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Analyzes Of Meiotic Behavior And Mitotic Chromosomes In Hexaploid Triticale

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Background and Aims: *We were interessted to the study of meiotic behavior and chromosomal abnormalities on the hexaploid triticale (2n=6x=42) and the behavior of B chromosomes (accumulation/elimination mechanism) in the studied variéties On the one hand, and on the other hand, the distribution and characterization of heterochromatin in the same varieties which are analyzed and compared by C-bands. This analysis reveals many variations in C^+ polymorphic bands.*
Methods : *to analyze the meiotic abnormalities observedin the varieties, and to identify and characterize the somatic chromosomes of A -B R genomes , using the C-banding technique.*
The meiosis studied showed a rather different meiotic behavior from one variety to another. The most forms of aneuploidia are nullisomy (2n-2) present in all the individuals examined.
Results: *These results confirm the hypothesis of the mechanism of accumulation/elimination of B chromosomes. the analysis en C-banding of mitotic chromosomes of genomes (A- B- D-and R) showed distinct marking. the total number of C bands is 326 of which 275 bands are polymorphic (C^+) bands, that is confirmed the presence of intervarietal polymorphisms (84.26%). A positive correlation has been demonstrated between the rate of constitutive heterochromatin and the increase in the number of B chromosomes.*
Conclusions*. The richness en heterochromatin and the presence of B chromosomes (adaptation factors) could be explained as a manifestation of triticale adaptation.*
Keys word*: Additionals C-bands, aneuploidy, chromosomes B, genome, meiotic abnormalities, polymorphism, x-Triticosecale wittmak (6x).*

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I. Introduction

Interspecific hybridization is very useful instrument for the improvement of the Triticeae cultivated species. This technique is widely used for the transfer of certain agronomic characters such as resistance to biotic and abiotic stresses (Ammar *et al*., 2004 ; Oetler, 2005).

A well-known case of interspecific hybridization is Triticale (x-*Triticosecale* Wittmack) a crop species created by Man, is a synthetic cereal resulting from the hybridisation of cultivated wheat (*T. durum* Desf. or *T. aestivum* L.) and rye (*Secale cereale* L.). The triticale brings together the ability to panification of bread and the rusticity of rye, which represents a gain in biodiversity and a certain economic interest. This cereal is a source of many high-potential genes (high yield, disease resistance, cold and dry tolerance with better amino acid intake). Gupta (1986) distinguished four groups based on to the ploidic level (tetraploids, hexaploids, octoploids, decaploids). Triticale consists as an essential resource of genetic variability. In cytogenetics, the triticale was subjected to deep studies:

– Chromosomes and genomes identification (Seal and Bennet, 1981; Badaev, 1992; Bento *et al.*,2010).
– Chromosomic mutations and determination of the ploidic level (Appels ,1982; Lukaszewski and Gustafson, 1983; Wanda, 1996 **;** Gill and John, 1997; Timofeev, 1998; Lapinski and Schwarzacher ,1998; Lee *et al.*, 2004; Lukaszewski , Christine , 2011).
– Characterization of different interspecific hybrid karyotypes (Silkova *et al.*, 2007).

Heterochromatin is considered as cytogenetic marker used in understanding some evaluative mechanisms and in exploring identical events for selection.

C-banding marking techniques allow the heterochromatic differentiation of different genomes and their origins, and analysis of chromosomes polymorphism (Gill *et al*., 1991 ; Vahidy and Mujeeb-Kasi, 1994 ; Deng-Cal *et al.*, 1997).

This work is part of the two cytogenetic (mitotic and meiotic) studies of hexaploide secondary triticale (2n=6x=42, genome formula AABBRR). We were interested in analysing heterochromatic variability of A – B - R genomes, evidenced by the C-banding technique and the study meiotic behavior to specify the nature of

chromosomal abnormalities and the behavior of B chromosomes (accumulation/elimination mechanism) in four variéties (Foca, Chrea , Chelia and Lamb2). The chromosomes B were also highlighted.

II. Materiel And Methods

MATERIEL

Plant material in the form of seeds includes secondary triticales 6x (F6 generations) which are the result between cross-triticales.The list of studied varieties and their characteristics are presented in Table 1.

Table1: List of studied varieties.

