *Myrothecium verrucaria*. Lesions are less than 1 mm in diam and grayish-tan, occasionally with a darkened margin. Lesions may coalesce and thus embrace a large portion of the leaf surface. In culture, the organism produces the characteristic annulations of greenish-black sporodochia on a flat, white mycelial mat. Conidia of *M. roridum* are cylindrical and measure 1-3 \times 5-11 μ , while those of the closely related *M. verrucaria* are lemon-shaped with a truncate base and measure 2-3 \times 6-10 μ . Two- to three-inch seedlings of several cultivars of *L. corniculatus* and 41 additional *Lotus* species were inoculated with a conglomerate of the fungus isolated from Empire, Fargo, and Viking. Results indicate from greenhouse tests that cultivars of *L. corniculatus* are slightly to moderately susceptible. *Lotus major* and *L. pusillus* are moderately resistant, while *L. arabicus* and *L. maroccanus* are highly susceptible. This constitutes the initial report of *M. verrucaria* on *Lotus* species.

Comparative downward movement of spores of Ceratocystis ulmi in diffuse and ring-porous hardwoods. R. CAMPANA, P. RING, & A. PRATT (Univ. Me., Orono). Conidia were introduced into twigs of five diffuse-porous (*Acer* [2 sp.], *Betula*, *Populus*, *Prunus*) and five ring-porous species (*Fraxinus*, *Quercus* [2 sp.], *Robinia*, *Ulmus*) in 1967 and 1969 to measure downward spore movement. Ten branches of each species were inoculated each year, making a total of 200 twigs. After 24 hr, each stem was severed 30 cm below the inoculation point, cut into 6 mm-long sections, and plated on potato-dextrose agar. Presence or absence of the fungus was noted in the following 2 weeks. Distance of fungus movement in all ring-porous species exceeded that in all diffuse-porous ones. Movement in ring-porous species was significantly greater at the .01 level. Among ring-porous species tested, distance movement in elm was least, that in ash greatest. The differences between movement in elm and other ring-porous species were not significant. The data suggest that initial downward spore movement under tensile forces of the sapstream is similar among all hardwoods, and is directly influenced by anatomical structure.

Mycoplasmalike bodies in plants infected with blueberry stunt and cranberry false blossom. T. A. CHEN (Rutgers Univ., New Brunswick, N.J.). Dormant and actively growing blueberry plants and cranberry vines were collected in New Jersey from November 1968 through July 1970. Leaf tissues of healthy plants and of those infected with blueberry stunt and cranberry false blossom were examined with the electron microscope. Mycoplasmalike organisms were found in the sieve-tube elements of both diseased plants. In blueberry, no mycoplasmalike bodies were observed in the dormant bud tissues. But as the growing season started, the number of mycoplasmalike organisms increased with the expansion of the leaves. In cranberry leaves, mycoplasmalike bodies could be observed throughout the year. These bodies ranged in diam from 80-300 nm for cranberry false blossom and 160-700 nm for blueberry stunt. The constant association of these microorganisms with the diseased plants and the absence from the healthy plants suggested the possible role they play in the etiology of the two diseases.

Establishment of Curvularia and Helminthosporium spp. in small-grain seeds. W. F. CROSIER, G. E. HARMAN, & S. W. BRAVERMAN (N.Y. State Agr. Exp. Sta., ARS, USDA, Geneva, N.Y.). Species of *Curvularia* and *Helminthosporium* were inoculated into the florets of barley, sorghum, and wheat. The fungi were increased on malt agar or potato-dextrose agar mixed with starch and talc, and pressed into the florets, and the plants held in a mist chamber for 2 days. A *Curvularia* sp. from peanut was recovered from 95% of surface-sterilized seeds regardless of cultivar, condition of the florets at time of inoculation, or competition with other fungi. Stromata were never observed on or near peanut pods, but fungal growths on sorghum and wheat seeds produced many long, cylindrical, branched, fertile structures. *Curvularia robusta* was found in 1% of grain seeds. *Helminthosporium maydis* isolated from captant-treated surface-sterilized seeds of 590X Minnesota-grown corn was recovered from 23% of Yorkstar wheat seeds placed on malt agar or PDA amended with a fungicide and an antibiotic or butyric acid. Neither *Fusarium oxysporum* nor *Rhizopus* sp. as a coinoculant affected the storage of *H. maydis*. A mercury-tolerant strain of *H. avenae* was present in 3% of barley, 3% of sorghum, and 5% of wheat seeds. *Helminthosporium biforme*, *H. erythrospilum*, *H. sorghicola*, and *H. tetramera* were recovered from 98, 2, 93, and 28%, respectively, of wheat seeds, and lesser percentages from sorghum seeds.

Influence of high concentrations of peroxyacetylnitrate on woody plants. D. B. DRUMMOND (The Pa. State Univ., University Park). *Acer saccharinum*, *A. saccharum*, *Betula pendula*, *Fraxinus americana*, *F. pennsylvanica*, *Gleditsia triacanthos*, *Liquidambar styraciflua*, *Liriodendron tulipifera*, *Malus pumola*, *Populus maximowiczii* × *trichocarpa*, *Quercus alba*, *Q. palustris*, *Q. robur*, *Q. rubra*, *Sorbus americana*, and *Syringa vulgaris* were exposed to 20 to 30 ppm peroxyacetylnitrate for 8 hr in a growth chamber at 24 C, 70% relative humidity, and 3,400 ft-c. *Acer saccharinum*, *F. americana*, *G. triacanthos*, *Q. alba*, *Q. palustris*, and *Q. rubra* demonstrated a pattern of sensitivity related to the age of the tissue; they showed either an early increase in sensitivity with a peak at 3 to 5 weeks followed by a decrease in sensitivity, or a high initial sensitivity at 2-3 weeks and a decrease with an increase in age. Symptoms ranged from a brown necrosis of the under-surface or a purpling of the upper leaf surface to an interveinal necrosis or necrotic fleck. In a time-dosage study, *F. americana* showed several different symptoms depending on the length of exposure: an oily upper surface, a wrinkling of the leaf margin, an interveinal necrosis, and severe leaf curling and abscission. Damage usually was restricted to the younger leaves.

