PECULIARITY OF ORGANIZATION OF CARIOTYPES CERTAIN SPRING TRITICALE FORMS

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Abstract

The cariotyping of chromosomes carried out with the method of Giemsa C-banding for the six lines of spring triticale showed the existence of the forms with various chromosome sets. The studied lines showed the existence of 2B/2D, 2R/2D substitution, translocation T.2RS.2RL/2BL and T:4BS.4BL/6BL:T6BS.6BL/4BL reciprocal translocation and also pericentric inversion in the chromosome 4B. The high polymorphism is found on the base of the pictures of Giemsa C-banding of the forms of triticale with 2RJ2D substitution. The data received can be used in the planning of breeding programs and in the studying evolution process of the cariotype of triticale.

Introduction

Triticale is a synthetic crop with a high potential of increasing yield. It has a high content of protein and irreplaceable amino acids such as lysine and triptofan and as a result is very valuable for food and feeding. In comparison with wheat triticale can give more stable yield on less fertile soils and when there are no conditions for growing wheat (Maksimov, 2004; Grabovets, Krohmal, 2008).

Being synthetical triticale has in its genome chromosomes of both rye and wheat that makes it suitable for studying the process of evolution of cariotypes. Interacting, the chromosomes in the subgenome of triticale are modified and can be replaced by the chromosomes from the other subgenomes and can participate in various chromosome transformations - translocations, deletions, inversions (Gustafson, 1976; Badaeva, 1984; Alkhimova et al., 1999; Divashuk, 2007; Divashuk et al., 2007).

The cariotype of the hexaploid triticale as a rule consists of full complects of chromosomes of A, B and R subgenomes. In some secondary forms of the hexaploid triticale the rye R subgenome is not fully represented and the rye chromosomes may be replaced by the homological chromosomes of wheat subgenome D. Most frequently met is the substitution of the chromosome 2R of the rye subgenome by the chromosome 2D of common wheat. Using the chromosome substitution and translocations aimed at lessening the part of the rye component of the cariotype makes it possible to overcome the drawbacks of spring triticale limiting its industrial use. With the help of translocation was modified the storage proteins of triticale (Lukaszewski, 2000).

The substitutions of the chromosomes of R subgenome by the homeological chromosomes of D subgenome halps to stabilize meiosis and improve the quality the triticale grain (Merker, 1975; Kaltsikes, 1985; Taketa, 1991; Zhi-Jun, Murata 2002). The process of chromosome replacement is not occasional, it takes place under the pressure of selections. Under the different conditions of growing different chromosome composition of base genomes are selected (Dubovets, 2008). The forms whis 2R/2D substitutionin some characteristics - the shortering of ear, the shortened kernel and earlier maturity differ from the non-substituted forms of triticale (Soloviev, Vishnjakova, 1997; Aung et al., 1998; Kurkiev, 2008).

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One of the main methods for identification of rye and wheat chromosomes is Giemsa C - banding. This method helps to identify each chromosome of the cariotype with high reliability (Seal, 1982; Badaeva, 2000; Divashuk, 2007; Dedkova, 2008).

The exploration of the cariotypes of the spring form of triticale is very important for the planning of breeding. The possibilities of the chromosome engineering of triticale are rather wide in synthesizing new cariotype variations. C-method makes it possible to identify the chromosomes of subgenomes of wheat and rye in triticale with high reliability and find big transformation of chromosomes.

Giemsa C-banding has a great practical usage. It helps to identify the chromosomes and to find heterochromatin which influences the development of the endosperm and the quality of grain (Seal, 1982; Kaltsikes, 1985).

Materials and methods

The material of the research served six lines of spring hexaploid triticale from the collection of the Genetics Department of Russian State Agrarian University - Moscow Timiryazev Agricultural Academy. There arc dates about the cariotypes of 2 lines: k-1185 has 2R/2D substitution (Soloviev, 2000) and 131/7 has 2B/2D substitution and translocation T:2RS.2RL-2BL (Divashuk, 2007). The lines Arta 59, Lena 86, Lena 1270 and L 8-4 are created as a result of breeding of spring triticale.

