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Euploid and monosomic interspecific *T. aestivum* x *T. durum* hybrids-production and cytogenetic characteristics

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SUMMARY – Euploid and monosomic F_1 hybrids for chromosomes of the 3rd and 5th homoeologic group of bread wheat cultivars Chinese Spring, Bezostaya and Mara with durum wheat cv. 788, were produced. The influence of the genotype and of the gene complexes of the above mentioned chromosomes on the chromosome pairing, as well as on the morphologic and biologic peculiarities of the hybrids was established. It was found that durum wheat possessed genetic systems similar in their effect and direction of action to those of bread wheat with considerable possibilities of reciprocal compensation in their hybrids. The hybrids obtained (and mainly those of cv. Bezostaya) with durum wheat can be used for the breeding needs of common and durum wheats.

Key words: Euploid, monosomic hybrids, homoeologous chromosomes, chromosome pairing.

RESUME* – *"Production d'hybrides interspécifiques euploïdes et monosomiques T. aestivum - T. durum ***et caractéristiques cytogénétiques".*** *Des hybrides F_1 entre les variétés Chinese Spring, Bezostaya et Mara de* T. aestivum *et la variété 788 de* T. durum *ont été obtenus. Les hybrides F_1 ont été euploïdes et monosomiques pour les chromosomes des troisième et cinquième groupes homéologiques. L'influence du génotype et des complexes géniques de ces chromosomes sur l'appariement des chromosomes et sur des caractéristiques morphologiques des hybrides a été établie. Il a aussi été établi que* T. durum *possède des systèmes géniques dont l'effet ressemble à ceux de* T. aestivum, *ce qui rend possible la compensation réciproque dans leurs hybrides. Les hybrides obtenus et surtout ceux de Bozostaya avec* T. durum *peuvent être utilisés dans l'amélioration génétique du blé dur et du blé tendre.*

Mots-clés : *Euploïde, hybrides monosomiques, chromosomes homéologiques, appariement des chromosomes.*

Introduction

The genetic systems controlling the meiotic chromosome pairing in bread wheat are subject to extensive research by many authors. Yet, still rather obscure are a number of questions related to the effectiveness of these systems in the individual cultivars of bread wheat and their manifestation in the hybrids of bread wheat with the other species and genera of Triticinae characterized by a different degree of relationship with it.

The purpose of this study was to establish the effectiveness of action of the gene complexes of the chromosomes of the 5th and 3rd homeologic groups of bread wheat on the chromosome pairing in its interspecific hybrids with durum wheat. At the same time the specific influence of these chromosomes on the crossability and major morphological and biologic peculiarities of the F_1 hybrids was investigated.

Materials and methods

To solve the set task the euploid and monosomic lines of chromosomes of the 5th and 3rd homeologic groups of the cultivars Chinese Spring, Bezostaya and Mara from bread wheat (AABBDD, 2n = 42) were included in hybridization with the tetraploid durum wheat cultivar 788 (AABB, 2n = 28). Hybridization was preceded by cytological control of the euploid states of the respective lines of the three cultivars of bread wheat. The investigations of the cytological and morphological peculiarities of the obtained F_1 interspecific hybrids followed the cytological control of all germinated hybrid seeds as to separate the monosomic from the euploid plants. The cytological investigations performed to establish the effectiveness of action of the studied genetic systems on the chromosome pairing included the meiotic behaviour of the chromosomes in the relevant monosomic and euploid hybrids in *Metafase I (MI)*, the number and character of the bivalent and multivalent associations and the percentage of paired chromosomes which were used as criteria for the effectiveness of action of the separate genetic systems.

Results and discussion

The results showed that in the euploid lines the crosses of the cultivars Mara (26.55%) and Chinese Spring (20.90%) were characterized by the highest crossability and viability of the hybrid seeds, while these were the lowest in the cultivar Bezostaya (12.83%). The monosomic state of the individual chromosomes of the 5th and 3rd homeologic groups had definite influence on the number and percentage of the produced and viable hybrid seeds. The absence of one or another chromosome in the most cases was accompanied by the reduction both of the number and percentage of the obtained hybrid seeds and their viability. The absence of the same chromosome in the crosses of the different cultivars did not manifest in the same manner. The observed genotypic differences as to the effect of the absence of a given chromosome were the manifestation of the influence of the biologic peculiarities of individual cultivars.

The results from the cytological investigations showed that there were no essential differences in the degree of chromosome pairing between the euploid hybrids of the three cultivars with durum wheat (Table 1). All chromosomes of durum wheat were included in various associations with the chromosomes of bread wheat. The main part was that of the bivalents which in their character were mostly of the ring type. These results showed the high degree of similarity between the identical genomes of bread wheat and durum wheat. The absence of *5B* and *3D* chromosomes did not cause any substantial change neither in the percentage of paired chromosomes nor in the average number and character of bivalents. It showed that the genetic systems in these species were similar in their origin and effectiveness of action and could compensate mutually. In the monosomic hybrids by *3D* chromosome the doubled dose of *5B* system originating from the two parent forms had probable influence and it did not allow for the absence of the *3D* system to be felt more significantly.

