GRASSES FOR OTHER ENVIRONMENTS

John Read
Department of Agriculture
Sydney.

DROUGHT TOLERANT GRASSES

Nature has provided certain plants with a form of suspended animation as a life-preserving mechanism when water is scarce. These plants are known as regenerative plants and can be found in the deserts of South America, southern Africa, India and Australia.

Dr Don Gaff from Monash University has devoted his research career to studying the mechanisms that regenerative plants use, and ways of incorporating these mechanisms in other plants. These plants biologically copy their environment, suppressing their need for water as the source dries up. They wither and appear to die but a faint flicker of life remains in the cells. When the conditions improve they come back to life. That is why they have been called resurrection plants. Dr Gaff is on the verge of creating a new plant by hybridising the resurrection plants. He wants to cross these desert dwellers with grasses that are suited to grazing. The result would be a commercially suitable plant that is resistant to drought.

The regenerative mechanism: As water is lost from resurrection plants unique biochemical reactions take place to prepare it to tolerate dessication. The trigger mechanism may take a couple of days to induce tolerance at a water content which is 50 to 80 percent below normal.

The cells of resurrection plants have an orderly sequence of disorganisation while drying out. The membrane systems remain intact and in proportion and the links between cells undisturbed but superficial membrane material appears to be broken down. The ribosomes, small granules where protein is made, clump together on the membranes in what is known as polysomes. This is usually an indication of rapid protein formation. Normal plants stop protein synthesis under water stress but resurrection plants break down membranes and use the released amino acids for protein formation. The main part of the cell, the vacuole which is a membrane-bound bag containing water and dissolved chemicals, breaks up into small units arranged on the outside of the cell. These become smaller as the cell dries up. Finally they disappear.

Chloroplasts, where photosynthesis takes place, normally contain complex membrane structures where starch granules are formed. During dessication the starch granules dissolve and the membranes change shape. The starch is broken down into sugars which can be used as an energy source when the plant is being resurrected.

As a result of dessication the cell reduces the photosynthesis and respiration rate so that when it is fully dried the cell is just ticking over to remain alive but biochemically ready to go when the conditions are right.

The aim of Dr Gaff's research is to transfer the genes which are responsible for these peculiar biochemical reactions, into useful agricultural grasses. The result would be a grass capable of returning to life when water is available after a drought, yet retaining a high nutritional state in the dessicated form.

There are more than 30 grass species in 9 genera which exhibit this resilience to water stress. One being researched is the Sporobolus genus.

The presence of excessive amounts of salt in a growing medium may have many ways in which it affects plant metabolism. Likewise plants have evolved many ways to cope with this stress.

Salinization of the soil makes it increasingly difficult for a plant to extract water for normal function. The plant must have sufficient protoplasmic drought tolerance to survive. Dr Gaff found that although no resurrection grasses have been collected from saline habitats, the genus Sporobolus contains salt glands. A series of tests was conducted to test the effects of soil salinity on Sporobolus species that are known to be resurrection grasses. The results showed that a range of salt resistance exists among the resurrection Sporobolus species. Consequently dessication tolerance does not ensure salt tolerance and factors other than dessication tolerance determine salt resistance.

SALT TOLERANT GRASSES

There are a number of grasses with tolerance to salt. Those that have been used successfully include:

(a) **Agropyron elongatum** (tall wheatgrass). This summer growing, tussocky, perennial grass is able to utilize the moisture often associated with salty areas. It seeds prolifically in autumn. Seedlings are slow to establish and are dormant during the winter. It is better suited to the `hard-pan' salt situation rather than the `wet-pan'. The commercial cultivar is Tyrrell.

(b) **Puccinellia stricta** (marsh grass) is a winter growing grass much shorter in stature than Agropyron but capable of growing in more saturated conditions. Hence it complements Agropyron in vegetating salted areas. Puccinellia grows best from autumn until mid spring and sets seed in mid summer.

(c) **Paspalum vaginatum** which has been a useful grass in early experiments by the Soil Conservation Service in NSW and commonly used in Western Australia. There are native and introduced strains which could be subject to selection and evaluation. This perennial grass has slender stems creeping at the base and roots from the nodes.

All three grasses complement each other in growth pattern and habit.

Other common grasses which contain salt tolerance include, barley grass (Hordium leporinum), Wimmera ryegrass (Lolium rigidum), couch grass (Cynodon dactylon) and tall fescue (Festuca arundinacea). All may be grown in moderately saline situations.

The combination of salt tolerance, drought resistance and quality would be useful attributes that may be capable of being combined using genetic manipulation techniques in the near future.

GRASSES FOR WATERLOGGED AREAS

Excess water may create anaerobic conditions which limit the growth of many of the recognised pasture plants. There are two grasses that are being examined by staff in the Department of Agriculture, which may have a role in waterlogged situations. These are limpograss and nile grass

Limpograss (Hemarthria altissima) is a perennial grass with short rhizomes and long spreading stem bases which root at the nodes. It grows to 150 cm - but normally only about 50 cm - and is widespread in the tropical, subtropical and warm temperate areas of the world. This grass requires at least temporary wet ground but can withstand seasonal droughts. It is well grazed by cattle. There are diploid and tetraploid types with wide variation in quality which indicates a potential for selection work.

Nile grass (Acroceras macrum) is a creeping perennial with rhizomes and stolons which originated in Africa where it grows on seasonally flooded grasslands and swamp edges. It forms a dense ground cover and grows up to 60 cm tall. Drought will severely affect survival. Generally it is not as productive as some other grasses but its ability to grow in flooded conditions is a valuable characteristic.

There is a wide range of genetic material within the grass genera which may be incorporated in the special purpose grasses of the future. The great shortcoming is that there are limited resources being used to this end. There are many doors likely to be opened in the near future in the field of `genetic engineering' and agriculture and the pastoral industries stand to be the major recipients of the breakthroughs. In spite of the work by CSIRO there is more that could be done with greater financial support.

This paper has highlighted a few species of grass that have adaptation to specific environments. There are many native grasses and other plants with useful characteristics that have yet to be fully realised.

The future technologists may be able to combine the characters nominated and create new plants that will be of use to save our environment and give stable agricultural systems.