Giemsa C-banding was carried out according to the standard methods worked out in the Institute of Molecular biology named after N.A. Engelhard (Bolsheva et al., 1984). The cariotypes were analyzed under the microscope Leits - Ortoplan. The metaphases plates were examined with the help of immersion objective 100^x Apochromat and digital camera Leica DFC 280. For making cariotype and redaction of photos there were used the programmes Adobe Photoshope 7.0.

Results and discussion

The collection of spring triticale of Genetics Department shows by various methods the existence of specimen with different chromosome variants (Soloviev, 2000; Karlov et al., 2000; Divashuk, Soloviev, 2005; Divashuk, 2007; Divashuk et al., 2007).

The research of the cariotypes of the lines of spring hexaploid triticale with C-method found several chromosome variants. The studying of cariotypes of line к-1185 showed that it was hexaploid 2n=42 (fig. 1). The subgenomes A and B of wheat are represented by the full number of chromosomes. The subgenome of rye is represented only by 6 pairs of chromosomes - 1R, 3R, 4R, 5R, 6R and 7R. The pair of chromosomes of rye 2R is replaced by homeological pair of chromosomes of wheat 2D, that corresponds to the data received earlier about the substitution 2R/2D in the line k-1185 (Soloviev, 2000). It is necessary to notice that the mentioned line is cytogenetically stable, according to the results of analysis of the cariotype. This line has no polymorphism either in the substitution or in the results of Giemsa C - banding.

The line 131/7 is rather polymorphic according to the results of our research of storage proteins. The morphological research of the line under field condition gave the opportunity to select the number of lines. In this research there were 3 relative lines: 131/7-197, 131/7-235, 131/7-263. It was found that the lines under research along with 2B/2D substitution and T2RS.2RL/2BL translocation which were identified earlier in the source line 131/7 (Divashuk, 2007), have polymorphism in the picture of C - banding (fig.2). The main difference was in the existence of some bands in homological chromosomes in different lines. The most polymorphous were the chromosomes 2A, 4A, 5A, 6A, 7A, IB, 3B, 7B, 3R, 4R and 2D. The lines 131/7-235 and 131/7-263 had similar picture of C-banding. We must notice that in the line 131/7-263 the chromosome 7B differed greatly from the homologies of the two sister lines in larger heterochromatinisation and in chromosome 3R there is no telomeres band in long arm. The presence in all researched relative lines of substitution and translocation found in the source specimen is the high of cytogenetic stability. In the same time the polymorphism found in the picture of C - banding in sister lines evidences of the continuation of form making process. It corresponds with many data of the changing the morphology of the chromosomes of wheat and rye in the triticale genome (Gustafson, 1976; Badaeva, 1984; Alkhimova et al., 1999).