The effect of temperature on the germination of Verticillium malthousei conidia. L. B. FORER & P. J. WUEST (Pa. Dept. Agr. & Pa. State Univ., University Park). *Verticillium malthousei* incites dry bubble disease of mushrooms. This disease is one of the most destructive mushroom diseases, but little is known about the effect of environment on the pathogen. Conidia used for the germination studies originated from 7-day, single-spored cultures of isolate GB-LF-7014. This isolate originated from diseased cream mushrooms 60 days before this study began. The conidia were collected from the 7-day culture of the pathogen by the addition of sterile, distilled water to the culture tube. The tube was shaken and the suspended spores were atomized onto 2% water agar plates. Plates were acclimatized to the incubation temp by placing them into the incubator 8 hr before seeding. The plates were sealed tightly and incubated at 12, 18, 24, 30, and 36 C for 3, 6, 9, 12, and 24 hr in the dark. Lactophenol-cotton blue was added to each plate at the end of incubation, and 25 fields of at least five spores each were counted for each of the duplicate plate treatments. No germination occurred at 36 C, nor was there germination at 12 C until 9 hr incubation elapsed. Maximum germination, 90-98%, at 12 C occurred in 24 hr, 18 C in 12 hr, and 24 and 30 C in 9 hr.

The sensitivity of ascospores of Venturia inaequalis from different sources to dodine. J. D. GILPATRICK & D. R. BLOWERS (N.Y. State Agr. Exp. Sta., Geneva). Ascospores of *Venturia inaequalis* produced in perithecia on infected leaves which fell to the ground in the previous year are the primary source of inoculum for the development of apple scab in most areas. Effective inhibition of ascospore germination with fungicides through the end of the bloom period is the key to successful control of scab in most seasons. Most fungicide studies with this fungus in the laboratory, however, have utilized for convenience either conidia or mycelium. Using a modified Hirst-Stedman wind tunnel, ascospores of *V. inaequalis* were collected on glass slides at selected sites and in controlled quantities. Drops of various dodine concn were placed on these spore sites, and dosage-spore germination curves determined. Ascospores from orchards not previously exposed to dodine or from some where this fungicide provided good control of apple scab during the severe epidemic of 1969 in New York State were at least twice as sensitive to dodine as those from orchards where this fungicide failed. A lower level of tolerance appears to have developed in some other orchards with a history of dodine spraying, but this has not yet resulted in unsatisfactory scab control.

Verticillium wilt of chrysanthemum: colonization of leaves in relation to symptom development. R. HALL & L. V. BUSCH (Univ. Guelph, Guelph, Ontario, Can.). The vascular system of leaves of chrysanthemum plants inoculated with *Verticillium dahliae* was invaded by mycelium before the appearance of visible symptoms. After flower buds appeared, there was a rapid rise in the amt of fungus in the leaf and severity of wilt symptom expression. Within individual leaves, areas with more advanced stages of wilt contained greater amt of fungus. It is suggested that the mycelium within the leaf makes a significant contribution to the development of visible symptoms of wilt.

Salt spray damage to roadside pine and white cedar. R. HALL & G. HOFSTRA (Univ. Guelph, Guelph, Ontario, Can.). Severe injury was observed on white cedar and several species of pine adjacent to highways in southern Ontario in spring 1970. Foliar injury, measured quantitatively as the ratio of brown to total leaf tissue, and foliar levels of sodium and chloride higher than background levels, occurred on trees up to 400 ft from the highway, particularly on the downwind side of the highway, on the windward side of the tree, and on trees in exposed positions. Injury and foliar levels of salt progressively declined at greater distances from the highway. For a given level of salt, more damage occurred on the windward side than on the sheltered side of the tree. The data suggest that salt applied to highways in the winter is whipped up in a spray by traffic and blown onto vegetation, and contributes to leaf injury. White pine was twice as sensitive to salt as white cedar. Among the pines, damage was greatest on white pine and red pine, intermediate on Scots pine, and least on Austrian pine and Mugo pine. At similar levels of damage, all pines contained similar foliar levels of sodium and chloride.

The influence of clipping height on neutral carbohydrate levels in root exudates from alfalfa plants grown under gnotobiotic conditions. R. A. HAMLIN, J. R. BLOOM, & F. L. LUKEZIC (Pa. State Univ., University Park). Because of the effect of harvesting on susceptibility of alfalfa to root rot and the importance of carbohydrates in root exudates on *Fusaria* chlamydospore germination, investigations were completed on the neutral carbohydrate fraction of root exudates of alfalfa clipped at different levels. Plants were grown in a nutrient solution in washed river-bank sand. After initial growth, plants were maintained for 3 months under the following clipping practices: light, removal of flower buds; intermediate, clipped to a height of 6 inches; and severe, the removal of all but four mature leaves. Distilled water leachings from roots in situ and root

dry wt determinations were obtained after 1 month's growth and again 2 months later. Trimethylsilyl derivatives of the carbohydrates in the leachates were analyzed by gas chromatography and confirmed by mass spectrometry. Glucose, inositol, and sucrose were detected. Amounts of carbohydrates released per g dry wt of root tissue were higher under severe clipping, suggesting that increased carbohydrates in exudates may increase the numbers of germinating chlamydozoospores, or that the greater loss of carbohydrates renders roots more prone to disease.

