QUALITY WHEAT
CRC PROJECT REPORT

Program 1: New Wheats & Breeding Aids
Program 2: Growing & Storing Quality Wheat

8th International Symposium on
Preharvest Sprouting in Cereals
Detmold, Germany

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A Report for the Quality Wheat CRC by Dr Daryl Mares

These symposia are held every 3-4 years and aim to advance research and cooperation in scientific disciplines relevant to overcoming the problems associated with weather damage or preharvest sprouting in cereals.

In many areas of the world each year, cereal grower’s battle against the elements to harvest their crops before rain or mist induces preharvest sprouting. Sprouting of grain in the field prior to harvest, and the activation of systems which breakdown the starch and protein reserves in grains, lowers the quality and commercial value of grain, severely restricts the range of processing applications and adversely affects grain storage. The period between crop ripeness and harvest will remain an anxious wait for farmers until we have a better understanding of this phenomenon and sprouting tolerant cultivars are more widespread.

The sprouting symposia through their multidisciplinary approach provide an opportunity for researchers from around the world to present and discuss their latest findings on topics including: a) breeding for sprouting tolerance, b) molecular and physiological mechanisms regulating seed development, dormancy and germination, c) assay methods, and d) the effects of sprouting damage on cereal products. The 8th symposium was organized by Dr Dorian Weipert of the German Federal Institute for Research on Cereals, Potatoes and Lipids, and attracted around 100 participants from 28 countries.

A program outline is attached at the end of this report. Abstracts for each presentation are available from Dr D Mares and a full proceedings will be published at a later date in line with previous practice.

Participants/presentations from Australia and the Quality Wheat CRC

Dr John Skerritt: CSIRO, Division of Plant Industry, Canberra.

Dr Daryl Mares and Dr Kolumbina Mrva: The University of Sydney, Plant Breeding Institute, Narrabri.

Dr Mares presented a report titled “The seed coat and dormancy in wheat grains” which detailed work carried out with funding from the GRDC on the genetic control and biochemical interactions involved in dormancy in wheat.

Dr Mrva presented a paper titled “Coordinated synthesis of high pt α-amylase isozymes in the aleurone of wheat grains” which detailed work carried out with funding from the GRDC that provides evidence for a gene or genes located on the long arm of chromosome 6B which regulates GA-induced synthesis of α-amylase by the Amy-1 genes on chromosomes 6A, 6B and 6D.

The research described in both these presentations has implications for the CRC’s involvement in the development of wheat cultivars that are less prone to both preharvest sprouting and late maturity α-amylase (LMA).
Highlights of the Symposium

* Progress towards molecular characterization of the \( yp-1 \) gene, reputed to be involved in sensitivity of some plant tissues to abscisic acid, and mapping of a homologue in wheat to chromosome 3D of Chinese Spring. We have assumed for some time that this gene is likely to be involved in dormancy, in particular, the embryo sensitivity factor which we are now using at Narrabri as an early screen to enrich populations for sprouting tolerance. The John Innes group places the \( yp-1 \) homologue approx. midway between the centromere and the \( R \) gene which controls seed coat colour in red-grained wheats. These results are consistent both with the assignment of 2 major dormancy genes in AUS1408 to chromosome 3D by the Narrabri group and with the observed segregation for dormancy in sub-populations which are homozygous for embryo sensitivity.

* The identification of new genes and new sources of dormancy not linked to red-seed coat colour. Genes were identified on chromosome 3A of Timstein and 1A of Chinese Spring which, theoretically at least, could be combined with the dormancy already in AUS1408. A number of white-grained, hexaploid landraces from China were described which appeared to have excellent tolerance to sprouting. These lines have already been brought into Australia as part of a proposed ACIAR project lead by Dr Paul Brennan at Toowoomba and including a sprouting component supervised by Daryl Mares at Narrabri. AUS1408, a white-grained, sprouting tolerant genotype identified at Narrabri, continues to be the benchmark for white wheats. Since it appears to have simpler genetic control than many other sources, it is being used by an increasing number of breeders around the world.

* Further evidence from South Africa that molybdenum application to wheat grown on Mo-deficient acid soils can improve tolerance to sprouting and reduce late amylase development. This effect appears to be mediated via modulation of levels of \( ABA \) whose synthesis is dependent on an enzyme for which Mo is a cofactor. Any role Mo-deficiency plays in LMA in Australia remains unclear but reinforces the idea that there may be several mechanisms involved in LMA.

* The occurrence of LMA (called PMAA – prematurity \( \alpha \)-amylase – in some areas) remains a problem in the UK and Japan. In addition, breeders from CIMMYT advised that Vc-5, a line identified as being prone to LMA by the Narrabri group, now represents a large slice of CIMMYT germplasm. This indicates that Australian breeders need to maintain their vigilance on material from this program and strengthens the need for reliable and efficient screening procedures. Unfortunately there were no other reports of work on the mechanisms involved in expression of LMA and the program at Narrabri under the leadership of Dr K. Mrva represents a major part of the international effort.