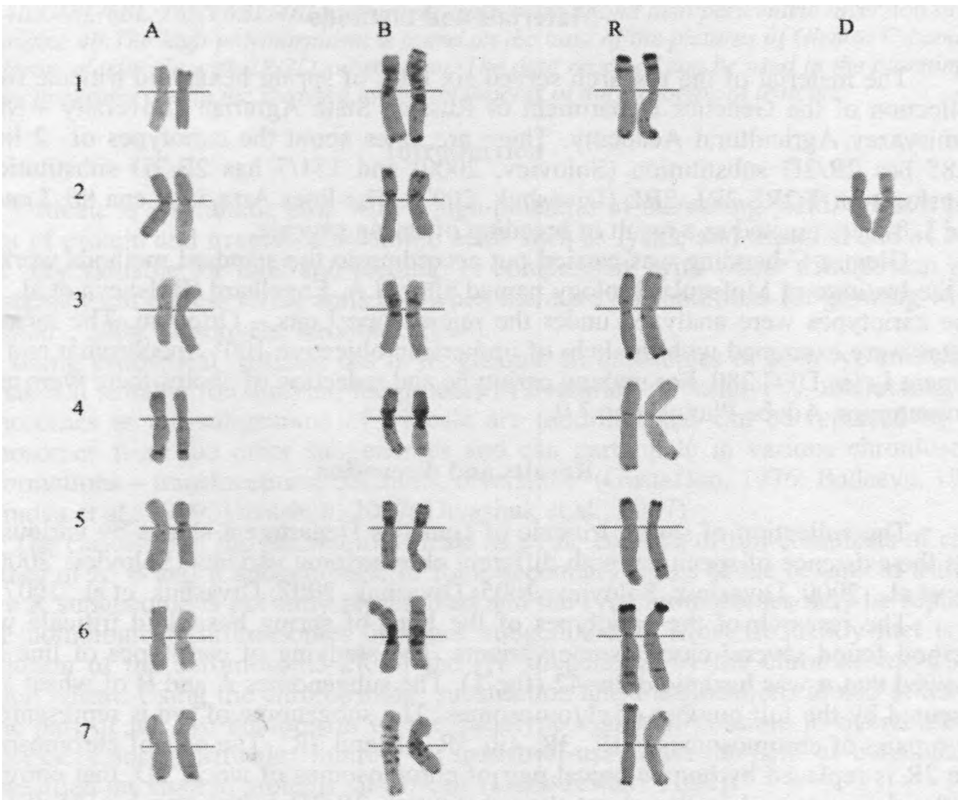

Fig. 1. The cariotype of hexaploid triticale line K-1 185. (Here and further - A, B, R and D the subgenomes of titicale, and numbers 1 - 7 - homeological groups of chromosomes)

The line L 8-4 splits and has plants with various cariotypes - full set forms (AABBRR) and the forms with 2R/2D substitution (fig.3). Nearly all the chromosomes in this specimen are characterized by the high polymorphism of the heterochromatic regions. Polymorphism showed itself not only in the intensity of band coloring but in the variants of their appearance. The most polymorphous were the chromosomes 2A, 4A, 2B,

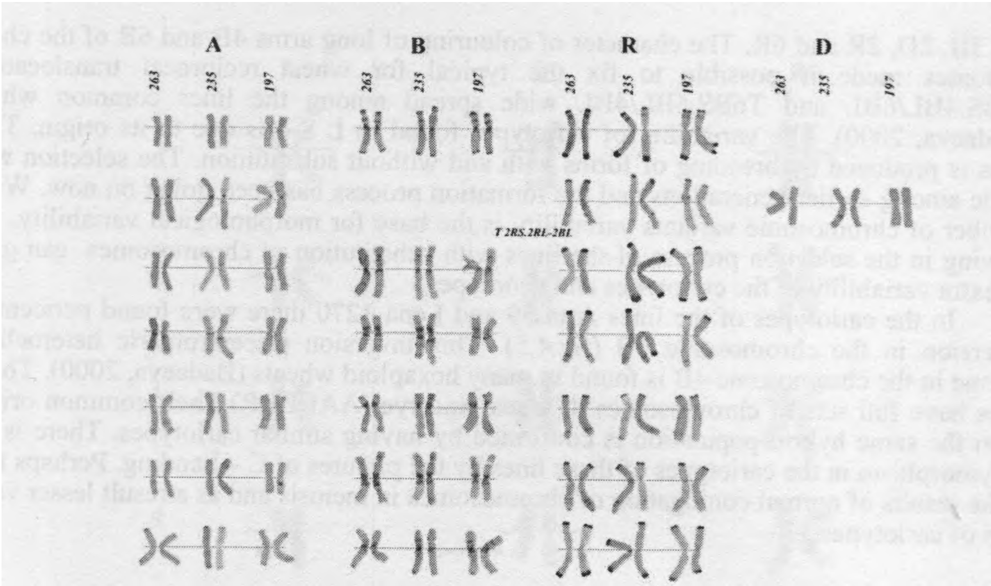

Fig. 2. The cariotypes of hexaploid triticale lines 131/7-263, 131/7-235 и 131/7-197