Nematode transmission of ash ringspot virus. C. R. HIBBEN & J. T. WALKER (Brooklyn Bot. Gard., Ossining, N.Y., & Univ. Ga., Experiment). Dagger nematodes, *Xiphinema americanum*, were recovered from soil beneath declining ash (*Fraxinus americana*) in Dutchess County, N.Y. Ash ringspot virus (ARV) had previously been isolated from trees in this plot. Transmission of ARV by a soil-borne vector was demonstrated by a bait-plant experiment. Cucumbers (*Cucumis sativus* 'Chicago Pickling') became infected with ARV after growing in field soil in which ARV-infected cucumbers had previously grown. *Xiphinema americanum* was demonstrated as a vector by transferring viruliferous nematodes from infected to healthy plants. Cucumber, cowpea (*Vigna sinensis* 'Early Ramshorn'), and pea (*Pisum sativum* 'Wando') seedlings, in soil-sand (1:1) in 100-ml beakers, were mechanically inoculated with ARV. Roots of systemically infected plants in each beaker were then infested with 300-700 *X. americanum* adults and larvae for acquisition periods of 4-6 weeks. Surviving *X. americanum* were recovered by screening, then transferred to roots of healthy cucumbers or cowpeas. Bioassay of the roots of these nematode-infested plants revealed the occasional transmission of a ringspot virus which was symptomatically and serologically identical with ARV. Thus, *X. americanum* can act as a soil-borne vector of ash ringspot virus.

Chemotherapeutic control of stem crown gall of Sherrill hybrid poplar trees. W. K. HOCK & L. S. DOCHINGER (ARS, USDA, Delaware, Ohio). Crown gall on stems of Sherrill hybrid poplar (*Populus grandidentata* × *P. alba*) cuttings was partially controlled by a coordination product of 2, 4-xyleneol and meta-cresol (Bacticin) applied topically to neoplasms. Six-month-old trees, wounded 10 cm above the base of the stem, were inoculated with *Agrobacterium* sp. originally isolated from a neoplasm on Sherrill poplar. Tumors were treated with either undiluted Bacticin, 1,020 ppm active streptomycin sulfate (Agrimycin 17), or distilled water at intervals of 6, 11, and 20 weeks after inoculation. No phytotoxicity was observed after any of the treatments. Bacticin completely inhibited further gall development on 50% of the trees after three treatments; whereas, Agrimycin 17 and water did not inhibit gall development. Examination of trees for new galls 1 year after treatment indicated that 47% of the Bacticin-treated plants were still healthy, as compared to only 5% of the trees treated with either Agrimycin 17 or water. Bacticin appears to have a high affinity for galled tissues, and possesses chemotherapeutic properties. By manipulating the timing and number of applications, perhaps greater control of crown gall by Bacticin can be achieved.

Differential temperatures for separate phases of Alternaria solani. J. G. HORSFALL & R. J. LUKENS (Conn. Agr. Exp. Sta., New Haven). While studying the high temp invasion of conidial and appressorial formation in *Alternaria solani* and while searching the literature, we discovered that this fungus has a different temp optimum for at least six phases in its life cycle and pathogenesis: approximately 28 C for growth, i.e., hyphae, spore germination, and germ tubes; 22 C for differentiation of conidiophores, conidia, and appressoria; 20 C for penetration of tomato foliage; 15 C for penetration of potato tuber tissue; 16 C for expansion of tomato leaf lesions; and 25 C for expansion of potato tuber lesions. Went, in 1957, stated that tomato

grows best at 26 C daytime and 20 C night-time temp, and potato (foliage and tubers) grows best at 20 C daytime and 14 C night-time temp. Thus, it is strikingly clear that *Alternaria* penetrates each host at the opt night temp for that host, but lesions expand best at temp below the opt for a warm weather host (tomato) and above the opt for a cool weather host (potato). Apparently, the fungus has adapted itself to differentiate its reproductive and penetrating structures at temp favorable to the host, but its pathogenicity is greatest at temp away from the opt for the host.

Studies on the nature and origin of satellite virus and some of its relationships to tobacco necrosis virus. F. G. JENIFER & M. K. CORBETT (Univ. Md., College Park). Satellite virus (SV) appeared in a culture of tobacco necrosis virus (TNV), which initially had no detectable SV, after serial transfers from plants infected for different time periods. The SV rose either de novo or its production from undetectable levels was enhanced by some factor produced or activated during the serial transfers. Several cycles of virus purification and reinoculation, termed batchings, proved to be the most sensitive technique for detecting trace amounts of SV. A SV stimulatory factor was detected in tissue infected with TNV, but not in uninfected tissue or tobacco ringspot virus-infected tissue. It is phenol-extractable, increases in concn with length of infection, and is not infectious. When this factor was mixed with TNV preparations which had trace amounts of SV, there was a sharp increase in the amount of SV present in the next generation of TNV. It is proposed that the SV stimulatory factor may be a SV-ribonucleic acid which is produced in TNV-infected tissue; however, before it can be converted to SV, or can induce preexisting SV to increase rapidly, it must be added to a preparation of TNV possessing trace amounts of SV.

