NORTH CENTRAL DIVISION ABSTRACTS

North Central Division abstracts were presented in conjunction with the 1994 APS Annual Meeting, August 6–10, 1994, Albuquerque, NM.

NC1

ASEPTIC SYNTHESIS OF ECTOMYCORRHIZAE USING ASPEN ROOT CULTURES. M.E. Ostry,[1] V. Raffle,[2] and N.A. Anderson[2]. [1]USDA Forest Service, North Central Forest Experiment Station, and [2]Dept. of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

Increased demand for aspen (*Populus tremuloides*) by the wood and paper industries has created an interest among land managers in planting superior aspen clones with improved growth rates. Several species of fungi have been associated with aspen ectomycorrhizae. Selection of symbionts with increased mycorrhizal efficiency may improve survival and growth of trees in plantations established with genetically improved nursery stock. We developed a root organ culture system using a roller bottle apparatus in which aseptic cultures of detached aspen roots of a superior clone (Pike Bay™) were inoculated with isolates of *Laccaria bicolor*. Mycorrhizae were synthesized within 15 days which allowed us to rapidly screen various isolates of *L. bicolor* for their ability to form ectomycorrhizae on aspen. An isolate collected from black spruce consistently produced fewer mycorrhizal root tips than an isolate collected from aspen.

NC2

SUSCEPTIBILITY OF POINSETTIA CULTIVARS TO *OIDIUM* SPP. G.J. Celio and M.K. Hausbeck. Dept. of Botany and Plant Pathology, Michigan State University, East Lansing 48824

Powdery mildew (*Oidium* spp.) on poinsettias (*Euphorbia pulcherrima*) growing in commercial greenhouses was first observed in Michigan in 1991. To investigate the susceptibility of 12 poinsettia cultivars to powdery mildew, multiple-stem poinsettias with mature bracts in 15.2-cm diam pots were arranged on a greenhouse bench in a completely randomized design with four replications. All plants were inoculated on 14 January 1994 by tapping mildew-infected plants held 46 cm above healthy plants to release conidia. Area under the incidence of disease progress curve (AUDPC) was used to express the incidence of bracts infected over a 31-day period after inoculation. Cultivars with red bracts (Freedom Red, Red Sails, V-14 Glory, Supjibi Red) had significantly more bracts infected (>91.2%) than the cultivars with pink (V-14 Pink, Hot Pink) (85%), white (Topwhite, V-14 White, V-17 Angelika White) (53-96%), or variegated bracts (Jingle Bells 3, Pink Peppermint, V-17 Angelika Marble) (53-79%). The mature foliage did not become infected with the exception of the cultivars Freedom Red, Jingle Bells 3, and Red Sails.

NC3

EFFECT OF GAUCHO SEED TREATMENT AND FURADAN ON BARLEY YELLOW DWARF OF WINTER WHEAT. M. A. Davis and W. W. Bockus, Department of Plant Pathology, Throckmorton Hall, Kansas State University, Manhattan, KS 66506-5502.

A replicated (X4) field experiment was established with two planting dates (14 Sep and 7 Oct 1992) and four treatments: nontreated control; Furadan 15G broadcast (50 lb/A) on 22 Sep, 14 Oct, and 23 Apr 1993; Gaucho 75W (imidacloprid) seed treatment at 1.33 oz/cwt; and Gaucho at 2.67 oz/cwt. High percentages of plants showing barley yellow dwarf (BYD) occurred (27 May) only with the early planting date. For that date, Furadan reduced ($P < 0.05$) the percentage symptomatic plants 88% and increased grain yields 65%. The high rate of Gaucho reduced symptoms 51% and increased yields 31%. Therefore, large losses (39.3%) in grain yield can occur from BYD in early-planted winter wheat in Kansas. Seed treatment with Gaucho should result in about 50% control of the losses. Finally, three applications of Furadan appears to provide high levels of control for research purposes.

NC4

β-ESCIN (SAPONIN), OAT SEEDLINGS, AND OAT RESIDUE IN SOIL AFFECTS GROWTH OF *APHANOMYCES COCHLIOIDES* HYPHAE, ZOOSPORES, AND OOGONIA. Cheryl A. Engelkes and Carol E. Windels. NW Expt. Station, University of Minnesota, Crookston 56716.