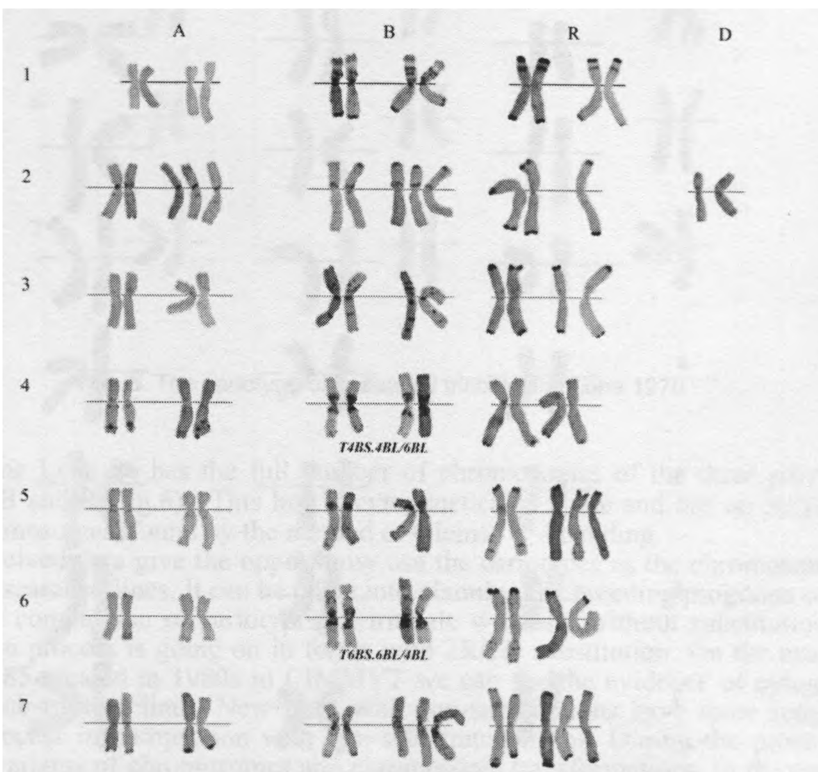

Fig. 3. The cariotype of hexaploid triticale L8-4

3B, 5B, 2D, 2R and 6R. The character of colouring of long arms 4B and 6B of the chromosomes made it possible to fix the typical for wheat reciprocal translocation T4BS.4BL/6BL and T6BS.6BL/4BL wide spread among the lines common wheat (Badaeva, 2000). The variability of cariotypes found in L 8-4 is due to its origin. This lines is produced by breeding of forms with and without substitution. The selection was made among earlier generations and the formation process has been going on now. Wide number of chromosome variants variability is the base for morphological variability. Involving in the selection process of the lines with substitution of chromosomes can give an extra variability of the cariotypes and genotypes.

In the cariotypes of the lines Arta 59 and Lena 1270 there were found pericentric inversion in the chromosome 4B (fig.4,5). This inversion pricentromeric heterochromatine in the chromosome 4B is found in many hexaploid wheats (Badaeva, 2000). These lines have full sets of chromosomes of wheat and rye (AABBRR).Their common origin from the same hybrid population is confirmed by having similar cariotypes. There is no polymorphism in the cariotypes of these lines by the pictures of C - banding. Perhaps this is the results of normal conjugation of chromosomes in meiosis and as a result lesser variants of cariotypes.

