

## Major Research Accomplishments and Cultivar Releases

◆ Gastrointestinal parasites are a major limiting factor for the small ruminant industry in the Southeast. The situation has become more critical recently in light of the development of increased resistance to anthelmintic drugs in the parasites. Feeding sericea lespedeza hay to goats and lambs has reduced nematode egg shedding. The number of intestinal parasites counted in sheep fed sericea lespedeza hay were comparable to animals receiving anthelmintic drugs. These results have been obtained with the grazing tolerant cultivar ‘AU Grazer’ developed at Auburn. **Impact:** sericea lespedeza hay can reduce fecal egg count by more than 75% thus has the potential to reduce pasture contamination, reduce parasite burden and improve animal health (US Patent Pending).

◆ Evaluated sunn hemp seeds from accessions from several parts of the world for the presence of pyrrolizidine alkaloids and potential toxic effects on chickens. Chemical analysis and tests on broiler chicken indicated that the seeds have a very low level of only two alkaloids and they are not toxic to chicken. **Impact:** any breeding program on sunn hemp can release cultivars without the possibility of having a negative impact on the poultry industry.

◆ Assessed genetic diversity of the genus *Crotalaria* using polymorphic expressed sequence tag – simple sequence repeat (EST-SSR). **Impact:** provided an immediate benefit to the USDA-NPGS clientele by identifying populations that were misclassified thus limiting the loss of resources to be invested in testing accessions that eventually would be found to belong to a different species.

◆ Assessed genetic diversity of red clover. This research has been conducted on the core subset held by the USDA Plant Genetic Resources, wild populations from the Caucasus Mountains in southern Russia and of cultivated red clover. Results indicated that red clover genetic diversity is high even when compared to other outcrossing crops. **Impact:** 1) provided an immediate benefit to the USDA-NPGS clientele by eliminating an undesirable population from the core collection; 2) determined that although wild populations had nearly twice as much variability as cultivars or landraces included in the core subset, genetic diversity was high in all groups thus it would be up to the user to decide which group (cultivars, landraces or wild populations) to utilize; 3) validated the use of GIS tools and remotely sensed data to develop maps that help germplasm collection and post-collection efforts to understand patterns of genetic diversity in collected germplasm.

◆ Genetic linkage information can be used as a tool to increase selection efficiency but is limited in red clover. Genetic analysis of 18 isozyme systems and three morphological traits was conducted. Joint segregation analyses among 8 isozyme loci and 3 morphological gene markers resulted in the assignment of one linkage group. Two morphological markers coding for flower (*c*) and stem (*gs*) color were found to be in the same linkage group. No linkage was found between any of the isozyme loci and the morphological traits. **Impact:** this is a first step toward the construction of a linkage map in red clover.

◆ Common vetch (*Vicia sativa* L.) seed contains the cyanogenic glycoside vicianin. Cyanide can cause nutritionally induced health disorders in animals. Research supported by USDA-NPGS

identified acyanogenic accessions. **Impact:** results can be accessed through the web and found using GRIN. Thus low-cyanide material can now be used by national and international breeding programs aimed at reducing cyanide-caused problems.

◆ Lack of or limited knowledge on the mating system of most of the *Vicia* species stored at the USDA-NPGS causes problems for regeneration of the accessions as well as the maintenance of their genetic variability. *V. articulata*, *V. benghalensis*, *V. ervilia*, *V. lutea*, and *V. sativa* were deemed self-fertilizing species. *V. pannonica* was also deemed to be self-fertilizing, however, seed production benefits from the visit of insects. *V. villosa* and *V. villosa* ssp. *varia* were deemed cross-fertilizing species. A study of isozyme polymorphism confirmed field results and indicated that *V. cracca* L., *V. peregrina* L., *V. pisiformis* L., and *V. narbonensis* L. were self-fertilizing species. **Impact:** isozymes proved to be a reliable and less expensive method to determine the mating system of these species. USDA-NPGS curator can use appropriate techniques to increase seed while maintaining genetic integrity of the accessions.

◆ Photoperiod and temperature requirements for flowering of several *Vicia* species were determined. A study on the effects of seed vernalization on flowering time and plant growth was also conducted to expedite development of *Vicia* plants grown in a greenhouse. Also optimal temperature range for seed germination and early growth was determined. **Impact:** results facilitate successful regeneration by USDA-NPGS of accessions of nine *Vicia* species.

◆ Measurements of seedling traits such as height or shoot weight were useful in increasing the frequency of genotypes with superior seedling vigor in sericea lespedeza (SL). The best criteria for selecting SL with good field emergence, especially when deep planting, was to identify genotypes with great maximum hypocotyl length and large seeds. Seedling vigor of SL was found to be limited by temperature during germination and by temperature and daylength after emergence. Also it was determined that, depending on the genotype, hulled SL seed that must remain in storage for a year in a nonclimatized warehouse may experience a reduction in germinability. **Impact:** these results provide information to the breeder on traits to be used when selecting improved cultivars, provide the seed industry with guide lines on seed storage and conditioning that will allow them to sell a better product.