To understand how an oat precrop suppresses *Aphanomyces* damping-off of sugar beet, *A. cochlioides* was exposed to β-escin (a saponin related to that produced by oat), volatiles and extracts from oat decomposing in soil, and oat seedlings. After 48 hr, hyphal growth of 13 isolates was reduced 31-100% with increasing β-escin concentrations (50-2500 ppm) in media compared to the PDA control. After 48 hr exposure to volatiles produced as oat decomposed in soil, hyphal growth on PDA was reduced 20-38% compared to the controls. By 24 hr after *A. cochlioides* was added to distilled water with 10 ppm β-escin, oat seedlings, or extracts from oat residue decomposing in soil, zoospores germinated and abundant oogonia formed. Formation of zoosporangia was delayed in 100 ppm β-escin; no zoosporangia or oogonia formed in 1000 ppm β-escin. Thus, an oat precrop directly affects growth of hyphae, zoospores, and oogonia of *A. cochlioides*.

NC5

A NEW VIRUS DISEASE OF CORN AND WHEAT IN THE HIGH PLAINS.
Stanley G. Jensen and Leslie C. Lane USDA-ARS, Univ. of Nebr. Lincoln, NE 68583.

Maize plants showing severe virus symptoms were received from several locations in the Texas panhandle, western Kansas, northeastern Colorado and central Idaho. Serological tests for wheat streak mosaic virus were positive but tests for all other maize viruses known in the area, including maize stripe, were negative. Mini-purification followed by polyacrylamide gel electrophoresis revealed the WSMV coat protein (about 44 kd) and another viral coat protein (about 34 kd). All samples of severely symptomatic maize had the 34 kd protein but not all had the WSMV coat protein. The unknown virus sedimented slowly as a diffuse band in sucrose density gradient centrifugation. The zone contained only the 34 kd protein. EM revealed very fine filamentous particles. Only three dent corn hybrids were infected but yield losses up to 75% were recorded. Several, but not the majority of sweetcorn and popcorn varieties were susceptible. One blue corn variety was infected. Through the fall and winter the same pathogen has been recovered from several wheat varieties in Texas, Kansas and Idaho. Most wheat seems to be susceptible and the damage is severe. We have confirmed the finding of Dallas Seifers Hays, Kansas, that the pathogen is transmitted by eriophyed mites. The virus shows characteristics of the tenuivirus group and the wheat spot mosaic family of pathogens. It appears to be very wide spread and poses a serious economic threat to both maize and wheat.

NC6

BIOCONTROL OF ALFALFA SEEDLING DAMPING OFF WITH A SUPPRESSIVE STRAIN OF *STREPTOMYCES*. Cecilia R. Jones[1], and Deborah A. Samac[1,2], [1]Dept. of Plant Pathology, Univ. of Minn., and [2]USDA-ARS, St. Paul, MN 55108.

A rolled paper towel assay was used to evaluate the ability of different concentrations of a *Streptomyces* strain to suppress the infection of alfalfa seedlings by *Pythium ultimum*. Spore suspensions were obtained from 10-day-old *Streptomyces* cultures grown on oat meal agar. Seeds were coated with these spore suspensions to obtain different number of colony forming units (CFU) per seed. Three inoculum concentrations were used per experiment (from 2 to 11000 CFU/seed). Twenty seeds were placed on sterilized soil containing 3 - 6 CFU of *P. ultimum* per gram on a moistened paper towel. The paper towel was rolled and kept moist for incubation. After 5 days at room temperature seedlings were scored for root rot on a 1 - 5 scale; 1= healthy seedling with roots free of necrosis, and 5= rotted seed. The experiment was repeated three times. Treating seeds with *Streptomyces* significantly reduced the average severity index (ASI), and increased the number of seedlings with no symptoms of infection (categories 1 and 2) compared to the untreated controls. The lower ASIs were associated with the higher number of CFU/seed. Variability observed between experiments was probably due to differences in the pathogenicity of the *P. ultimum* inoculum. The suppressive strain of *Streptomyces* may be effective to successfully control alfalfa seedling damping off.

NC7

BIOCONTROL OF PHYTOPHTHORA ROOT ROT OF ALFALFA WITH A SUPPRESSIVE STRAIN OF *STREPTOMYCES*. Cecilia R. Jones[1], and Deborah A. Samac[1,2], [1]Dept. of Plant Pathology, and [2]USDA-ARS, Univ. of Minn., St. Paul, MN 55108.