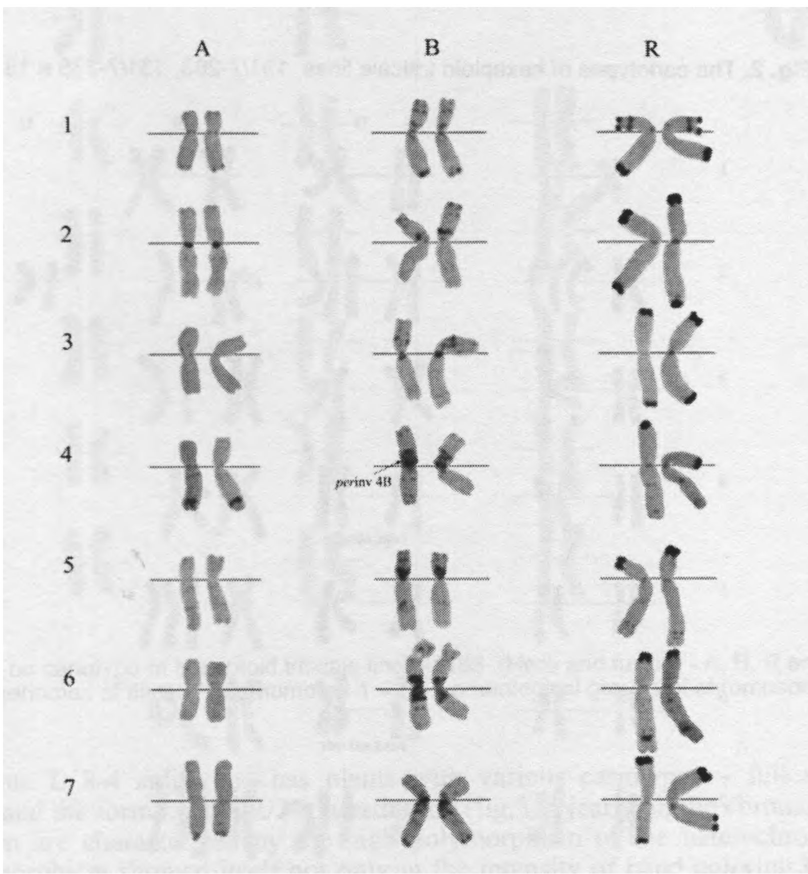

Fig. 4. The cariotype of hexaploid triticale line Arta 59

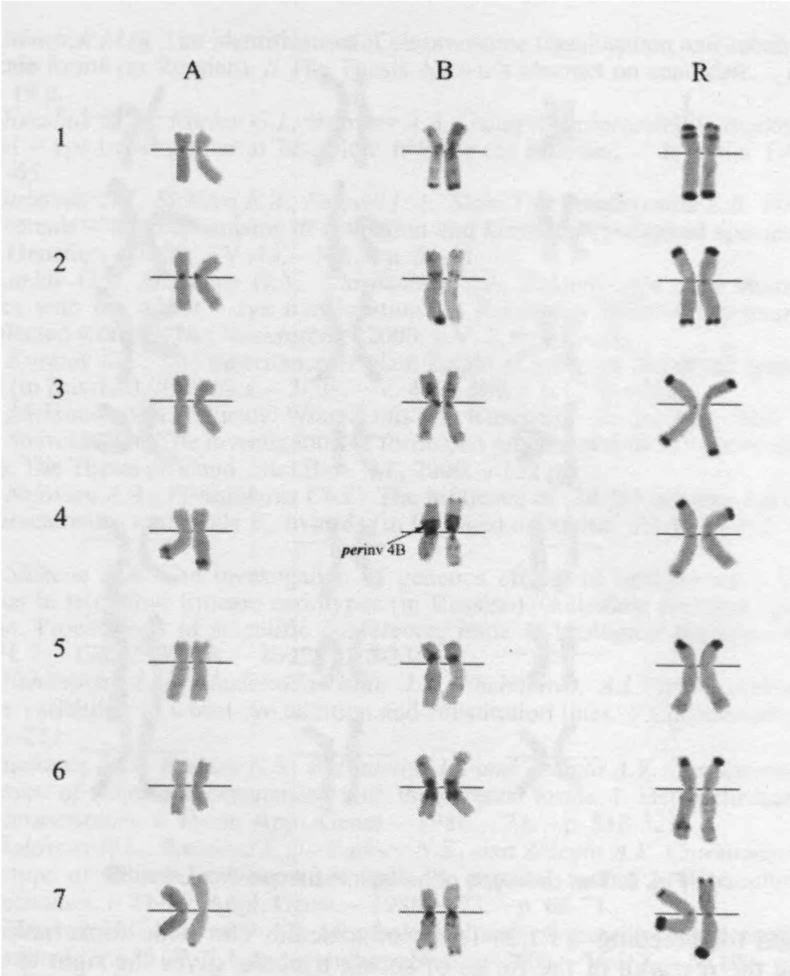

Fig. 5. The cariotype of hexaploid triticale line Lena 1270

The line Lena 86 has the full number of chromosomes of the three parental genomes - A, B and R (fig.6). This line is cytogenetically stable and has no polymorphic locus of chromosomes, found by the method of Giemsa C - banding.

The recived data give the opportunity use the cariotypes as the chromosome passport of the researched lines. It can be taken into planning the breeding programs on spring triticale. The comparison of cariotypes of triticale with and without substitution shows that formation process is going on in forms with 2R/2D substitution. On the example of the line k-1185 created in 1980s in CIMMYT we can see the evidence of cytogenetical