

Wheat Research Progress Report - Final

Project #: 3019-7344

Title: Development of Wheat Varieties Resistant or Tolerant to Fusarium Crown Rot

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Cooperators: J Richard Smiley, OSU, G. Poole, A. Thompson, C. Hoagland

Progress Report Year: 2008

Accomplishments and Results by Objective:

A. Objectives:

1. Make crosses with PNW varieties and Fusarium tolerant material from Australia and CIMMYT-Turkey . Cross PNW varieties with Fusarium tolerant Australian and Turkish material. We made have advanced backcross populations between Sunco and Gluyas with Masami, MDM, and others and, in the winter of 2009, will evaluate progeny for resistance to Fursarium Crown Rot in the Greenhouse using the seedling screening method described below. We crossed PNW cultivars and breeding lines to resistance sources in the first CIMMYT International Root Disease Nursery which we received from Julie Nicols in Fall 2007. Approximately 150 crosses were made and are being backcrossed to PNW breeding lines in 2009.

2. Develop and test greenhouse screening techniques. For phenotyping and selecting resistant/tolerant progeny, it is crucial that we have a reproducible, consistent, and reliable seedling screening technique. The following methods were be evalauted 1) applying millet seed inoculum adjacent to seedlings growing in peat-sand mix; 2) coating seeds with macrospores of *Fusarium* and planting; 3) inoculating leaf sheaths with a drop of macroconidia; 4) applying macroconidia mixed with 1% agar at the base of a seedling surrounded by a straw to hold the inoculum in, an adaptation of a method used to inoculate for strawbreaker foot rot. These optimization experiments, using replicated block designs with 10-20 plants per rep, were conducted during the winter and spring of 2009 in growth chambers in the at the WSU Plant Growth Facility. Four cultivars with previously known reactions to Fusarium Crown Rot were rated. . The Australian cultivars '2-49' and 'Sunco' were considered to be resistant while the PNW hard spring wheat 'Macon' and the Australian cultivar 'Seri' were susceptible. Three rating disease rating scales were evaluated for each inoculum method and cultivar combination Previously PNW Fusarium isolate No. 4 had been determined to cause the most disease so this was applied to seedlings using three inoculation methods. The results indicated that the most pathogenic methods were the Seed dip with lots of dead plants. The inoculated millet and the agar straw methods also caused disease. The best rating system was to rate the first seedling leaf sheath on a 0-4 or on a 1-10 scale. The Agar straw method seemed to separate out the known cultivars most reliably. This method was then used during for two experiments in the summer of 2008 to evaluate lines in the Sunco/Macon mapping population in order to identify the number and locations of genes influencing seedling resistance to Fusarium in that population. We plan

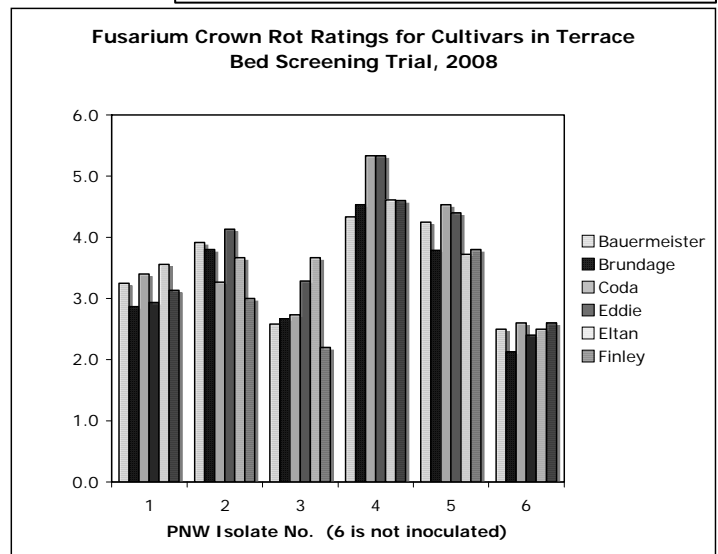
to use the seedling screening method to select for resistance in the backcross populations with Sunco and Gluyas described above.

3. Develop outside sand bed screening method. In the field, symptoms of Fusarium Crown Rot are not observed until the adult plant stage so a terrace bed screening system was constructed to mimic field symptoms on adult plants. This method will be used as a complement to seedling screening. We constructed a terrace bed between two greenhouses on Grimes Way at WSU, and planted an experiment to evaluate the main hard wheat cultivars grown in Washington. The Sunco/Macon mapping population was planted in the spring of 2008.

This method uses cylinders with the bottoms open, so the roots can grow out and into the sand. The sand can be irrigated with a drip system, to impose a drought stress on the plants. This bed will have the capacity to grow 5,000 plants. Our initial experiment evaluated five Fusarium isolates and one un-inoculated treatment with 12 replications of the following cultivars: Finley, Eddie, Bauermeister, Eltan, Brundage, and Coda, and. The hard wheat cultivars were chosen because they were the major hard wheat cultivars grown in WA and hard wheat seems to exhibit more disease symptoms than soft white wheat. Eltan was included as a check and Coda and Brundage were included because they are parents of a large winter wheat mapping population that could be useful for additional determination of additional resistance genes. The experiment was managed during the winter and summer of 2008 and harvested and rated in the fall. Preliminary results (Table 1) indicate that there were significant differences in the amount of disease caused by each isolate with isolate 4 being the most aggressive, although disease pressure was moderate to low. Although cultivar differences were not significant, Coda and Eddy had more disease than others and Finley had less. There was a significant amount of disease in the un-inoculated treatment

Table 1. Results of Terrace Bed evaluation for Fusarium Crown Rot, 2008

Isolate	Disease Rating (1= no infection; 10=badly infected)	No. nodes infected
1	3.2	2.2
2	3.6	2.5
3	2.9	2.0
4	4.8	3.1
5	4.1	2.4
No Inoculum	2.5	2.0
LSD (0,05)	0.3	0.2



(6). In conclusion, we will take more precautions to minimize disease in the un-inoculated treatments and we will increase the number of replications evaluated. In the fall of 2008, we planted a similar trial using just one isolate, plus an un-inoculated control treatment to evaluate 60 named cultivars currently being tested in the WA state variety trials.

