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AN ANALYSIS OF CHROMOSOME PAIRING IN F_1 (WHEAT × RYE) HYBRIDS[1]

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Summary. The chromosome pairing was analysed in F_1 hybrids obtained from the crossing of three hexaploid wheat cultivars — Chinese Spring, Roazon and Rusałka with the rye cv. Petkus and breeding strains L. 136/77, M-8, M 12-0, MOMN/76. The mean number of chiazmata was 1.33 ranging from 0.52 to 2.30 depending on cross combination. The bivalent number was on average 1.27. Besides that, trivalents were sporadically observed (on average, 0.02). It was found that the degree of chromosome pairing in F_1 hybrids depends on both maternal wheat and paternal rye forms.

A possibility of recombination of the genetic material of wheat and rye is of great importance to breeders of these two species as well as to breeders of wheat-rye — *Triticale*. A condition for the exchange of wheat and rye genes is pairing of their chromosomes. According to many authors analysing hybrids with different genome composition, this phenomenon is fairly rare (Nakajima, Zennyozi 1966, Miller, Riley 1972, Mettin et al. 1976, Stefanowska 1977, Pohler, Kistner 1977, Schlegel et al. 1977, Naranjo et al. 1979).

The degree of chromosome pairing observed in F_1 wheat-rye hybrids is different; this concerns both intra- and intergeneric combinations. The reason of differences is probably the influence of the genotype of the maternal wheat form (Nakajima, Zennyozi 1966, Gorbań 1980). A polygenic control system of the paternal rye counterpart, the presense of which was revealed in many studies, is also of great importance for the probability to exchange genetic material (Mettin et al. 1976, Lelley 1978, Dvorak 1977, Lelley, Larter 1980).

The purpose of the present paper was to analyse the degree of chromosome pairing in the cells of various F_1 wheat-rye hybrids and an attempt to display the influence of the maternal and paternal forms on the frequency of chromosome pairing.

MATERIAL AND METHODS

Three wheat varieties (Chinese Spring, Roazon, Rusałka) were crossed with a single rye variety (cv. Petkus). In order to obtain hybrids differing by the paternal component the wheat cv. Chinese Spring was crossed with four breeding strains of Polish

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rye — L. 136/77, M-8, M 12-0, MOMN/76. Anthers at the metaphase I stage of meiosis were gathered from five hybrid plants of each combination. They were fixed in Carnoy's mixture 3:1. Smear preparations were made by staining in aceto carmine. About 50 cells were analysed from each plant. In this way we also analysed the chromosome pairing at M-I meiosis in rye.

RESULTS AND DISCUSSION

A significant percentage of the analysed hybrid cells showed no chromosome pairings (Table 1). The number of cells with univalents was very different depending on combination — from 5.60% in Chinese Spring × MOMN/76 hybrids to 57.95% in Roazon × Petkus hybrids.

Table 1. Percentage of cells with different number of bi- and trivalents at metaphase I of meiosis in wheat and rye hybrids

Cross combination (wheat × rye)	No. of analysed cells	Percentage of cells with												
		bivalents							trivalents		bivalents and trivalents			
		0	1	2	3	4	5	6	1	2	1+1	2+1	3+1	
cv.Chinese Spring × strain L.136/77	219	17.81	47.49	25.57	8.22	—	—	—	0.91	—	—	—	—	
cv.Chinese Spring × strain M-8	170	37.65	25.88	28.23	6.47	1.18	—	—	0.59	—	—	—	—	
cv.Chinese Spring × strain M 12-0	229	6.11	20.09	41.92	18.78	8.73	0.87	—	1.75	—	1.31	0.44	—	
cv.Chinese Spring × strain MOMN/76	250	5.60	20.00	34.80	25.60	10.80	0.40	0.40	—	0.40	0.80	0.80	0.40	
cv.Chinese Spring × cv.Petkus	292	35.62	41.09	16.44	3.77	0.34	—	—	2.05	—	0.68	—	—	
cv.Roazon × cv.Petkus	233	57.95	33.90	7.30	0.43	0.43	—	—	—	—	—	—	—	

Gorbań (1980) obtained a lesser differentiation in the frequency of cells with univalents as a result of the analysis of hybrids of three common wheat cultivars with three rye cultivars. The majority of the analysed cross combinations showed a larger share of metaphases with unpaired chromosomes.

In all the analysed combinations we observed a significant percentage of cells with 1 - 3 bivalents, which were chiefly rods with 1 terminal chiazma. Hybrids of Chinese Spring with the rye MOMN/76 and M 12 - 0 were frequently found to have cells with four and five bivalents, which were rather rare in the remaining combinations. Hybrids of Chinese Spring with MOMN/76 rye were found to have a single cell with six bivalents (which constitutes 0.4%), five of which were rod-shaped and one ring-shaped with well-visible two terminal chiazmata.

In all the combinations (except Roazon × Petkus) we also observed cells with trivalents (1 - 2) or simultaneously with a different number of bivalents (1 - 3) and a single trivalent (Table 1). The mean number of bivalents in a cell ranged from 0.51 in the combination Roazon × Petkus to 2.18 in Chinese Spring × MOMN/76, whereas the number of trivalents ranged from 0 (Roazon × Petkus) to 0.03 in hybrids of Chinese Spring with the strains MOMN/76, M 12 - 0 and the cv. Petkus (Table 2).

