Chromosome substitution lines

1. The disomic donor genotype is first crossed as the male with a stock monosomic for each chromosome (i.e. 1A)
2. The monosomic progeny will have only one copy of the monosomic chromosome coming from the donor genotype
3. The monosomic donor chromosome has no homologous pairing partner and therefore no opportunity to recombine
4. The recipient monosomic is repeatedly crossed as the recurrent female parent to monosomic F_1
5. Backcrossing will continue until the recipient background is recovered to the desired level to produce a monosomic substitution line
6. The monosomic substitution line is selfed and disomic substitution lines are selected

Chromosome substitution lines

1. Allow the study of the affect of a single chromosome from a donor variety in the genetic background of the recipient variety.

2. Particularly useful for studying disease resistance that may be difficult to classify in segregating populations

3. Disomic substitution lines are stable and will breed true and can be increased and evaluated similar to other pure lines

Chromosome substitution lines

- If a male n-1 gamete functions, the recipient chromosome may be present rather than the donor chromosome. This can be avoided by selfing the F_1 monosomic after each backcross and using the resulting disomics as the male.
- A monotelosomic or monoisomic can be used as recurrent recipient female parent in the backcross to allow detection of transmission of n-1 gametes through the male.
- If an n gamete rather than an n-1 gamete is contributed by the recipient, it can be recognized by the presence of a telosomic chromosome in the F_1.

Chromosome substitution lines

Advantages of using monotelosomic or monoisomic as recipient:

1. As rapid as using monsomic recipient
2. Very little possibility of an undetected shift to a chromosome that is different than the one represented by the telocentric chromosome
3. No chance of the whole chromosome univalent coming from the reciepent parent.

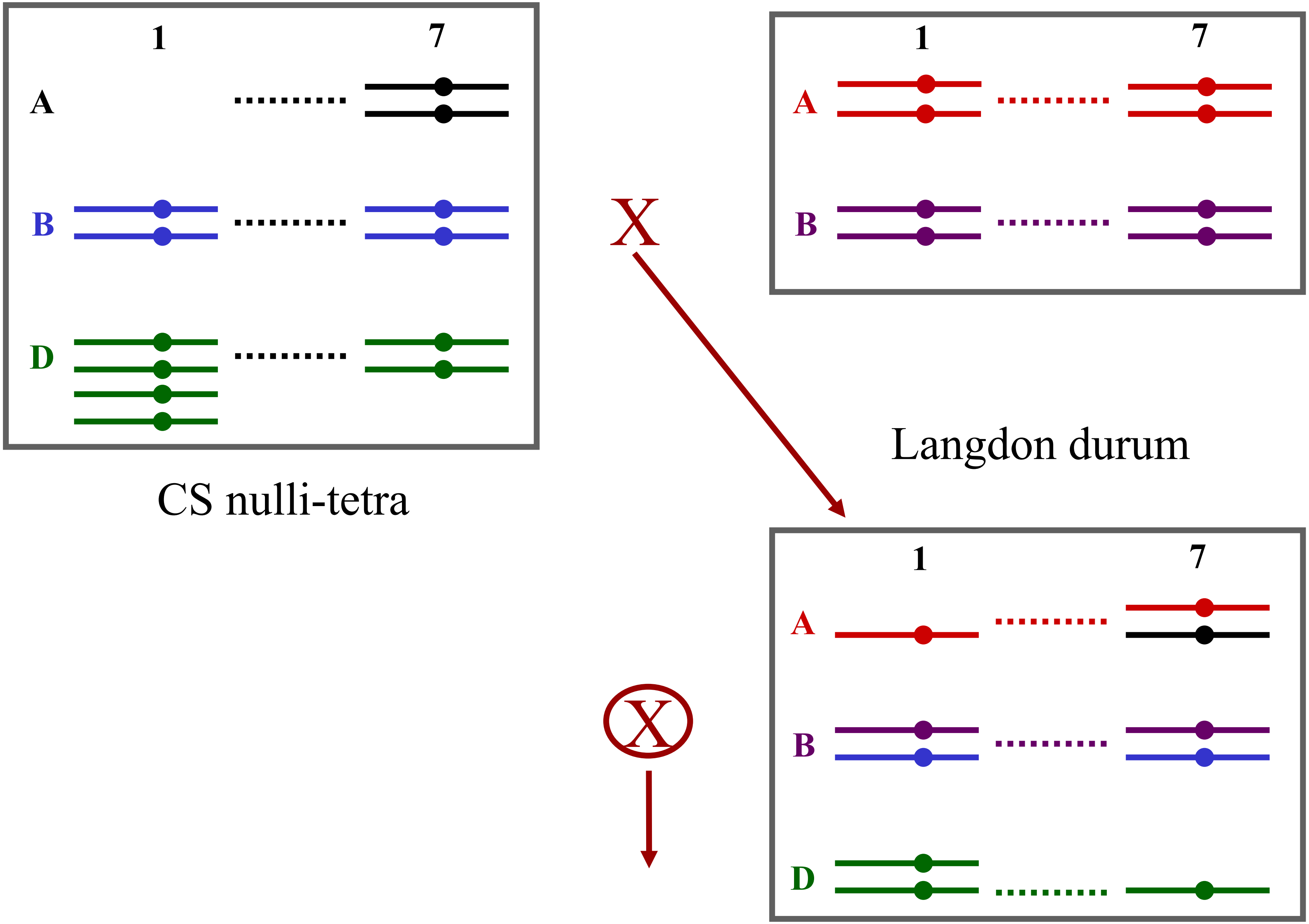
D-Genome disomic chromosome substitution lines in durum