Streptomyces strains isolated from soils suppressive to potato scab, were previously shown to have the potential for biocontrol of various microorganisms pathogenic to alfalfa. Field and greenhouse studies were performed to test the ability of a suppressive strain of *Streptomyces* to control the incidence and severity of Phytophthora root rot, caused by *Phytophthora megasperma* f. sp. *medicaginis*, in alfalfa. Field plots were established in Saint Paul, MN in 1993. *Streptomyces* was grown in vermiculite plus oat meal broth, and incorporated into *Phytophthora* infested soil at planting. Treatment with *Streptomyces* significantly improved plant establishment, number of plants at harvest, and yield when the fungicide metalaxyl was also applied. *Streptomyces* treatment alone resulted in an increase of the variables measured, but differences with controls were not significant at P=0.05. One resistant cultivar (WAPH-1) and one susceptible cultivar (Saranac) of alfalfa were used in greenhouse studies. For Saranac, *Streptomyces* significantly increased the percentage of plants with no symptoms or resistant type of reaction (%R), from 13.3% to 42.4-51.3% and decreased the average disease severity index (ASI), from 3.3 to 2.5-2.7 compared to the untreated control. For WAPH-1, *Streptomyces* significantly reduced the ASI (from 2.1 to 1.6-1.8), but had no effect on %R.

NC8

PCR ANALYSIS OF AVIRULENCE GENES FROM *PSEUDOMONAS SYRINGAE* PATHOVAR *GLYCINEA*. L. W. Keith and J. E. Partridge. Department of Plant Pathology, University of Nebraska - Lincoln, 68583-0722.

Strains of *Pseudomonas syringae* pv. *glycinea* (Psg), the causal agent of bacterial blight of soybeans, are divided into physiological races based upon their reaction on a set of differential soybean cultivars. Psg races 1 through 6 were analyzed for the presence of avirulence (*avr*) genes A, B, C, and D using the polymerase chain reaction. It is proposed that individual avirulence genes may account for the race phenotype of the bacteria. Successful amplification of a 3.4 kb fragment of *avr*A was obtained from Psg race 6. A smaller, 2.9 kb fragment was found in Psg race 1. An amplified product of *avr*B was evident only in Psg race 1 (2.3 kb). *avr*C was not amplified in any race. However, a 3.1 kb fragment of *avr*D was amplified in all 6 races examined.

NC9

RHIZOCTONIA ZEAE PATHOGENIC TO SPRING WHEAT AND SUGAR BEET SEEDLINGS. R.A. Kuznia and C.E. Windels. NW Experiment Station, University of Minnesota, Crookston 56716.

Rhizoctonia zeae was isolated from diseased sugar beet (*Beta vulgaris* L.) seedlings and discolored subcrown internodes of spring wheat (*Triticum aestivum* L.). Cultures of *R. zeae* (12 from wheat, 11 from sugar beet) were grown on cornmeal-sand, mixed with steamed soil (5% inoculum by weight), and planted to wheat. Of the 23 cultures tested and averaged across two trials, 54% of the isolates significantly (P=0.05) reduced total emergence and stand at 3 wk after planting, 87% reduced fresh weight of shoots, and 72% reduced fresh weight of roots. Pathogenicity of the same cultures of *R. zeae* on sugar beet was tested by an inoculum layer technique. When averaged across two trials, 61% of the isolates significantly (P=0.05) reduced total emergence and 67% reduced stand by 3 wk after planting. Cultures of *R. zeae* varied in pathogenicity, but the same cultures reduced emergence and stand counts 3 wk after planting in spring wheat and sugar beet. Thus, *R. zeae* is pathogenic to both spring wheat and sugar beet seedlings.

NC10

DISTRIBUTION OF SCABBY WHEAT AND VOMITOXIN IN NORTH DAKOTA AND ADJACENT AREAS IN 1993 **R.W. Stack[1], M.P.McMullen[1] and H. Casper[2]. 1) Dept. of Plant Pathology, 2) Dept. of Veterinary Science, N.D. State Univ., Fargo ND 58105 USA**

Fusarium head blight or scab was severe on spring wheat in eastern North Dakota and northwestern Minnesota in 1993. To assess the impact of the disease, we examined 1137 wheat samples from this region for evidence of scab damage. Incidence of scabby kernels was determined by visual counting. Vomitoxin (deoxynivalenol) was determined by the NDSU Veterinary Sciences Toxicology Laboratory using GC-MS of the trimethylsilyl derivatives. In individual grain samples, vomitoxin levels ranged from <0.2 to 43 mg/kg, while incidence of scabby kernels ranged from 0 to 75%. County averages were calculated for 26 counties with four or more samples. Regression of county averages of vomitoxin with incidence of scabby kernels was highly significant (R^2 = 0.76). The 10 northern tier counties showed a lower average vomitoxin level than the central tier and the southern tier counties, when equivalent levels of scabby kernels were compared.