stability of substitution lines. New lines with non-substitutions have more long-lasting formation process in comparison with non-substituted forms. During the process there appear new variants of chromosomes and chromosome transformations. In the same time in these lines there were found out some chromosome transformations typical for wheat, that may be the result of their presents in the parental forms

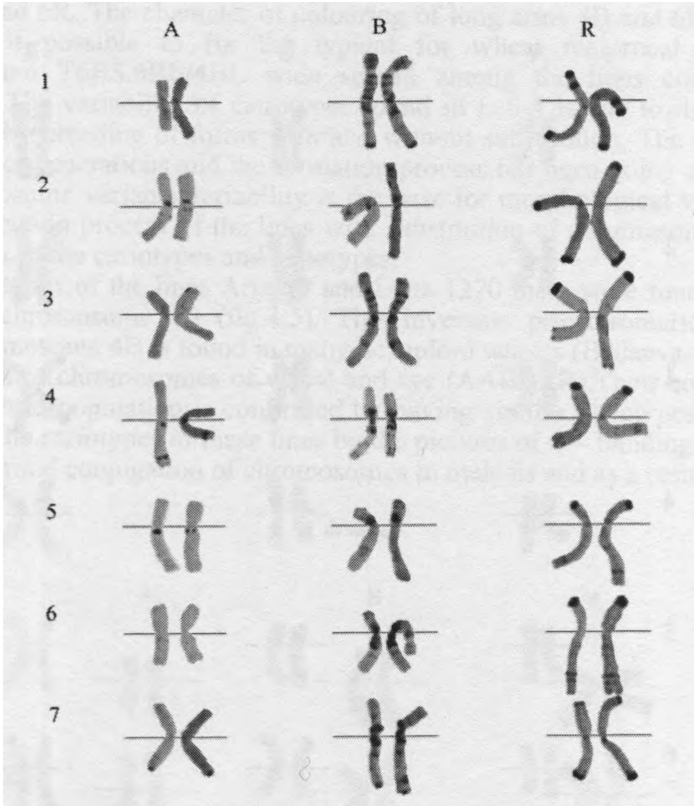

Fig. 6. The cariotype of hexaploid triticale line Lena 86

of wheat used for breeding of that forms of triticale. The wide form making process, found during the research of the forms of spring triticale, gives the right to speak about evolutional development of this first manmade crop and can be used in the experiments with the evolution of the cariotype.

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