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Variability in the Morphology of Rye (*Secale cereale*) Chromosomes when placed in Wheat (*Triticum aestivum*) Background

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With 5 Figures

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Introduction

No genetic recombination is known to be possible between wheat and rye chromosomes by using conventional methods. Attempts, therefore, have been made to add or to substitute a pair of rye chromosomes to the wheat complement inorder to incorporate certain useful characteristics from rye into wheat. These addition or substitution lines could be identified either by the altered morphology of the respective plants or by the distinct morphology of the rye chromosome present in a line. Bhattacharyya & Jenkins 1960 studied the karyotype of *Secale cereale* var. 'Dakold' and pointed out that the seven rye chromosomes had distinct morphology. This feature was later used by Dr. B. C. Jenkins **) and his co-workers at The University of Manitoba, Canada, inorder to prepare a set of addition lines and some substitution lines (Bhattacharyya & al. 1961; Evans & Jenkins 1960; Jenkins 1966). During this process, difficulties were encountered in the identification of the rye chromosomes and only four rye chromosomes, namely, I, IV, V and VI (designated after Bhattacharyya & Jenkins 1960) were readily recognized in the presence of the wheat genome. Material pertaining to these four rye chromosomes was used in a study of transmission of rye chromosomes in their respective substitution lines (Gupta 1969a). It was observed that in the background of the wheat genome, the rye chromosomes behaved in a manner different from the wheat chromosomes at meiosis (Gupta 1969b). During these studies it was also

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noticed that the morphology of at least two rye chromosomes, namely, V and VI had undergone changes. It is the purpose of this paper to describe these variations in the chromosome morphology. This work was done by the author as a Commonwealth Scholar during 1964—1967 at the Department of Plant Science, The University of Manitoba, Winnipeg, Canada.

Material and Methods

Four wheat-rye addition lines, namely those for rye chromosomes I, IV, V and VI and seven monosomic lines of the D genome in 'Kharkov' wheat were kindly made available by the Department of Plant Science, The University of Manitoba, Canada. Rye chromosomes were studied at the metaphase of the somatic division. Addition lines as well as material obtained by crossing addition lines with monosomics were used for the study of the morphology of the rye chromosomes.

For somatic preparations, technique outlines by TSUNEWAKI & JENKINS 1960 was followed.

Observations

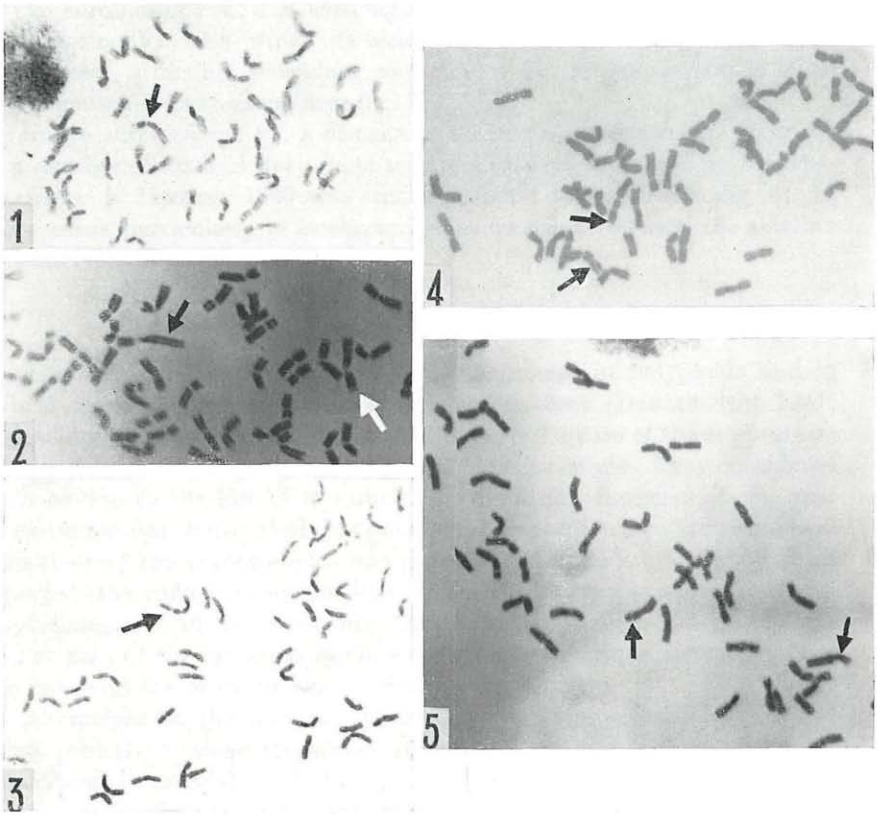
From the history of the material used, the identity of the rye chromosome expected in a somatic preparation was known. When the observed morphology of the rye chromosome was compared with the description given by BHATTACHARYYA & JENKINS 1960, they did not match, particularly in case of rye chromosomes V and VI. Since in case of rye chromosome I and IV, there was no change in the morphology, only rye chromosomes V and VI will be dealt here in detail.