NC11

VOMITOXIN LEVELS IN HARD RED SPRING AND DURUM WHEATS IN NORTH DAKOTA IN 1993. **M. P. McMullen[1], R. W. Stack[1], and H. Casper[2]. [1]Dept. of Plant Pathology, [2]Dept. of Veterinary Sci., N. D. State Univ., Fargo ND 58105**

Hard red spring (HRS) and durum wheats grown in cultivar trials in eastern ND in 1993 had severe natural infections of Fusarium head blight (scab), due primarily to Fusarium graminearum. Prolonged wet periods during flowering and early kernel development favored scab infection. Following harvest, composite grain samples of named cultivars or numbered lines in each trial were analyzed for vomitoxin using GC-MS of the trimethylsilyl derivatives. Trial sites were treated as replicates for ANOVA. Vomitoxin levels were significantly different among 16 HRS lines grown at four sites and ranged from 4 to 11 ppm. 'Sharp' and '2370' averaged the lowest levels at 4 ppm and 4.1 ppm, respectively. Vomitoxin levels among eight HRS lines grown at six sites also were significantly different. Vomitoxin levels were much higher at some sites than at others, for all wheat lines. However, lines with the lowest average levels of vomitoxin also ranked among the lowest at individual sites. Of ten durum lines grown at four sites, 'Renville', 'Monroe' and 'D8460' had the lowest vomitoxin levels.

NC12

ULTRASTRUCTURAL CHANGES INDUCED BY BARLEY YELLOW DWARF VIRUS INFECTION IN TOLERANT AND SENSITIVE OAT LINES. Petra H. Nass and Cleora J. D'Arcy, University of Illinois, Department of Plant Pathology, 1102 South Goodwin Ave., Urbana, IL 61801.

Barley yellow dwarf virus (BYDV) infection causes fewer symptoms and smaller yield losses in tolerant (T) than in sensitive (S) oat lines. Though lower virus titers have been reported in some T oat lines, the differences are neither consistent nor large enough to explain tolerance. The objective of this study was to determine whether different ultrastructural changes occur in T and S oats that could account for tolerance to BYDV infection. Seven-day-old seedlings of Coast Black oats, IL86-5262, and IL86-1150 were inoculated with BYDV-PAV-IL by approximately 30 viruliferous *Rhopalosiphum padi* L. At 2, 4, and 6 days after inoculation samples from the midrib of the inoculated primary leaf were taken and prepared for electron microscopy. Viral coat protein was located using an *in situ* immunogold labelling assay. The ultrastructural alterations were similar for all oat lines, except in IL86-5262 viral particles enclosed in vesicles with a single membrane appeared to be deposited at the cell wall and were occasionally embedded in a callose deposit.

NC13

MODELING WITHIN FIELD SPREAD OF SOYBEAN MOSAIC VIRUS WITH STRAIN-SPECIFIC MONOCLONAL ANTIBODIES. Forrest W. Nutter, Jr., John H. Hill, and Patricia M. Schultz. Department of Plant Pathology, Iowa State University, Ames, Iowa 50011.

Virus disease management strategies that utilize coat protein-mediated transgenic-based resistance, will require the development of proper biological assessment procedures to facilitate agribiotechnology transfer. For soybean mosaic virus (SMV), quantitative information concerning the spatial and temporal movement of specific strains is lacking. In 1991 and 1992, we successfully tracked the spatial and temporal spread of SMV strain G-5 in 'Corsoy' soybean using strain specific monoclonal antibodies. Monoclonal antibody S4 reacts with all known SMV strains, while S2 antibody reacts with all SMV strains except G-5. We tracked within-field spread of strain G-5 after it was released from point sources in field plot experiments. Plants in 30 cm row sections were sampled and tested weekly for the presence of strain G-5. In 1991, only strain G-5 was detected in field plot experiments; however, a strain other than G-5 was detected late in the 1992 season. The rate of SMV spread ranged from 0.12 to 0.14 logits/day in 1991 and from 0.06 to 0.08 logits/day in 1992. This project will provide new biological assessment tools and methods to quantify the risks and benefits of transgenic-based virus resistance strategies.

NC14

MOLECULAR BASIS OF RESISTANCE TO SOYBEAN MOSAIC VIRUS (SMV): DIFFERENTIATION OF STRAINS USING UNIQUE RNA SEQUENCES. M. E. Omunyin, J. H. Hill, and W. A. Miller. Plant Pathology Department, Iowa State University, Ames, IA 50011.