Especies	varieties	Ploidy	Pedigree	origins	Source
x-Triticosecale Wittmak	Chrea	(6x) AABBRR	T 304 (*Triticum aestivum*) x (Rye) n°10 CTSS95Y00296S-10M-0Y-0B-0Y-0B-1B-0Y	Algeria	I.T.G.C
	Chelia		CTSS95Y00296S-10M-0Y-0B-0Y-0B-1B-0Y	Cimmyt	I.T.G.C
	Foca		CTSS95Y00296S-10M-0Y-0B-0Y-0B-1B-0Y	Cimmyt	I.T.G.C
	Lamb2			Cimmyt	I.T.G.C

METHODS

1-Meiosis study

Meiotic analyses are performed on the hexaploid triticales antherse (Chrea, Chelia, Foca and Lamb2 varieties). The technique described by Jahier (1992 ; 2005) allows a perfect spreading of chromosome associations at the pachytene and zygotene stages. The different steps are as follows:

-**The levy of epis** is collected at the swelling stage in the morning between 10h-10h30.

Fixation: It is made in acetic Ethanol (3V:1V) for 72 hours in the refrigerator.

-**the epis are rinsed** with 95% Ethanol for 5 minutes and 100% Ethanol for 5 minutes.

Storage:epis are stored in Ethanol 70% in the refrigerator during a year.

2-Mitosis study

The study of the shape and structure of chromosomes uses cytogenetic marking methods that must be applied for each species.

Cytogenetic techniques applied of the used varieties for C-banding is that described by Badaeva *et al.* (2007) for triticale, with modifications introduced in denaturation and renaturation of DNA steps (Hammouda and Khalfallah, 2014).

Root tips were pretreated and fixed in solution 3 ethanol: Lacetic acid (v/v). The cover slips were removed with liquid nitrogen (–196°C).

The best preparations were undergone the following steps.

***Denaturation of DNA**: the slides were submerged in barium hydroxide solution (50 g / l) for 7 minutes at room temperature.

***Renaturation of DNA**:the slides were incubated in a 2xSSC solution (0.3 M Nacl
and 0.03 M Na citrate), at pH 7 for 1h at 60°C.

***Staining**: the preparations were stained with 5% Giemsa for 40 minutes in Sorensen phosphate buffer (pH 6.8). In experimental procedure, we have modified hydrolysis and coloration steps, by varying the concentrations of the solutions so as to have optimum band coloration.

III. Results And Discussion

Meiotic behavior analysis

We were interested in studying meiotic behavior and chromosomal abnormalities on hexaploid triticale varieties (Chrea, Chelia, Lamb2 and Foca). 10 individuals per variety are analyzed and 10 CMPs examined per individual.

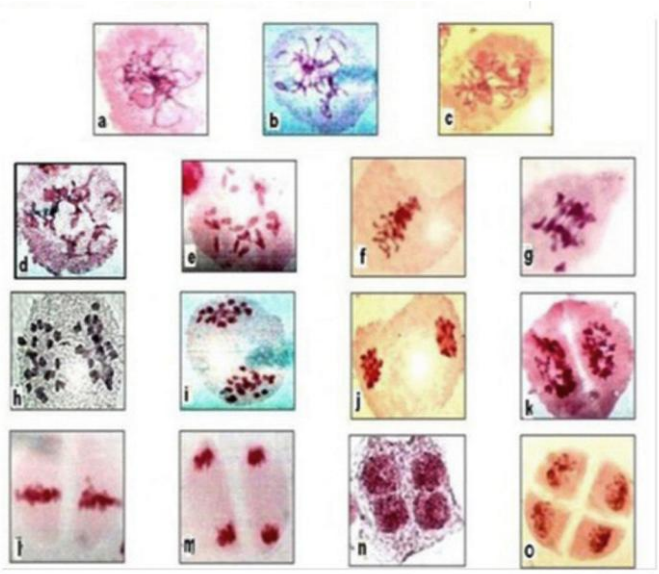

Fig.1: Pollen meiosis of four varieties of a hexaploid triticale? **a,e**: prophases to Stages: (**a**)Leptotene **(b)** Zygotene **(c)** Pachytene **(d)** Diploptera , (**e**) Daicinaise **(f) :** prométaphase; (**g**) métaphase I, **i, j:** anaphase I, **k-l-m:** télophase I, **n, o:** Tétrades.

The five stages of prophase I (Fig. 1) are observed. The different meiotic configurations show that the pairing of the homologous chromosomes takes place in different forms of univalents, bivalents in rings, straight bivalents, and bivalents in V. (Fig. 2). These bivalents then form the equatorial plate.

The five stages of prophase I (Fig. 2) are observed. The different meiotic configurations show that the pairing of the homologous chromosomes takes place in different forms of univalents, bivalents in rings, straight bivalents, and bivalents in V. (Fig. 2). These bivalents then form the equatorial plate.

