Meiosis and Productivity Relationship in Bulgarian Winter Barley Lines

J. Stoinova [1] and S. Tsvetkov [2]
[1] Institute of Genetics "Acad.D.Kostoff", 1113 Sofia, Bulgaria
[2] Dobrudja Agricultural Institute, 9520, General Toshevo, Bulgaria

Abstract
Meiosis was investigated in winter barley lines № № 115, 139 and 318. Closed ring and 1-2 open ring bivalents were scored at diakinesis. There exists great diversity of chromosome configurations with closed ring and rod bivalents as well as univalents at metaphase I, however, chromosome division proceds correctly and only in line 115 about 1.90% of the tetrads have one micronucleus. The highest mean grain number and mean grain mass per ear were also recorded in line 115.
Key words: barley, chromosome configuration, meiosis, productivity

Introduction
The investigations related to meiosis proceeding are quite rare and usually treat the interrelationship between meiotic phases and ear length (Ekberg, Eriksson 1965) meiosis duration (Bennett,Finch 1971; Finch, Bennett 1972; Lindgren et al 1969), and its influence on ear fertility and grain yield in tetraploid cultivars (Fedak 1975; Reinbergs et al 1970; Evans, Rahman 1990). Sakata et al (2000) studied high temperature effect on the development of pollen mother cells and microspores in *H.vulgare*. The aim of these investigation was analysis of the chromosome configurations at diakinesis and metaphase I as well as the productive elements in bulgarian barley lines.

Material and Methods
The poly-rowed winter barley lines № № 115, 139 and 318 were investigated. The three lines were developed at the Dobrudja Agricultural Institute by Prof. S.Tsvetkov. Meiosis was assessed by the acetocarmine method. Diakinesis, metaphase I and telophase II being also included. From 90 to 100 cells were recorded at diakinesis, while at metaphase their number varied from 251 to 298 and that of tetrads varied from 195 to 210.

Ear length, grain number per ear, mass of grain per ear and grain absolute mass were studied. The data were statistically analysed, a scale discuted earlier (Stoinova , Lidansky 1997) beng used to characterize variation degree.

Results and discussion
Closed ring and open ring bivalents are observed at diakinesis in the three barley lines studied (Table 1). Over 63% of line 139 cells have only closed ring bivalents. The major part of the cells from line 115 have one open ring bivalent. Two open ring bivalents are observed only in a small part of the cells (5.56 – 6.00%). The open bivalents are always connected with the nucleolus at diakinesis (Fig.1a), suggesting that the open bivalents are formed first by the nucleolar chromosomes, which may be due either to NORs or to any other reasons.

Great diversity is observed at metaphase I of chromosome configurations with close ring bivalents, rod bivalents and univalents, which may be included in the following groups:
-seven closed bivalents
- closed ring bivalents and rod bivalents(Fig.1b)
-closed ring bivalents and univalents
-closed ring and rod bivalents and univalents (Fig.1c, d)
In all lines the percentage of cells with closed bivalents is higher than that of the other cell types (Table 2). There are cells with three rod bivalents in the second group indicating that such a bivalent is originated from non- nucleolus producing chromosome very rarely.

Metaphase cells with 6 closed bivalents and 2 univalents are major. Among the configurations possessing closed and rod bivalents along with univalents the highest is the number of cells with 5 ring bivalents, 1 rod bivalent and 2 univalents.

The lack of multivalents and the low univalent number determines normal chromosome division and complete meiotic cell division. Only in line 115 about 1.90% of the tetrads contain 1 micronucleus at telophase. Formation of microspores and of pollen grains without any damage is related to normal pollination and fertilization.

Batasheva (2000) found that poly-rowed barley productivity correlates positively with that of the ears. Zu-liu and Yu-ping (2000) define grain number per plant and grain mass as a principal traits of highly productive barley cultivars. Our data show that the investigated barley lines 115 and 139 are of higher grain number per ear (Table 3). Line 318 has the longest ear, however, it is not dense enough. Ear length is of homogenic variation (VC appr. 10%) while the other two traits studied vary slightly heterogenically, thr variation coefficients beng lower than 30%. Lines 115 and 139 are of higher absolute grain mass.

Conclusion
There exists considerable diversity of chromosome configurations at metaphase I, yet the meiotic process is completed without any damage, allowing high grain number per ear. Lines 115 and 139 are of considerable interest to agricultural practice.

Table 1. Bivalent configurations at diakinesis

Barley lines	7 closed ring bivalents		6 closed +1 open ring bivalents		5 closed + 2 open ring bivalents	
	No. of cells	%	No. of cells	%	No. of cells	%
115	38	42.22	47	52.22	5	5.56
139	57	63.33	28	31.11	5	5.56
318	50	50.00	44	44.00	6	6.00