Ability to differentiate strains of SMV in mixed infections can yield insight into complex systems such as the basis for disease resistance. To extend the utility of mixed-infection approaches to such studies, we have developed a reverse transcription polymerase chain reaction (RT-PCR) assay that allows

detection of and discrimination between RNAs of individual SMV strains G2 and G7 in soybeans. The soybean cultivar Williams, susceptible to strains G2 and G7, was inoculated with each strain separately at the primary leaf stage. Strains G2 and G7 were detected using RNAs from trifoliate leaf samples containing either strain and yielded RT-PCR products of 277 bps and 439 bps, respectively. The SMV strains G2 and G7 were also detected from mixed samples of cDNAs prepared from total RNAs of plants inoculated separately with these strains. The results support the use of RT-PCR for differentiation of SMV strains using unique RNA sequences and should be applicable in studies to understand the molecular basis of virus resistance in soybeans.

NC15

EVALUATION OF SOYBEAN LINES AND VARIETIES FOR TOLERANCE TO *PHYTOPHTHORA SOJAE* RACE 4. R. L. Ruff[1], B. K. Voss[2] and X. B. Yang[1]. [1]Department of Plant Pathology and [2]Department of Agronomy, Iowa State University, Ames, Iowa 50011.

More than 700 soybean lines and varieties are tested in the Iowa Soybean Yield Test for tolerance to phytophthora root rot. The tolerance tests have been conducted in soybean fields infested with *P. sojae*, but the results have been variable among locations and replications apparently due to variations in population densities of the pathogen and environmental conditions. A greenhouse test for tolerance to *P. sojae* race 4 was conducted in 1994 to improve the precision of the ratings. *P. sojae* was grown on lima bean agar for 14 days. The agar and mycelium were placed on vermiculite, covered with 2 cm vermiculite and seeds were planted. Evaluations of disease progress on the roots was conducted after 3 wks. The inoculum-layer method produced more consistent results and was less expensive than the field tests. Soybean lines and varieties were designated resistant or susceptible to *P. sojae* races 1, 3, or 4 by the entrants. The degree of tolerance in these lines and varieties to *P. sojae* race 4 and the relationship of the presence or absence of single dominant resistance genes to tolerance was studied.

NC16

VIRULENCE OF THE NATURAL WHEAT LEAF RUST POPULATION IN NEBRASKA IN 1992 AND 1993. S. Rutledge, J. Watkins and P.S. Baenziger, Department of Plant Pathology, 448 Plant Sciences Hall, University of Nebraska, Lincoln, NE 68583-0722.

A total of 163 urediniospore isolates of *Puccinia recondita* f. sp. *tritici* were collected in 1992 and 133 in 1993 from four wheat growing regions in Nebraska and grouped for virulence to 16 Thatcher near-isogenic differential lines. In 1992, 37 virulence combinations were identified and 46 were identified in 1993. Forty two % of the 1992 isolates and 25% of the 1993 isolates were virulent to 10 or more near-isogenic lines. The most prevalent virulence phenotypes were TFHS (virulent to *Lr1, Lr2a, Lr2c, Lr3, Lr10, Lr11, Lr18, Lr21, Lr24, Lr26* and *Lr30*) in 1992 and TFHQ (virulent to *Lr1, Lr2a, Lr2c, Lr30, Lr10, Lr11, Lr18, Lr24, Lr26* and *Lr30*) in 1993. The frequency of virulence was high (greater than 60 percent) in both years to *Lr1, Lr10, Lr11, Lr18, Lr24, Lr26* and *Lr30*. Virulence was not detected to resistance genes *Lr3ka, Lr9* and *Lr16* in 1992 but was in 1993. Fewer virulence combinations were found in both years in the panhandle as compared to the other three regions east of the panhandle.

NC17

GENETICS OF RESISTANCE TO RYE STEM RUST IN BARLEY LINE Q21861. Y. Sun and B. J. Steffenson. Department of Plant Pathology, North Dakota State University, Fargo, ND 58105.

The barley line Q21861 possesses two genes for resistance to the wheat stem rust pathogen (*Puccinia graminis* f. sp. *tritici*): *Rpg1*, which has provided durable resistance in Midwest barley cultivars, and *rpg4*, a gene that confers resistance to pathotype Pgt-QCC. In a preliminary experiment, Q21861 also exhibited resistance to the rye stem rust pathogen, *P. g.* f. sp. *secalis*. To determine the genetics of resistance to this pathogen, a doubled haploid population (129 lines) derived from the cross Q21861/SM89010 was evaluated with the *P. g.* f. sp. *secalis* isolate 92-MN-90 at the seedling stage. Infection types (ITs) were assessed on the primary leaves of plants after two weeks of incubation at 16-21°C. Progeny exhibiting ITs of 00; to 0;1 were classified as resistant, and those exhibiting ITs of 23- to 33- were classified as susceptible. A 1:1 (resistant:susceptible) segregation ratio ($\chi^2 = 0.94$; $P = 0.35$) was found indicating that a single gene conferred resistance to isolate 92-MN-90. In comparing this data set to one obtained on the same progeny in response to pathotype QCC, we found that resistance to rye stem rust cosegregated with resistance to pathotype QCC. This result suggests that, in addition to pathotype QCC, *rpg4* also confers resistance to *P. g.* f. sp. *secalis*.

