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Identification of a 1B/1R wheat-rye chromosome translocation

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Summary. The common wheat selection '79-4045' was identified as a wheat-rye 1B/1R chromosome translocation line, by means of C-banding patterns and test cross with 'Chinese Spring' double-ditelosomic line. The translocation chromosome consisted of the long arm of wheat chromosome 1B, including its centromere, and the short arm of rye chromosome 1R or tis portion.

Key words: Wheat/rye – Translocation – C-banding – Double-ditelosomic line

Introduction

In previous publications, many 1B/1R wheat-rye chromosome translocations were identified from the European common wheat cultivars by test crosses with wheat monosomic lines and wheat-rye chromosome addition lines (Zeller 1973; Mettin et al. 1973). With the application of wheat telosomic lines and wheat-alien telosomic addition lines, identification of translocation has become more precise. Using this approach, Zeller and Koller (1981) identified two wheat-rye chromosome translocations 4Aα/7RS and 7BL/4RL, and Zeller and Fuchs (1983) identified a wheat cultivar 'Amigo' as a 1AL/1RS wheat-rye translocation line. However, it is difficult to determine the size of segments involved in the translocation chromosome and to locate the translocation point using these methods.

The introduction of the C-banding technique to wheat and its relatives has made possible the identification of individual chromosomes with unprecedented precision (Endo 1986, Gill 1981; Singh and Röbbelen 1975; Endo and Gill 1984; Linde-Laursen et al. 1986). Another application of C-banding is in locating translocation (Gill and Kimber 1977; Badaev et al. 1985; Lukaszewski and Gustafson 1983; Lapitan et al. 1984; Seal and Bennet 1982; Merker 1982).

However, clearly identifying translocations is often difficult and requires extensive and detailed analysis. The aim of the present study is to make a more precise identification of translocation between wheat and rye chromosomes in the common wheat cultivars or selections of China, by C-banding and by test cross with 'Chinese Spring' double-ditelosomic line.

Materials and methods

The seeds of the common wheat selection '79-4045' and cultivar 'Lovrin 13' were provided by Dr. Y. S. Ma and Dr. Y. C. Dong, Crop Resources Institute, Chinese Academy of Agricultural Sciences. The selection '79-4045' was derived from the cross (Norin 10 × Octoploid triticale)$_{F1}$ × Lovrin 13. Lovrin 13 is a 1B/1R wheat-rye chromosome substitution line (Bluthner and Mettin 1977). The seeds of 'Chinese Spring' and its double-ditelosomic line 1B were provided by Dr. P. D. Chen, Cytogenetics Research Laboratory, Nanjing Agricultural University, China, and the seeds of *Secale cereale* c.v. 'Jingzhou-heimai' by Jingzhou Agricultural Research Institute, Hubei, P.R. China.

The materials were germinated on wet filter paper in a Petri dish at 25°C for about 24 h. Then the sprouting seeds were chilled in a refrigerator at 2°C for 20–30 h. The seeds were subsequently allowed to germinate for 16–19 h in a 25°C incubator. Roots were excised when 1–2 cm long, immersed in ice water for 20–24 h, and fixed in 1:3 acetic acid-ethanol. After fixation for 2–3 days at room temperature, roots were squashed in 45% acetic acid without any staining and the preparations were observed on the phase contrast microscope. Cover-glasses were removed by freezing the slides.

The C-banding technique employed in this study followed the procedure provided by Dr. A.G. Seal (personal communication).

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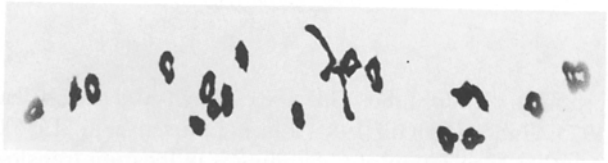

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Figs. 1 and 2. **1** Somatic chromosomes of '79-4045', arrows indicate satellites; **2** metaphase I in PMC's of '79-4045' showing 21 bivalents

Fig. 3. Somatic chromosomes of '79-4045' after C-banding; arrows indicate 1B/1R translocation chromosomes

Results and discussion

Disease resistance and the number of SAT-chromosomes

The authors selected 17 common wheat varieties or selections from all over China, which were thought to have rye chromatin. In the field only one of these, the selection '79-4045', was immune to wheat powdery mildew and highly resistant to all three wheat rusts, 'Lovrin 13', 'Aurora' an triticale, when grown adjacent to susceptible varieties or selections showing 100% infection. Observation of the somatic chromosomes of '79-4045' showed that the selection has only two satellite chromosomes instead of four (Fig. 1). This result indicated that the other two satellit chromosomes of '79-4045' may be substituted by the chromosomes of other species, or their sat-arm may be replaced by the arms from other species. Therefore, translocation or substitution between wheat chromosomes 1B or 6B and the chromosome of other species has probably occurred in '79-4045'. The chromosome pairing in PMCs of '79-4045' usually shows 21 bivalents (Fig. 2) and no multivalents were observed.