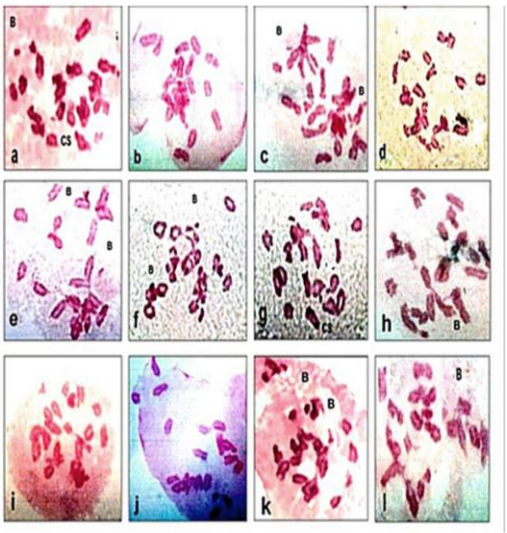

Fig. 2 : Main chromosomal variations (aneuploidy) observed: **a)** 21 Bivalents and 1B chromosomes. **b)** 21 Bivalents, 2 univalents and 2 B chromosomes. **c)** 21 Bivalents and 1 univalent (2n+1). **d)** 21 Bivalents. **e) and f)** 21 Bivalents et **1** univalent (2n+1). **g) and j)** 20 Bivalents (2n-2) and 1 B chromosome. **h)** 20 Bivalents (2n-2). **i)** 20 Bivalents (2n-2) and 2 B chromosomes. **k)** 20 Bivalents (2n-2) and 2 B chromosomes. **l)** 21 Bivalent 1 B chromosome.

Aneuploidy

The hexaploid triticale (6x) meiosis is remarkable for the regular presence of 21 right bivalents. However, in some cells, different chromosomal numbers were observed to indicating the phenomenon of aneuploidy. The latter is accompanied by an increase or a reduction of genetic material in the quantity of DNA. aneuploidy is characterized by the additional presence or absence of one or more chromosomes of genomes. The first form monosomic aneuploidy (2n-1), was observed in wheat in 1924. In our study, the most forms of aneuploidia are nullisomy (2n-2) present in all the individuals examined, but with a low frequency (Fig. 2).

Anomalies at different stages

Examination of Prophase I, of metaphases I and II, of anaphases I and II, and of telophase II, allowed visualization of meiotic irregularities of the studied varieties with low frequencies. These anomalities are the laggards chromosomes and micronuclei.

Laggards chromosomes

These chromosomes are observed in metaphase (I-II) and anaphase (I-II) stages. The calculated frequencies are noted for the varieties (Foca= 30.9%, Chelia = 28.9%, Chrea=27.6%, Lamb2= 24.9%) (Fig. 3, Table 2).

Table2: The frequencies of B chromosome, the laggards chromosomes and the micronuclei in hexaploid triticale varieties

number	**B chromosomes**					**Laggards chromosomes**						**Micronuclei**					
Varieties	1	2	3	4	T	1	2	3	4	T	F	1	2	3	4	T	F
Chrea	1,66	1,04	0,21	0,09	3,00	9,2	7,2	9,9	13	27,6	0,24	1,66	0,04	0,06	0	1,76	0,08
Chelia	1,70	0,76	0,33	0,13	2,92	14	10,3	4,6	7	30,9	0,27	5,60	1,60	0,73	0,16	8,09	0,39
Foca	1,47	0,86	0,19	0	2,52	10,1	12,3	3,9	2 ,6	28,9	0,25	5,36	1,06	0,38	0,06	6,86	0,33
Lamb2	1,36	0,56	0,09	0	2,01	12,6	7,6	4,6	0,1	24,9	0,22	2,19	0,90	0,33	0,10	3,52	0,47
Total											**0,98**						**0,97**
average	0,56					7,02						1,26					
Ecar- type σ	0,05					0,69						0,70					

In all varieties, the highest rate of Laggards chromosomes was observed in cells with one and two Lagging chromosomes and the lowest rate was detected in cells with three or four lagging chromosomes (Table 2).

