USDA-ARS-PWA
Vegetable and Forage Crops Research Unit
24106 N. Bunn Road
Prosser, WA

SUMMARY OF FORAGE RESEARCH ACCOMPLISHMENTS

by
Ashok Alva, Research Leader
Phone: 509-786-9205
Fax: 509-786-9277
Email: aalva@pars.ars.usda.gov

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Project Title:
Enhanced Disease Resistance and Improved Methods of Plant Selection for Alfalfa and Other Legumes

Richard Larsen, Research Plant Pathologist (786-9259)
Vacant Position, Research Geneticist
Plus – Two technicians

Alfalfa

- Produced novel molecular tests for detecting and quantifying several soilborne pathogens of alfalfa, including Phytophthora, Aphanomyces, Verticillium and Phoma. These tests have resulted in more precise and efficient methods for screening alfalfa plants for disease resistance.

- Produced the alfalfa populations PEAC 2-6 and PEAC 5-9. These are composite populations derived from multiple generations of mating among elite commercial plants from fall dormancy classes 2 through 6, and 5 through 9, respectively. These populations serve as a broad base for developing new alfalfa germplasms and cultivars.

- Produced alfalfa half-sibling populations that are specifically designed for studying the inheritance of traits in alfalfa. Determined how resistances to aphanomyces root rot and verticillium wilt in alfalfa are inherited

- Annually increased standard alfalfa check seed populations for use by the global alfalfa community.

- Developed a series of molecular markers for examining genetic diversity in alfalfa. These markers have been used to: (i). Genotype specific alfalfa clones for supporting patent claims by seed companies, and (ii). Determine levels of genetic diversity both within and between over 100 commercial alfalfa cultivars ranging in fall dormancy from 2 through 10. This information is very useful to both breeders and also for growers, as they can use the results to estimate which cultivars produced by different seed companies will likely perform equally under similar environments.

- Alfalfa breeders and plant pathologists require improved tools for addressing problems associated with soil borne organisms such as P. medicaginis, F. oxysporum, and V. albo-atrum, that cause root rot and wilt diseases. Real-time PCR assays were developed for all three of the above mentioned pathogens and were used to quantify the pathogen in infected plants. Robust examinations have been conducted with several alfalfa populations and P. medicaginis and V. albo-atrum. In both cases, positive and significant correlations were observed between disease severity observed in infected plants and the amount of pathogen DNA detected with real-time PCR. These assays allows for more precise identification of highly resistant alfalfa plants than was previously possible. The assays are being used by pathologists to diagnose disease and by plant breeders as an alternate method for selecting disease resistant alfalfa plants.

- Brown root rot of alfalfa, caused by the soilborne fungus Phoma sclerotioides is considered a very serious disease of alfalfa in regions where winters are severe. Plant pathologist and growers need a rapid and accurate method for diagnosing disease and detecting the pathogen in field soil.

- Identified a SCAR marker that is used in a PCR assay to detect P. sclerotioides in soil and infected plants. The pathogen can be identified in a single day using the PCR assay, as opposed to previously available methods which required up to 60 days. The assay provides the opportunity for rapid disease diagnosis and evaluation of germplasm for resistance to the pathogen using real-time PCR.

- Verticillium albo-atrum causes one of the most serious diseases of alfalfa throughout the world where climatic conditions are favorable for disease development. It has been suggested that cultivars require at least 60% resistant plants to afford maximum protection against disease. These calculations showed that up to 90% of the resistance to this pathogen was controlled by genetics. Estimates were generated for two alfalfa populations

developed from the cultivars Affinity + Z and Depend + EV. Heritability on a half-sib progeny means basis was calculated based on data from greenhouse pathogenicity tests. Results of pathogenicity tests suggested that neither cultivar had resistance levels approaching 60%. The heritability estimates suggest that resistance levels in both Affinity + Z and Depend + EV could be improved further through selection. These values, and values that can be derived for other varieties, will directly assist plant breeders in optimizing breeding strategies to most rapidly enhance levels of disease resistance in alfalfa.

Timothy

- Completed two years field tests on 7 different commercial timothy varieties grown under three different levels of rill irrigation. This is the first known empirical examination of timothy variety performance in the Kittitas Valley and is currently providing growers with suggestions for choosing cultivars that express high performance in the region.

- Developed a series of molecular markers and examined genetic diversity among many commercial timothy cultivars and other timothy populations. This is an essential first step in developing a breeding program that could use marker-assisted-selection for more timely development of improved timothy cultivars.

- Conducted a field evaluation of over 2000 individual timothy plants representing seven different popular cultivars. Demonstrated that cultivar performance based on spaced plant nurseries was very similar to performance based on field plot trials. Selected the best performing plants and crossed the plants during the summer of 2005. These selected plants can serve as the parental base for developing new timothy cultivars particularly adapted for the Kittitas Valley or Columbia Basin.

Future Research in Alfalfa

- Develop a genetic map of alfalfa using populations derived from elite commercial clones. Identify markers linked to several agronomic traits, including non-lodging, resistance to potato leaf hopper, water use efficiency, and seed yield.

- Release alfalfa germplasm with high resistance to root rot caused by race 2 of Aphanomyces.

- Develop alfalfa germplasm with drought resistance (high water use efficiency).

- Identify management strategies that will maximize alfalfa seed yields for seed producers.

Future Research in Timothy

- Expand timothy variety trials to include more varieties and also conduct a variety trial in the Columbia Basin.

- Identify management strategies (water use, fertilizer management, seeding rate, timing of seeding, harvest timing, etc.) to maximize yield and quality of harvested timothy.

- Develop timothy cultivars those are especially adapted for high yields and excellent quality in the timothy growing regions of Washington.

- Develop a system for timothy plant tissue culture and transformation that could be used for cultivar improvement for disease resistance, resistance to abiotic stresses, and improved quality traits.