Domestication and use of curly Mitchell grass as a sown pasture

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Summary. A new program, based at Walgett in north western NSW, to domesticate the useful, summer growing, perennial native, curly Mitchell grass, *Astrebla lappacea ,* is reviewed in this paper. Seed will be collected from plants in natural populations and evaluated to determine the extent of genetic variability and identify superior individuals in terms of seed and vegetative production. These superior plants will then enter a program of selection and seed increase. This should culminate in the release of a cultivar. This species will be useful for reseeding degraded rangeland and exhausted marginal croplands on the heavy soils of western NSW.

Introduction

Curly Mitchell grass, *Astrebla lappacea* is a native Australian grass found mainly on the heavy grey clay soils of the flood plains of northern NSW, the downs country of Queensland and in areas of the Northern Territory and Western Australia. The species is summer dominant and distributed in the 250-500 mm annual rainfall zone. Curly Mitchell grass is a deep rooted, perennial which lives for up to 20 years. It is very tolerant of drought, surviving by becoming dormant during the dry periods. It has the ability to reshoot rapidly with warm-season rain and regenerate readily from seed given suitable conditions. The natural curly Mitchell grasslands of NSW are stable plant communities that provide a matrix of grass tussocks with a wide variety of herbage species in between, usually either saltbush or naturalised medics.

Work has been carried out by NSW Agriculture at Walgett to select summer growing perennial grasses suitable for use in rehabilitating exhausted cropping country. This evaluation work, which began in 1985, demonstrated that the native curly Mitchell grass could be sown and established on the heavy grey self-mulching soils of north western NSW (1). Curly Mitchell grass pastures can be established by aerial seeding or conventional sowing (2) and seed should be placed on or just below the soil surface. Aerial seeding into stubble, after the wheat crop was harvested, has also been successful with the stubble providing protection from the high soil evaporation rates over summer. Further work demonstrated that there were two possible times at which curly Mitchell grass could be sown, in the spring or in the late summer. In the spring temperatures are optimum for curly Mitchell grass germination but there is a high risk of false starts. In northern NSW storm rain will often germinate the seed but there is not sufficient soil moisture or crucial follow-up rain for establishment. While sowing in the late summer means a greater probability of achieving good rainfall (January/February being consistently the months of greatest rainfall) the plants can often be too small going into winter and a proportion can be lost if there are early frosts. At present, late summer is the recommended sowing time but in the eastern part of this NSW region, where rainfall is more reliable, spring sowings often succeed (3).

The recommended sowing rate for curly Mitchell grass is about 2 kg/ha, but this depends on the germination percentage at sowing. Mitchell grass seed that is freshly harvested often has a very low germination percentage (30-40%) but if stored for up to 12 months the germination percentage will rise to 70-80%. This time related dormancy mechanism can be broken by threshing the seed; removing the caryopsis from the spikelet immediately causes the seed to become almost 100% germ inable. This process, however, would not be economic as threshing makes the cost of seed too high. At present seed sells in NSW for $8-$10/kg but this would probably decrease if a few successive years of summer rain ensured good harvests from natural stands.

One of the major gaps in our information about curly Mitchell grass is understanding the rainfall sequences that initiate germination and control establishment. Work done at the University of New England (4) has shown that follow-up rain a few days after the initial fall is needed for emergence. If the required rainfall patterns were understood, probability models could be used to predict the most likely times of the year when these patterns would occur. With such predictions, sowing times could be narrowed down and the risk of failure of the plants to establish could be reduced.

Curly Mitchell grass can be sown with annual legumes. It is compatible with barrel and snail medics and probably with lucerne. There is, however, little information on how to manage Mitchell grass pastures. There are no registered herbicides for use in these pastures, although Ally at 5-7 g a.i/ha can be used safely to control broadleaves and Roundup (glyphosate) at low rates can be used to clean pure Mitchell grass pastures in winter. Pastures are usually not grazed in the first year but allowed to produce seed in the first summer. Later they can be grazed continuously and should be heavily grazed in winter to remove old rank growth. If a legume is also sown, grazing management should ensure good legume regeneration. The optimum stocking rate would be between 1.5 and 2.5 DSE/ha.

One of the main reasons that curly Mitchell grass can be used successfully as a sown pasture is that it can be harvested with a conventional wheat header with minor modifications. Curly Mitchell grass is one of the few native grasses in which the seed ripens evenly in the head and it has high seed retention. Both characteristics simplify harvesting of the seed. Seed has, for many decades, been harvested from natural populations for on-farm reseeding in western NSW and Queensland.