The chromosome *3A* showed certain activity on the chromosome pairing in the hybrids of Bezostaya and Mara and insignificant activity in the hybrids of Chinese Spring. The explanation of this fact can be sought, on one hand, in the presence of similar systems in the homeologic chromosomes of durum wheat and, on the other hand, in the interaction between the genetic systems with opposite action. More considerable reduction of the degree of chromosome pairing caused the absence of *5A* chromosome and up to a certain extent that of *5D* chromosome. According to Feldman (1966) compared to *5A* chromosome *5D* chromosome had a stronger effect on the chromosome pairing in bread wheat. The results obtained by us can be explained by the opinion expressed by Riley (1974) that the genetic activity of *5D* chromosome of Chinese Spring was directed mainly to the behaviour of the chromosomes of the *D* genome which in these hybrids had no analogue as well as that the activity of *5D* chromosome was manifested at a temperature lower than 15ºC. In the monosomic hybrids by *5D* chromosome there was no *D* genome and thus the function of *5D* chromosome in relation to the temperature reaction was undertaken partly by *5A* chromosome originating from the tetraploid species in which the gene L_{tp} was dominant (Baylis and Riley, 1972).

The absence of the different chromosomes of the 5th and 3rd homeologic chromosomes in the monosomic hybrids had a considerable effect also on the main morphological signs of the leaves, stems and ears. The value of the most quantitative parameters was lowered. The absence of the same chromosome in hybrid plants of various cultivars had different influence. It applies mainly to the quantitative signs which is due to their complex hereditary basis. The biologic peculiarities of the mother form had definite influence on the stem length in hybrids of the three cultivars. Lowest were the hybrids of the cultivar Mara followed by those of Bezostaya, while those of the hybrids of Chinese Spring were the highest. Essential differences were observed in the way of inheritance of the separate signs determining the structure and morphological peculiarities of the ear. The absence of the separate chromosomes of bread wheat was not always accompanied by phenotypic compensation at the account of the presence of the chromosomes of the other species participating in hybridization. Most substantial was the influence of *5A* and *3D* chromosomes. The absence of *5A* chromosome caused the appearance of a *spelta*-shaped ear at the account of the absence of the suppressor of that sign localized in the missing *5A* chromosome as well as of the inactivity of the gene in a hemizygous state (Sears, 1954; Tahir and Tsunewaki, 1969). The monosomic hybrids by *5A* chromosome of the cultivar Mara were characterized by awned ears which was probably due to a difference in the allele state of the genes for awnedness from those of the cultivar Mara or to the presence of different alleles for awnedness in their genome. The genetic background and the interaction between the separate genomes in the hybrids in result of which they had not always the same manifestation had also definite influence on the specific action of the individual chromosomes determining the morphological signs of the hybrid plants.

The hybrids produced and mainly those of the cultivar Bezostaya with durum wheat can be used for the breeding needs of hard and soft wheats.

Table 1. Number and character of bivalent and polyvalent associations in MI of PMC in euploid and monosomic hybrids of bread wheat with durum wheat

Mother lines	Bivalents			Poly-valents	Univalents		Paired chromosomes per cell (%)	Difference in % of paired chromosomes from euploid
	Average number (M av.)	t	Ring like (M av.)	(Triva-lents)	Average number (M av.)	t		
Ch. Spring	13.47	–	11.40	0.07	7.97	–	77.57	–
Mono 5A	11.67	6.49***	7.04	0.03	10.57	5.13***	68.94	-8.63
Mono 5B	12.58	2.60*	10.38	0.08	8.50	1.03	74.71	-2.86
Mono 5D	12.60	3.73***	9.03	0.03	8.70	1.87	74.41	-3.16
Mono 3A	12.30	4.36***	9.50	0.53	7.60	0.84	77.85	+0.26
Mono 3B	12.00	3.61**	9.33	–	9.47	2.01	70.59	-6.98
Mono 3D	12.93	2.23*	11.13	0.07	8.27	0.69	76.67	-0.90
Bezostaya	13.35	–	11.05	0.18	7.78	–	77.83	–
Mono 5B	12.73	2.57*	11.00	0.17	7.97	0.42	76.38	-1.45
Mono 5D	12.07	4.85***	8.70	0.07	9.77	3.92***	71.62	-6.21
Mono 3A	12.48	3.61***	9.00	0.03	9.02	2.69	73.68	-4.15
Mono 3B	13.40	0.24	10.20	0.27	6.40	3.42**	81.20	+3.37
Mono 3D	13.17	0.72	10.27	0.23	6.97	1.91	79.50	+1.67
Mara	13.57	–	11.40	–	7.33	–	77.54	–
Mono 5A	11.60	4.48***	7.65	–	9.53	3.30	68.24	-9.30
Mono 5B	12.44	7.15***	10.32	0.48	7.62	1.51	77.41	-0.13
Mono 5D	11.93	5.82***	9.67	0.10	9.63	5.50***	71.06	-6.48
Mono 3A	13.93	1.28	11.56	0.17	5.67	3.97***	83.41	+5.67

*,**,***Reliability of difference at $p < 0.05$, $p < 0.01$, $p < 0.001$, respectively.

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