

Luxi YAN^{1,2}, Isabelle NADAUD¹, Floriane CHERON¹, Dengcai LIU² and Pierre SOURDILLE¹

¹ UMR INRA / UCA 1095 Unité GDEC, 5 chemin de beaulieu 63000 Clermont-Ferrand, France

² Triticeae Research Institute, Sichuan Agricultural University 611130 Chengdu, Sichuan, China

Introduction

To meet human needs by 2050, bread wheat (*Triticum aestivum* L.; $2n = 6X = 42$) production needs to be significantly improved but considering the context of a sustainable agriculture. One effective approach is to better utilize the extensive but underexploited genetic resources in cereals. Disease resistance genes from wild species have been introduced into wheat, such as the rust-resistance locus *Lr37/Yr17/Sr38* (2A/2N translocation) [1] and the eyespot resistance gene *Pch1* (7D/7Dv translocation) [2] from *Aegilops ventricosa* (DvDvNN). However, the meiotic effects of these alien segments in inter-varietal hybrids remain poorly understood. The objective of this study is to evaluate the pairing behaviour in wheat hybrids in presence of introgressed fragment 2N by cytogenetic Oligo-FISH approach.

1. How takes place the meiosis on hybrid ?

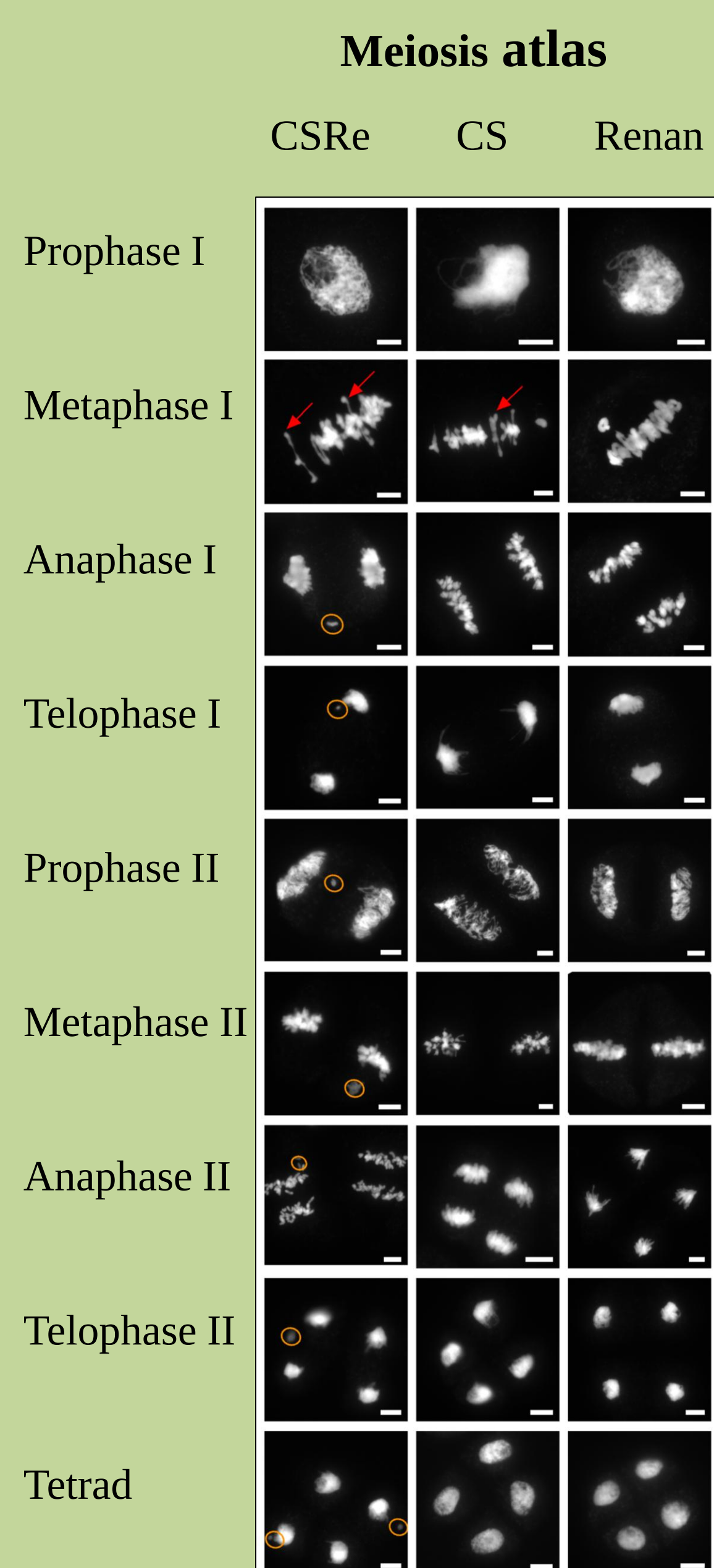


Fig 1. Meiosis progression in CSRe hybrid and parents. Scale: 10 μ m

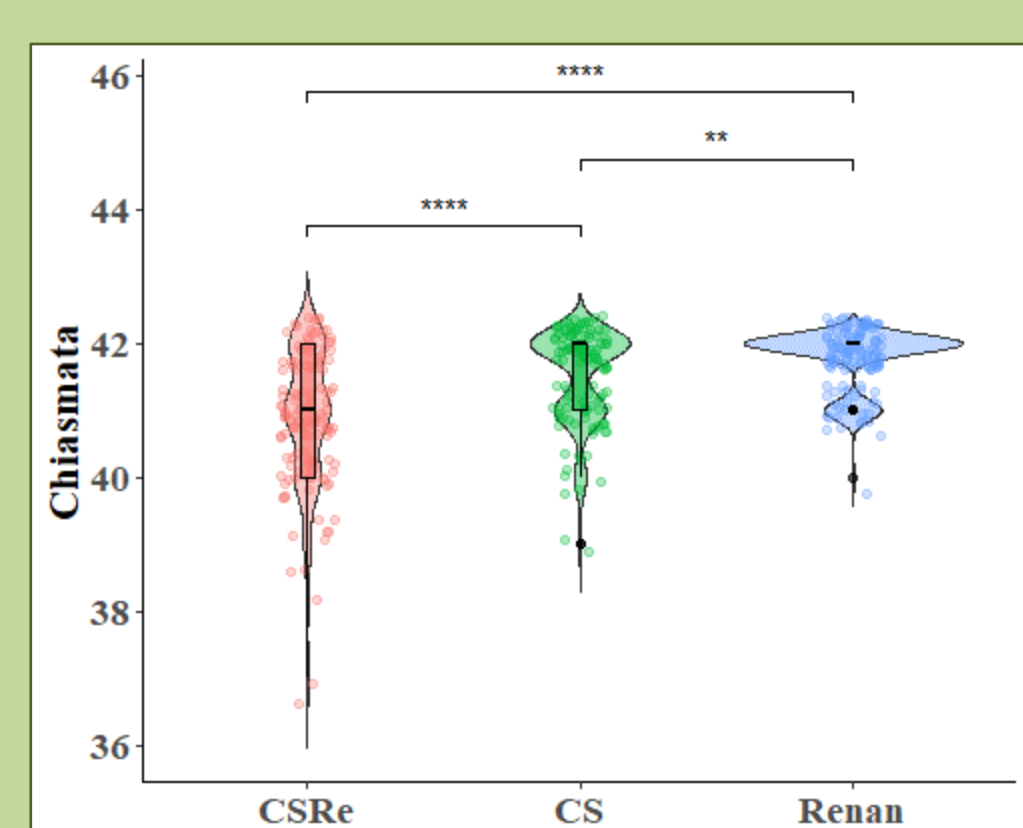
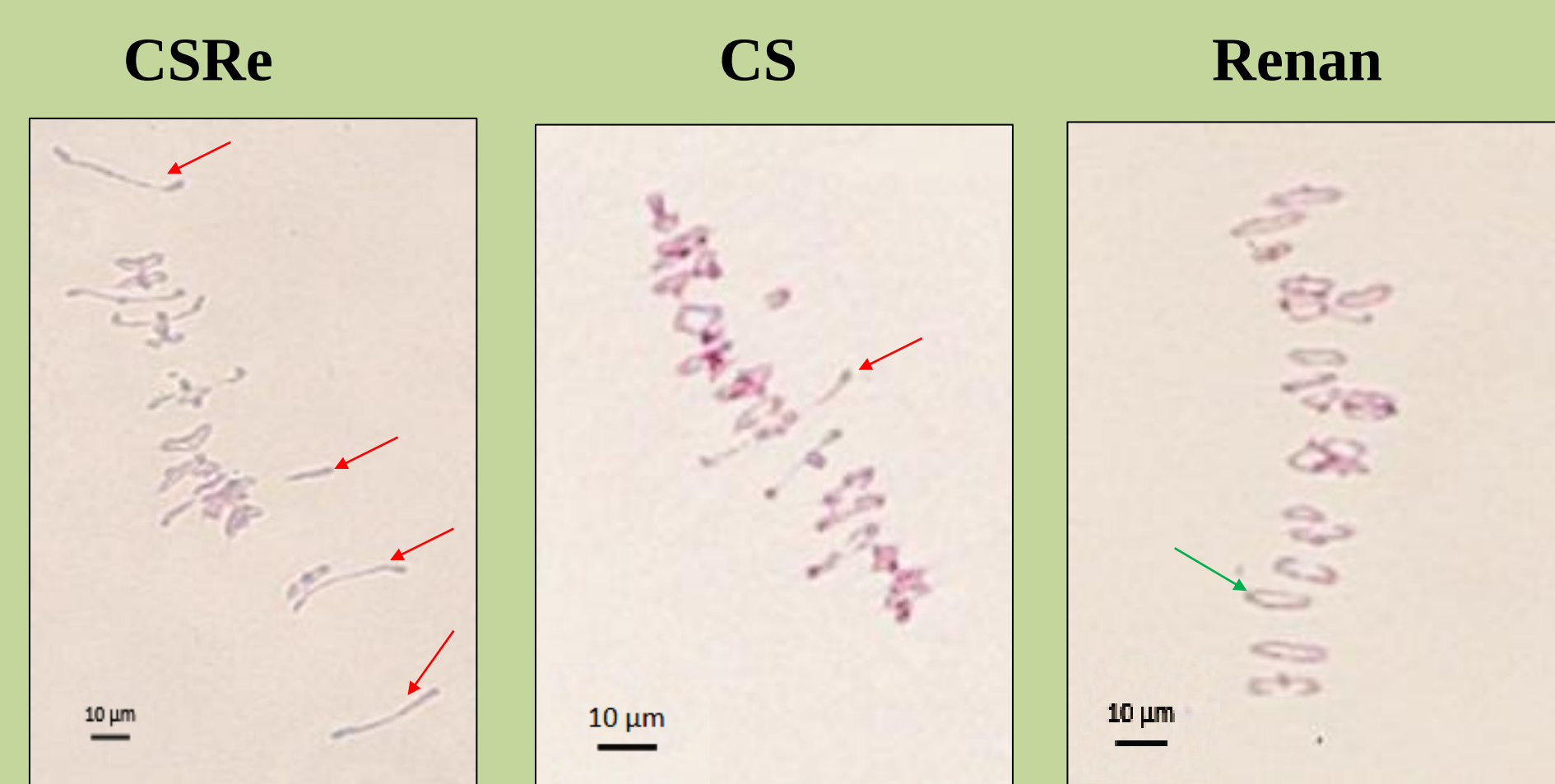


