MONOSACCHARIDE FERMENTATION BY SELECTED FUSARIUM STRAINS AND MUTANTS. A.A. Antonopoulous and E.G. Hene, Argonne National Laboratory, Argonne, IL 60439.

More than 200 Fusarium isolates and UV-mutants were tested, and all were able to ferment glucose and xylose to ethanol at some degree. These fermentations were conducted in 250-mL shake flasks and in 5-L fermentors. The ability of Fusarium to produce ethanol under a variety of conditions was also studied. Yields under fermentor conditions were improved by increasing inoculum size and controlling aeration. Of the isolates tested, several yielded 4.3 g/mL of ethanol within 48 hr in 13 glucose solutions, a conversion efficiency approximately 83% of the theoretical maximum for xylose fermentation. Several strains and mutants produced up to 4.2 g/mL ethanol from 17 xylose broth in 48 hr, and up to 8 g/mL from 24 xylose in 48 hr. Fermentations with 3% xylose required 72 hr to equal the 48 hr ethanol production rate from 2% solutions. P. avenae were able to grow and produce ethanol in 10 up to 30% xylose broth. Addition of glucose to higher xylose concentrations appeared to increase the yield ethanol.

Biological control of Pythium ultimum on Red Kidney bean by bacterial and fungal biocontrol agents. B. M. Wiesonnet, B. J. Jacobsen, Dept. of Plant Pathology, Univ. of Illinois, Urbana, IL 61801.

Biocontrol candidates were isolated from the rhizosphere of Phaseolus vulgaris (cv. California Light Red Kidney bean) grown in field soil naturally infected with P. ultimum. Field soil was obtained from a field which had been in Kidney bean monoculture for over 10 yrs. Twenty-eight candidates, including fungi, bacteria (including Bacillus subtilis), were screened for control of P. ultimum. Isolates were applied as seed treatments. Treated seeds were grown in field soil in the greenhouse for 30 days using a CDB, mN. Three bacterial candidates designated 3, 3F, and 3T, and three fungal candidates designated 1, 2, and 8, exhibited significant control of P. ultimum as measured by oomycetes dry weight, total height, and root length. In steamed soil the treatments provided a significant increase in root length, and no other effects were found. Isolates are being identified and tested in the field.

REACTION OF SUNFLOWER LINES TO PHOMA MACDONALDI. P. A. Donald, J. F. Miller, J. R. Venette, Dept. Plant Pathology and USDA/ARS Dept. of Agronomy, North Dakota State University, Fargo, ND 58105.

Death of sunflower (Helianthus annuus L.) can occur when plants are parasitized by the fungus Phoma macdonaldisi Boerema. The pathogen can cause stem girdling lesions that lead to premature ripening of flowering plants. Immunity to P. macdonaldisi has not been identified in commercial sunflower hybrids. Spore inoculation with conidial suspensions of P. macdonaldisi of greenhouse grown seedlings was used to test 18 inbred and hybrid lines for response to the pathogen. Inoculated lines were assessed for lesion intensity 10 days after inoculation. All hybrids and inbreds were susceptible; however, significant differences occurred among lines. Hybrids generally were less susceptible than their inbred parents. Hybrid performance could not be predicted by inbred parental reaction. Results from this study indicate that resistance factors are complex.

POPULATION DYNAMICS OF FOUR DIABROTICINAE BEETLE VECTORS OF BACTERIAL WILT OF CUCURBITA. L. Kineman and J. Steadman, Dept. Plant Pathology, Univ. of Nebraska, Lincoln, NE 68583-7022.

Four beetle species, southern (spotted) cucumber, western corn rootworm, striped cucumber and a new vector, Acalymma goudii, Barber carried cucurbit bacterial wilt. Censusing (25 times) in 1986 from June to October indicated westerns and A. goudii were less than 5% and 1% of the total beetle population, respectively. The pathogen was harbored 4% (1984) and 9% (1985) of westerns and 4% (1984) and 2% (1985) of A. goudii. Striped beetles carried 95% to 6% of the population while their frequency of carrying wilt was 28% to 37%. Southern (spotted) beetles comprised 40% to 90% of the population, but only 8% carried the pathogen. Vector potential was determined by extract injection into cucumber seedlings.