NC18

CROP RESIDUE COVER OF NO-TILL SOIL AFFECTING PRODUCTION OF CORN AND ITS COLONIZING FUNGI. N. G. Vakili and J. L. Hatfield, USDA-ARS, National Soil Tilth Laboratory, Ames, IA.

A crop residue and no-till experiment was conducted for three seasons until the flood of July, 1993, interrupted the study. The no-till treatments included wheat straw, pressed peat moss, corn residue, black plastic, and bare soil as control. The over wintering of above-ground crop residue on soil surface and below-ground residue in undisturbed epipedome caused physical and biological changes that affected corn growth and yield. The greatest physical difference between residue-covered and bare soil was the difference in diurnal temperature fluctuations in the spring. The biological differences were: Greater seedling damping-off caused by Pythium spp. and root lodging caused by corn rootworm; different frequency of fungi that colonized cornstalk; and lower grain yield due to less ears per plant and kernels per ear. Colonization of crown by a Phomopsis sp. increased by each season of no-till from 36 to 60% as compared with 0.5 to 10% in fall and spring disking. The results indicate that seed corn should not be planted in no-till, hybrid corn should not be in continuous monoculture and no-till, and the association of Phomopsis sp. with corn requires further evaluation.

NC19

EFFECT OF TEMPERATURE AND DEW PERIOD ON INFECTION EFFICIENCY OF *UROMYCES STRIATUS* ON ALFALFA. D. H. Webb and F. W. Nutter, Jr., 351 Bessey Hall, Iowa State University, Ames, Iowa 50011

The relationships between temperature and dew period duration on infection efficiency was determined for *Uromyces striatus* on alfalfa. For the temperature study, alfalfa CV "Ranger" was inoculated with 110 urediospores/cm^2 in an inoculation chamber and subjected to the following constant temperatures during a 24 hour continous dew period: 16.5, 18, 21, 24 and 27° C. At the end of the 24 hour dew period, inoculated plants were placed on a greenhouse bench and the number of pustules per leaf was determined 13 days later. As temperature decreased from 27 to 16.5° C, infection efficiency increased. To quantify the relationship between dew period duration and infection efficiency, we exposed alfalfa plants to continuous dew periods of 4, 8, 12, 16, 24, and 32 hours. Plants were then placed in a growth chamber at 22° C and 16 hours of light daily. As dew period increased from 4 to 24 hours, infection efficiency increased. The 32 hour dew period had an infection efficiency similar to the 16 hour period. Information from this study will be used to quantify the relationship between leaf lignin content and rust disease components (infection efficiency, latent period, and sporulation capacity).

NC20

ASSESSING THE BENEFITS OF USING FUNGICIDES TO CONTROL FOLIAR DISEASES OF SEED CORN IN IOWA. Stephen N. Wegulo, Charlie A. Martinson, and Forrest W. Nutter, Jr. Department of Plant Pathology, Iowa State University, Ames, IA 50011.

Eight experiments were established in Iowa commercial seed corn production fields in 1993 to determine the benefits of applying fungicides for control of foliar fungal diseases of seed corn. Land at the experimental sites had been planted with corn the previous year; infested debris provided the initial inoculum for Exserohilum turcicum, Cercospora zeae-maydis, Aureobasidium zeae, and Bipolaris zeicola. The predominant disease during the growing season at all sites was common rust (Puccinia sorghi). Fungicide sprays were initiated at 2 to 4% disease severity about 2 wk before detasseling and were repeated up to five times at about 10-day intervals. Fungicide sprays reduced overall disease severity and increased yield significantly ($p=0.05$). Based on an average wholesale price of $30/unit of 80,000 seeds and a fungicide application cost of $45, $36, and $22/ha (per application) for chlorothalonil, propiconazole, and mancozeb, respectively, a net profit of up to $1790/ha was achieved with the use of fungicides. The most profitable treatments were a) 5 sprays of chlorothalonil, b) 3 sprays of mancozeb, and c) 2 propiconazole sprays followed by 1 spray of mancozeb.