* A group in the UK reported progress towards a predictive model for use by growers that included both LMA and sprouting risk. The system involved field sampling at late grain development for amylase and germination tests and aims to advise growers of the likely economic benefits of early harvest. Similar schemes have been trialed previously in Holland and Sweden with some success. Work carried out at Narrabri, reported at the 6th symposium and published in A.J.A.R. indicated that
sprouting tolerance at harvest-ripeness could be predicted from the amount of rain which fell during the final 20 days of grain ripening. This work has not been taken to a practical stage although it was originally included as a component of Colin Wrigley's CRC program 2.6.

* There were no new methods reported for the determination of sprouting or the extent of weather damage in cereals. There was, however, an indication that under extreme conditions occasionally experienced in the UK (i.e. a combination of cool, humid, low light intensity conditions), high amylase could be attributed to retention of early development, pericarp-amylase as opposed to LMA or sprouting. The pericarp enzyme is genetically and electrophoretically distinct from the major isoforms found in LMA or sprouted grain, usually disappears by the mid to late stages of grain development, and is almost entirely removed during milling. Nevertheless, in some situations it could confound the results of whole grain assays.

* The symposium program included a visit to a private plant breeding company located near Detmold, Germany. Despite its small size this company had invested considerable resources in doubled haploid breeding, anther and microspore culture, and molecular marker (RFLP, RAPD, microsatellites etc.) technology (14 staff out of a total of approx. 35 together with a very impressive array of capital equipment).

* The symposium also included a short forum discussion on an application by the Delta-Pine company to patent a gene system that would be activated near grain maturity to render the seed non-viable. Such a move would clearly be of considerable value to seed companies marketing non-hybrid cultivars but could also have implications for sprouting tolerance.

* The symposium concluded with a general meeting at which it was decided to hold a 9th symposium in South Africa at a date to be advised.

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8. International Symposium
Pre-Harvest Sprouting in Cereals
In Detmold, Germany
June 2 - 5, 1998

Tuesday, June 2, 1998

09:00 Registration
09:30 Opening and Welcome Address by M.G. Lindauer, Director of the Federal Centre for Cereal, Potato and Lipid Research, Detmold (Germany)
09:45 Address by the President of the International Committee of the Symposium, K. Noda, Japan

Plenary lecture
10:00 K. Noda, Japan
Pre-harvest sprouting in wheat in Japan

Session 1: Effects of sprouting damage on cereals and products and strategies for reducing damage

Development of a scheme for pre-harvest prediction of Hagberg Falling Number in wheat

10:40 1.2. Annelie Barnard, South Africa
Multivariate analysis of factors affecting preharvest sprouting of winter wheat cultivars in South Africa

11:00 Break

11:30 1.3. Annelie Barnard, South Africa
The relationship of preharvest sprouted seed and seed treatment to emergence and yield of winter wheat (Triticum aestivum L.) in South Africa

11:50 1.4. J.M. Brümmer, Germany
Possibilities and remedies of reducing sprouting damage in processing of wheat and rye to bread

12:10 1.5. Mariatta Salminen-Marttila, M. Fabritius and Karin Aalto, Finland
Florescences microscopy and image analysis as tools to study the effects of germination on grain microscopy

12:30 Lunch

14:30 1.6. D. Welpert and H.-J. Kersting, Germany
A contribution to the study and presentation of alpha-amylase activity in course of baking

14:50 1.7. H.J. Pieper, Germany
Enzyme potential of cereals suitable for the production of ethanol and glucose syrup

15:10 Break

16:30
Session 2: Physiology and molecular biology of grain development, dormancy and germination

15:40  2.1. J. Flintham, Rachel Adlam and M. Gale, United Kingdom
      Seedcoat and embryo dormancy in wheat

16:00  2.2. D.J. Maras, Australia
      The seed coat and dormancy in wheat grains

18:20  2.3. R.C. Schuurink and N.A.J. Sedde, United Kingdom
      Climatic conditions during barley development determine levels of Ltp 1

Wednesday, June 3, 1998

09:00  2.4. R.L. Banech-Arnold, Christine M. Giarelldanz and Juliete Frank, Argentina
      Dormancy release in developing barley grains in relation to embrionic ABA content and sensitivity

09:20  2.5. P. Bailey, J. Flintham, M. Gale, R. McKibbin, J. Lenton and M. Holdsworth, United Kingdom
      Transcription factors in wheat seed dormancy

09:40  2.6. X.B. Liu, G.H. Wang, J. Jin, Y.H. Li and S.P. Yang, P.R. of China
      Endogenous hormone activity during grain filling of wheat genotypes differing in pre-harvest sprouting

10:00  Break

10:30  2.7. M. Holdsworth, L. Russel, Vicky Larmor, H. Jonas, N. Peters and S. Kurup, United Kingdom
      Molecular genetic approaches to the analysis of the dormancy to germination transition

10:50  2.8. R. McKibbin, P.C. Bailey, J.E. Flintham, M.D. Gale, J. Lenton and M.J. Holdsworth, United Kingdom
      Molecular analysis of the viviparous 1 (VP1) homologue