Infection and disease development of Cercospora omphakodes in Phlox divaricata. R. W. JUDD, JR., & J. L. PETERSON (Rutgers Univ., New Brunswick, N.J.). *Cercospora omphakodes* spores germinated best at 20 C and 98% relative humidity. The pathogen was always observed entering the host through open stomates, never penetrating directly through the epidermis. Infectivity was tested under nine light intensities ranging from 360 to 3,000 ft-c and at 16, 26, and 32 C. Significantly more infections occurred under 1,600 ft-c than under 3,000 or 500 ft-c and below. Also, significantly more infections occurred at 26 and 32 C than at 16 C. Disease development after infection was observed under six light intensities ranging from 360 to 3,000 ft-c and at 16 and 32 C. The disease developed more rapidly and severely at 32 C. The disease also developed best under 1,600 to 3,000 ft-c, with 3,000 ft-c being the opt.

Some factors involved in the failure of red clover in Massachusetts. H. A. KHAN & W. M. BANFIELD (Univ. Mass., Amherst). Viruses and Fusarium spp. are associated with failure of red clover in Massachusetts. Of 73 plants with virus symptoms that were indexed from six localities, 47 reacted; 32 showed the presence of bean yellow mosaic virus (BYMV); 15 showed the presence of viruses not yet identified. *Aphis bakeri*, the clover aphid, is the more common aphid on red clover in Massachusetts. When *A. bakeri* was transferred from red clover plants with BYMV symptoms to healthy plants, it transmitted the virus to all four test plants used in 8 of 30 trials. Fusarium spp. were isolated from 17 of 20 plants with BYMV symptoms; from 19 of 20 plants that displayed yellowing, stunting, wilting and/or necrosis; and from 6 of 12 healthy plants. Injuries caused by the clover root borer, *Hylastinus obscurus*, and/or root curculio, *Sitona hispidula*, were found on the roots of 15 of 52 plants cultured. Fusarium was isolated from 14 of these. It is apparent from this study that there is a complex of Fusarium, viruses, and insects contributing to failure of red clover in Massachusetts.

Buffers affecting tetracycline chemotherapy. M. KLEIN, R. J. FREDERICK, & K. MARAMOROSCH (Boyce Thompson Inst., Yonkers, N.Y., & Warner-Lambert Res. Inst., Morris Plains, N.J.). The activity and uptake of 100 ppm tetracycline hydrochloride (Achromycin) in aster yellows-diseased *Callistephus chinensis* plants were determined by a bioassay of leaf samples, using *Bacillus cereus* as the test organism. Antibiotic activity was retained in leaves irrespective of disease suppression. Uptake through roots was much greater than through sprayed leaves. Suppression of yellows was more effective with solutions buffered at pH 5.3 than at 7.7 or 10. Slight suppression without tetracycline occurred with buffers at pH 10. At pH 5.3, tetracycline activity was lowered by KH_2PO_4 and acetate but not affected by citrate, succinate, citrate-phosphate, and maleate buffers. When citrate buffer molarity was varied, no tetracycline activity was detected in leaves at 0.2 M. Activity increased gradually to 10 times with a decrease from 0.1 to 0.005 M. The results focus attention on the discrepancies in findings that may be encountered when buffers, pH, molarity, and mode of application of tetracycline antibiotics are not specified or controlled.

The influence of time and pollutant concentration on the response of three deciduous tree species to ozone. R. KOHUT (Pa. State Univ., University Park). The responses of tulip poplar (*Liriodendron tulipifera*), hybrid poplar (*Populus N.E. maximowiczii* × *trichocarpa*), and English oak (*Quercus robur*) to exposures of ozone were studied. A total of 280 trees from 2 to 5 years old with 10- to 11-week-old foliage were exposed to 10, 25, or 40 ppm ozone for 2, 4, 6, or 8 hr. All fumigations were conducted at 24 C, 75% relative humidity, and 2,400 ft-c. Evaluation of injury was made 5 days after exposure; all trees were compared with unexposed checks. Only slight injury was noted on 10-week-old foliage of tulip and hybrid poplars at 10 ppm. At 25 ppm, the degree of injury on tulip poplar was directly related to length of exposure. The injury at 8 hr was more than twice that at 4 hr. At 25 ppm, the amount of injury produced on hybrid poplar was directly related to exposure time through 6 hr; at 8 hr the injury decreased to the level observed at the 4-hr exposure. Eleven-week-old foliage of English oak, resistant at 25 ppm, showed injury at 40 ppm. Symptom severity increased through 6 hr of exposure and then diminished. This type of response has been observed by others and ascribed to stomatal closure.

Effect of age, time, and pollutant concentration on the response of three conifer species to ozone. L. W. KRESS (Pa. State Univ., University Park). Eighteen-hundred 4- to 10-week-old seedlings of Austrian pine (*Pinus nigra*), Scotch pine (*Pinus sylvestris*, French and Scotch Highland strains), and Virginia pine (*Pinus virginiana*, three seed sources) were exposed to 10 or 25 ppm ozone for 2, 4, 6, or 8 hr in a growth chamber maintained at 24 C, 75% relative humidity, and 2,400 ft-c. Pre- and post-exposure conditions were 27 C, 75% relative humidity, 12 hr photoperiod, and 2,400 ft-c. Check seedlings were subjected to the same environmental conditions as the test seedlings. Primary needles and cotyledons were examined for symptoms 5 days after exposure. Symptoms varied from light chlorotic mottle to total necrosis of the needles. Symptom severity increased with age to a peak at 6 or 8 weeks, and decreased from 8 to 10 weeks. Severity also increased with duration of exposure, with a sharp increase from 2 to 4 hr and lesser increases to 8 hr. In a few cases, symptom severity decreased after 6 to 8 hr of exposure.

