NATIVE GRASS BREEDING PROGRAM AT ALBERTA ENVIRONMENTAL CENTRE

by

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Introduction:

A program to develop genotypes of native Alberta species for reclamation of disturbed lands was begun at the Alberta Environmental Centre in 1983. As a part of this larger program a native grass breeding project was initiated for use in the alpine and subalpine regions of the province. The project objectives are:

- To develop genotypes of native species for reclamation, erosion control and wildlife range improvement in high-stress environments on the east slopes of the Alberta Rocky Mountains.
- To initiate and carryout all testing programs required to obtain licenses.
- To initiate licensing procedures for the lines under consideration and to obtain licenses for same.
- To produce breeder's seed of the licensed lines.

Of major importance in revegetating alpine disturbances has been the selection of adapted plant species. Historically, most revegetation research has been concentrated on identifying commercially available species adapted to high altitudes. The use of native species for revegetation has been limited by the commercial unavailability of good quality seeds with assured performance under stress conditions.

In Alberta, introduced agronomic grass species are presently used in the reclamation of high altitude mine sites. Stands of these grasses often begin to deteriorate after a few growing seasons without additional inputs such as fertilizer. Native species; on the other hand, show increased vigour and rates of spread with minimal management. A second concern is the apparent inability of local native species to invade even sparse stands of some introduced agronomics. For aesthetic and practical reasons therefore, native grass species, particularly those that are adapted to stress environments, will be most suitable for reclamation purposes. Unfortunately suitable native plant material is often not available. Selection of genotypes within the chosen species for their suitability to commercial production (without losing stress tolerance) and then licensing them as reclamation cultivars would ensure availability of good quality seeds with proven performance in the market.

It was initially decided to limit the project to the four most promising grass species. From an extensive search of the literature, consultation with interested parties, as well as our own experience Agropyron latiglume (broad glumed wheat grass), Poa alpina (alpine blue grass), Festuca ovina (alpine fescue) and Trisetum spicatum (spiked trisetum) were picked as suitable target species. These perennials occur in a wide range of habitats in the east-slopes particularly in severe stress environments and have been observed to successfully invade alpine disturbances. Their invading nature and adaptive qualities, combined with an observed preference of wildlife for these species make them particularly promising materials for land reclamation and wildlife range improvement.

The following assumptions were made at the beginning of the research work:

- Plants collected from severe stress enviroments will have genetic adaptation to such environments.
- The progenies of the collections will retain the adaptation for stress environment regardless of where they are grown as long as they are not produced by intercrossing with non-adaptive plants.
- Through selection it will be possible to identify genotypes that can be commercially produced.

Plant Collections

Success in a breeding program depends entirely on the presence of adequate genetic variability in the material from which selections are made. To include an adequate number of genetic variants for each of the four target species a collection target of 2000 plants/species was set. Systematic collections for each target species along latitudinal and elevational gradients were planned for maximizing genetic diversity within the collections.

Plants of the four target species were collected from 315 sites in the Rocky Mountains from the U.S. border to Jasper Park Townsite. The collection area included four national parks (Waterton, Banff, Jasper and Yoho) and many locations outside the parks. The elevations of collection sites ranged between 990 and 2,700m. The collections were mainly from disturbed or poorly vegetated sites. Plants from some permissive environments were included to widen genetic diversity in the collections. Plants were dug up with roots and attached soil, bagged and stored on ice during transportation. Approximately 10 plants from each species were collected from each site depending upon availability and perceived variability of the material. A detailed biophysical description of each site was made at the time of collection.

To avoid mortality the collected plants were kept in transit for a maximum of three days, transplanted into pots and nurtured for two weeks in growth chambers at 22/15°C day/night temperature. After two weeks the plants were hardened in sheltered outdoor conditions for a further two weeks. At the end of that time they were transplanted to a collection nursery. This collection technique had over 98% success in transplanting grasses from the mountains to the AEC nursery. Plants transplanted to the AEC nursery numbered:

2,550	Poa alpina
779	Agropyron latiglume
1,347	Festuca saximontana
1,061	Trisetum spicatum

Germplasm enrichment through fresh collections will continue in subsequent years although plant collection will no longer be the highest priority (as it was during 1984 and 1985). For the breeding program further collections will consciously include plants with good agronomic characters like large seed size, large seed heads, early maturity and better plant vigor.

Plant Breeding

The breeding method used is determined by the mating system of the plant species involved, whether self-pollinated or cross-pollinated or apomictic. Self-pollinated and apomictic plant populations have essentially homogeneous and homozygous plants. The selfed progenies are like the parents, or very nearly so. By contrast, cross pollinated species foster heterozygosity and heterogeneity. Plants in a population may be inherently different. Selfed progenies may differ from the parent plants. Several generations of self-pollination, or inbreeding, in naturally cross-pollinated species is generaly accompanied by a loss of vigor and productiveness.

Apomixis, the production of seed without the union of male and female gametes, is a type of asexual reproduction in which the genotype remains constant over generations unless mutations occur. This type of seed production allows any desirable genetic combination to be propagated indefinitely.

Mating System Studies

Floral structures, flowering behavour and anthesis were studied to determine mode of pollination and reproduction. Two flowering heads of each 1984 collected plant of the target species were bagged separately with pollination control bags to obtain self-pollinated seeds. These bags were removed after anthesis. Floral structures and anthesis were observed on two other flowering heads on these plants. The two self-pollinated and two more open pollinated heads were harvested after maturity. Percentage seed set in self and open pollinated heads were compared.