A COMPARISON OF METHODS TO STORE ISOLATES OF PYRENOPORA TRIITICÂ-REPTENS. R. R. Huesker, Plant Pathology Dept., Oklahoma State University, Stillwater, OK. 74078-0285.

Four, single-sporulated isolates were stored continuously on clarified V-8 juice agar (CV-8) at 4 C, on CV-8 at 4 C but transferred monthly, on CV-8 at 4 C, in 10% DMSO in liquid nitrogen and on autoclaved straw at room temperature and at 10 C. Isolates were stored at 0, 4, 8, 12, 16 wk of storage for growth and sporulation on potato dextrose agar and CV-8, and for pathogenicity on wheat seedlings. Growth and pathogenicity were not affected by storage on CV-8, but isolates sporulated sparsely after 16 wk at 4 C. Two isolates stored on straw showed abnormal and decreased growth after 12 wk of storage. Growth and pathogenicity of the other isolates was not affected by storage on straw, but sporulation declined after 16 wk. No changes in the isolates occurred when stored in liquid nitrogen and results indicate that storage in liquid nitrogen is best to maintain isolates of P. triitici-repentis.

LABORATORY IDENTIFICATION OF PATHOGENIC ISOLATES OF FUSARIUM OYSIFORUM P. sp. APF1 RACE 2. Karen F. Ireland, Melynn L. Lacy, Department of Botany and Plant Pathology, Michigan State University, East Lansing, MI 48824.

Fourteen isolates of Fusarium oxysporum f. sp. apf1 (FOA) race 2 and one FOA race 1 isolate were grown on potato sucrose agar containing 15 g KNO3 per L. Mutants that could not utilize KNO3 as a nitrogen source were recovered for each isolate. Two complimentary mutants were selected from each isolate and all mutants were paired in all possible combinations. Mutants from four FOA race 2 isolates formed nitrate-utilizing heterokaryons with at least one mutant from all other FOA race 2 isolates. No FOA race 2 mutants formed heterokaryons with the FOA race 1 mutants. Mutants from 11 other forms of K oxyysporum did not form heterokaryons with FOA mutants. This procedure can identify FOA race 2 isolates in half the time it takes for pathogenicity tests, but success depends upon the production of good tester strains. Partial characterization revealed the FOA mutants were lacking either nitrate or nitrite reductase activity.
OVERTWINTERING POPULATIONS OF PSEUDOMonas SYRINGAE PV. TOMATO AS A SOURCE OF SPRING INOCULUM IN MICHIGAN. D. L. Jardine and C. T. Stephens, Dept. of Plant Pathology, Kansas State Univ., Manhattan, KS 66506. Studies were undertaken to determine if Pseudomonas syringae pv. tomato (Pat) could overwinter and serve as a spring inoculum of tomato bacterial spot. Pat-colonized tomato plants were inoculated with leaves or roots of weed species sampled from fields in which infected tomato plants had grown the previous year. The pathogen also was not detected in moss-humus soil of infested fields. Pat was recovered in April from overwintered surface debris inoculated with a rifampicin-resistant isolate the previous year. The ability of overwintered Pat to serve as a source of spring inoculum was related to the tillage system used. Least infections were produced in greenhouses while resistant Pat-strain seedlings were planted into a previously infested field that was either spring-plowed or left untilled. Plants did not become diseased when planted into areas that were fall plowed.

CHARACTERIZATION OF WHEAT SPINDLE STREAK MOSAIC VIRUS AND TIME COURSE STUDY OF VIRAL DISEASE PROGRESSION BY WESTERN BLOT ANALYSIS. L. L. Kendall and S. A. Lomelii, Department of Plant Pathology, Kansas State University, Manhattan, Kansas 66506.