11:10  2.9. Barbara Fretzdorff and T. Betsche, Germany
      Oxalate oxidase activities during germination of cereals

11:30  2.10. M. Stehli and A.M. Stehli, Germany
      Viability loss of sprouted wheat seed during storage

11:50  2.11. M.O. Lindheuer, Germany
      Tests and targets of the Federal Centre for Cereal, Potato and Lipid Research

12:30  Lunch

13:30  Visit of the Federal Centre for Cereal, Potato and Lipid Research

Session 3: Synthesis and molecular control of sprouting damage enzymes

15:00  3.1. M. Kay Walker-Simmons, A. Gomez-Cadenas, S.D. Verhey, P. Zhang, L.D. Holappa and
      T.H. David Ho, United States of America
      Involvement of PKAβ1 protein kinase in molecular control of alpha-amylase and protease gene
      expression in barley aleurone cells

15:20  3.2. Kolumbina Mv and D.J. Maras, Australia
      Coordinated synthesis of high pI alpha-amylase isoforms in the aleurone of wheat grains

15:40  3.3. J. Yamaguchi, K. Toyofuku, A. Morita, A. Ikeda, C. Matsukara and P. Perata, Japan
      Sugar repression of alpha-amylase genes in rice embryos

16:00  Break

16:30  3.4. A.S. Basra, R. Bhati and R.K. Basra, India
      Genotypic variation in temperature and hormonal responsiveness of germination and seedling growth
      in wheat: relationship to carbohydrate metabolism

16:50  3.5. A.L.P. Coins and A.K. Cowan, South Africa
      The effect of allopurinol and molybdenum on seed dormancy

17:10  3.6. Z. Alkufov, Kazakhstan, and A. Izundu, Nigeria
      Possible roles of molybdenum hydroxylases in dormancy and germination of wheat seeds

17:30  Poster Presentation
Thursday, June 4, 1998

Session 4: Genetics and plant breeding; techniques and results

09:00  4.1. N. Przulj, V. Momalovic, N. Mladenov and M. Molosevic, Yugoslavia
       Resistance of two-rowed barley to pre-harvest sprouting

09:20  4.2. Yuchun Zou, P.R. of China
       Screen white-grained pre-harvest sprouting resistance germplasm from landraces growing in high
       rainfall Yangtze Valley

09:40  4.3. Y. Amano, T. Atsushi and S. Sibata, Japan
       Possibility of breeding white grained wheats under Japanese humid condition

10:00  Break

       Techniques for the study and incorporation of pre-harvest sprouting resistance in white-seeded wheat

10:50  4.5. A.K. Joshi and R. Tripathi, India
       Inheritance of pre-harvest sprouting tolerance in crosses involving Indian white seeded wheats
       (T. aestivum L.)

       GE interaction in wheat germinability

11:30  4.7. Guo-Liang Jiang and Zhao-Xia Chen, P.R. of China
       Inheritance analyses of pre-harvest sprouting resistance in white wheat

11:50  4.8. W. Saurer, Bae Senger and Yvonne Häfele, Switzerland
       A novel method for the breeding for sprouting resistance in wheat

12:10  4.9. Jutta Förster, Germany
       Biotechnology and plant breeding - first results

12:30  Lunch

14:00  Excursion, visit to the W. von Borries-Eckendorf, Plant Breeding Station, and Saaten-Union,
       Laboratory for Resistance Breeding

Friday, June 5, 1998

09:00  4.10. D. Hamanstäd, Gitta Oettler, G. Waehle and H.H. Geiger, Germany
       Recurrent selection to improve pre-harvest sprouting in triticale

09:20  4.11. W. Flamme, Gisela Jansen, P. Dill, H. Wortmann and A. Täufel, Germany
       Results in breeding of sprouting resistant rye, breeding relevant analytical methods, possible
       industrial applications

Session 5: Influence of environmental and agronomic factors on sprouting
and potential for control

09:40  5.1. G.D. Lunn, P.S. Kettlewell, B.J. Major and R.K. Scott, United Kingdom
       The contribution of pericarp activity and pre-maturity sprouting to alpha-amylase activity in
       wheat grain

10:00  5.2. Zaneta Ugaric-Haridi and A. Novatić, Croatia
       Climatic and cultivar effects on some properties of wheat grain

10:20  5.3. P. Wilda and D. Welpart, Germany
       Sprouting resistance in rye as influenced by environment and cultivar

10:40  Break
Session 6: Combined breeding for sprouting resistance, yield, disease resistance and processing quality

11:10  6.1. M.E. Kazmann and D. Weipert, Germany
       Variation for Falling Number in synthetic 6x triticale lines exhibiting improved sedimentation values

       Transgenic wheat and barley to improve disease resistance and quality

11:50  6.3. Guo-Lieng Jiang, P.R. of China
       Studies on pre-harvest sprouting and relative traits in red and white wheat

12:10  Wrap up of the Symposium by M. Kay Walker-Simmons, United States of America

12:20  Adjourn of the Symposium