Fig 2. Kruskal-Wallis test was applied to compare the number of chiasmata in CSRe hybrid vs. parents. **: p-value < 0.01; **** p-value < 0.0001

2. What type of pairing occurs in the hybrid vs. the parents?



Genotype	Nb of cells	chiasmata	Univalents	Rod Bivalents	Ring Bivalents
CS x Renan	131	40.87 ± 1.04	0.09 ± 0.42	1.03 ± 0.94	19.92 ± 0.97
CS	119	41.48 ± 0.71	0.00	0.51 ± 0.71	20.48 ± 0.71
Renan	131	41.77 ± 0.43	0.00	0.22 ± 0.43	20.77 ± 0.43

Fig 3. Chromosome configurations at metaphase I in CSRe hybrid and parents.

→ rod bivalent; → ring bivalent

Table 1: Mean of chiasmata and bivalents number (uni, rod and ring) by cell.

3. Does the introgressed fragment in the hybrid favor a type of chromosomal pairing?

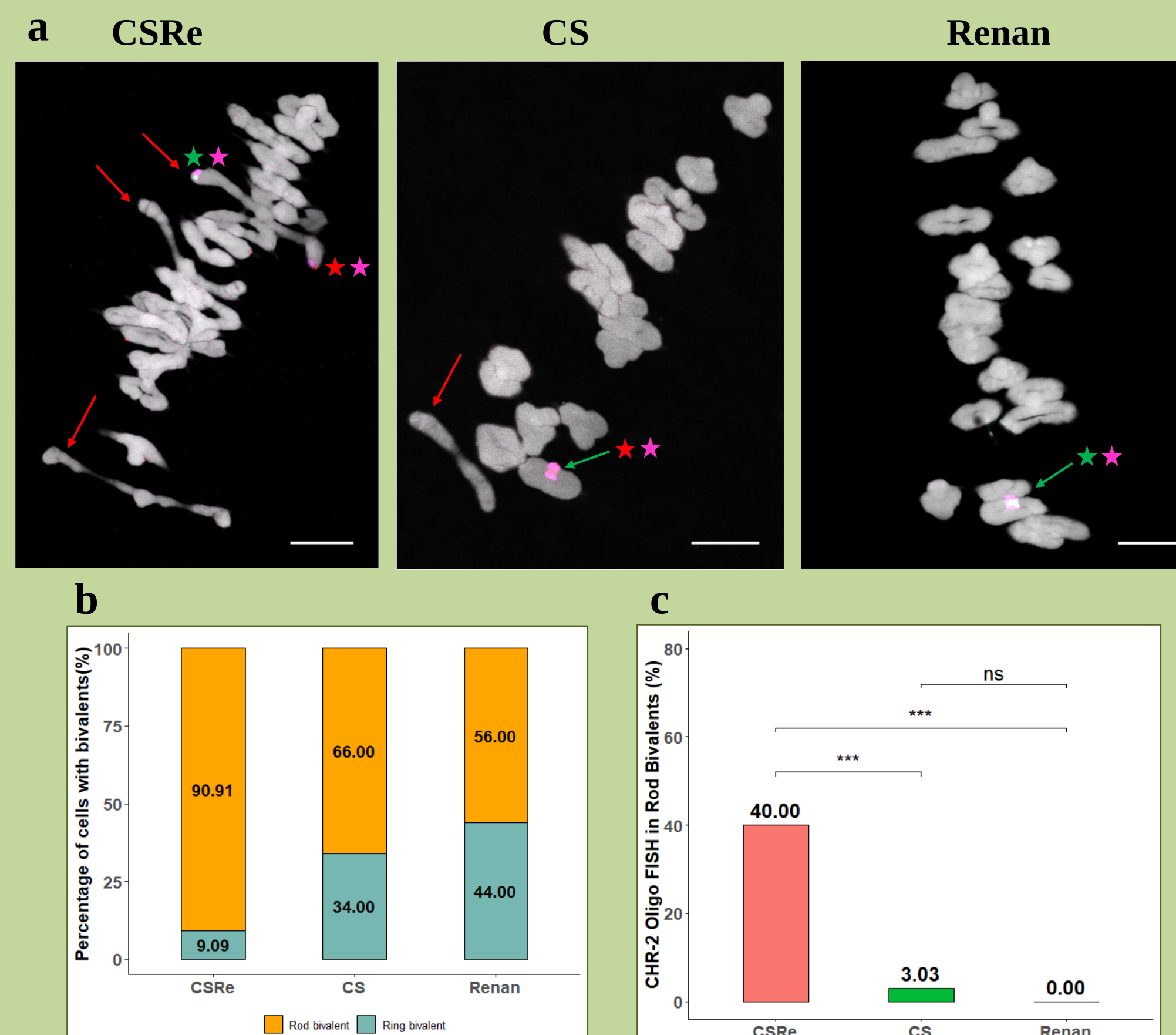


Fig 4. a. Oligo-FISH signals at metaphase I in CSRe hybrid vs. parents: 2A ★; 2N ★; 2C ★. Scale: 10 μ m
b. Percentage of cells having rod and ring bivalents
c. Percentage of cells with 2A, 2N, 2C signals among rod bivalents. Fisher test was performed with significance levels between hybrid vs parents: *** p-value < 0.001; ns: non significant

Material and methods

Material: Chinese spring (CS), Renan (Re) harboring the 2 introgressions of *Ae. ventricosa* on 2N and 7Dv and hybrid CS X Re.

Plants were grown in greenhouse standard conditions (photoperiod 16H/8H day/night, T° 17-22°C). Anthers in metaphase I were collected according to F. Benyahya et al 2020 [3].

Chrom 2 Oligo-FISH probes of 45 nucleotids on 34 Mb were designed and labeled by Arbor Biosciences (USA)

2A-ATTO550 specific of CS

2N-Alexa 488 specific on 2N

2C-ATTO647N common to CS and Re