The molecular weight of a field isolate of wheat spindle streak mosaic virus (WSSMV) capsid protein was determined to be 36 kd by SDS-polyacrylamide gel electrophoresis. Antiserum made against denatured WSSMV capsid protein was found to be specific when compared with a known WSSMV antiserum and with antiserum to wheat scabies mosaic virus (WSMV). Viral disease progression in the source field was monitored at two-week intervals with Western Blots using WSSMV, WSMV, and WSSMV nucleocapsid antigens. WSSMV decreased over time and was not detected in the last collection. WSSMV was detected at the second collection and increased over time. WSSMV was not detected at any time.

MODIFICATION OF DNA BY THE HOST-SELECTIVE TOXIN FROM HELMHINSPORIUM CARBONUM. RACE 1. Shin-Duk Kim, Stephen J. Ganka, and Herman W. Kocke, Department of Agricultural Biochemistry, University of Nebraska, Lincoln, NE 68583-0718

Maize lines susceptible to Helminthosporium leaf spot, caused by Helminthosporium carbonum, race 1. are also very sensitive to HC-toxin, a cyclic tetrapeptide produced by the fungus. Because the toxin contains an epoxide group essential for biological toxicity, HC-toxin may damage sensitive maize by modification of nucleic acids or proteins. This hypothesis is supported by the observation that HC-toxin requires an extended incubation period and time to form an active molecule with slow toxic effect. When HC-toxin was incubated with deoxyguanosine, dTMP, poly-d(G-C), or DNA isolated from susceptible or resistant maize, a toxin-substrate adduct was formed, as evidenced by the appearance of new fluorescence absorption and emission bands. The modification appears to be covalent and non-specific. If the basis for sensitivity of maize to HC-toxin involves modification of DNA in vivo, resistance may be due to detoxification, differential uptake, or DNA repair.


Weekly inoculations of soybeans with conidia of Phomopsis lenticiculosa showed that higher levels of pod infection, as measured at growth stage R6, occurred in plants inoculated at reproductive compared to vegetative growth stages. Individual environmental parameters measured following inoculation of reproductive stage plants, were not highly correlated with pod infection. When moisture events in the 48 hour period following inoculation were defined by combining moisture parameters, wet events (minimum relative humidity 90%, greater than 25% hours of >902 relative humidity, and greater than 30 hours of leaf wetness) were associated with increased pod infection. Twenty cultivars were screened for susceptibility to Phomopsis pod infection using the R6 stage and 10 kg per acre. Differences in susceptibility to pod infection by P. lenticiculosa were detected in the 20 soybean cultivars tested in the field and greenhouse.

PITTED SCAB OF RUSSET BURBANK POTATOES. D. A. McQueen, W. A. Anderson, and A. D. Peterson, Departments of Plant Pathology and Entomology, University of Minnesota, St. Paul, MN 55108.

Deep pitted lesions were observed on Russet Burbank potatoes grown in large rotations on sandy soils in central Minnesota. Although 66% of the lesions contained insects, mites, or annelids, no decrease in the number of lesions occurred when replicated plots in production fields were treated with Aldicarb, Dyfonate, or Phorate. Plots in the same field treated with a 20 kg PRate of Phorate significantly reduced the number of lesions. Isolates of Streptomyces were obtained from the lesions. In inoculation studies in the greenhouse, pitted lesions occurred on tubers only from plants growing in inoculated soil.

INFECTN OF ASPEN BY HYPOXYLON NUMMATUM THROUGH TREEHOPPER WOUNDS. M. L. Ostry and N. A. Anderson, USDA Forest Service and Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

During oviposition female treehoppers (Family: Membracidae) cut slits into small diameter (x = 5 mm) twigs, often killing the distal portion. We have found Hypoxylon cankers associated with these wounds. Small cankers (x = 3.5 cm) may not extending beyond the wound--were usually found on 2-year-old branch wood. In the upper twigs Hypoxylon cankers were present on several of the cankers examined. Cankers do not advance to the main stem because the small twigs dry and fall off before the fungus reaches a major branch. Treehoppers make wounds into the wood similar to wounds made by sapreeds or cicadas. This is further evidence that a deep, incompletely closed wound is necessary for infection.