*Reaction of selected onion varieties to infection by *Fusarium oxysporum* f. sp. *cepae*.* J. W. LORBEER & G. S. ABAWI (Cornell Univ., Ithaca, N.Y.). In field tests with natural inoculum, the time of initial root infection of onion (*Allium cepa*) by *Fusarium oxysporum* f. sp. *cepae* and the level of root infection at intervals later in the growing

season were similar in the cultivars Treasurer, Autumn Spice Improved, Grandee, and Elba Globe. Differences in the incidence of stem plate discoloration occurred throughout the growing season and at harvest. The percentage of bulb decay differed among the varieties after several months of storage. The most decay occurred in Treasure, the least in Elba Globe. The percentage of discoloration of the stem plate was not consistent with, though always higher than, the percentage of bulb decay. The frequency of isolation of each of the four morphological types (sporodochial, rosy, pionnotal, mycelial) of the fungus from the root or stem plate tissues was similar for these varieties. In greenhouse tests in soils with different levels of artificial infestation with *F. oxysporum* f. sp. *cepae*, seedlings of the four varieties generally were equally susceptible as measured by emergence and stand. Of 21 commercial and experimental onion cultivars screened for reaction to the fungus, Japanese Bunching, Eastern Queen, and Beltsville Bunching were found highly tolerant.

Spore germination and appressorial formation, a new assay for fungicides. R. J. LUKENS & J. G. HORSFALL (Conn. Agr. Exp. Sta., New Haven). Dry conidia of *Alternaria solani* will germinate and form appressoria on dry slides in a humid atmosphere. For testing of fungicides this offers two new possibilities: (i) effect of absence of free water and (ii) differential effects on spore germination and appressorial formation. Generally, spore germination is more severely inhibited by fungicides under wet conditions than under dry conditions, but Zn-maneb is equally toxic under both. Inhibition of appressorial formation is approx the same under wet or dry conditions. Under both wet and dry conditions, appressorial formation is more sensitive than spore germination to treatments of captan, difolatan, dodine, and Bordeaux (5:5:40). But little difference occurs between the two responses with the dithiocarbamates (maneb, Zn-maneb, and thiram). With captan and difolatan, toxicity to appressorial formation is the same for wet and dry spores, although the fungicides fail to inhibit appreciably germination of dry spores. Presumably, the success of a fungicide on *A. solani* in the field depends upon its effectiveness in the absence of free water as well as when water is present, and part of the action of protective fungicides is against appressorial formation.

Decline of muskmelon caused by cucumber mosaic virus. A. A. MACNAB & A. F. SHERF (Cornell Univ., Ithaca, N.Y.). A survey of 68 fields in eight counties of New York State in 1968 and 1969 revealed that plants said to have sudden wilt did not all have the same symptoms. General use of the term sudden wilt is misleading; we have used the terms "collapse" and "decline" for the two major syndromes. Collapse refers to wilt of an entire plant or of one or more laterals. Decline symptoms include wilt and necrosis of tip leaves; chlorosis and necrosis of sectors on crown leaves; chlorosis, wilt, and necrosis of expanding leaves. Cucumber mosaic virus (CMV) was consistently associated with decline. Decline was prevented by growing plants in insect-proof cages, but not by soil fumigation with chloropicrin. Inoculation tests were made with *Myzus persicae* and a CMV isolate from muskmelon with the following results: Individual leaves inoculated in field and greenhouse tests developed chlorotic and necrotic sectors; inoculation of caged field plants and of greenhouse plants resulted in decline symptoms; field plants inoculated early in the season developed earlier decline symptoms and subsequently had more necrotic crown leaves than did naturally inoculated controls. CMV was concluded to be the cause of decline; whether CMV is involved in causing collapse is still unknown.

Changes in strain characteristics of tobacco mosaic virus after passage through grafted tomato hosts. B. H. MACNEILL & J. T. FLETCHER (Univ. Guelph, Guelph, Ontario, Nat. Agr. Adv. Serv., Leeds, England). Three tobacco mosaic virus (TMV)-tolerant cultivars heterozygous for the

genes *Tm-1*, *Tm-2*, and *Tm-2²*, respectively, plus the susceptible cultivar Craigella, were united into a bundle of four plants by tongue grafts. The Craigella component of this graft combination was then inoculated with either a strain 0 or strain 1 isolate of TMV. Subsequently, leaf samples from all four components of the graft were analysed on a differential host series and the virus was identified as being either the same as or different from that of the original inoculum. Seventeen out of 20 such grafts inoculated with strain 0 yielded variants which were either strain 1 or 2 or 1.2; in one instance, strain 1.2 was isolated from a graft combination which had been inoculated with strain 1. No new strains could be detected in samples from the Craigella component. It is concluded that certain changes in pathogenicity of the virus are mediated by graft passage into TMV-tolerant hosts.