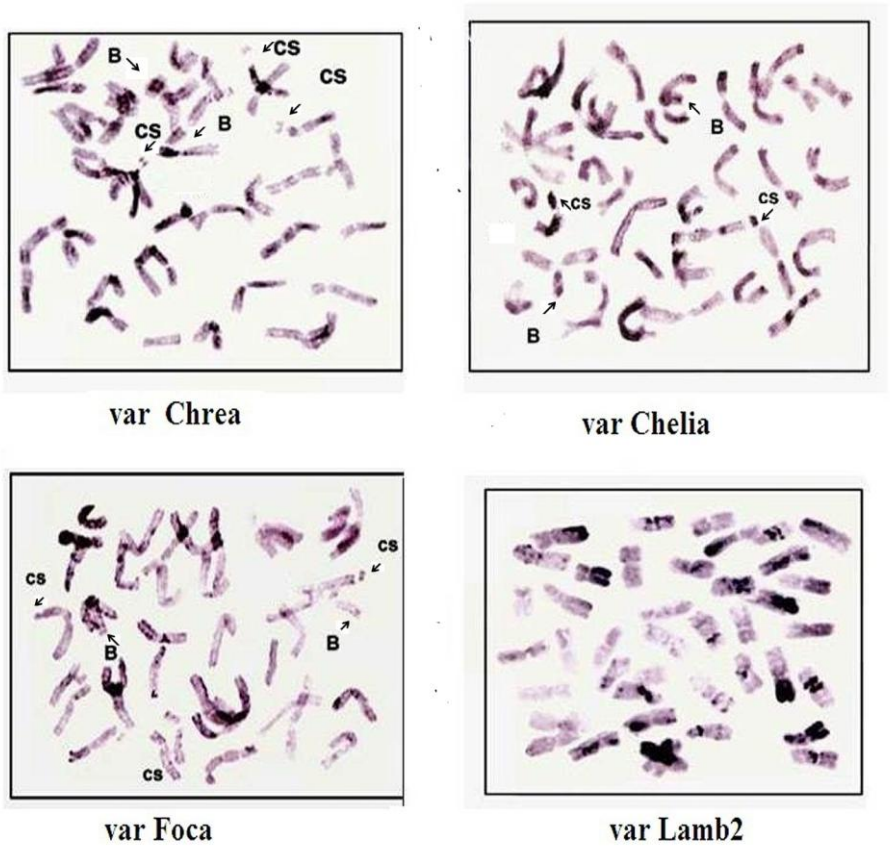

Fig.3 : Mitotic chromosomes marked by C-banding in the varieties of *x-Triticosecale* Wittmack (6x).

Micronuclei

In the tetrades and young pollen grains, fragments were found inside the cells, smaller than the main nucleus, these being micronuclei (Fig. 3). The micronuclei are observed at the end of anaphase II and telophase II (Fig. 3). These micronuclei are probably likely due to laggards chromosomes and B supernumerary chromosomes that do not appear during prophase and appear in meiosise as univalents. They segregate from the beginning of metaphase I to appear as micronuclei in the tetrades (Fig. 3).

The calculation of the averages shows that the number of micronuclei varies from one individual to another and from one variety to variety. The Foca and Chelia varieties showed high frequencies with 8.09% and 6.86% micronuclei respectively; in contrast to Lamb2 and Chrea varieties with low frequencies (3.52% and 1.76%) (Table 2).

The highest frequency of micronuclei is clearly visible in cells containing a B and the lowest frequency in cells containing 2,3 or 4 B. The Chrea variety is characterised by an absence of micronuclei and a high number of B chromosomes (Table 2).

We remind that karyotypes of the studied varieties are symmetrical both in the form and size of the chromosomes and this means that they are primitive (Hammouda, ,2014).

Variations in chromosomes forms are observed in varieties, because the degree of condensation (or spiralization) is not the same of metaphasic plaques (Fig. 3).

The meiosis studied in the hexaploid triticale (6x) showed a rather different meiotic behavior from one variety to another.

Some authors (Nudd and Gearts, 2005) showed that in polyploid species, several genes and structural mechanisms play an important role in the regularity of meiosis and apparently of homologous chromosomes.
The Configurations, bivalents (ring, right) and univalents are detected in all four varieties, only the univalents are many in the Chrea variety. These configurations are reported in triticales (Bernard, 1977; Oudjehih and Boukaboub, 2000).

The absence of meiotic pairing in interspecific hybrids may be due to genomic shock resulting important chromosomal rearrangements. (Stoinova, 2002). According to Bernard (1992), triticales have irregular meiotic behaviours than their parents, with many unpaired chromosomes (univalents). C-banding analyzes show that these univalents mainly correspond to the rye R chromosomes.

Polyploidy and aneuploidy are related phenomena, as has been noted for long time. Gaut (2002) has demonstrated statistically that the higher the degree of polyploidy achieved by the species, the more frequent the aneuploid variation.