NC21

ATTEMPT TO DEVELOP OF A POLYCLONAL ANTISERUM SPECIFIC FOR APHANOMYCES EUTEICHES OOSPORES SEPARATED BY SONICATION. Jean L. Williams, B. E. L. Lockhart, and F. L. Pfleger, Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

Antiserum specific to oospores of *Aphanomyces euteiches*, causal organism of common root rot in pea, was sought to enhance ecological studies of the pathogen. Whole intact oospores from 4-wk-old cultures grown on corn meal agar were obtained by blending and sonicating (50,000 Joules) which completely disassociated hyphae from oospores, but did not disrupt the oospores. Oospores were separated from agar and hyphal fragments by wet sieving through a 20 μm sieve (No. 635). Whole oospores (100/μl) were injected intravenously into a rabbit at 7-10 day intervals for 7 wk. Polyclonal antiserum was obtained and screened against *A. euteiches*, *Pythium ultimum* and *Phytophthora megasperma medicaginis*. Cross reactivity was observed to both *P. ultimum* and *P. megasperma medicaginis*. Antiserum was cross-absorbed with *P. ultimum* and *P. megasperma medicaginis*, separately, and screened for specificity to *A. euteiches*. No specificity to *A. euteiches* oospores was found with the developed polyclonal antiserum. Future efforts to develop an antiserum specific to *A. euteiches* oospores should be concentrated on the development of a monoclonal antiserum.

NC22

IMPROVEMENT OF THE ROLLED TOWEL BIOASSAY FOR ESTIMATING APHANOMYCES EUTEICHES INOCULUM POTENTIAL IN SOIL. Jean L. Williams and F. L. Pfleger, Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

The rolled towel bioassay has been used for estimating inoculum potential of *Aphanomyces euteiches* in soil, but variability between assay replications of samples has confounded its reliability. A study was conducted to understand and reduce this variability. Clay loam soil was artificially infested with *A. euteiches* oospores (ranging from 100 to 2000 oospores/cc dried ground soil); 20 and 40 seedlings were evaluated with 0.5 and 1.0 cc ground soil per seedling (5 assay replications/oospore concentration). The number of seedlings evaluated per assay replication significantly (P=0.05) reduced variability among assay replications per soil sample and increased the level of significance among treatments. Increasing the number of assay replications per soil sample or the quantity of soil applied to each seedling root did not increase precision of the bioassay. Placing soil on the seedling root 1-2 cm below the seed resulted in twice the number of infected plants as 1-2 cm above the root tip. Thus, the most accurate estimate of inoculum potential with the rolled towel bioassay consists of two assay replications per soil sample of 40 pea seedlings using 0.5 cc dried ground soil per seedling placed 1-2 cm below the seed.

NC23

FIRST REPORT OF *THANATEPHORUS CUCUMERIS* (=*RHIZOCTONIA SOLANI* AG-3 AND AG-5) ON SUGAR BEET. C.E. Windels[1], R.A. Kuznia[1], and J. Call[2]. [1]Northwest Experiment Station, University of Minnesota, Crookston, 56716, and [2]American Crystal Sugar Co., East Grand Forks, MN 56721.

In 1993, superficial, white to gray, dusty growth, identified as hymenia of *Thanatephorus cucumeris*, was observed on sugar beet (*Beta vulgaris* L.) petioles in five fields. Of 28 cultures of *Rhizoctonia solani* isolated from hymenia, 23 were AG-3 and 5 were AG-5. Three of the four fields where *R. solani* AG-3 occurred had been planted to potatoes in 1992 and in the other field, potato culls had been discarded in 1992. Cultures of *R. solani* AG-5 were from a field planted to edible beans in 1992. Yields in three fields from plants infected by *T. cucumeris* (=*R. solani* AG-3) averaged 36.5 t/ha and 13.7% sucrose compared to yields of unaffected plants in these fields which averaged 38 t/ha and 16.7% sucrose. No symptoms of rot occurred on *T. cucumeris*-infected plants at harvest. Thus, potatoes or beans may serve as a source of *R. solani* inoculum, which increases on sugar beet as *T. cucumeris*.

NC24

GENETIC DIVERSITY AMONG *FUSARIUM GRAMINEARUM* ISOLATES FROM MINNESOTA. R.P. Woodward[1], E.L. Stewart[2], and R.D. Wilcoxson[1]. [1]Department of Plant Pathology, University of Minnesota, St.Paul, MN 55108. [2]Department of Plant Pathology, Pennsylvania State University, University Park, PA 16802.