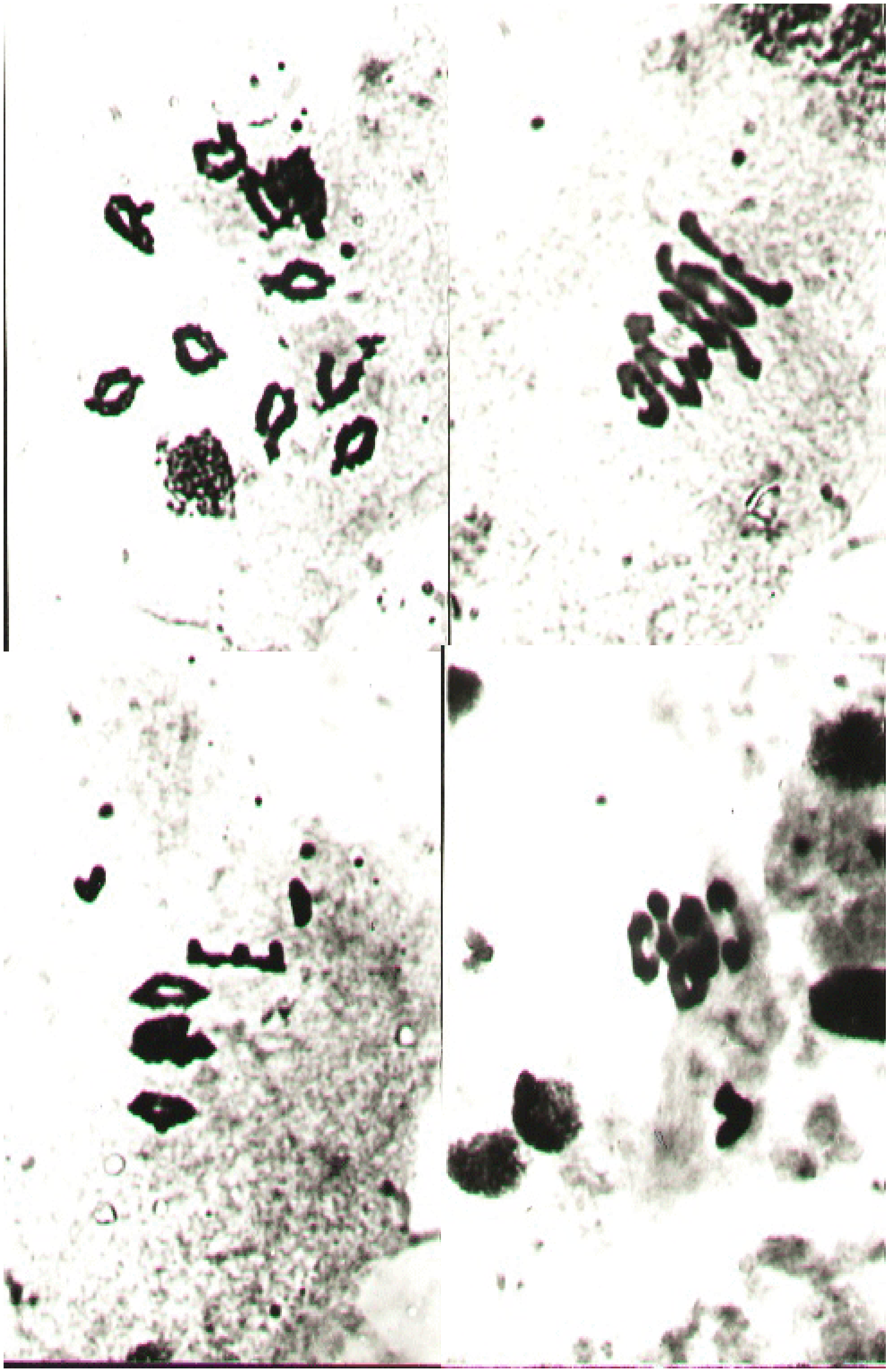
Table 2. Chromosome configurations at metaphase I

Barley lines	7 ring + 0 rod bivalents		6 ring + 1 rod bivalents		5 ring + 2 rod bivalents		4 ring + 3 rod bivalents		6 ring bivalents + 2 univalents	
	No.	%	No.	%	No.	%	No.	%	No.	%
115	115	38.6	100	33.6	52	17.4	14	4.7	10	3.6
139	113	45.0	93	37.0	21	8.3	7	2.7	12	4.7
318	115	39.9	99	34.4	44	15.3	6	2.1	12	4.2

Barley lines	5 ring bivalents + 4 univalents		5 ring + 1 rod bivalents + 2 univalents		4 ring + 1 rod bivalents + 4 univalents		4 ring + 2 rod bivalents + 2 univalents	
	No.	%	No.	%	No.	%	No.	%
115	0	0	4	1.3	0	0	2	0.8
139	0	0	5	1.9	0	0	1	0.4
318	2	0.7	7	2.4	1	0.4	2	0.6

Table 3. Productivity of barley lines

Barley lines	Ear length (cm)		Grains number per ear		Mass of grains per ear (g)		Mass of 1000 grains (g)
	M ± m	VC%	M ± m	VC%	M ± m	VC%	
115	4.28± 0.7	7.96	49.43 ± 1.4	13.78	2.14 ± 0.8	18.53	51.00
139	4.90± 1.0	10.33	47.30 ±1.6	16.55	1.96 ± 0.7	19.36	51.70
318	7.09 ± 1.2	9.11	41.4 ± 1.0	12.95	1.58 ± 0.5	16.20	48.80



Legends of figures:
Figure 1a (upper left): diakinesis with 6 closed ring bivalents and 1 open ring bivalent
Figure 1b (upper right): metaphase I with 5 ring bivalents and 2 rod bivalents
Figure 1c (lower left) and 1d (lower right): metaphase I with 4 ring bivalents, 1 rod bivalent, and 2 univalents

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