Aneuploidy is very important in the evolution of the plants, because it allows the stabilization of the polyploids more quickly than does diploidization. In polyploid species, after duplication of the genome, both copies of a gene may be preserved in their original state, provided this gives the species a selective advantage. One of two copies may be lost by deletion. There is sometimes a sharing of ancestral functions between copies (Adams and Wendel, 2005). So polyploidy has an important role in evolution and speciation. In amphiploids, chromosomes are not randomly paired and form only homologous chromosomes of associations excluding the homeologists. In prophase I, only bivalents should be formed (Amirouche, 2007).

The obtained results in triticale (6x), varieties (Chelia, Chrea, Lamb2, and Foca) , in comparison with those of the authors (Oudjehih and Boukaboub, 2000) observed in triticale (6x), Beagle variety are different in the rates and forms of aneuploidy, as well as in the number and stage of meiosis (metaphaseI and anaphaseI).

In our varieties, the form of aneuploidy observed is nullisomy (2n=40), whereas in the Beagle variety, the form detected is monosomy (2n=41). Hyper-aneuploid varieties are more genetically tolerant than hypo-aneuploid varieties (Gorenflot and Raicu, 1980).

Laggards chromosomes

The number of laggards chromosomes of our varieties, compared to those of the Beagle variety, is very frequent. They are observed at different stages (metaphases I - II, anaphase I - II) and reach the number 7 in the Foca variety (Fig. 4). Whereas, in the Beagle variety, they are detected only in the anaphase II stage, and do not exceed 4.

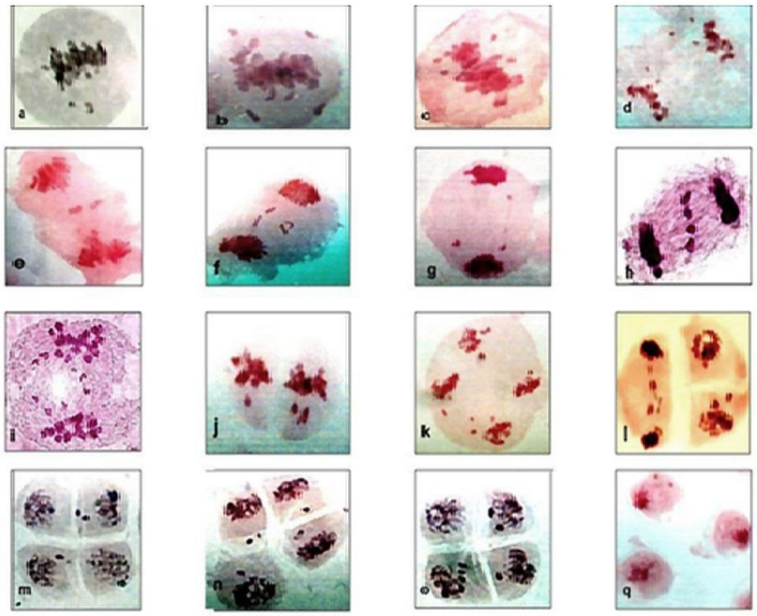

Fig. 4 : Meiotic abnormalities. **a-b-c)** Métaphase I with laggards chromosomes and B chromosomes. **d)** Anaphase I with 5 chromosomes B. **e)** Anaphase I with 2 laggards chromosomes. **f)** Anaphase I with 4 laggards chromosomes. **g)** Metaphase II with 3 laggards chromosomes. **h)** End anaphase II and start telophase II with 4 fragments. **i)** Anaphase I with 7 laggards chromosomes **j)** Anaphase II with 2 laggards chromosomes and 5 B chromosomes. **k)** telophase II with 5 laggards chromosomes. **l)** Chromatin bridge with 3 laggards chromosomes. **m-n-o)** tetrads with micronuclei. **q)** Pollen grains with micronuclei.

Stoinova (2002), also revealed them in other triticales, but with a reduced number. The frequency of laggards chromosomes is positively correlated with that of micronuclei (0.97 to 0.98) (Tab. 2). These correlations are also observed by Oudjehih and Boukaboub (2000). These irregularities would result from structural aberrations. They are also observed in many polyploid complexes, particularly perennial grasses (Cnudde F, Gerats T, 2005). in triticales (6x), it has been determined that the absence of one chromosome pair can be compensated by the additional presence of another pair. Thus, the 21 chromosome pairs are divided into 3 groups, each group consisting of 7 chromosome pairs belonging to three different genomes (A, B, R). Within the group, there is a nullitetrasomic compensation (2n+2-2), since the genomes A, B and R are related. This type of relationship between non-homologous chromosomes that belong to different but similar genomes and have a common origin is called homeology (Morris and Sears, 1967; Comeau and Jahier, 1995).

