Project HY-WHEAT Plant KBBE III

Project HY-WHEAT: Hybrid Wheat for Reduced Inputs and Sustainable Yield

The development of a commercially-viable hybrid wheat breeding system based on the msH1 CMS and fertility-restoration technology derived from *Hordeum chilense*

From: Pilar BARCELO, Agrasys, March 2012, KBBE Assembly Barcelona , Spain

HY-WHEAT Project Partners I

1. Agrasys SL**, Spain** (Coordinator) - *AgriFood SME, working on the development and introduction of the msH1 CMS hybrid system in close collaboration with the Institute of Sustainable Agriculture (IAS) Córdoba.*

2. Saaten Union Biotec GmbH and **Affiliates, Germany**; including **Deutsche Saatveredelung** AG, **Strube Research** GmbH, **Südwestdeutsche Saatzucht** GmbH, **W. von Borries-Eckendorf** GmbH - *plant breeding technology company and affiliate plant breeding companies with active wheat breeding programmes, including hybrid wheat breeding based on gametocide technology.*

HY-WHEAT Project Partners II

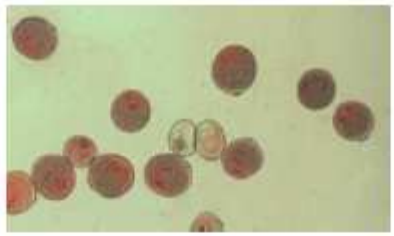
3. Saaten Union Recherche SAS, **France** - *leading European plant breeding company in hybrid wheat varieties, based on gametocide technology.*

4. CSIC Instituto de Agricultura Sostenible (IAS), Spain - *original developer of the Hordeum chilense msH1 CMS technology. Working together with Agrasys to produce systems for hybrid breeding in bread and durum wheat.*

5. University of Tras-os-Montes and Alto Douro, Portugal - *cereal breeding and cytogenetics group working with IAS on the optimisation of the msH1 technology.*

Hybrid Parents

Female parent - sterile open flowers, with no pollen



pollen

Good combining ability leading to **hybrid vigour**

Male parent - good anther extrusion and pollen production

Hybrid parents from **Saaten Union Recherche** SAS

Source of Sterility: CMS *Cytoplasmic Male Sterility*

A maternally inherited trait resulting from incompatibility between nuclear and cytoplasmic genomes

→ Non viable pollen

→ No effect on female fertility

- About 287 plant species and species crosses
- In wheat first reported by Kihara (1951)
- Genera tested for induction of CMS in *Triticum aestivum*:
  - *Agropyron* (Sánchez-Monge 1968)
  - *Haynaldia* (Sánchez-Monge 1968)
  - *Secale* (Maan and Lucken 1971)
  - *Triticum* (Sage 1976)
  - *Aegilops* (Panyotov 1980)
- Most satisfactory source of CMS → *Triticum timopheevi*

Search for alternative CMS cytoplasm - observation of CMS in some Tritordeum ($H^{ch}H^{ch}AABBDD$) lines