In studies on F_1 hybrids of *T. vulgare* × *S. cereale* carried out by Nakajima et al. (1966) the mean number of bivalents in the cell was 1.782, ranging from 0.639 to 7.967. Mettin et al. (1976) found the occurrence of on the average 0.52 bivalents per

cell (ranging from 0 to 3.9), about 1% of which fell on conjugations of wheat and rye chromosomes. These authors observed that the analysed hybrids had also trivalents and 1 quadrivalent. The revealed differences in the degree of chromosome pairing in hybrid cells resulted from use of various rye forms as pollinators.

Table 2. The number of chiazmata, univalents, bivalents and trivalents in metaphase I of meiosis in wheat and rye hybrids (mean values)

Cross combination (wheat × rye)	Number of			
	Chiazmata	Univalents	Bivalents	Trivalents
cv. Chinese Spring × strain L. 136/77	1.26	25.51	1.23	0.01
cv. Chinese Spring × strain M-8	1.08	25.85	1.06	0.006
cv. Chinese Spring × strain M 12-0	2.12	23.86	2.02	0.03
cv. Chinese Spring × strain MOMN/76	2.30	23.56	2.18	0.03
cv. Chinese Spring × cv. Petkus	0.94	26.17	0.87	0.03
cv. Roazon × cv. Petkus	0.52	26.97	0.51	—
cv. Rusałka × cv. Petkus	1.04	25.96	0.99	0.02

Hybrids analysed in the present paper significantly differed by the number of chiazmata, which was the lowest (0.52) for the combination Roazon × Petkus and the highest for Chinese Spring × MOMN/76 hybrids (Table 2). Among paternal components the largest chiazma number was found in the cells of the rye breeding strain MOMN/76. May be, a high degree of chromosome pairing of that rye form caused an increased frequency of chromosome pairing in the cells of F_1 hybrids of Chinese Spring × MOMN/76. A large number of chiazmata was also found in the cross of Chinese Spring wheat with M 12 - 0 rye, which was characterized by an average number of chiazmata as related to the remaining forms of rye. F_1 hybrids of all crossed wheat varieties with the rye cv. Petkus displayed the smallest number of chiazmata in comparison to the remaining cross combinations. It should be emphasized that in the cells of that rye variety the observed degree of chromosome pairing was also average.

Table 3. The number of chiazmata in the studied rye forms

Rye	Number of	
	analysed cells	chiazmata in cell (mean)
strain L. 136/77	200	14.30
strain M-8	250	15.10
strain M 12-0	250	14.97
strain MOMN/76	250	15.24
cv. Petkus	250	14.98

Lelley and Larter (1980) detected that the level of the chiazma number in hybrid cells depends on the both components, i.e. wheat and rye. A higher homeologus chromosome pairing was, however, found in hybrids with an inbred rye line having an increased number of chiazmata.

It seems that continuation of studies on the basis of the use of the both homozygous parental forms will permit to elucidate in detail the problem of chromosome pairing in intergeneric hybrids.

CONCLUSIONS

1. Various degree of chromosome pairing observed in hybrids from crossing Chinese Spring with various rye forms indicates the dependence of that trait on the parental component.

2. Unsimilar level of chromosome pairing in hybrids obtained from crossing various wheat varieties with the same rye variety suggests the influence of the maternal form on that trait.

3. The highest degree of chromosome pairing was found in hybrids from the cross of Chinese Spring with rye MOMN/76 having the largest number of chiazmata.

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ANALIZA KONIUGACJI CHROMOSOMÓW U MIESZAŃCÓW F_1 (PSZENICA × ŻYTO)

Streszczenie

Analizowano koniugację chromosomów u mieszańców F_1 otrzymanych ze skrzyżowania trzech odmian heksaploidalnej pszenicy: Chinese Spring, Roazon i Rusałka z żytem odmiany Petkus i rodami hodowlanymi: L. 136/77, M-8, M 12-0, MOMN/76. Średnia liczba chiazm wynosi-

ła 1,33 z wahaniami od 0,52 do 2,30 zależnie od kombinacji krzyżówkowej. Liczba biwalentów wynosiła średnio 1,27. Obserwowano ponadto sporadycznie triwalenty (średnio 0,02). Stwierdzono, że stopień koniugacji chromosomów w mieszańcach F_1 zależy zarówno od pszennej formy matecznej jak i żytniej formy ojcowskiej.

АНАЛИЗ КОНЬЮГАЦИИ ХРОМОСОМ У F_1 ГИБРИДОВ (ПШЕНИЦА × РОЖЬ)

Резюме

Анализировалась коньюгация хромосом гибридов F_1, полученных в результате скрещивания трёх сортов гексаплоидной пшеницы (Chinese Spring, Roazon и Rusałka) с рожью сорта Petkus и селекционными линиями L. 136/77, M-8, M 12 - 0, MOMN/76. Среднее число хиазм составляло 1,33 с колебаниями от 0,52 до 2,30 в зависимости от комбинации скрещивания. Число бивалентов составляло в среднем 1,27. Кроме того, спорадически наблюдались триваленты (в среднем 0,02). Установлено, что степень коньюгации хромосом в гибридах F_1 зависит как от материнской формы пшеницы, так и от отцовской ржаной формы.