There is no general rule for the effects of aneuploidy. However positive correlations established between chromosomal disturbances and poor agronomic quality such as reduction of fertility and size are controversial, For example, the triticale is a better performing hybrid than its wheat parent under marginal agro-climatic conditions and give high productivity compared to wheat. However, this grain cereal remain subject to certain constraints, such as scalded grain, meiotic instability, aneuploidy and partial sterility, devaluiensg its technological and commercial value. According to these authors (Rogalska, 1996 ; Kousaka and Takashi, 2012 ; Hammouda *et al*., 2017), the scaling of grain is due to:

-Telomeric heterochromatin of rye chromosomes.
- Aneuploidy.
- The cultural environment.
- Strong activity of ά amylase during maturation

Mitotic analysis

The intervarietal heterochromatic variability

Comparative analysis of genomes

The Distribution and the characterization of heterochromatin in several varieties belonging to t XTriticosecale Wittmack (6x) species are analyzed and compared by C-bands. This analysis reveals many variations in C-polymorphic bands. Indeed, the number of bands and their localization on the chromosome, and their intensity, differ from one variety to another. These different bands are of telomerical, centromeric and intercalary types.

The distribution profiles of the hetochromatic bands chromosomes show a structural variations in all genomes (Fig. 5).

Genome A

The four varieties showed fine bands marked on all chromosomes, except Chrea variety chromosome 5A (short arm), Chelia variety chromosome 6A (short arm) and 4A chromosome all varieties.

Genome B

All varieties showed a differentiation in the localization of the thick centromeric bands. These bands are marked respectively on 1B, 2B, 3B, 7B chromosomes, on 2B, 3BS, 4BL, 6B, 7B chromosomes, on 2B, 5B, 7B chromosomes And on 1B, 5BS, 6B, 7B chromosomes.

Genome R

The Chrea and Foca varieties are characterized by the absence of thick telomeric and centromeric bands on all chromosomes (except 1RS and 3RL of Foca).

By contrast, the varieties Chelia and Lamb 2, showed thick centromeric bands marked on the chromosomes 1R, 1,3RL, 5RL, 6R, 7R and on chromosomes 2RS, 5RS, 6RL, 7RL, respectively.

The secondary constrictions (cs) are localized on 1B and 6B chromosomes of genome B (*Triticum durum*) and 1R chromosome of genome R (*Secale cereale*) (Figs 3 and 4).

