Grass Seed Cropping Systems for Sustainable Agriculture
National Forage Seed Production Research Center
USDA Agricultural Research Service
2006 Progress Report

Introduction. Since the inception of the Grass Seed Cropping Systems for Sustainable Agriculture (GSCSSA) CSREES Special Grant Program, ARS scientists at the USDA-ARS National Forage Seed Production Research Center (NFSPRC) in Corvallis, OR have collaborated with university researchers in Oregon, Washington, and Idaho to pursue the common goal of developing economically sustainable cropping systems for grass seed producers in the Pacific Northwest. The report below summarizes in-house NFSPRC research progress during 2006.

Floregon Italian ryegrass release: A new Italian ryegrass (*Lolium multiflorum*) cultivar, Floregon, with crown rust resistance was released to provide additional new germplasm to the public. Floregon has improved resistance to crown rust, has seed yield similar to or higher than other Italian ryegrass cultivars grown in Oregon, and has forage production similar to other cultivars for winter pastures in the southeastern U.S., but up to 20% of the plants do not flower in the forage producing region providing longer grazing availability. The cultivar was developed and tested over several years in cooperation with the University of Florida and was used as the annual parent in the USDA annual X perennial ryegrass genomics program. Floregon has received wide acceptance by ryegrass seed growers and it is anticipated that two million pounds of certified seed will be available by the end of the 2007 growing season.

Identification of genes involved in salinity stress tolerance. 528 unique gene sequences associated with salt stress in grasses were identified, 167 corresponded to previously identified plant stress response genes. Soil salinity is one of the major abiotic stresses responsible for reduced persistence, yield and biomass accumulation in many crops including forage grass. PCR based subtractive suppression hybridization was used in the model grass species *L. temulentum* to identify genes associated with salt stress. The isolation and identification of these genes provided valuable tools to develop molecular approaches to improve stress tolerance in forage and turf grasses in end-use environments.

Heat tolerance in grasses: An isolate of *Dichanthelium lanuginosum*, a grass that tolerates extremely high soil and air temperatures, was discovered which lacks this resistance to stresses. Discovery of this isolate permitted the direct comparison of biochemical and molecular factors that differentiate this isolate from those that resist heat stress. Isolates were exposed to temperatures ranging from 45-55°C for extended periods of time and examined for survival, leaf curling, and morphological changes that accompany the development of tolerance in the wild type plants. This new isolate with reduced capacity to respond to heat stress provides researchers with a valuable tool to determine why certain isolates tolerate stress so well.

Molecular markers associated with plant type located on ryegrass genetic map: Variations (called single nucleotide polymorphisms or SNPs) of four genes, *LpCO* (on linkage group 7), *LpVrn-1* (on LG 4), *ID-1* (on LG 5), and the isozyme *pgi-2* (on LG 1), were identified and located on the annual X perennial ryegrass genetic linkage map. Markers are needed as an aid in development of a seed lab test that will predict growth type in ryegrass. These genes were examined on plants from grow-out tests from the Oregon Seed Testing Lab to compare with other lab traditional test results and additional validation studies on 15 to 20 fluorescence tests from a commercial lab will confirm the usefulness of a DNA-based test that predicts growth type. A timely conducted and accurate predictive test could save the grass seed industry $7 to 10 million annually from inappropriately labeled seed.

Isolation and analysis of a flowering control gene. The flowering control gene, Indeterminate, was cloned from annual and perennial ryegrass. Comparative analysis of Indeterminate gene expression patterns for the two species of ryegrass in different tissues over development were performed. This research provides new insights into the role the Indeterminate gene plays in controlling flowering in annual and perennial grasses. This information will enable development of new genetic approaches to avoid the reduction in forage and turf grass quality associated with the transition from vegetative to reproductive growth.