Influence of limestone dust on foliar disease incidence and leaf surface microflora of three native plants. W. J. MANNING (Univ. Mass., Waltham). Wild grape (*Vitis vulpina*), sassafras (*Sassafras albidum*), and hemlock (*Tsuga canadensis*) plants near an active limestone-processing plant in a valley in Virginia were examined for foliar disease incidence in June 1970. Grape and sassafras leaves were moderately coated with dust, while those of hemlock were heavily coated. Forty leaf samples were examined at five locations. Control samples were examined in a bend of the valley 4 miles away, where dust was not present. Leaf samples from both areas and grape leaves heavily encrusted with dust were also used for leaf-print and dilution-plate isolations. Dusty grape and sassafras leaves averaged 2-3 spots (caused by *Guignardia bidwellii*) and 6-7 spots (caused by a *Gloeosporium* sp.) per leaf, respectively, while clean leaves for both had 0-1. Hemlocks had no foliar diseases. Dusty grape and sassafras leaves had greatly increased numbers, but not kinds, of bacteria and fungi when compared to clean leaves. Bacteria were greatly reduced in number on dusty hemlock leaves, while fungi were increased. *Streptomyces* spp. were isolated almost exclusively from dusty leaves. *Streptomyces* spp. were absent and bacteria and fungi were drastically reduced in kind and number on grape leaves heavily encrusted with dust.

Epishow: a modification of Epidem specifically designed for prediction of early blight epidemic progression. L. B. MASSIE (The Pa. State Univ., University Park). Through modification of Waggoner and Horsfall's Epidem, and utilization of a graphic display unit and keyboard input terminal, a Fortran program has been produced which enables the operator to readily interact with the computer and predict the probable course of an early blight epidemic based on weather forecasts. The program is written in two versions: Fortran IV with IBM's Graphic Subroutine Package for use with an IBM 2250 cathode ray tube; and Basic Fortran for use with an Adage Graphics Terminal Model 30. Both versions allow the operator to alter values of various input data and select for display one of several graphs depicting the predicted course of the disease.

Spore liberation by Botrytis cinerea under controlled environment conditions. R. E. MCCOY & A. W. DIMOCK (Cornell Univ., Ithaca, N.Y.). Liberation of conidia by *Botrytis cinerea* sporulating on necrotic *Chrysanthemum morifolium* and *Allium cepa* was observed in a programmable dew chamber equipped with a rotating drum spore trap. Temperature was held at 20 C, with dew forming upon the introduction of a fog into the chamber. Rates of condensation and evaporation of dew were measured by electrical resistance methods. Release of spores into the air was conditioned by the presence of free moisture in the substrate, and by the degree of atmospheric turbulence and mean wind velocity. The effect of wind was secondary, release not occurring when wind was increased in the absence of moisture. Over 98% of all conidia trapped were released during two daily dew periods of 5 hr each. These results suggest that the liberation of conidia is a process requiring free water, and

that the effect of wind is primarily on dispersal of the spores away from their source.

Genes for pathogenicity conditioning virulence of isolates of Helminthosporium maydis on graminaceous hosts. R. R. NELSON & D. R. MACKENZIE (Pa. State Univ., University Park). The virulence of 72 isolates pathogenic to 1-9 graminaceous host species by possessing from 1-13 known different genes for pathogenicity was evaluated on each of their susceptors to determine if qualitative genes for pathogenicity to other hosts also contribute quantitatively to virulence on specific hosts. Lesion size was the criterion for virulence. Simple linear regression analyses showed significant and consistent increased virulence associated with increasing numbers of genes for pathogenicity. All regression coefficients were significant and positive for all 9 host species when the number of hosts attacked and number of genes for pathogenicity were taken as the independent variable and relative virulence as the dependent variable. For example, isolates with 13 genes for pathogenicity are more virulent on *Secale cereale* than isolates with only the 2 genes needed for pathogenicity to *S. cereale*. The linearity of the response suggests that increased virulence is due to the equal, additive action of genes for pathogenicity. Pathogen genes conditioning specific abilities to incite disease (pathogenicity) appear also to contribute collectively to the intensity of disease (virulence).

The effect of various peptone sources on germ tube elongation in Uromyces phaseoli. R. M. NILES & A. E. RICH (Univ. N. H., Durham.). Six commercial peptones and two plant extracts of pinto bean and lima bean were tested for their ability to stimulate germ tube elongation in *Uromyces phaseoli*. The test substances were added individually at a concn of 0.1% to a basal medium consisting of Czapek's minerals and 2% agar. Trials were run with and without 0.1% yeast extract, and water agar was used as a control. Uncontaminated bean rust uredospores were seeded onto the appropriate media and incubated at 17 C. Germ tube lengths were measured on days 1, 3, 7, 14, 21, and 28. Lima bean extract was the most successful stimulator of germ tube elongation. Among the commercial peptones, only Difco peptone failed to yield tube lengths at least twice those recorded for the control. Increasing concn of peptones and plant extracts resulted in longer germ tubes up to a max point, after which higher concn yielded shorter germ tubes. A synergistic effect was noted in all cases when the yeast extract was combined with the peptones or plant extracts.

Chrysomyxa weirii found on blue spruce (Picea pungens) in New Hampshire. W. H. PAWUK (Univ. N.H., Durham). During the spring of 1969, our attention was called to the casting of 1-year-old needles in a blue spruce plantation in northern New Hampshire. Chlorotic bands with orange-brown elongate-elliptical telia appeared on the needles in late April and early May. By mid-May, the infected needles began to drop. To assure having mature teliospores for identification, twig samples were collected on 4 May 1970 and placed in a moist chamber for 48 hr. Teliospores were collected and suspended in water, and 100 were measured at $\times 860$ using an ocular micrometer. Spores were oblong-attenuate, measuring from 5.5-11.7 \times 17.6-35.1 μ , and having a mean spore size of 7.9 \times 24.9 μ . Two *Chrysomyxa* species are microcyclic on spruce. In Europe, *C. abietis* found on many *Picea* species including *P. pungens* has oblong teliospores measuring 10-15 by 20-30 μ in size with rounded ends. *Chrysomyxa weirii* occurs in North America on *P. engelmannii*, *P. rubens*, *P. glauca*, *P. mariana* and *P. sitchensis*, and has oblong teliospores measuring 5-8 \times 16-28 μ in size which are either truncate or obliquely attenuated at both ends. This compares favorably both in size and shape to the teliospores found on blue spruce in New Hampshire. This constitutes the first report of *C. weirii* on blue spruce.