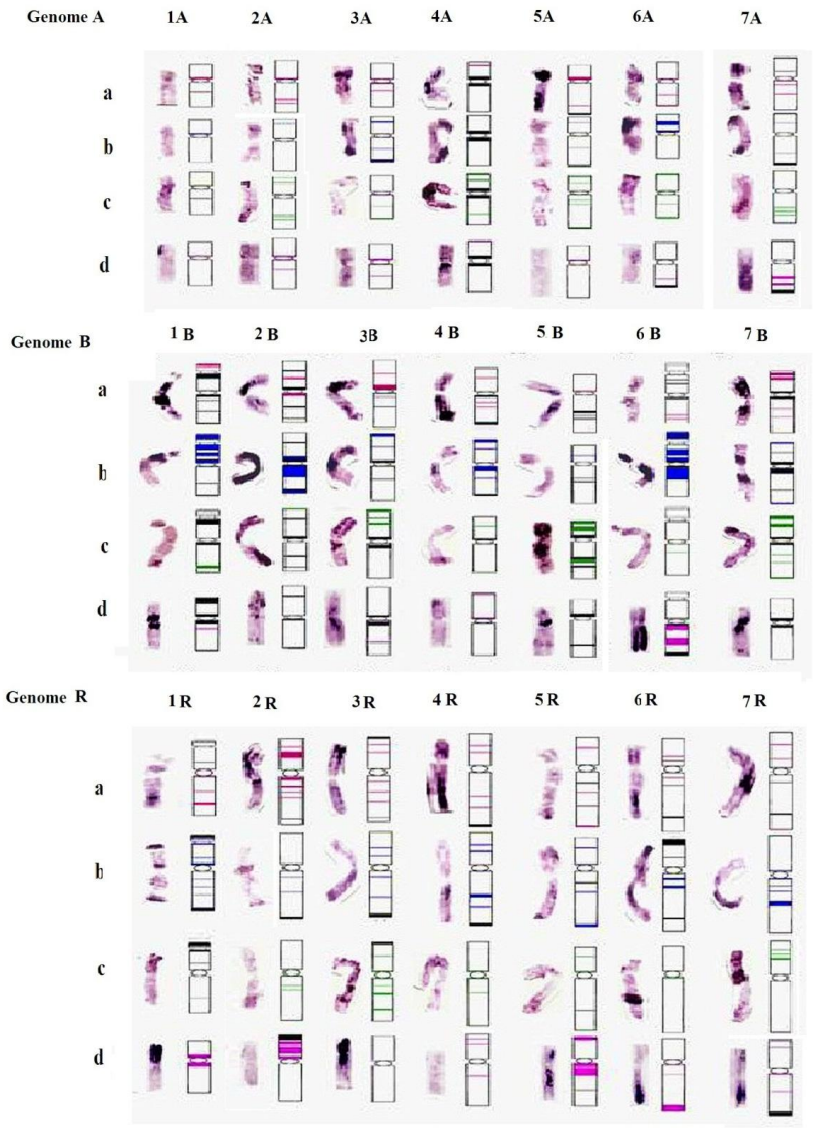

Fig. 5: Heterochromatic polymorphism (in C-banding) of x-Triticosecale Wittmack (6x): varieties a-Chrea, b-Chelia, c-Foca, d-Lamb2. Colors C^+ bands are specific (additional) to varieties .

Genomes A of the Chrea, Chelia, Foca, Lamb 2 varieties possessing 22, 16, 26, 14 bands respectively. B Genomes of the same varieties containing 37, 35, 31 20 bands. R genomes with 39, 36, 23, 23 bands (Table3).

Table3. Number and localization of C-bands genomes A, B and R of hexaploid triticale.

Genomes		Varieties											
		Chrea			**Chelia**			**Foca**			**Lamb2**		
Types and numbers of C-bands		BC	BI	BT	BC	BI	BT	BC	BI	BT	BC	BI	BT
Genome A	1A	1	1	0	1	0	0	1	1	0	1	0	0
	2A	1	2	0	1	1	0	0	3	1	2	1	0
	3A	2	1	0	0	2	1	0	1	1	1	1	0
	4A	2	1	0	2	0	0	2	2	1	1	0	1
	5A	1	2	1	0	2	1	0	3	2	1	1	0
	6A	1	1	1	1	2	0	1	1	2	2	0	0
	7A	1	3	0	0	2	1	0	3	1	0	2	1
Genome B	1B	2	2	2	2	2	1	1	0	2	2	1	0
	2B	2	4	0	3	3	1	1	3	1	1	1	1
	3B	1	3	0	1	2	1	2	2	1	2	1	0

	4B	1	3	2	1	2	2	1	2	0	0	1	1
	5B	1	3	2	0	3	0	1	5	1	1	1	0
	6B	2	4	0	4	1	0	0	1	2	3	1	1
	7B	2	4	0	2	2	2	2	3	1	2	0	0
Genome R	1R	1	3	0	1	4	2	1	2	1	2	1	0
	2R	1	7	0	0	2	1	1	2	0	1	3	1
	3R	0	6	1	0	4	1	2	4	1	0	0	0
	4R	0	4	1	0	4	1	2	1	0	0	3	0
	5R	0	4	0	1	3	1	1	2	0	1	3	1
	6R	0	6	0	0	4	2	1	0	0	1	1	1
	7R	1	4	0	2	3	0	0	3	0	1	2	2
Total of bands		89		88		81			59				
		326 Bands											

BC: Centromeric bands
BI: Intercalary bands
BT: Telomeric bands

The most important group in all triticales is that of hexaploids, which are stable from an agronomically point of viewstable. Comparative analysis of A, B and R genomes of studies varieties (Chrea, Chelia, Foca, Lamb2) revealed heterochromatic variation in band profiles (number, position and intensity of bands).

Table 4 represents the different structural forms (in C bands) between the chromosomes of the studied genomes. According to this table, the A genomes show similarity in the majority of chromosomal pairs exception 3A, 6A of ,the Chelia variety, 5A of the Chrea variety (Fig. 5). Only the 4A chromosome with important bands comparable to B-genome chromosomes.

In the B genomes, all chromosomes show a great heiterogenity in the distribution of dark bands, with the exception of 6B of the Chrea and Foca varieties, 4B of the Lamb2 variety and 5B of the Chelia variety (Fig. 5).

The R genomes are distinguished by the absence of thick telomeric bands in all chromosomes except 5R, 6R and 7R of the Chelia and Lamb2 varieties and 1R of the Foca variety Many fine intercalary bands are observed in the Chelia, Chrea and Foca varieties (Fig. 5).