Following is the description of the morphology of the rye chromosomes V and VI and is based on the account given by BHATTACHARYYA & JENKINS 1960.

Chromosome V: Long (10.39 μ) with a submedian primary constriction and a secondary constriction in a submedian position in the long arm. Average arm index was 1.50. No satellite was present.

Chromosome VI: Comparatively shorter (9.74 μ) with a submedian primary constriction and a very short satellite on the short arm. The long arm was almost double the length of the short arm. The arm index was 1.82. There was no secondary constriction on the long arm.

Both these chromosomes hat undergone such a variability in their morphology, that it would make their identity doubtful in the absence of the history of that chromosome. Chromosome V in many cases showed a faint satellite (fig. 1) like the one reported by BHATTACHARYYA & JENKINS 1960 for chromosome VI. The secondary constriction also became inconspicuous (fig. 2). In figure 2, two rye chromosomes can be noticed. Both of these rye chromosomes could be traced back to the same rye chromosome V, but differed considerably in their morphology in this cell. In other cells



Figs. 1—3. Metaphase in root tip cells showing variability in the morphology of the rye chromosome V. Fig.1: 42 wheat chromosomes and one rye chromosome (Arrow indicates rye chromosome; notice a faint satellite). Fig. 2: 40 wheat chromosomes and 2 rye chromosomes (Arrows indicate rye chromosomes; notice that there is a difference in the length of the long arm and also that there is a faint satellite with one rye chromosome). Fig. 3: 42 wheat chromosomes and one isochromosome for the long arm of the rye chromosome (Arrow indicates the isochromosome; notice the distinct secondary constriction).

Figs. 4, 5. Metaphase in root tip cells showing variability in the morphology of the rye chromosome VI. Fig. 4: 40 wheat chromosomes and 2 rye chromosomes (Arrows indicate rye chromosomes; notice the presence of a distinct secondary constriction and the absence of a satellite). Fig. 5: 40 wheat chromosomes, one rye chromosome and one isochromosome for the short satellited arm (Rye chromosome and the isochromosome have been arrowed; notice the satellites on both the arms of the isochromosome).

of the same root tip. this difference was not observed. In such an event, where the secondary constriction had disappeared and a satellite appeared in rye chromosome V, this chromosome could be easily confused for rye chromosome VI with which its description then matched. However in many cases, a distinct secondary constriction was present as shown in an isochromosome for the long arm (fig. 3).

In rye chromosome VI, a distinct secondary constriction was observed in a number of cases. A very short terminal satellite described by BHATTACHARYYA & JENKINS 1960 was similarly found to be absent (fig. 4). In other cases, particularly in isochromosomes for the short arm, the satellite was fairly distinct (fig. 5).

Discussion

Alterations in the morphology of chromosomes in polyploids and in hybrid materials are known in a number of cases (DARLINGTON 1941; NAVASHIN 1934). KRISHNAN & DE 1968 described a case of the suppression of the nucleolar organiser in a tetraploid *Phaseolus* species. They considered it to be due to the loss of the nucleolar organising function of one pair of chromosomes. REES 1961 reviewed the literature where structure and behaviour of the chromosomes was genetically controlled. In many cases reported, the change in morphology of chromosomes was associated with the organisation of the nucleolus. Consequently, in such cases, only the loss or gain of the nucleolar organiser was reported. Such, however is not the case with the observations reported in this paper.