◆ Sericea lespedeza (SL) residues were found to have a small negative effect on rye and tall fescue seed germination and seedling growth whereas ryegrass, bermudagrass, and bahiagrass were not affected. Biomass production of all grass species were reduced by high levels of SL residues, however, the increases in biomass due to N fertilization more than compensated for the reductions caused by the residues. Hence, immobilization of N was the main factor limiting plant growth in grasses grown in association with SL. **Impact:** agronomists and ecologist will have a better understanding of the interaction between commonly grown grasses and SL.

◆ Condensed tannins in sericea lespedeza (SL) were located in vacuoles of paraveinal mesophyll cells that function in photosynthate transport within the leaves. This finding suggested that these substances play an active role in physiological processes. Alternatively, they could represent a form in which these plants store excess photosynthates. Condensed tannins were abundant in leaves and stems regardless of their developmental stage. Low-tannin SL lines were found to be proportionally less productive than high-tannin sericea lespedeza lines in high-yielding

environments. A nonlinear relationship between palatability and tannin concentration was documented. However, there were indications that other factors are also involved in palatability of SL genotypes. **Impact:** results demonstrated that condensed tannins were not the main factor limiting palatability.

◆ Limited attention has been given to the effect of sample size on the precision of heritability estimates, expected selection responses and genetic correlations. Results showed that the effect of increasing number of families and replications on reduction of sampling error and interval width was greater than that of increasing plants per family. The sampling error and interval width of parameters decreased at a decreasing rate as sample size increased. Precision of genetic correlations was influenced by sample size and traits measured. **Impact:** these results can be used by plant breeders to estimate sample sizes needed to estimate more precise genetic parameters of breeding populations.

◆ Research on red clover has shown that information on the correlation between juvenile and mature plant traits is critical in determining the opportunities for early stage selection. We determined that plants and families with low potential yield can be eliminated at the seedling stage in red clover. Furthermore, using selection index updating, a method of multistage selection, was determined that early culling at the seedling stage resulted in significant cost savings and increased gain to cost ratio. Among five selection schemes tested for direct selection of mature plant traits, mass selection produced the largest genetic gain. **Impact:** results will allow breeders to increase the number of superior plants to be field tested or conduct a more rigorous evaluation of the selected plants. This represents a major improvement in breeding methodology of forages and red clover in particular.

◆ Genotype-environment (GE) interactions reduce the correlation between phenotype and genotype, and decrease selection progress. We proposed the use of unbiased estimate of phenotypic variance ( $V_P$ ) and phenotypic coefficient of variability ( $PCV_i$ ) to estimate GE. The  $V_P$  unlike S and Type 4 stability measure MS Y/L (year within location mean square), includes location, year within location and error variance components from ANOVA based on a linear model. **Impact:** The *F*-test can be used to classify cultivars into location unstable, year unstable, or both location and year unstable, or vice versa.

◆ The statistical basis of the two available procedures to conduct an analysis of generation means (GMA), a common method used in genetic analysis, were presented and discussed. This work was continued by the development of a method that measures cytoplasmic and maternal effects and quantitative genetic parameters. Because it was difficult to make the calculations to use the mentioned methods, a BASIC program to calculate the above parameters in a personal computer was created. **Impact:** GMA it is a powerful tool to measure the relative importance of genetic effects. A close correlation between GMA and discrete observations using molecular marker was reported in the literature.

## **Cultivar Releases**

♣ ‘AU Olympic’, released in 2003, is a common vetch cultivar with a biomass production 12 to 28% higher than the cultivar Cahaba White. Seed production may be higher than that of Cahaba

White in some locations.

♣ ‘AU Merit’, released in 1999, is a hairy vetch cultivar that, on average, has a biomass yield 4-12% higher than common hairy vetch and flowers 7-13 days earlier than the common type.

♣ ‘AU Grazer’, released in 1997, is the first sericea lespedeza cultivar tolerant to grazing. This cultivar has higher survival and more vigor under grazing conditions than other sericea lespedeza cultivars. Stems are fine and pliable.

♣ ‘AU Sunrise’, released in 1997, is the earliest maturing crimson clover cultivar in the market. AU Sunrise flowers 5 to 18 days earlier than AU Robin and 12 to 28 days earlier than Tibbee. It was selected and released in cooperation with Mr. Charles M. Owsley and Mr. Malcolm Kirkland, USDA-Natural Resources Conservation Service, formerly known as Soil Conservation Service.

♣ ‘AU EarlyCover’, is the earliest flowering hairy vetch cultivar commercially available. AU EarlyCover flowers 23 to 36 days earlier than common hairy vetch. It was released in cooperation with Mr. Charles M. Owsley and Mr. Malcolm Kirkland, USDA-NRCS, in 1994.

♣ ‘AU GroundCover’, is the only caley pea (*Lathyrus hirsutus*) cultivar available in the market. It was released in cooperation with Mr. Charles M. Owsley and Mr. Malcolm Kirkland, USDA-NRCS, in 1994.

♣ Cooperated in the release of the hairy vetch cultivar ‘Americus’ by the Georgia Agricultural Experiment Station and the USDA-Soil Conservation Service in 1993.

♣ ‘AU Donnelly’, a cultivar of low-tannin sericea lespedeza was released in 1987. AU Donnelly has more early spring growth and is higher yielding throughout the season than AU Lotan, the only other low-tannin cultivar available to farmers. AU Donnelly averages 6% higher in digestible dry matter and 10% higher in crude protein than AU Lotan at the hay stage. Tannin content is about the same in AU Donnelly as in AU Lotan.