C-banding

The C-banding showed that '79-4045' carries a pair of chromosomes with a large, heavy centromeric band and a large terminal band on its long arm, and prominent terminal and subterminal bands on its short arm (Fig. 3). Since wheat, triticale and a 1B/1R substitution line were involved in the pedigree of '79-4045', the authors used C-banding on the chromosomes of the common wheat cultivars 'Chinese Spring' and 'Lovrin 13', and on the rye cultivar 'Jingzhou-heimai'. Detailed analysis of C-banding patterns of 'Chinese Spring', 'Jingzhou-heimai', 'Lovrin 13', and '79-4045' indicated that the centromeric terminal bands on the long arm of the pair of chromosomes in '79-4045' were similar to those of the wheat chromosome 1B. The terminal subterminal bands on its short arm were also similar to those on the short arm of the rye chromosome 1R (Fig. 4a).

From these results, it can be concluded that the pair of chromosomes with an unusual C-banding pattern in '79-4045' is a pair of translocated chromosomes and probably consists of the long arm of 1B, including its centromere, and the short arm of 1R or its portion. By analysing the C-banding patterns of chromosomes 1B, 1R and 1B/1R, the estimated location of the translocation point can also be determined (Fig. 4b). Although 1R also has a satellite on its short arm in rye, its nucleolar organizer is inactive in the wheat genetic background (Badaev et al. 1985), and chromosome 6B expresses the activity of nucleolar organizer in '79-4045'. Therefore, only two satellited chromosomes were observed in '79-4045'.

Furthermore, some translocations can be detected by the presence of relocated, characteristically banded segments or, in the case of introduced alien chromosome segments, by the absence of conspicuously banded regions of the recipient species' chromosomes. However, it remains difficult to recognize translocation precisely using only C-banding, particularly translocations between unbanded segments or segments without differences in bands.

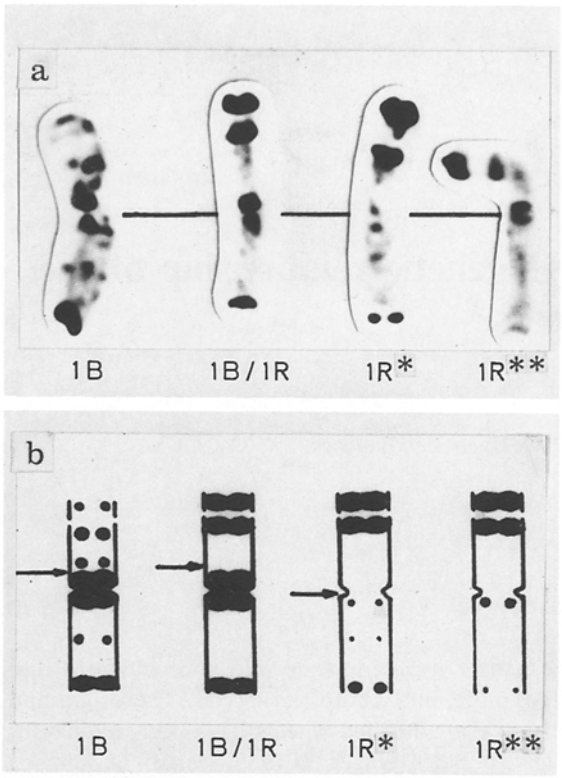

Fig. 4. **a** C-banded chromosomes 1B (from 'Chinese Spring'), 1B/1R (from '79-4045'), 1R* (from *S. cereale* c.v. 'Jingzhouheimai') and 1R** (from 'Lovrin 13'); **b** diagramatic representation of the C-banded chromosomes, arrows indicate estimated location of translocation points

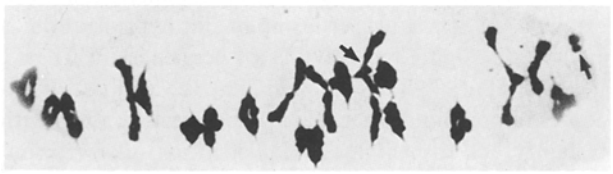

Fig. 5. Metaphase I in PMC's of F1 hybrid between CS double-ditelosomic line 1B and '79-4045'; arrows indicate a heteromorphic bivalent (formed by chromosome 1B and telo-1BL) and a 1BS-telosomic univalent

Test cross with CS double-ditelosomic line

In the hybrid of CS double-ditelosomic line 1B with '79-4045', a heteromorphic bivalent (t1″) and a 1BS-telosomic univalent (t′) were observed in 100% of the cells (109 cells in five plants) (Fig. 5). This result further confirmed the conclusion drawn from the C-banding.

All these results indicated that the common wheat selection '79-4045' is a wheat-rye 1B/1R chromosome translocation line. Furthermore, this study proved that the combination of C-banding with test cross is an effective approach for translocation identification.

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