Alterations in the morphology of the rye chromosomes V and VII when present in their respective addition lines were also reported by BHATTACHARYYA & al. 1961. In chromosome V, they recorded a change in the arm index from 1.50 to 1.29. In chromosome VII, the secondary constriction became inconspicuous. The changes reported in this paper were different from these observations. In the present study two types of changes were observed. While in chromosome V, where no satellite was originally present, a satellite appeared; in chromosome VI, the existing one disappeared. A similar situation was found to be present with respect to the secondary constriction. The existing secondary constriction disappeared in chromosome V in some cases, but a very distinct secondary constriction appeared in chromosome VI (fig. 4), where none was originally known to be present. It was also an important observation that in a root tip cell, two rye chromosomes which could be traced back to an original single chromosome, differed morphologically. No exact mechanism involved in this phenomenon can be proposed, particularly because such a feature was not common in other cells of the same root tip. In this case and also in cases where altered morphology was a common feature in all the cells of a root tip, such a change should have taken place at the time of chromo-

some replication and must have been influenced by the wheat genome with which the rye chromosomes were associated in these lines.

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Summary

Morphology of 4 different rye chromosomes was studied when these chromosomes were present with wheat genome in wheat-rye addition and substitution lines. Variability was observed in the morphology of two of the four rye chromosomes studied. While in one case (rye chromosome V) a satellite appeared and the secondary constriction in the long arm disappeared, in the other case (rye chromosome VI) reverse situation was found to be present i. e. the satellite disappeared and a secondary constriction appeared in the long arm. Such variability creates difficulty in the proper identification of these rye chromosomes, if previous history of the respective addition and substitution lines was not known. The exact mechanism of such a variability in morphology was not known, but wheat genome was believed to have some influence.

Literature cited

BHATTACHARYYA N. K., EVANS L. E. & JENKINS B. C. 1961. Kartoyype analysis of the individual 'Dakold' fall rye chromosome additions to the 'Kharkov' winter wheat. — The Nucleus 4: 25—38.

— & JENKINS B. C. 1960. Karyotype analysis and chromosome designations for *Secale cereale* L. 'Dakold'. — Can. J. Genet. Cytol. 2: 268—277.

DARLINGTON C. D. 1941. Polyploidy, crossing over and heterochromatin in *Paris*. — Ann. Bot. 5: 203—215.

EVANS L. E. & JENKINS B. C. 1960. Individual *Secale cereale* chromosome additions to *Triticum aestivum* I. The addition of individual 'Dakold' fall rye chromosome to 'Kharkov' winter wheat and their subsequent identification. — Can. J. Genet. Cytol. 2: 205—215.

GUPTA P. K. 1969a. Studies on transmission of rye substitution gametes in common wheat. — Ind. J. Genet. & Pl. Br. 29 (2): 163—172.

— 1969b. Cytology of monosomic rye (*Secale cereale* L.) substitutions in wheat (*Triticum aestivum* L.) with reference to univalent behaviour. — Cytologia 34: 586—592.

JENKINS B. C. 1966. *Secale* additions and substitutions to common wheat. — Proc. 2nd. Int. wheat Genet. Symp., Lund, 1963: 301—321.

KRISHNAN R. & DE D. N. 1968. Suppression of nucleolar organiser in *Phaseolus*. — The nucleus 11 (2): 155—159.

NAVASHIN M. 1934. Chromosome alteration caused by hybridization and their bearing upon certain general genetic problems. — Cytologia 5: 169—203.

REES H. 1961. Genotypic control of chromosome form and behaviour. — Bot. Rev. 27: 288—318.

TSUNEWAKI K. & JENKINS B. C. 1960. A comparative study of various methods of root-tip preparation in screening wheat aneuploids. — Cytologia 25: 373—380.