Joppa and Williams produced a complete set of 14 different disomic substitution lines with 13 pairs of durum chromosomes and a pair of D-genome chromosome substituted for their homoeologs in the A or B genomes.

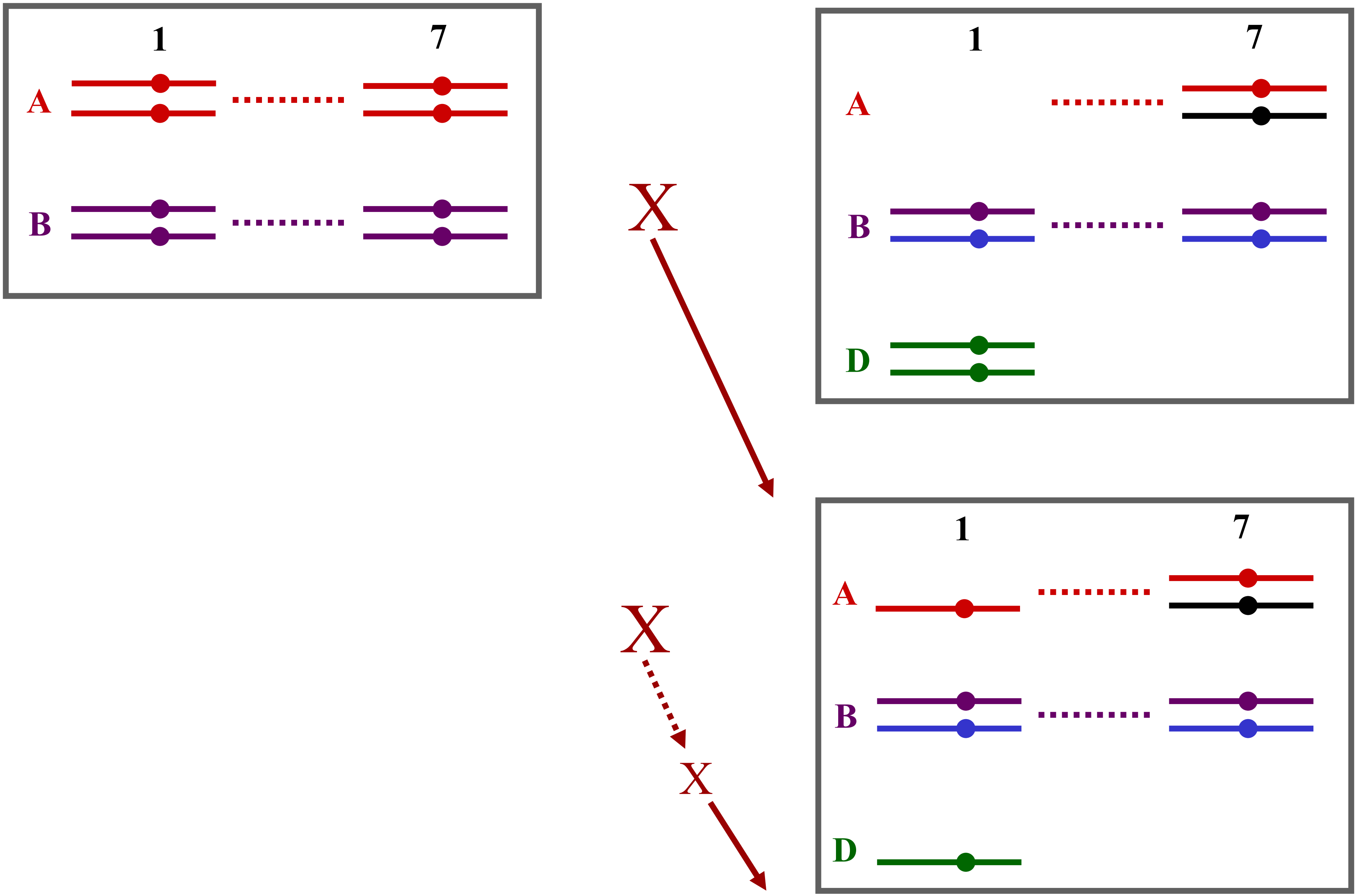
Procedure:

1. Cross hexaploid 'Chinese Spring' compensating nullisomic-tetrasomic (nulli-tetra) with 'Langdon' durum.
2. Self F_1 plants
3. Select plants with 2n=28 (these have a pair of homoeologous 1D chromosomes substituted for the pair of 1A chromosomes).
4. Backcross to Langdon repeatdly and at each generation select for 13"+2' (double monosomic) individuals.
5. Self the last generation and select the disomic substitution lines.

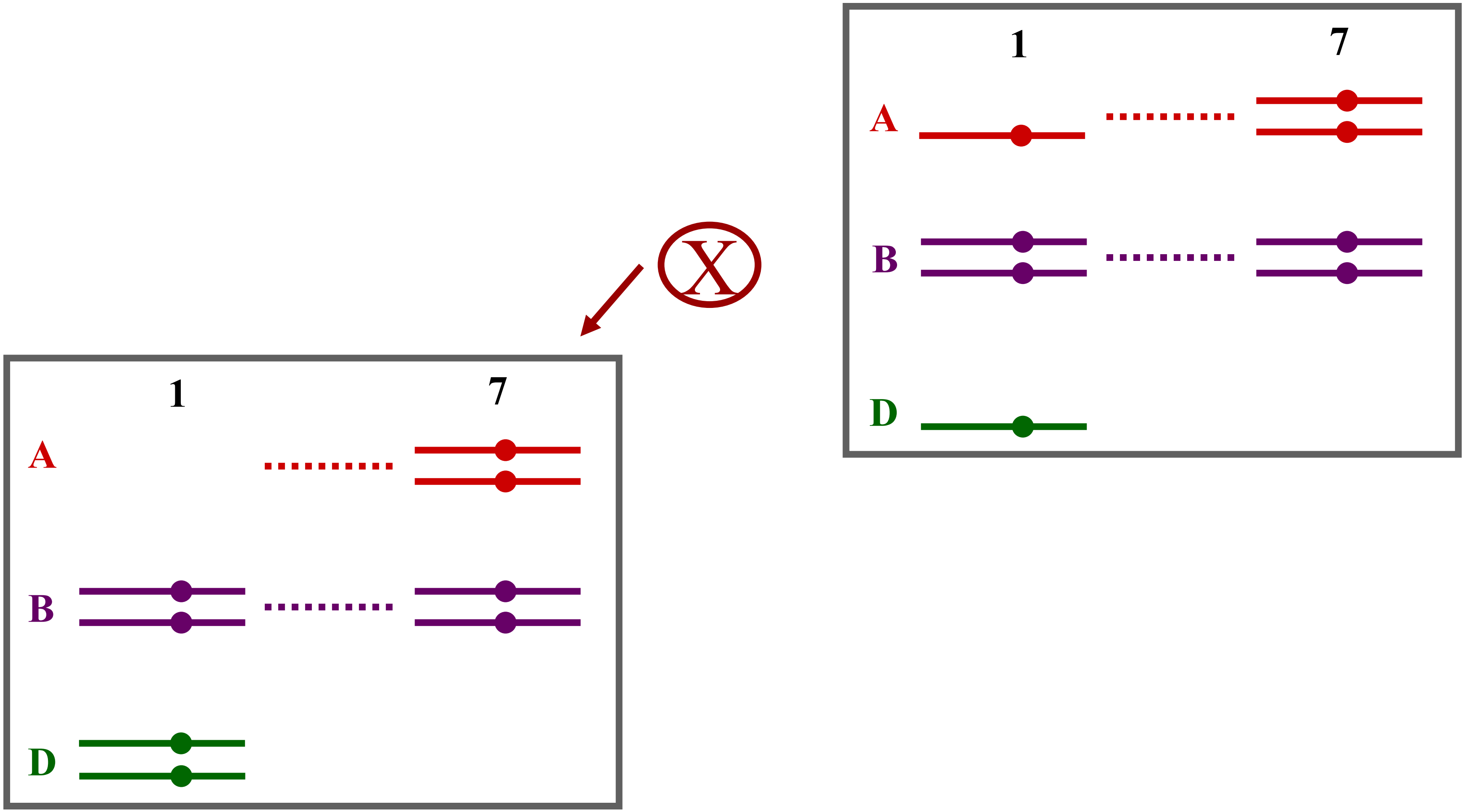
D-Genome disomic chromosome substitution lines in durum