PECTOLYTIC BACTERIA IN SORGHUM STALK ROT TISSUE. J. E. Partridge and P. T. Nordquist, Dept. of Plant Path. and Agron., UNL, Lincoln, NE 68583.

Organisms were isolated from the second internode of sorghum plants standing in the field throughout the Nebraska winter. As previously reported in the literature, Fusarium armeanum and F. moniliforme were the predominant microorganisms in many sorghum plants before harvest. However, after the predominant microorganisms present were bacterial species. Many of the bacterial isolates possessed pectolytic activity as judged by their growth on pectin containing media. The pectolytic activity of these bacteria continued until only the rind and vascular tissues remained. After the tissues were "shelled out", the bacterial predominance waned and the major microorganism was B. armiformum. The concomitant meaceration of stalk tissue leads to a postharvest rot in sorghum. Pectolytic bacteria may play a major role in post-cut stalk decomposition (stalk rot).

ESTIMATION OF EFFICACY OF FOLLAR FUNGICIDES ON BARLEY BY MULTISPECTRAL RADIOMETER. V. D. Pederson, North Dakota State University, Fargo 58105.

Fungicide treatments were applied at the 2 leaf stage and boot plus 10 days to barley (Hordeum vulgare L.) cultivars 'Larker' at Fargo and 'Robust' at Langdon, ND. Prevalent foliar diseases were Botrytis (Botrytis cinerea) at Fargo and Scald (Phylocoecporpus coecalis) at Langdon. Fungicides included Mancozeb (Dithane M-45, Propiconazole (Tilt) and Ortho 8779 applied at recommended rates. A multispectral radiometer with wavelengths of 0.400 to 0.700 nm at 10 nm intervals was used to record percent reflectance of radiation from plot canopies at the soft dough stage of kernel development. Highly significant positive correlations between percent reflectance and all wavelengths of the IR were obtained. A regression equation on the upper 3 leaves were obtained at both locations. Prime advantages of the multispectral radiometer over visual observations for estimation of foliar disease control are speed and objectivity of measurements.

NUTRITIONAL REQUIREMENTS FOR SEXUAL REPRODUCTION BY PYRENOPHORA TRITICI-RENTENIS. W. F. Pfender and S. L. Wooten, Dept. of Plant Pathology, Kansas State University, Manhattan, KS 66506.

Pyrenophora tritici-repentis, a causal agent of wheat tan spot, was inoculated onto plates of purified cellulose amended with various combinations of inorganic salts and urea, then incubated under conditions favorable for production of pseudohyphae and ascospores. Sexual reproduction was dependent on nitrogen (N), phosphorus (P) and potassium (K) levels. Given P and K at adequate levels, 900 ppm N (1.9 mg urea/g cellulose) supported
abundant sporation. At 90 ppm sporaulation was reduced 60%. At 9 ppm N very few ascocarps or ascospores were produced. In the presence of 900 ppm N, requirements for P and K were clearly lower. When supplied with only 500 ppm each, no ascospores were produced; with P alone a few ascocarps were produced, but none developed ascospores. When supplied with 200 ppm P and 500 ppm K together, abundant sporaulation occurred. Reducing both simultaneously by 80/10 these levels had no significant effect, but at 2 ppm P + 5 ppm K sporaulation was virtually eliminated.

**MULTIVARIATE ANALYSIS TO COMPARE MICROBIAL COMMUNITIES OF WHEAT STRAW UNDER DIFFERENT SIMULATED TILLAGE PRACTICES.** M.F. Pfenefelder and S.L. Woote, Dept. of Plant Pathology, Kansas State University, Manhattan, KS 66506.