Tritordeum: amphiploid *H. chilense* – wheat

HH

H. chilense

X

AABBDD

T. aestivum

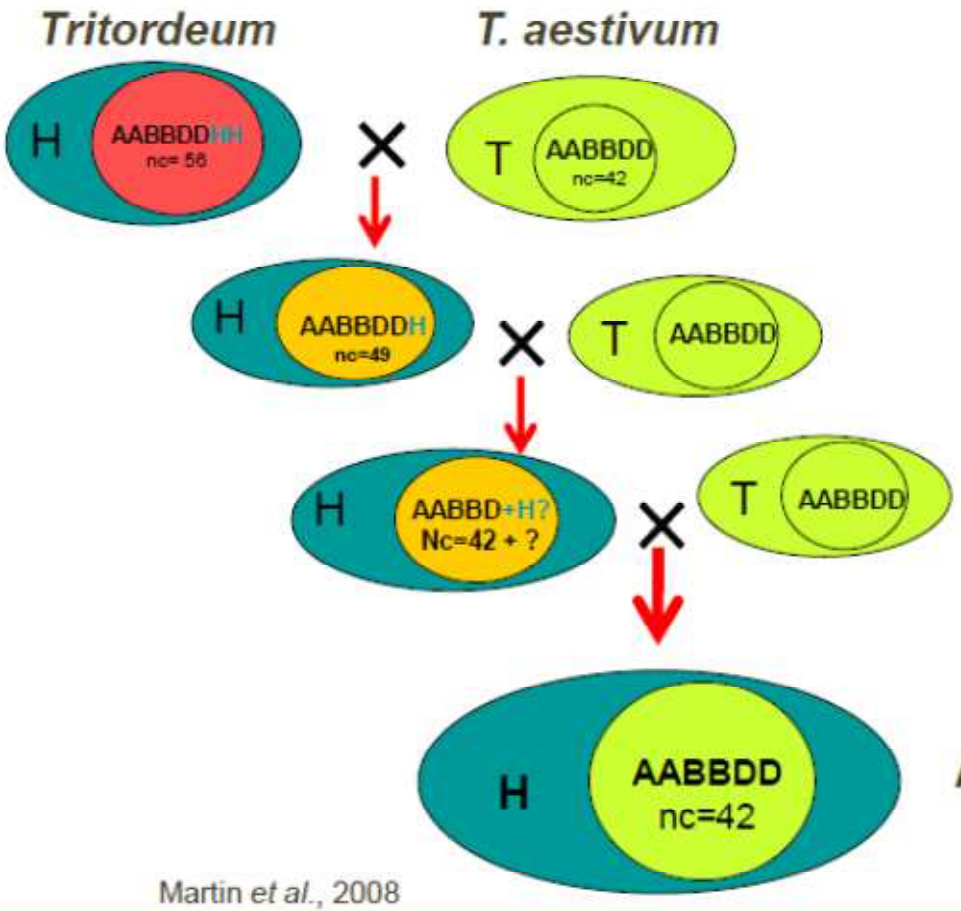
HABD

Chromosome doubling

HHAABBDD

***x Tritordeum* octoploid**

Obtention of male sterile alloplasmic lines



Martin *et al.*, 2008

Alloplasmic wheat

Hordeum chilense; a source of sterile cytoplasm for wheat

- Resistance to several pests and diseases
- Drought and salt tolerance
- High seed carotenoid content
- **High crossability with other members of the Triticeae tribe:**

Aegilops, Agropyron, Dasypirum, Secale, Triticum, XTriticosecale

➢Series of lines of *Hordeum chilense* tested for sterilising capacity in alloplasmic wheats

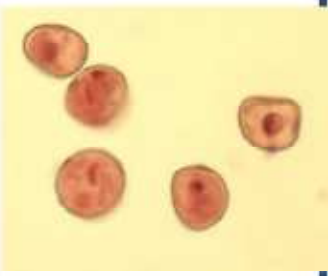
➢Cytoplasm H1 chosen as first candidate

Characteristics of msH1 System

- **Stable** and **complete** male sterility
- Works in a **range** of varieties
- **Normal** flower morphology
- Some (days) **delay** in flowering
- Slight **height reduction**
- Some **leaf color change**
- Agronomic effects under **field conditions** needs to be examined

Chinese Spring

(H1) Chinese Spring



Morphological Characteristics of msH1 System

Reduction in height acceptable for female parental

Identification of Restorer Chromosomes

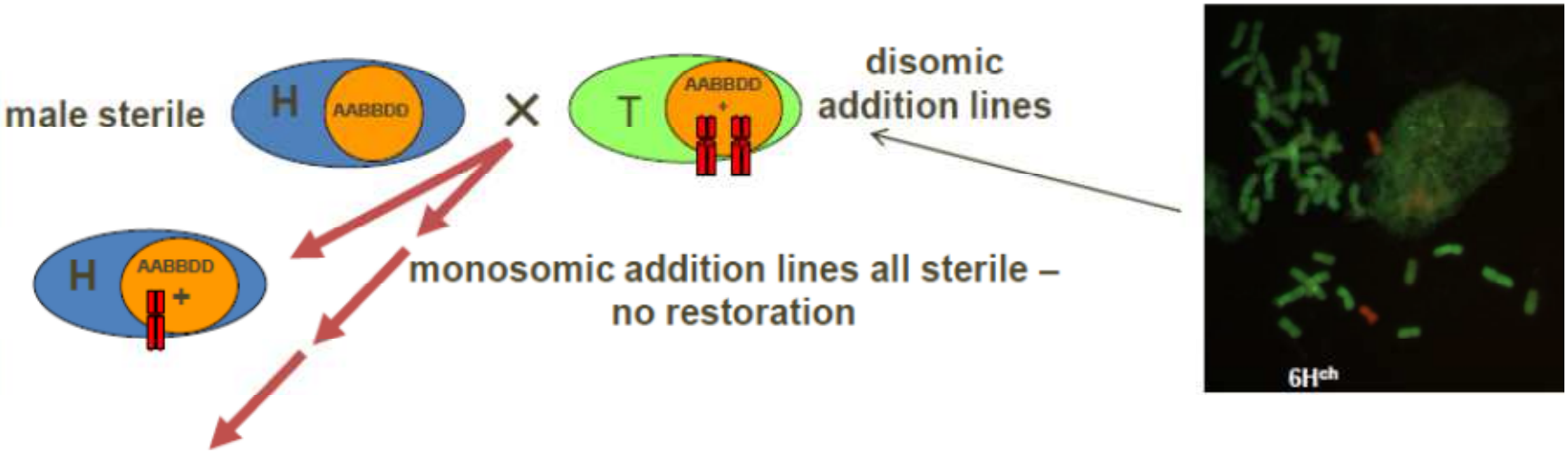
Crosses with 25 known restorer genes from a range of different *Triticeae* species:

- USDA, ARS, Aberdeen, 18 lines
- CIMMYT, 4 lines
- Dr. Chen, Guizhou, China, 4 lines

No H1 restoration

Identification of *Hordeum chilense* restorer chromosomes

Series of crosses with the 7 disomic addition lines of *H. chilense* in wheat

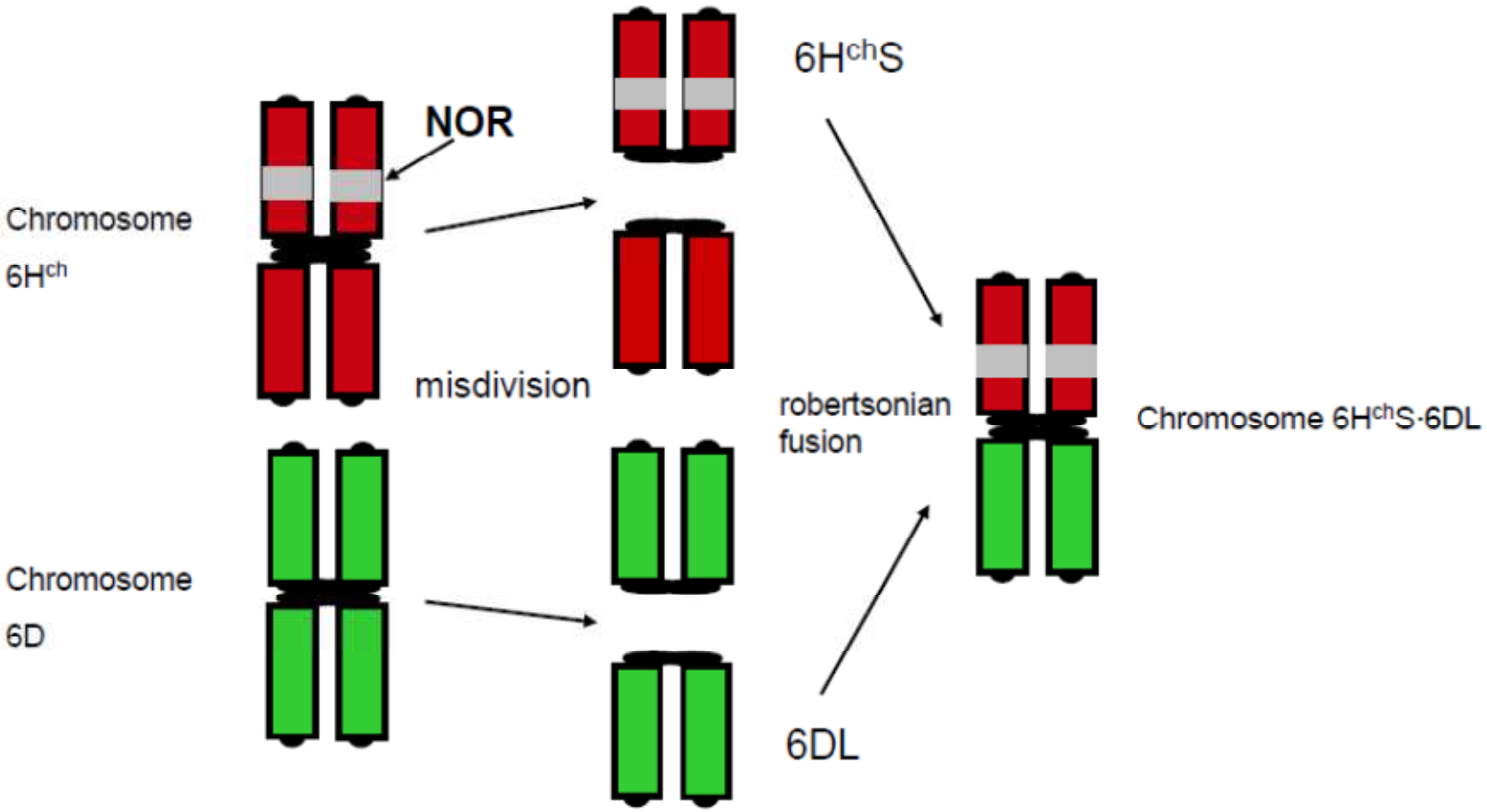