One of the main aims of a domestication program for this useful grass is to exercise some control over the seed industry. In the past, opportunistic seed harvesting from natural stands has led to unreliable supply and poor genetic quality of seed. While there is no controlled seed industry or seed certification scheme, poor quality seed will continue to find its way to farmers. In many cases this poor quality seed means poor establishment responses, the reasons for which are not properly understood by the farmer. If a cultivar of this grass was released, seed that is sown should produce plants that breed true. This would facilitate harvesting and control the genetic and physical quality of seed.

Proposed Methods

The original work done at Walgett examining sowing and establishment methodology involved seed harvested from local wild populations. There was no plant selection. In the 1991-92 summer seed is being collected from particular plants in natural populations, or, in some cases, individual plants will be transplanted. These collections will cover the environmental range in which Mitchell grass is found. As Mitchell grass is found to have little genetic variation within a site only a small number of plants will need to be collected from each site (Silcock, pers. comm., 1991). This seed will be germinated in seedling trays and individuals transplanted into a nursery area at Walgett. While under irrigation in the nursery, plants from each of these collection sites will be assessed for vegetative production and seed production including seasonal growth, vigour, leafiness, time and length of flowering, seed production, seed retention, seed size, photoperiod and vernalisation responses, incidence of pests and diseases. This should help determine the extent of genetic variability within the accessions and allow the identification of agronomically superior individuals and those amenable to commercial seed production. Further evaluation of selected accessions will then be made and superior plants will be see- increased. Seed from these individuals will the be grown out in replicated plots over a range of climates and soil types. This should give an indication of the contribution of genetic and environmental influences to each of the above characters. The end result should be a cultivar with improved characters such as - persistence, productivity, nutrient value, plant type (perenniality and reliable establishment) and higher seed production (harvestable yield and maintenance of selection). At the same time, the breeding system of the species will be investigated.

Discussion

This work has started with minor seed and plant collection so far and the setting up of a nursery area at Walgett. However, the program has two major advantages over other native grass domestication programs under way in Australia, such as the *Danthonia* and *Microlaena* (5) programs. Firstly, the sowing and establishment methodologies arc already available (2). Secondly, curly Mitchell grass has particular characteristics uncommon to most native grasses that make domestication simpler; these are seed retention and even seed ripening. These two areas, seedling establishment and seed production, arc critical in the domestication of a native grass (6).

Important information is lacking in understanding the breeding system of curly Mitchell grass. Many sub-tropical grasses are apomictic, which means that the progeny are genetically identical to the parents. Although this is useful for a selected species, as outcrossing does not occur, it means that there is little variation in the populations. However, even within apomictic taxa, adaptations become evident fairly rapidly. Populations can differentiate in response to soil type for example. The main objective of a program such as this one is to collect the maximum amount of useful genetic variability within a limited number of samples. To do this a study of the breeding mechanisms of curly Mitchell grass must be made.

It is probably important in this program to let grazing animals do some of the selection work. Hence, sites for field collections should try to cover a range of grazing regimes. By selecting plants which have survived fairly heavy grazing, material which shows greater grazing persistence should be found.

One major concern of a domestication program is that the inherent variability within a species is removed through selection. This may not necessarily be beneficial for a species which is being used in environments as variable as those of western NSW and Queensland. Thus germplasm should be collected and stored for future use and a range of cultivars eventually developed.

In conclusion, there is a great demand from pastoralists for grasses suitable for sowing on the soils of western NSW (7). In spite of this demand there are few species available. Productive, persistent, perennial grasses are needed in marginal cropping areas for use in long term rotations, particulary in areas where continuous cropping has caused the formation of compaction layers in the soil. These layers can be broken down with the use of deep rooted perennial plants. Likewise pasture grasses are needed to replace the declining perennial component of the western rangelands. In the past much effort has been put into seeking exotic species to meet these demands. Although these programs have provided useful species such as buffel grass, *Cenchrus ciliaris* many introduced species have failed to persist under the semi-arid conditions. The erratic rainfall patterns in these regions of Australia are the main barrier to pasture establishment. In contrast, little emphasis has been put on exploring the potential of native species, which are naturally adapted to these climatic conditions. Curly Mitchell grass has already been identified as a worthwhile pasture grass suitable for the cracking clay soils and is therefore worthwhile domesticating.

Acknowledgment

This work is funded by the Australian Wool Corporation.

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