Genetic diversity was assessed among 54 *Fusarium graminearum* isolates using isozyme analysis and restriction fragment analysis of the PCR-amplified ITS4/ITS5 rDNA region. Twenty-eight isolates were collected from Minnesota, and the remainder represented a worldwide distribution. Isozyme analysis (9 enzymes) revealed considerable inherent genetic variability among the 54 *F. graminearum* isolates. Twenty electrophoretic types (ETs) were found among all 28 Minnesota isolates. Seventeen ETs were found among all 26 non-Minnesota isolates. Isolate clusters based on geographic location or pathogenicity were not evident after UPGMA cluster analysis. Four isolate groups were identified based on restriction analysis of the ITS4/ITS5 rDNA region cut individually with five endonucleases. Forty-eight of the 54 *F. graminearum* isolates, including all Minnesota isolates, produced identical restriction patterns. Isozyme data suggest parasexual or sexual recombination may be involved in maintaining diversity, while rDNA data suggest Groups 1 and 2 are divergent.

NC25

PATHOGENIC VARIATION AMONG *FUSARIUM GRAMINEARUM* ISOLATES CAUSING HEAD BLIGHT OF SPRING WHEAT CULTIVARS. R.P. Woodward and R.D. Wilcoxson, Department of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

Little is known about pathogenic variability among *Fusarium graminearum* populations from different geographic locations. A study was conducted in the glasshouse to assess the pathogenicity of 12 *F. graminearum* isolates collected from Minnesota and 15 from a wide geographic area. At anthesis, the middle spikelet of each spike of five spring wheat (*Triticum aestivum*) cultivars differing in resistance to head blight was injected with 1000 macroconidia of each isolate, individually. Necrotic lesion size (mm) measured vertically from the inoculation site and presence or absence of sporodochia within the lesion were measured 14 and 21 days after inoculation, respectively. Significant (P=0.01) differences were found for cultivars, isolates, and the isolate x cultivar interaction using both disease measurements. Necrotic lesion measurements ranged continuously from 7 to 62 mm. Isolate pathogenicity was not associated with geographic location or population type (Group 1 or 2). Minnesota *F. graminearum* isolates possessed the range of pathogenicity found among isolates from the worldwide collection.

NC26

K. Tubajika, F. Workneh, and X.B. Yang. Survival rate of brown stem rot pathogen in corn/soybean rotation fields. Department of Plant Pathology, Iowa State University, Ames, Iowa 50011.

Survival of brown stem rot pathogen of soybean (Phialophora gregata) in soybean residues was determined from fields with different rotation histories. To determine the propagule densities of the pathogen in debris, 0-, 1- and 2-year old residues were collected from adjacent fields at 24 locations in Iowa and assayed for populations of P. gregata on a selective medium. The average colonies/g of residue were 7.1×10^3, 3.0×10^4, and 3.1×10^4 for 0-, 1-, and 2-year old residues, respectively. More variations in population densities were recorded among locations than among years. Results of field survey indicate that enough inoculum can survive in soybean debris through the corn rotation to cause significant disease on subsequent soybean. Soybean residues of known propagule density/unit^2 were also buried or left on the surface in different fields and the pathogen survival rate over the winter was examined.

NC27

POTENTIAL OF *RHIZOCTONIA SOLANI* FOR BIOCONTROL OF *EUPHORBIA ESULA*. G. Y. Yuen and R. A. Masters, Dept. of Plant Pathology and Dept. of Agronomy, University of Nebraska, Lincoln, 68583.

An isolate of *R. solani* AG-5 (R230) from a leafy spurge (LS) in Nebraska was tested for its potential as a mycoherbicide against the weed and for effects on nontarget plants. Transplantation of LS into R230-infested soil in the greenhouse resulted in root and crown rot and blighting of adventitious shoots. The fungus in soil reduced emergence of soybean, but had no effect on seedling growth of alfalfa, corn, Kentucky bluegrass, smooth brome, tall fescue or wheat. R230 applied onto the soil surface or onto foliage caused blighting of young LS stems and adventitious shoots, but did not infect mature LS stems without wounding. The fungus caused varying degrees of foliar necrosis on all nontarget plants tested, in addition to the related weed *E. maculata* (spotted spurge). High humidity (>95% RH) was required for sustained infection of above-ground parts on any plant. To test R230 for control of LS in the field, grain inoculum was incorporated below the soil surface in early spring. One month after treatment, R230 reduced emergence of LS seedlings (p=0.10) but did not affect stem growth from overwintering crowns. The fungus could no longer be detected in inoculated plots after 2 months.