ONE fertile line recovered

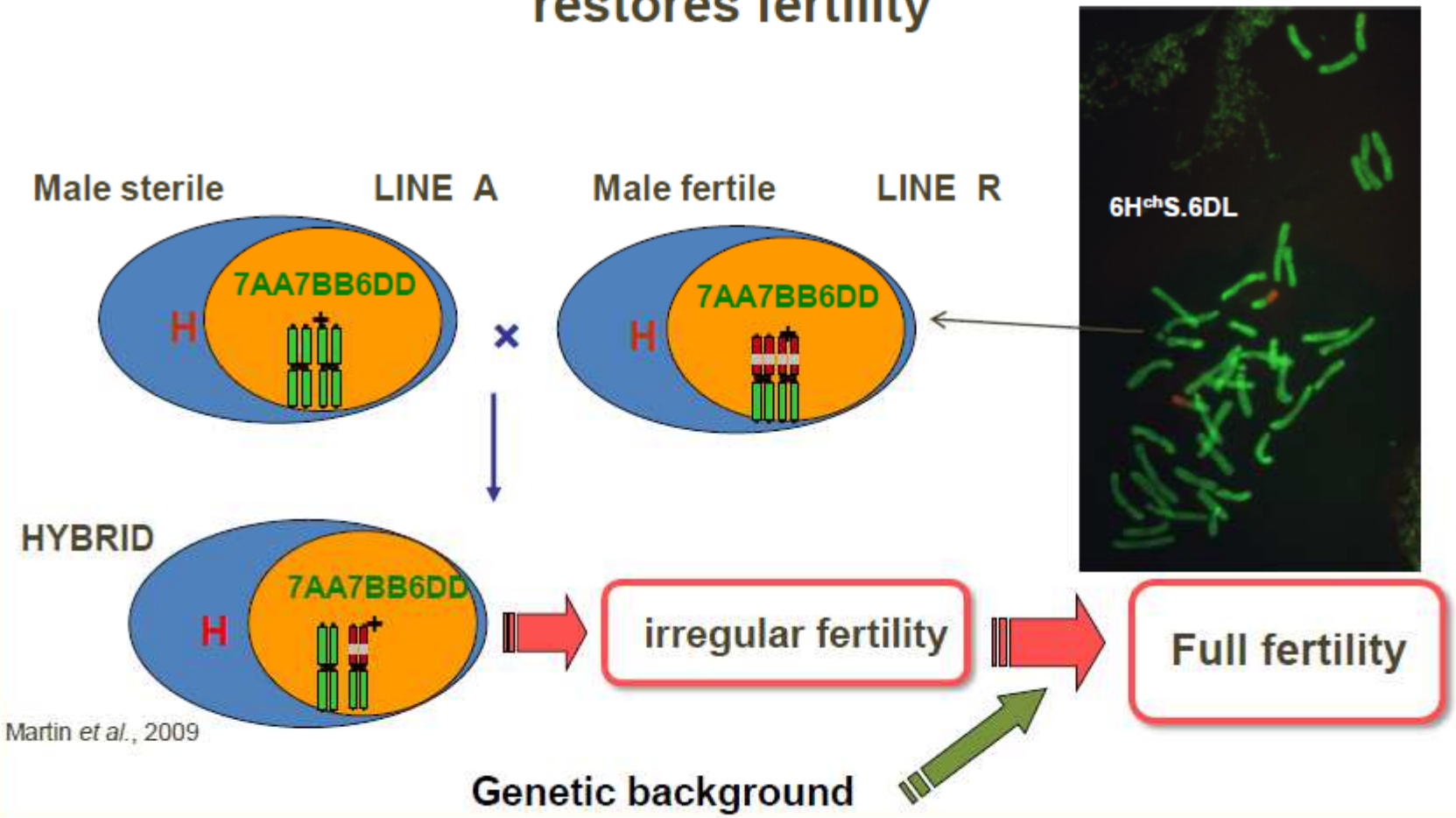
Telocentric 6H^{ch}S

→ some fertility

Restorer; Engineering of Translocation 6H^{ch}S·6DL



Hordeum chilense engineered chromosome 6HS·6DL restores fertility



Martin *et al.*, 2009

Restorer BC 06/2012

Many thanks for your attention !