GIS Analysis of Grass Seed Weeds. A GIS database that relates the severity of grass seed weeds in one year to their severity in surrounding fields during previous years was developed. This accomplishment provides landscape-level views of the distribution and changes in weed populations across an entire industry during a recent period of dramatic changes in crop production practices and enables new approaches to determine how management practices impact weed severity. Data on the occurrence and severity of weeds from over 10,000 inspection reports were linked to actual production fields and related to the cropping practices including crop rotation and stand age that may have impacted the occurrence of weeds in the crops. This accomplishment provided unprecedented detail on how weed species change across the landscape under different cropping practices, identified a need for grass seed herbicide registrations, and documented the efficiency of farmer and seed industry management of grass seed production.

Remote Sensing of Grass Seed Cropping System Components in a Landscape. A Geographic Information System (GIS) was developed that represents grass seed cropping system practices utilized during 2004 and 2005 in Linn County, Oregon, in six major categories from a ground-truth roadside census and a series of Landsat images. The GIS is being used to characterize spatial variability in tillage and ground cover within numerous sub-basin drainages being monitored for water quality by unit scientists and Oregon State University collaborators. Classification methods were developed that distinguished highly similar crops at an accuracy of 74%, and extensions of these methods will allow us to expand the scope of the GIS. In addition to research in water quality and conservation practices, the data are of great interest to private industry personnel looking for improved methods to track grass seed acreage for production forecasting/price negotiations and feasibility studies of biomass conversion to ethanol.

Geospatial Analysis of Grass Seed Yield Monitor Data. Procedures were developed to improve the quality of combine yield monitor data by use of variation in ground travel speed as an indicator of suboptimal operating conditions. Traditional approaches for improving quality of yield monitor data used ad hoc removal of aberrant data points, a procedure likely to distort the data by omitting points of interest merely because they differed too far from the average. Data from over 200 harvests were analyzed using automated procedures to improve data quality and evaluate the impact of soil type and field elevation on seed yield. Improved analysis validity will increase the value of combine yield monitor data in developing precision agriculture site-specific management plans to improve production efficiency and economic return.

Grass Seed Farming Landscapes Provide Excellent Fish and Wildlife Habitat. ARS scientists cooperated with local farmers and State and Federal extension and scientists of different disciplines and learned that native fish and amphibians utilized seasonal streams, originating from western Oregon grass seed fields, and that these streams serve as refuge during the winter high flow periods. Water quality constituents were found to be at ranges not harmful to aquatic wildlife. These findings show that farm aquatic and terrestrial habitats can indeed protect many fish and wildlife species, and serve as a valuable resource worthy of enhancement and protection. To accomplish this work, aquatic wildlife populations and water quality measurements were concurrently assessed throughout the year at over 100 field sites. These studies are providing the first-of-its-kind comprehensive information showing how managed upland agricultural landscapes in watersheds where species listed under the Endangered Species Act can flourish during seed production cycles.

Development of Dynamic Linkage between Economic and Physical Models. ARS scientists cooperated with Oregon State University economists to develop a novel method to integrate economic and physical models for policy analysis. It is clear that the environment responds to producer behavior while the producer responds to both the environment and policy, but there was no previous modeling system that described these interactions all at once. This research used new mathematical techniques from computer science to simulate simultaneous interactions of producers with the environment. This new software provides a more accurate decision tool than is currently available to evaluate application and placement of conservation practices in the landscape.

Modeling the spread of plant pathogens. Field and modeling studies demonstrated that the spread of airborne pathogen spores can be estimated by means of a complex model originally used to describe movement of particulate air pollutants. This is important because many plant pathogens spread by means of airborne spores, and distances and patterns of movement can be complicated and difficult to predict. To accomplish this, we collected field data on weather conditions and rust spore concentrations, and used the information to run the complex air pollution model. By demonstrating the use of this complex dispersal model, we provide an additional tool to derive more realistic information about spread of pathogenic spores than is available by conventional means, thereby allowing better prediction and management of disease spread.

Understanding disease resistance in Kentucky bluegrass. A procedure for evaluating partial resistance of Kentucky bluegrass to ergot (*Claviceps purpurea*) was developed. Little is known about the mechanisms of resistance to ergot. The procedure includes controlled timing of pollination and inoculation to separate the effect of post pollination resistance development. This procedure will facilitate the evaluation and separation of resistance components in Kentucky bluegrass that are needed to effectively develop cultivars resistant to ergot.