The images were acquired on LSM 800 confocal microscope.

Results

Cytogenetic analyses revealed chromosomal fragmentation at telophase I to tetrad in CSRe hybrids, indicating disrupted meiotic progression (Fig 1). The number of chiasmata for CSRe varies from 37 to 42 and is significantly different from the two parents (Fig 2) due to the occasional presence of univalents in some cells (0.09 ± 0.94) and a high number of bivalent rods. The mean of rod bivalents was 1.03 ± 0.94 (Table 1).

91% of cells contained rod bivalents (Fig.3, Fig. 4b). The frequency of rod bivalents is 2 to 5 times higher in the hybrid compared to CS and Renan, respectively (Fig.3, Fig.4a, Fig.4b, Table 1).

Chr2-oligo-FISH 2A/2N/2C probes were detected on 40 % of the rod bivalents (12 cells on 30), 3.03% on CS and none on Renan. Fisher's test confirmed highly significant differences between CSRe and CS (p-value = 0.00034) and Renan (p value = 0.00013) (Fig. 4c).

Finally, we observed that the CSRe hybrid population showed a marked reduction in chromosome pairing stability and a significant increase in unpaired events compared to parents leading to a smaller number of chiasmata.

Conclusion

This preliminary study on meiotic behaviour in heterologous wheat context contributes to a better understanding of the introgression of wild relatives into wheat. Futures research more-in depth will be conducted to develop effective breeding strategies using wild relatives, thus promoting the exploitation of wheat genetic diversity and its improvement potential.

References

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