Effect of benomyl on the response to ozone in Pinto

beans. M. PELLISSIER, N. L. LACASSE, & H. COLE, JR. (Pa. State Univ., University Park). Seven-day-old Pinto beans '111' were grown in a soil mixture of Hagerstown sandy loam:peat:perlite (2:1:1) and in Hoagland's solution. The plants were treated with different concn of benomyl [methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate] by drenching known quantities of benomyl on the soil and by mixing the benomyl in Hoagland's solution. Four days after treatment, beans were fumigated with 25 ppm ozone for 4 hr. Temperature during exposure was maintained at 30 C, relative humidity at 78%, and light intensity at approx 650 ft-c. Fumigated check plants showed flecks on 60% of the leaf area. Complete protection was observed at 20 ppm benomyl or higher concn in Hoagland's solution. Partial protection was afforded by 5 and 10 ppm benomyl in Hoagland's solution. A benomyl concn of 400 ppm in soil was required to obtain complete protection from ozone fleck. Soil drench treatment with low concn of benomyl (40-80 ppm on a soil wt basis) did not protect the plant from ozone damage.

Uptake of benomyl by bean plants. M. PELLISSIER, N. L. LACASSE, & H. COLE, JR. (Pa. State Univ., University Park). Seven-day-old Pinto beans '111', were grown in a soil mixture of Hagerstown sandy loam:peat:perlite (2:1:1) and in Hoagland's solution. The plants were treated with benomyl [methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate] by drenching known quantities of benomyl on the soil and by mixing the benomyl in Hoagland's solution. Leaf discs 6 mm in diam were cut daily and placed on malt agar seeded with spores of *Penicillium cycloplum* (5.5×10^2 spores/ml). Diameter of the inhibition zone was measured 2 days after plating. The bioassay detected the presence of a fungitoxicant in leaves 1 day after treatment with 10, 20, 40, 80, or 160 ppm benomyl in Hoagland's solution. Maximum inhibition occurred within 3 days after treatment. When beans were grown on benomyl-treated soil, bioassay revealed the presence of a fungitoxicant 2 days after treatment with soil concn of 200, 250, or 300 ppm, and 3 days after treatment with 160 ppm. Maximum inhibition was obtained 4 days after treatment. No zone of inhibition was observed when soil was treated with 40 and 80 ppm benomyl. To obtain similar zones of inhibition, the concn of benomyl in a soil drench was 15 to 20 times greater than that in Hoagland's solution.

A microtechnique for evaluation of antifungal activity. R. W. PERO & R. G. OWENS (Nat. Inst. Environmental Health Sci., Research Triangle Park, N.C.). A new, antifungal bioassay, particularly useful with natural products where only mg quantities are available, is being reported. A mycelial-spore suspension of *Helminthosporium sativum* was prepared, using potato-dextrose broth fortified with 1% sodium glycocholate and then diluted 1:1 with a 2% agar solution at 50 C. The resulting suspension was immediately pipetted onto microscopic slides so that a 2-mm film was deposited on the surface. Next, solutions of phenylmercuric acetate (PMA) in ethanol and two *Alternaria tenuis* toxins, alternariol and its monomethyl ether, both in pyridine, were made up at their appropriate inhibitory dosages and dried onto clean slides as spots 5-8 mm in diam. Discs of 1 cm in diam were cut from the prepared agar slides and placed over the spots containing compound. The slides were incubated in a moist chamber at 26 C for 3-5 hr and the per cent spore germination recorded. Germ tube and mycelial growths were also rated on a 0-4 scale after 48-72 hr. When PMA was used, sensitivity compared with that obtained with the standardized slide germination method. The *Alternaria* toxins showed antifungal activity when together at concn greater than 62.5 µg of each, when the method described above was used. Other reported methods proved to be unsuccessful for these toxins.

Resistance of Venturia inaequalis to n-dodecylguanidine acetate. M. SZKOLNIK & J. D. GILPATRICK (N.Y. State Agr. Exp. Sta., Geneva). Despite excellent control of apple scab (*Venturia inaequalis*) for a decade with n-dodecyl-

guanidine acetate (dodine), this fungicide as Cyprex 65W failed to control scab in many orchards in western New York State during 1969. In an aerial spray research program, the control of scab with Cyprex 65W at the recommended 21 oz/acre was poor, while the control with captan and maneb was excellent. In this orchard in 1970, Cyprex 65W applied by airplane in separate blocks at 28 and at 42 oz/acre allowed scab infection, respectively, on (i) the foliage of 42% and 22% of the fruit clusters; (ii) 23% and 11% of the terminal leaves; and (iii) 15% and 7% of the fruit. Captan and a zinc-maneb fungicide (Dikar) allowed infection on 2% (or less) of the fruit clusters, 0.5% of the terminal leaves, and 1% of the fruit. The scab fungus of both ascospore and conidial sources from this research orchard and others were studied in spore germination tests and spray tests on greenhouse trees. The results confirm earlier findings that the fungus from orchards where Cyprex failed to control scab tolerates a higher level of dodine than does the fungus from orchards where the fungicide is still effective.

