

Germplasm for Ameliorating Production Constraints

C.R.Grime and W.J.R.Boyd

Department of Plant Sciences, University of Western Australia, Nedlands W.A. 6009.

Introduction

The first step in all plant breeding programs involves a critical analysis of production constraints, their translation into specific breeding objectives and the generation of hybrid populations segregating for the target traits. Achieving this objective depends on whether appropriate sources of genetic variability (germplasm) are available and above all, whether information on that and other variation is expressed within the breeder's target area.

The general objective of one project (UWA 262) within the Western Region is to provide a germplasm and related information service to other projects within that region. Actual and perceived limitations to production and export potential are reviewed annually by project supervisors, with prioritised conclusions expressed in terms of germplasm requirements and / or objectives for agronomic manipulation. The sourcing of the requested germplasm, information on that germplasm and, on the trait(s) in question, determine the project's specific objectives.

Most of the information on the materials introduced, and of their local evaluation, has only been circulated within the Western Region. Details / information have, however, found their way into other regional programs within the GRDC's sub-program 1.7.3; with requests for seed and information increasing substantially over the past 2 years. For that reason it has been decided to widen the circulation of information and to develop germplasm specific nurseries for evaluation in other regions.

The purpose of this paper is simply to outline the design and operational details of project (UWA 262) so as to indicate the nature of the information available and details of trait - specific nurseries we hope to assemble.

Project Design

There are 4 components to the project:

1. Germplasm introduction

Includes germplasm exchange agreements with the Western Canadian Barley Breeders and Sensako (S.Africa), plus trait-specific introductions from various sources including the AWCC (Tamworth), ICARDA, CIMMYT, USA, Japan, and Uruguay. AgWA elite nurseries (Stage III and IV) and interstate materials are also sourced and treated as introductions.

2. Seed multiplication and Germplasm Evaluation.

The multiplication and evaluation of introduced germplasm extends over 2 years with other Western Region projects contributing in the second year. General details are:

In Quarantine.

Overseas introductions are quarantined at 22/14C under an 18 h photoperiod. This allows for quantifying the duration of the basic vegetative period and identifying those introductions requiring vernalisation.

In Year1 (SMN 1 = Seed Multiplication Nursery -Year1).

The progeny from introductions which have passed through quarantine, together with all domestic introductions, are multiplied in hill plots on the UWA Field Station from an early June planting each year. The controls include cultivars from WA and interstate.

During this multiplication introductions are evaluated for their seedling growth class (4 and 8 weeks), for the timing of the commencement of stem elongation, awn appearance, agronomic type (plant height, lodging, straw strength), spike descriptors (row number, awn type) and grain descriptors (husk and aleurone colour).

Seed supply permitting the multiplied seed is distributed as follows:

- Up to 50 g into long term storage and 25 g into a working collection.
- Any 2-row, white aleurone lines of acceptable agronomic type, and flowering within specified ranges for AgWA's Low, Medium and High rainfall programs, are deemed to be "potentially adapted" and forwarded to the breeder
- Introductions specifically requested by other projects are also forwarded to them.
- All 6-row, blue aleurone, "unadapted" and agronomically unsuitable materials are put aside for evaluation for the specific traits for which they were introduced. Should those traits be expressed such introductions are forwarded to the Grain Quality Lab. For analyses pending a decision on their use as potentially useful parents.

In Year 2 (SMN 2) at UWA.

A number of SMN 2 nurseries are planted in Year 2. These nurseries are planted for specific operational purposes such as the replenishment of seed stocks and specific evaluation purposes. The latter include:

- Disease nurseries for Scald and Net-Blotch inoculated with infested straw.
- Evaluating tolerance to boron at 20ppm, followed by 40ppm for survivors.
- Evaluating response to vernalisation among all late flowering introductions
- Determining the duration of the basic vegetative period under field conditions.

In Year 2 (SMN 2) in other Western Region projects.

The evaluation of introductions multiplied in SMN 1 continues within other AgWA projects in Year 2. Details vary with those to whom seed was distributed:

- the Breeder - phenology, agronomic type and perceived potential (Observation trials).
- the Plant Pathologist - receives all introductions for inclusion in disease nurseries for Scald, Net and Spot forms of Net-Blotch, Mildew and BYDV.
- the Agronomists - as part of projects for their specific research. (eg. K.Young at Esperance for kernel discolouration, end-point staining and grain plumpness)
- the Grain Quality Lab - The assumption is made that any interesting introductions fed into the breeding and agronomy projects will automatically be forwarded to the quality lab as a part of their routine operations.

