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Chromosome Localization of Genes for Soluble Proteins in Hexaploid Wheat (*Triticum aestivum* L.)

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Abstract. An electrophoretic spectra of proteins, extracted with tris–HCl buffer, pH 8.3 are studied. The ditelosomic lines of the Chinese Spring common wheat cultivar are analysed by the chromosomes of the B genome and of the ditelosomic lines of the same cultivar by first and third chromosomes of the D genome. It is found that structural genes for the synthesis of components Nos. 7, 8, 9 and 10 are localized in 1BL, 2BS, 4BS and 5B chromosomes respectively. The genetic control of the component No. 3 is realized by genes, localized in 1BL and 3D chromosomes, while for component No. 2, in the 3D chromosome.

Genetic studies of proteins from *Triticum aestivum* (L.) wheat were carried out with gliadine fractions mainly. It was found that chromosomes of the first and sixth homoeological groups are responsible for the synthesis of the individual gliadin components (Wrigley and Shepherd 1973 ; Kasarda *et al.* 1976 ; Mitrofanova 1976).

Investigations to elucidate the genetic control of nongliadin proteins are rather sparse and have been carried out with aneuploid lines of common wheat, developed by Sears (1954, 1966) for the first time. Among the earliest investigations are the works by Garcia-Olmedo and Carbonero (1970), Noda and Tsunewaki (1972) and Aragoncillo *et al.* (1975) who established that in 4A, 3BS, 6BS, 3D, 4D, 5D and 7D chromosomes genes are localized which are responsible for the synthesis of proteins extracted with a chloroform-methanol mixture, with tris-glycine buffer and non-gliadin proteins from a 70 % ethanol extract of common wheat. Immunochemical investigations confirmed that 3D and 4D chromosomes take part in the control of the proteins studies (Bozzini *et al.*, 1970). The participation in the genetic control of chromosomes 1B, 5B, 6B and 7D has been demonstrated in more recent investigations, using two-dimensional electrophoresis of albumin proteins from nulli-tetrasomic Chinese Spring lines (Fra-Mon *et al.*, 1984).

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The aim of our work was to show the participation of the B and D genome chromosomes in the genetic control of the other except for components of the soluble proteins known from the literature.

MATERIAL AND METHODS

Ditelosome lines of the Chinese Spring (CS) wheat cultivar by the seven chromosomes of the B genome are included in the present investigation: 1BL, 1BS, 2BL, 2BS, 3BL, 3BS, 4BL, 4BS, 5BL, 5BS, 6BL, 6BS, 7BL and 7BS. Likewise, the ditelosomic lines (Dt) by 1D and 3D chromosomes are studied (1DL, 1DS, 3DL and 3DS), also Chinese Spring where the 3D chromosome is substituted by 3A and the euploid. The wheat cultivars Thatcher (ABD) and its tetracomponent Tetra-Thatcher (AB) in which the D genome is lacking are included in the paper and the Tseveryana durum wheat cultivar (AB) and *Triticum monococcum* (A) as well. The arm quoted was available in each ditelosomic line, while the other arm was lacking.

Seeds (200 mg) were crushed and extracted with 1,5 ml 0,2 M Tris–HCl buffer (pH 8,3). The homogenate was centrifuged at about 10 000 g for 10 min after which the supernatant was placed into the upper part of the gel. The protein subunits were fractionated in vertical slab gels (180 × 140 × 2,7 mm) by the method of Peacock *et al.* (1965). Tris-EDTA boric acid buffer (pH 8,3) was used as electrode buffer. the electrophoretic separation was carried out at 180 mA for 6 h. Staining of the proteins after electrophoresis was carried out with 0,15 % amido black solution in 7 % acetic acid.

RESULTS AND DISCUSSIONS

Fig. 1 shows the electrophoretic spectra of Chinese Spring ditelosomic line proteins by chromosomes of the B genome – from 1B to 5B inclusive. Qualitative differences between the spectra of the euploid and the ditelosomic line with respect

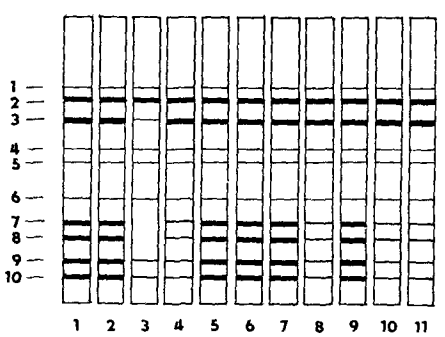

Fig. 1. Schemes of electrophoretic spectra of proteins of the Chinese Spring (CS) wheat cultivar and of the ditelosomic lines of the same cultivar by the chromosomes of the B subgenome. 1 – CS; 2 – CS Dt1BL; 3 – CS Dt1BS; 4 – CS Dt2BL; 5 – CS Dt2BS; 6 – CS Dt3BL; 7 – CS Dt3BS; 8 – CS Dt4BL; 9 – CS Dt4BS; 10 – CS Dt5BL; 11 – CS Dt5BS In vertical columns: 1–10 – protein components.

to the 1BS chromosome are found, expressed in the absence of a pair of components Nos. 7 and 8 of the line spectrum (Fig. 1 – column No. 3). Therefore, structural genes for the synthesis of these components are localized in the L-arm of chromosome 1B. Quantitative differences are also found which are related to the decrease in the intensity of components Nos. 3,9 and 10 in the spectra of CS Dt1BS in comparison with their homologous components in the euploid spectra. The decrease in the intensity of components Nos. 7, 8, 9 and 10, is likewise found in the lines CS Dt2BL, CS Dt4BL, CS Dt5BL, CS Dt5BS (Fig. 1 – columns Nos. 4, 8, 10, 11). This fact indicates that in the S-arms of chromosomes 2B and 4B and of chromosome 5B genetic factors are localized, related to the synthesis of the corresponding components. No effect is found in the ditelosomic status of 6B and 7B chromosomes of Chinese Spring on their protein electrophoretic spectra.