4. Develop Fusarium field nursery with inoculated plots at Lind. We will establish inoculated field plots in naturally infected fields at Lind in order to evaluate the resistance during a complete growing season. A Fusarium trial was conducted at Lind on annual crop ground using spring wheat, planted in March 2008. We used the methods of Richard Smiley (as well as Dr. Smiley and his tractor) to set up a Fusarium nursery at Lind WA at the WSU Dryland Research Station. Millet seed inoculum of 5 isolates of *F. pseudograminearum* was produced in the lab, dried and mixed together. Fusarium colonized millet seed was applied at the time of seeding right above the seed. Side by side plots inoculated and un-inoculated plots were established with four replications. Stems were sampled at harvest are currently being evaluated by Grant Poole..

5. Phenotype crosses with greenhouse and sand bed, test best candidates in the field nursery. The field screening method described above was also used to evaluate synthetic wheat germplasm from CIMMYT but emergence was poor. This trial will be repeated in 2009. Plants will be evaluated for spread of the root lesions, white heads, and for yield and test weight. The best plants will be inter-mated to combine resistance genes.

C. Cooperation/Coordination: Dr. Kim Campbell provided the plant breeding and genetics expertise. Dr. Tim Paulitz provided the pathology expertise. They are co-supervising a PhD student, Grant Poole, who is working on this project, partially funded from a collaboration with Julie Nicol of CIMMYT in Turkey. Dr. Richard Smiley has provided *Fusarium* isolates, and expertise in the greenhouse, sand bed, and *Fusarium* nursery implementation. Many of our current PNW varieties are also being evaluated in his *Fusarium* nursery. Technical assistance was supplied by Chris Hoagland and Allison Thompson.

Presentations:

Appeal and Pitfalls of Continuous Wheat Rotation. Spokane County Crop Improvement Association Annual Meeting, Airway Heights, WA. Nov. 20, 2007

The appeals and pitfalls of an all-wheat rotation. Kennewick Far West Associates Meeting, Dec. 11, 2007.

The appeals and pitfalls of an all-wheat rotation. Clearwater Direct Association meeting, Jan. 15, 2008.

The appeals and pitfalls of an all-wheat rotation. Walla Walla Growers, Feb. 5, 2008.

The appeals and pitfalls of an all-wheat rotation. Spokane Farm Forum, Feb.6, 2008.

Plant Pathology 101: Cereal Diseases. Presented to the Seed Academy, a 3-day workshop for seed workers, Pullman, WA, June 4, 2008.

Fusarium Diseases of Cereals. Lind Field Day, June 19, 2008.

Integrated control of soilborne wheat pathogens. 9th International Congress of Plant Pathology, Torino, Italy, Aug. 28, 2008.

Publications: (partially supported with Wheat Commission Funding)

*Paulitz, T.C., Schroeder, K. L. and Schillinger, W. L. 2008. Root diseases of cereals in an irrigated cropping system: Effect of tillage, residue management and crop rotation. Phytopathology: submitted.

*Raaijmakers, R. M., Paulitz, T. C., Steinbert, C., Alabouvette, C. and Moënne-Loccoz. 2008. The rhizosphere: a playground and battlefield for soilborne pathogens and beneficial

microorganisms. Plant and Soil: in press

***Paulitz, T. C.**, Schroeder, K. L. and Okubara, P. 2008. Integrated control of soilborne plant pathogens. *Journal of Plant Pathology*, Vol. 90 (2, Supplement) Aug. 2008 S 2.62.

Mavrodi, D., Mavrodi, O., Bonsall, R., **Paulitz, T.**, Okubara, P., Schroeder, K*, Kwak, Y and Weller, D. 2008. Biology, biological control and molecular genetics of root diseases of wheat and barley. *Journal of Plant Pathology*, Vol. 90 (2, Supplement) Aug. 2008 S 2.18.

Paulitz, T. C. Back to back wheat rotations: What are the risks of root diseases. DirectSeed Link- the Pacific Northwest Direct Association. Vol. 9, No. 1. pg. 1-2.

*Okubara, P., Schroeder, K., **Paulitz, T.**, Steber, C., and Kidwell, K. 2008. Controlling soilborne pathogens in wheat production systems. pp. 37. In: *2008 Dryland Field Day Abstracts: Highlights of Research Progress*. Dept. of Crop and Soil Sciences Technical Report 08-1, Washington State University, Pullman.

Schillinger, W., Kennedy, A., **Paulitz, T.**, Young, D., and Smith, T. 2008. Winter canola as a rotation crop in the low and intermediate precipitation zones. pp. 23 *2008 Dryland Field Day Abstracts: Highlights of Research Progress*. Dept. of Crop and Soil Sciences Technical Report 08-1, Washington State University, Pullman.