In Agropyrom latiglume anthers normally did not protude from the glumes. In many cases anthesis occurred when the spike was still inside the leaf sheath. The proportion of flowers bearing seed in open and self-pollinated spikes of each plant was similar, although, there was variation in seed-set among the plants. These three observations indicate that A. latiglume is a naturally self-pollinating species. Some plants produced viviparous spikelets under growth cabinet conditions. The propagules produced new plants when planted.

In Poa alpina anthers exert from the glumes 3-4 days after stigma emerges. The self-pollinated spikes had significantly lower seed set than the open-pollinated spikes. In many cases the self-pollinated spikes did not produce seeds or produced extremely small non-viable seeds. This indicates

that P. alpina is a naturally cross-pollinated species requiring high proportion of outcrossing for seed production. Some completely or partially vivparous P. alpina heads capable of propagating themselves vegetatively were observed in the growth cabinets.

Attempts will be made to get a precise estimate of outcrossing rate in the target species by using electrophoretic techniques. Presence of apomixis will be studied using cytological techniques.

Survey of Genetic Variability

Success of a breeding program depends very much on the presence of genetic variability within the material from which selections are made. Therefore, observations were made on the collected plants for the presence of variability in agronomic traits including plant height, flowering and maturity duration, number of tillers, plant growth habit, flag leaf length and width and seed yield. For each of these characters the collected plants of each target species exhibited tremendous variability. Since the plants are growing in one plot it is assumed that most of this variability is due to genotypic differences.

To maximize genetic variability in the collected material through new collections it is important to identify the environments (sites) that harbor genetic variants. Electrophoretically discernable characters, and morphological as well as quantitative characters will be used for this purpose.

Cytogenetic Studies

Cytogenetic studies on the target species were started to determine the extent of inter- and intra-specific genetic variation in morphological and reproductive traits influenced by the numerical variation in chromosome numbers. Intra-specific variation of chromosome number may result in seed sterility and also influence the mode of reproduction and adaptibility.

The cytological techniques for studying chromosomal variation in A. latiglume and P. alpina have been standardized. Mitotic chromosome counts on 80 random A. latiglume plants indicated no variation from 2n=28. Observations on P. alpina plants however showed a large variation (2n=36 to 46) among 50 random plants from the collection nursery. Additional work will be done to establish ralationship between morphological and chromosomal variation in the target species. The presence of apomictic seed production in the collected material will be surveyed using cytological techniques.

Selection Program

Since we expect the collected plants to be genetically adapted to stress environments the major breeding goal is to select genotypes suitable for commercial seed production. The selection criteria used were: winter-hardiness, seedling and plant vigour, erect or creeping growth habit, tillering habit, uniform seed maturity (early or late), seed yield, seed size, disease and insect resistance.

Selections in 1986 were made on the basis of single plant performance in the collection nursery. However, this can be extremely deceiving because of microenvironmental influences on the plants. Therefore, future selection of superior genotypes will be on the basis of superior progeny row performance.

Time Line for Agropyron latiglume Selection Program

1984-85
- A relatively large population of this species was collected and established in Vegreville with a 1m X 1m spacing among plants.

1986 summer
- Each plant was scored for desirable agronomic characters and 10% of the plants were selected on the basis of their morphology and environmental conditons of the collection site. Self-pollinated seeds were produced from each selected plant. Ten self-pollinated progenies of each selected plant were then transplanted into the progeny row nursery.

1987 summer
- The progeny rows planted in 1986 will be scored for various desirable agronomic characters. The best 10% of the progeny rows and morphologically superior plants within the rows will be selected. Self-pollinated seeds of each of these selected plants will be established in another progeny row nursery.

1988 summer
- Another cycle of selection will be exercised on the 1987 selections.

1989 summer
- Seed increase for the ten most promising lines will be initiated. Multilocation trials may start depending on the availability of seed.

Time Line for Poa alpina Selection Program

1984-85
- A relatively large population of this species was collected and established in Vegreville with 1m X 1m spacing between plants.

1986 summer
- Each plant was scored for desirable agronomic characters and 10% of the total number of plants were selected on the basis of their morphology and collection site. Ten open-pollinated progenies of each selected plant were transplanted into another nursery. In the fall one plant from each selected row will be brought to growth cabinet for inter-crossing.

1987 summer
- Progeny rows established in 1986 will be scored for agronomically important characters. Growth-room produced seeds of all the selected plants will be used to establish a population of 2,000 plants.

1988 summer
- Selection will be made on the basis of single plants. Seeds from very early, medium and late maturing selects will be bulked separately. These will then be established in separate nurseries for seed increase.

1989 summer
- Multilocation trials will be initiated for licensing the three populations.

Although we started with four target species at the moment emphasis is on two only (A. latiglume and P. alpina). The present constraints on manpower and our inability to make Festuca ovina and Trisetum spicatum flower in the growth cabinets are the reasons for this shift. If in the future the manpower situation improves selection programs may be started in the other two species.

PROCEEDINGS

ALBERTA RECLAMATION CONFERENCES

1985
Planning and Certification
of Land Reclamation
April 16-17, 1985
Edmonton Inn, Edmonton

1986
Reclamation in the
Eastern Slopes of Alberta
September 25-26, 1986
Overlander Lodge, Hinton

C.B. Powter
R.J. Fessenden
D.G. Walker
Compilers

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CANADIAN LAND RECLAMATION ASSOCIATION

P R O C E E D I N G S

1985 AND 1986
ALBERTA RECLAMATION CONFERENCES
ALBERTA CHAPTER, CANADIAN LAND RECLAMATION ASSOCIATION

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For more information on the Alberta Chapter of the Canadian Land Reclamation Association please write to CLRA, Box 682, Guelph, Ontario, Canada N1H 6L3.

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