D-Genome disomic chromosome substitution lines in durum



D-Genome disomic chromosome substitution lines in durum



Langdon 1D(1A)

D-Genome disomic chromosome substitution lines in durum

Joppa and Williams produced a complete set of 14 different disomic substitution lines with 13 pairs of durum chromosomes and a pair of D-genome chromosome substituted for their homoeologs in the A or B genomes.

Procedure:

1. Cross hexaploid ‘Chinese Spring’ compensating nullisomic-tetrasomic (nulli-tetra) with ‘Langdon’ durum.
2. Self F_1 plants
3. Select plants with 2n=28 (these have a pair of homoeologous 1D chromosomes substituted for the pair of 1A chromosomes).
4. Backcross to Langdon repeatdly and at each generation select for 13”+2’ (double monosomic) individuals.
5. Self the last generation and select the disomic substitution lines.

D-Genome disomic chromosome substitution lines in durum

Procedure:

6. Crossing a disomic D-genome substitution with Langdon double ditelosomics (i.e. 1AL” + 1AS”) will produce F1 plants with 13”+t1t” if the chromosome substituted is incorrect and 13”+1’+t’+t’ if the substituted chromosome is correct

Langdon 1D(1A) X Langdon dDt (15” or 13”+ts”+tL”)

13”+t1t”

13”+1’+ts’+tL’