Wood constituent analyses and mapping of discolored and decayed sugar maple, Acer saccharum, wood associated with Fomes connatus. T. A. TATTAR, W. C. SHORTLE, & A. E. RICH (Univ. N.H., Durham). Discolored and decayed tissue associated with *Fomes connatus* in sugar maple showed a pattern of physical changes and microbial successions. The lignin to cellulose ratio remained approx the same in clear, discolored, and decayed tissue. No quantitative change occurred in the amount of total extractives in all tissues. The pH and ash concn increased and total phenolic compounds decreased as tissues discolored and decayed. Microorganisms were in discolored tissue that showed qualitatively altered extractives and increases in pH. *Fomes connatus* was in a narrow zone of discolored tissue at the border of discolored and decayed tissue. Microorganisms were in decayed tissue that showed qualitative changes in extractives, increases in pH, and substantial decreases in amount of lignin and cellulose.

Effects of ozone on the steroid content of bean leaves. H. TOMLINSON & S. RICH (Conn. Agr. Exp. Sta., New Haven). Primary leaves of pinto bean (*Phaseolus vulgaris*) 12-14 days old contain small amounts of sterol glucosides (SG) and esterified sterol glucosides (ESG). When leaves were exposed to 25 ppm of ozone for 3 hr, the levels of SG and ESG were consistently and significantly increased. These increases were accompanied by decreases in free sterol and monogalactosyl diglyceride (MGD) content. Changes in these steroid compounds, measured by the Lieberman-Burchard reaction, indicate that SG and ESG were formed at the expense of free sterol. The loss of MGD suggests that hydrolysis of this lipid may provide the fatty acids incorporated into ESG. In alcoholic solution, ESG increases the leakage of beta cyanin from beet root discs by 80%. We suggest that ESG and its formation through the loss of free sterol and lipid hydrolysis are important to the subsequent development of injury in leaves exposed to ozone.

Sap transmissible viruses from elderberries in New York. J. K. UYEMOTO & R. M. GILMER (N.Y. State Agr. Exp. Sta., Geneva). Elderberries (*Sambucus canadensis*) with foliage symptoms of ringspots, line patterns, and/or dark green mottle yielded either tomato ringspot virus (TomRSV), tobacco ringspot virus, or cucumber mosaic virus when indexed on *Chenopodium quinoa*. Respective viruses were identified by differential host ranges and serology. Elderberry foliage with vein clearing and a faint diffuse mottle yielded another virus. Particle morphology ($640 \times 15 \text{ m}\mu$) suggested a member of the PV-S virus group, but confirmation by serology is not completed. Two soil-borne viruses, tobacco necrosis virus and satellite virus, were isolated from elderberry roots and from elderberry plantation soil. In elderberry seedlings derived from TomRSV-infected mother plants, about 11% were infected with TomRSV, indicating that TomRSV is seed-transmitted in elderberry.

The influence of ozone on selected woody ornamentals. F. A. WOOD & J. B. COPPOLINO (Pa. State Univ., University Park). Approximately 900 plants of 24 woody ornamental species were exposed to 25 pphm ozone for 8 hr at 24 C, 75% relative humidity, and 1,400 ft-c of light. *Cercis canadensis*, *Cotoneaster divaricata*, *C. horizontalis*, *Forsythia intermedia spectabilis* 'Lynwood Gold', *Gleditsia triacanthos inermis*, *Rhododendron kaempferi* 'Camp fire', *R. kurume* 'Snow', *R. catawbiense album*, *R. nova zembla*, *R. roseum elegans*, *Sorbus aucuparia*, *Syringa vulgaris*, and *Viburnum carlesii* were sensitive. The most common symptoms were brown to black necrotic stipples on the upper leaf surface and premature defoliation. Interveinal necrotic and chlorotic flecks occurred infrequently. Current leaves of intermediate age were most sensitive. *Euonymus alatus compacta*, *Hedra helix*, *Juniperus communis depressa plumosa*, *Pachysandra terminalis*, *Pieris japonica*, *Pyracantha coccinea lalandi*, *Rhododendron caroliniana*, *R. mollis*, *Taxus cuspidata*, *T. media hicksii*, and *Vinca minor* were resistant.

Germination of Verticillium malthousei conidia as influenced by rhizomorph exudates and volatiles of Agaricus bisporus. P. J. WUEST & L. B. FORER (Pa. State Univ., Pa.

Dept. Agr., University Park). Malt agar plates containing 3-week-old rhizomorph-laden cultures of *Agaricus bisporus* strain 208 or 310 grown at 22 C were placed at 18 C for 8 hr and atomized with conidia of *Verticillium malthousei*, the cause of the mushroom dry bubble disease. Incubation was terminated after 12 hr by staining with cotton-blue lactophenol. Germination was ascertained in areas free of *A. bisporus*. Germination after 12 hr in the presence of strain 208, 310, and on the malt agar check was 59, 45, and 42%, respectively. Germination on a water agar check was 56% after 12 hr. Equal wt of colonized compost or equal volumes of mycelium-impregnated casing or casing supporting mature and immature mushrooms were added to screw-cap jars. Strain 310 was present in all added materials. The jars were sealed and incubated at 12, 18, and 24 C for 1 day before introducing conidia of *V. malthousei*. Conidia were atomized onto 2% water agar and the open plates placed within sealed jars. Incubation was terminated as above after 3, 6, and 12 hr. Twelve fields per duplicate plate were counted. Maximum germination, 85-95%, occurred in 12 hr at 12 and 18 C and in 9 hr at 24 C. Rhizomorph exudates and volatiles produced by the additives had no significant effect on spore germination.

The 1970 Annual Meeting of the Northeastern Division of The American Phytopathological Society was held 5-6 November in Syracuse, New York.