Winter wheat straw naturally infested with Pyrenophora triticirepentis (Pt) and Septoria nodorum (Sn) was buried in the soil, placed directly on soil surface, or buried under soil surface within a straw layer to simulate different tillage practices. Periodically between June and April straw from each treatment was sampled and assayed for microorganisms by determining numbers of ascospores and conidia. A data matrix of samples X species was constructed and analysed by detrended correspondence analysis (DCA). The major DCA axes ran from newly-colonized and abandoned straw (influenced by primary colonizers such as Pt and Sn) to on-soil and buried straw (occupied by secondary colonizers such as Trichoderma and actinomycetes). Pt and Sn were absent from most on-soil and buried straws. Laboratory studies on primary and secondary colonizers of wheat straw showed that colonization and low-temperature cellulosylsis were associated predominantly with secondary and primary colonizers, respectively.

**VARIATION IN A FIRST-RESISTANCE REACTION OF PHASEOLUS VULGARIS L. DUE TO LEAF AGE.** M. Shaik and J.R. Steadman, Dept. of Plant Pathology, University of Nebraska, Lincoln, NE 68083-0722.

Leaf age at the time of inoculation has been reported to influence the degree of susceptibility to bean rust (*Uromyces appendiculatus* (Pers.) C. F. Jonger var. *appendiculatus*). In a resistant reaction, manifested by small pustules surrounded by necrosis on the stem, the incidence of necrosis decreases as older leaves are inoculated. Inoculation of 2- to 8-day-old leaves resulted in the development of necrosis around all the pustules. On 10- to 14-day-old leaves, necrosis occurred in 49% of the pustules. On 21-day-old leaves necrosis did not develop around any pustules. The morphological and microscopic manifestations of this variation and its importance in evaluating resistance to the bean rust pathogen is discussed.

**EFFECT OF SELECTING FOR RESISTANCE TO PHERONOPSIS TRIFOLIIUM IN Alfalfa.** M. L. Borden and D. A. Stevenson, Dept. of Plant Pathology, Kansas State University, Manhattan, KS 66506.

Selecting in alfalfa to alter forage saponin content has affected resistance to *P. trifoliium* (Crop Sci. 16:193-199; Can. J. Plant Sci. 58:89-96; 1978). By OFU 101 alfalfa and genetically derived from it by one and two cycles, respectively, of recurrent phenotypic selection for resistance to *P. trifoliium* were evaluated for forage saponin content. The percent of plants resistant to aphids was 80% for OFU 101, 28% for 3; UC 123, 62 and 3; and UC 143, 61 and 72. Saponin index (greater value = lower saponin content) were COU 101, 100, UC 123, 92; UC 143, 100; 'Lahontan' (low saponin check), 98; and 'Unita' (high saponin check), 35. Saponin apparently played no role in the resistance to *P. trifoliium* as the highly resistant UC 143 germplasm was derived from the very low saponin COU 101 cultivar without affecting the saponin index.

**ISOYME DIFFERENCES BETWEEN GEOGRAPHIC SOURCES OF ENCODERMARIUM HARKNESSII.** G.A. Tuskan and J.A. Walla, North Dakota State University, Fargo, ND 58105.

Starch gel electrophoresis was used to study isozyme variability of *E. harknessii* from two geographic sources in North Dakota. Spores (5 mg) were prepared using three techniques: 1) 10 hr digestion in 10 ml of 1% cellulase, 1% chitinase and 1 M mannitol, followed by maceration in phosphate buffer, 2) maceration in distilled water and 2) 24 hr germination, followed by maceration in phosphate buffer. Samples were then electrophoresed and screened for 33 enzyme systems using 3 buffers (morpholine-citrate, histidine-citrate and lithium-borate), with 11 enzymes/buffer. Twenty-one enzymes displayed isozyme activity. Spore preparation technique affected response of 11 enzymes. Five of the enzymes showed isozyme banding differences between the geographic sources. It appears that isozyme banding technique using spores will be useful for distinguishing between geographic sources of *E. harknessii*.

**ISOLATION AND SCREENING OF CELLULOLYTIC FUNGI STRAINS.** E.G. Wene and A.A. Antonopoulos, Argonne National Laboratory, Argonne, IL 60439.