Indicates correct substitution

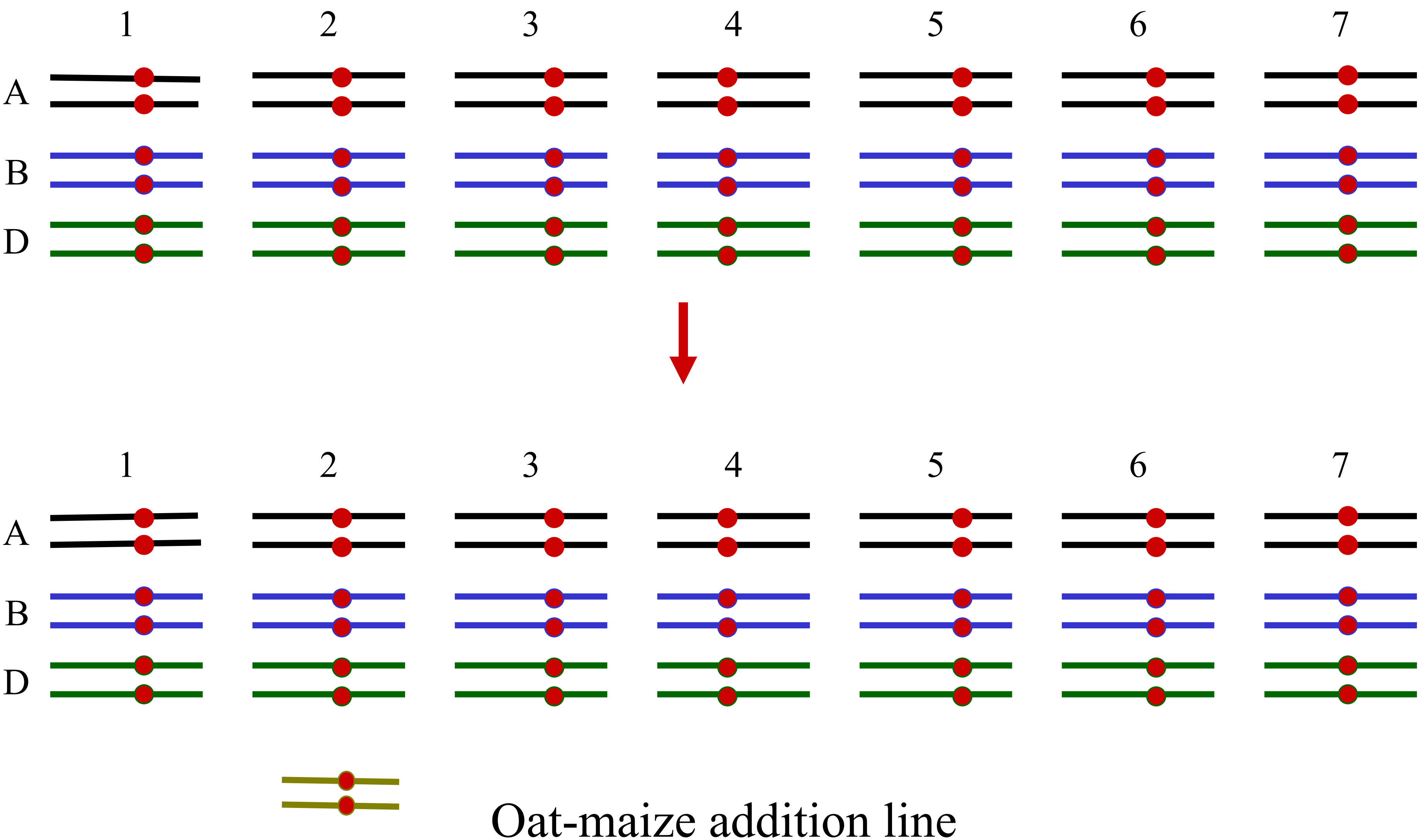
Alien chromosome addition lines

Riera-Lizarazu et al. 1996, oat x maize alien chromosome addition lines TAG 93:123-135

- ✓ In cereals, interspecific and intergeneric hybridizations which yield karyotypically stable hybrid plants have been used to widen the genetic base
- ✓ Uniparental genome elimination in karyotypically unstable hybrids has been utilized for cereal haploid production
- ✓ Maize has been used as a pollen source to recover wheat and oat haploids
- ✓ Crosse of oat with maize produce mostly haploid plants (58%) except for some (31%) which are stable partial hybrids

Alien chromosome addition lines

Riera-Lizarazu et al. 1996, oat x maize alien chromosome addition lines TAG 93:123-135



Alien chromosome addition lines

Chrosmosome constitution of plants recovered from oat x maize crosses based on root-tip chromosome preparations

Crossing set	# Plants analyzed	Distribution of plants according to root-tip chromosome content (2n)					% Plants with maize chromatin
		21	21+1	21+2	21+3	21+4	
1	16	13*	1		2		25%
2	10	8*		1		1	60%
3	4	3		1			25%
4	13	6	6	1			54%
5	11	5*	2	2		2	72%
6	11	8*	2	1			36%
7	25	17	5	2		1	32%
Total	90	60	16	8	2	4	

* Some individuals were found to have an oat-maize chromosome translocation

Alien chromosome addition lines

Fertility and flowering of oat haploids with and without retained maize chromosomes

Chromosome content	# Plants analyzed	Sterile plants	Senesced before flowering	Partially fertile plants
2n=21	60*	10	3	47
2n=21+1	16*	3	3	10
2n=21+2	8	2	3	3
2n=21+3	2	0	2	0
2n=21+4	4	0	4	0
Total	90	15	15	60

* Some individuals were found to have an oat-maize chromosome translocation

Alien chromosome addition lines

Riera-Lizarazu et al. 1996, oat x maize alien chromosome addition lines TAG 93:123-135

- ✓ Crosse of oat with maize produce mostly haploid plants (58%) except for some (31%) which are stable partial hybrids
- ✓ Partial hybrids were found to contain between 1 to 4 maize chromosomes in addition to a haploid set of oat chromosomes
- ✓ DNA analysis indicated maize chromosomes 2, 3, 4, 5, 6, 7, 8, and 9 to be present in the partial hybrids
- ✓ Upon selfing, partial hybrids with one or two maize chromosomes showed nearly complete transmission of the maize chromosome to give self-fertile maize-chromosome-addition oat plants

The deletion stocks of common wheat

Endo & Gill