All data collected at UWA and in AgWA projects in Year 2 are added to the Western Region Germplasm Database (under development in Microsoft Access). When that is complete data will be lodged with the AWCC and AustPigs.

3. *Germplasm Enhancement*

The objective of this component is to introgress desirable traits from introduced materials into better adapted and more agronomically suitable backgrounds. Specific cross combinations depend on the characteristics of the donor parent. A preference is given to those least likely to introduce undesirable traits and identified in the Grain Quality Lab as expressing acceptable quality traits. Where segregation can be readily observed (eg. disease resistance, short stature) doubled haploid (DH) populations are developed. Both conventional F2 and DH progeny populations are handled as follows:

- Single plant selection is practiced; based on time to flower (relative to regional controls), agronomic type and desired trait(s). Samples of each selected line are composited to develop mass selected bulks for both field evaluation (breeder) and malting quality (Grain Quality Lab). This represents an evaluation of cross potential.
- Residual seed of the single plants selected, and sampled to provide the mass selected bulks, are multiplied (SMN2M = miscellaneous). Reselection is practised, and once cross-potential has been evaluated, the progeny of selected individuals from promising cross combinations are forwarded to the breeder as F3/F4 lines..

4. *Germplasm Research*

With students, DH and segregating populations available from the enhancement component of this project, and the AgWA DH project, a wide range of investigative projects can be entertained. Such investigations are restricted to those traits relevant to the actual and perceived limitations identified by project supervisors and for which introductions are made. Examples include:

- Investigating an apparent linkage / pleiotropism between for short / stiff straw, later flowering, a prostrate seedling growth form, synchronous tillering and small grain.
- Investigating variation in the duration of the basic vegetative period and its relationship with the timing of developmental events after floral initiation. We hypothesise that varieties having a short basic vegetative period are more responsive to variation in seeding date.
- Investigating relationships between growth, development and yield determination. (Poster at this Symposium).

Nursery Development

We are contemplating the development of trait - specific nurseries for circulation to other breeding projects, and in the hope that observations by those projects will be available for inclusion in the database. The first such nursery for short / stiff straw was circulated in 1999 to Queensland, NSW and Victoria. Seed supply limited the entries sent to SA and Tasmania.

Short / Stiff Straw

With straw strength being a major and common production problem in the Western Region, an emphasis has been placed on sourcing introductions exhibiting this trait and, introgressing it into high malting quality backgrounds. Most sources have a prostrate seedling growth form and are characterised by small seed. Entries derive from populations identified through mass

selected bulks to be of high yield / quality and segregating for short and stiff straw, time to flower and seedling growth form.

Future Nurseries

- A large number of introductions have exhibited resistance to Scald, Net Blotches and Mildew in both our and AgWA disease nurseries. It is proposed to assemble these into nurseries for those who may wish to evaluate them.
- Similar comments apply to tolerance to Boron Toxicity

Other Germplasm Information

Potentially Useful Sources of Germplasm.

<i>Large Grain Size **</i>	<i>Short/Stiff Straw **</i>	<i>Low Kernel discolouration **</i>
Yagan	Pitcher	WA 5033
Prisma	Dallas	WA 5034
WA 5040	Tankard	TR 118
TR 140	TR 140	WA 6369
TR 238	TR 326	
Turk	TR 569	
<i>Low End Point staining **</i>	<i>Scald Resistance</i>	<i>Boron tolerant (40 ppm)</i>
WA 2594	Ethiopia (via Japan)	Sahara
WA 5034	TR 145	Arupo
WA 5040	TR 329	WA 2545
WA 6364	TR 333	WA 5158
WA 6370	TR 334	WA 5241
TR 139	Turk	WA 5446
TR 144	Shyri	
<i>Low B glucan (< Stirling)</i>	<i>High Extract (=/> Harrington)</i>	<i>Diastase (> Stirling)</i>
Sloop	WA 5040	WADH 2595
WADH 849	WADH 2600	WA 6362
WADH 2595	WA 6367	WA 6362
WA 6363	WA 6370	WA 6369

** Data provided by K.Young, AgWA, Field Crops Research, Esperance, WA.