Noda and Tsunewaki (1972) found effects by 1B, 2B and 4B chromosomes on electrophoregrams of proteins, extracted with a tris-glycine buffer. However, according to the authors, the effect of chromosome 1B is related only to a decrease in the intensity of the faster of the pair of protein components, corresponding to component No. 8 in the present investigation. Our results indicate that in 1BL chromosome structural genes are located not only for the synthesis of the component No. 7, but for the synthesis of the components No. 8 and No. 3 as well. The effect of 2B and 4B chromosomes on the protein spectra according to Noda and Tsunewaki (1972) proved to be similar, a diffusion of the individual components being observed in certain cases.

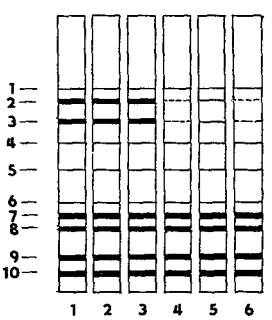

Fig. 2. Schemes of electrophoretic spectra of proteins of the Chinese Spring wheat cultivar, of ditelosomic lines of the same cultivar by the first and third chromosomes of the D subgenome and of Chinese Spring – 3D–3A: 1 – CS; 2 – CS Dt1DL; 3 – CS Dt1DS; 4 – CS Dt3DL; 5 – CS Dt3DS; 6 – CS 3D–3A. In vertical columns: 1–10 – protein components.

Upon examining the effect of the ditelosomic state of 1D and 3D chromosomes of Chinese Spring on the genetic control of the proteins studied it was found that the genes for the synthesis of components 2 and 3 are localized in the 3D chromosome. Grounds for a conclusion of this kind are provided by the decrease in the intensity of these components in both ditelosomic lines as compared with Chinese Spring (Fig. 2,

columns Nos. 4 and 5). No effect of the ditelosomic state of the 1D chromosome on the protein spectra is established. The importance of chromosome 3D on the genetic control of components Nos. 2 and 3 is found also when investigating Chinese Spring in which chromosome 3D is replaced by 3A (Fig. 2, column No. 6). The two components are less pronouncedly expressed in comparison with the euploid which indicates that chromosomes of the other subgenoms are also responsible for their synthesis to a certain extent (participation in the genetic control of component No. 3 has been found in CS Dt1BS).

Additional confirmation of the participation of chromosome 3D in the control of components Nos. 2 and 3 is the spectrum of the Tetra-Thatcher in comparison with the spectra of the Thatcher, Chinese Spring and Tseveryana cultivars (Fig. 3). no qualitative and quantitative differences between the spectra of the Chinese Spring and Thatcher cultivars are established in the zones of components Nos. 2 and 3, while in the case of Tetra-Thatcher a slight manifestation of a component is observed in the same zone which, according to mobility, corresponds to component No. 3 in the spectra of hexaploid wheats (Fig. 3, columns Nos. 2, 3 and 4). A component homologous to the above mentioned one is found also in the spectra of *T. monococcum* (Fig. 3, column No. 5) which shows that chromosomes of the A genome are also related to its control. From the results obtained the conclusion can be drawn that component No. 3 in the spectra of Chinese Spring is found under the control of chromosomes 1BL and 3D, and in all probability, likewise under the control of chromosomes of the A genome (in this case the diversity in the quality of the A genomes in both species should be taken into consideration).

Our findings in relation to the participation of chromosome 3D in the genetic control of components Nos. 2 and 3 is in agreement with the studies of other authors (Noda and Tsunewaki 1972; Fra-Mon *et al.* 1984).

Component No. 4 which is well expressed in the spectrum of the Tseveryana durum wheat cultivar, but has a weaker intensity in the Tetra-Thatcher one, is

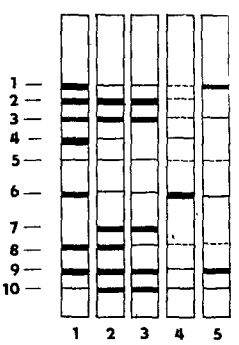

Fig. 3. Schemes of electrophoretic spectra of proteins of: 1 – Tseveryana durum wheat cultivar; 2 – Chinese Spring; 3 – Thatcher; 4 – Tetra-Thatcher; 5 – *T. monococcum*. In vertical columns: 1–10– protein components.

lacking in the spectra of hexaploid wheat. This can be explained by the action of genes modificators of the D genome which repressed the synthesis of this component. Component No. 9, well represented in the spectra of the wheat cultivars studied has a weak intensity in the Tetra-Thatcher spectra. This is probably also the result of gene modificators or structural genes, related to the D genome.

In conclusion, when studying the electrophoretic spectra of proteins in the Chinese Spring ditelosomic lines by the chromosomes of the B genome and of the ditelosomic lines of the same cultivar by the first and third chromosomes of the D genome it is found that the structural genes of component No. 3 are localized in chromosomes 1BL and 3D, while in the case of component No. 2, they are in the 3D chromosome. Components Nos. 7 and 8 are controlled by genes in the 1BL, 2BS, 4BS and 5B chromosomes. The absence of these components from the spectra of the CS Dt1BS line shows that genes for its synthesis are localized mainly inthe L-arm of that chromosome. The participation of the 2BS, 4BS and 5B chromosomes in the genetic control of components Nos. 9 and 10 is also shown.

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