Breeding Lucerne for Southern Australian Dryland Farming Systems

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The long-term sustainability of dryland farming in southern Australia is under serious threat from the spread of dryland salinity, declining soil fertility and problems with weed and disease management. Many recent studies have established lucerne as the most suitable herbaceous perennial to address these problems in the cereal rotations of Australia. The aim of this project is to breed lucerne cultivars specifically for the southern Australian dryland cereal belt. This zone has a temperate climate with a frost-free, winter dominant rainfall and a long summer drought. The challenge is develop cultivars that are compatible with existing farming systems as well as being productive and persistent. The breeding program is focusing on improving tolerance to acidic soils and persistent grazing, as well as improving establishment with companion crops.

In Western Australia and Victoria the soil pH is frequently below 5.0. Current lucerne cultivars are persisting, yet under performing in soils with pH 4.2 ($CaCl_2$) and low aluminium. Field trials containing a diverse range of germplasm are being used to select the best performing plants in order to create a synthetic population. Solution culture is being used to compare aluminium tolerance of lines selected from the acidic field sites with available aluminium tolerant controls including 'GAAT'. A diverse range of germplasm will also be screened, targeting diploid *Medicago sativa* subsp. *caerulea*, previously identified by Sledge (1996) as a source of tolerance. If successful, the genes for tolerance will be transferred into field selected, non-dormant lucerne using a modified backcrossing strategy.

Establishing lucerne in low rainfall (250-350mm) dryland environments can be challenging, and this is made more difficult by over-sowing with a harvestable companion crop (this is practiced to recover establishment costs). We are developing a lucerne variety that is easier to establish with competitive winter cereals. Although very non-dormant lucerne is being promoted for this method of establishment, our early trials in 2001 revealed no effect of winter activity (fall dormancy) on success of lucerne establishment under a crop.

Another major restriction to the broad adoption of lucerne in southern Australian farming systems is its inability to withstand persistent grazing pressure. The design and management of a trial at Roseworthy, South Australia used a modified NAAIC grazing protocol with sheep used instead of cattle and increased period of grazing. After one year of continuous grazing, plant densities ranged from 2-100% of their original population. Although a general relationship between grazing tolerance and winter vigour exists in unselected germplasm ($r= 0.80$), three cycles of selection pressure have successfully increased the grazing tolerance in winter active lines and consequently reduced this correlation ($r=0.32$). There were significant differences between the winter active (dormancy 6-8) and highly winter active (dormancy 8-10) cultivars. The USA bred highly winter-active cultivars included had significantly less grazing tolerance than those developed in Australia (especially Sceptre) where there is a greater history of intensive sheep grazing in the breeding and selection process. In September this year, 250 individual plants will be selected and transplanted into an isolated polycross seed production nursery. Selected plants will be transplanted in a randomised grid and allowed to randomly intermate using honeybees. Seed harvested will be used for evaluation in progeny tests for aphid and disease resistance. The original plants will then be selected on their progeny performance, and inter-crossed to form a synthetic cultivar containing parents that are very grazing tolerant, and when inter-crossed, have progeny that meet minimum standards for production, insect and disease resistance.

Reference: Sledge MK, Bouton JH, Tamulonis J, Kochert G, Parrot WA (1996) Aluminium Tolerance QTL in Diploid Alfalfa. Report of the Thirty-Fifth North American Alfalfa Improvement Conference.