Various techniques were used to isolate more than 3,500 *Panaeum* isolates from a wide variety of locations. This work involved the isolation and development of potential cellulolytic *Panaeum* strains. In the absence of cellulose, inorganic nitrogen served as the preferred carbon source. Several cellulase enzyme screening assays were compared. Most of the isolates were screened for cellulolytic activity with a rapid test-tube-cellulose-charcoal clearing assay. Potential cellulolytic strains were grown on endopectin in 250-ml shake flasks and 5-L fermentors. Nearly all the isolates showed some degree of cellulolytic activity in the rapid screening techniques. *Panaeum* cellulases were the most often isolated species and generally showed a higher degree of cellulolytic activity. Several isolates produced up to 1.2 IU/ml cellulase when grown in 5-L fermentors. Aerobic or anaerobic conditions, along with the presence of nitrogen, 

**FOUR YEAR FIELD EVALUATION OF FUNGICIDE SEED TREATMENTS ON WHEAT SEEDLING EMERGENCE.** E.R. Williams, J.R. Pink, Dept. of Plant Pathology, Oklahoma State University, Stillwater, OK 74079-0265.

Five commercial fungicide formulations (Carboxin-Capten, Carbosim-Thiram, PCBN, TCMPS; Metalaxyl) labeled for treating wheat seeds were compared for effectiveness in improving seedling emergence from 1981-84. Percent seedling emergence was determined from plantings of 200 seeds in 12 ft rows in 10-15.5 C soil with adequate moisture. Metalaxyl occurred in 1982-84 with TCMPS more prevalent in 1985. Certain fungicides significantly increased seedling emergence 2 of the years. No fungicide gave consistently high readings all 4 years. No post emergence plant mortality was observed from readings 4 weeks and 7 months after planting. Significant increases in seedling emergence occurred 50% of the time, however emergence increases from a given fungicide for a given year were unpredictable.

**FIELD EVALUATION OF SUGAR BEET SEED TREATMENTS.** L. E. Windels, Northwest Exp. Sta., Univ. of Minn., Crookston, MN 56716.

Sugar beet 'Maribo Ultramar' seeds was treated with fungicides active against *Ptychozoon* (metoxyfluralin, Rhizoctonia solani (chloronit, quinzotene, furmecyclob, thiophanate), broad-spectrum fungicides (captan, thiram, quintozone-trifluoroal or with stenex MD 30) (bacillus subtilis), singly and in combination. In a field naturally infested with Pythium sp., R. solani and Aphanomyces coxeidioles, oxadixyl and metalaxyl gave 91% and 84% emergence, respectively, over untreated seed. Metalaxyl + furmecyclob, captan, thiram, and thiaminiontetenietridazole and fungicides active against R. solani gave plants equal to untreated seed. Stand loss was 4% for treated and untreated seed 8 wk after planting. Thus, in a field with soilborne diseases, fungicides active against *P. pythium* gave the best stands, but seed treatment did not affect post-emergence damping off.

**POTATO DAMAGE TO TURF MINING SEVERAL PATHOGENIC DISEASES.** G.L. Worf, J.A. Stewart, and M.F. Heinman, O.R.P. Department of Plant Pathology, University of Wisconsin-Madison, WI 53706.

Subfreezing temperatures in early May caused injury resembling several pathogenic diseases to Kentucky bluegrass. Several mistaken diagnoses were later observed. White leaf tips, often associated with the external plants, were the primary effects of frost injury. Of 24 cultivars examined, 11 showed no color deterioration between green and white tissue, 'Merit' and 'Glade' had distinct purple margins, and the remaining 11 showed occasional purpling. These symptoms resembled infections caused by *Ascochyta* and *Rhizosporia* or *Lama* and *Melrhopodiun*.* Ascochyta* was isolated from some spots, suggesting *Ascochyta* related lesions. Some tips were damaged in pockets, especially where closely mowed. Their grey-brown coloration suggested *Helminthosporium* infections. Effects of low temperature were confirmed by growth chamber tests at -5 C.