Our results, showed that the genomes of the Chrea, Chelia and Foca varieties are more rich in constitutive heterochromatin (C+), whereas those of the Lamb2 variety are moderately.

Kuleung et *al* (2004), proves that the genome analysis of hexaploid triticals has identified molecular polymorphism in 31% of the markers used. In hexaploid triticals, the structural differences highlighted indicate the existence of intervarietal polymorphisms with 84.26% (Table 4).

Table 4: percentage of heterochromatic polymorphism detected by C+ bands in hexaploid triticale.

Bands Varieties	Polymorphic $\mathbf{C}^{+}$Bands					% polymorphism
	BT	BI	BC	B chromosomes	Total number	
Chrea	7	59	14	1 Heterochromatic 1 Euchromatic	80	**84.26%**
Chelia	16	49	14	1Heterochromatic 2 Heterochromatic	79	
Foca	10	28	14	1 Heterochromatic 1 Euchromatic	52	
Lamb2	7	18	21		42	

$$\% \textbf{ polymorphism } = \frac{\textbf{Number of polymorphic bands (C+) per variety}}{\textbf{total number of C bands}} \boldsymbol{X100} \quad (\textbf{Bushreen, 2007})$$

Charles *et al.* (2011), showed that the two populations of triticale 6x of selection had all the chromosomes of rye marked in C bands except 2R. In our case, all rye chromosomes (genome R) are marked by different bands (centromeric, intercalary, telomeric).

We were able to demonstrate a positive correlation between the rate of constitutive heterochromatin and the increase in the number of B chromosomes in triticales This correlation was demonstrated in *Nicotiana sylvestris* by Lespinasse et *al.* (1993) and in millet androgenetic plants.

Chromosomes B

The analysis of averages shows that the number of B chromosomes varies between cells of the same individual, between individuals of the same variety and even between varieties. The Chrea variety showed a significantly high rate with 3.00%, followed by Foca 2.92%, Chelia 2.52% and Lamb2 with 2.01% (Table 2).

According to Trivers et *al.* (2004), the frequency of B chromosomes increases when climatic conditions are unfavorable and decreases when they are not.

B chromosomes are responsible for the irregularity of the meioses, and tend to accumulate in the meiosis, which leads to an increase in the number of chromosomes B per generation (Riera *et a.l*, 2004)

According to Houben et *al.* (2011), the B accumulation mechanism in rye and corn requires a factor at the end of the long arm of chromosome B that can act in translocations. Al_kaff *et al.* (2008) shows that the B chromosome of rye produces some transcriptions acting on the expression of these genes (cdk) as the ph1 gene does.

According to Khalfallah (1990), heterochomatic B chromosomes in the mil are subject to a accumulation/elimination mechanism: They accumulate to a point beyond which management of heterochromatin becomes burdensome for the plant. Once this limit is reached, the B chromosomes are eliminated and the cycle can start again

In our case, the meiosis studied in the secondary hexaploid triticals (6x) of the sixth generation shows that, despite a regularity of divisions, we were able to observe some anomalies (laggard chromosomes, micronuclei and aneuploidy) **To what can they be due?** Genomic shock may be involved in these manifestations and in this case meiosis stability requires a greater number of generations.

However, a rigorous observation of these anomalies in the four varieties shows that three of them (Chelia, Foca and Lamb2) have an average number of B (1 to 3) and several micronuclei and the fourth (Chrea) has a high number of B (1 to 4) and absence of micronuclei.

These results confirm the hypothesis of the mechanism of accumulation/elimination of B chromosomes. The Chrea variety is in the accumulation phase while the other three are in the elimination phase, which is reflected in the presence of micronuclei.

IV. Conclusion

The meiosis studied in the hexaploid triticales (6x) showes a behavior quite different from one variety to another. The Preferential association of chromosomes is the legal bivalent but the presence of univalents is remarkable. The most common form of aneuploidy is nullisomy (2n-2). Also, Chromosomes B are detected in high numbers in the Chelia and Foca varieties only. Chromatin bridges, lagging chromosomes and micronuclei were observed in the Chelia and Foca varieties, as well as in the Chrea and Lamb2 varieties. These results confirm the hypothesis of the mechanism of accumulation/elimination of B chromosomes. The Chrea variety is in the accumulation phase while the other three are in the elimination phase, which is reflected in the presence of micronuclei.

The analysis en C-banding of chromosomes of all genomes (A- B and R) in hexaploid triticales showed distinct marking, that is confirmed the presence of intervarietal polymorphisms (84.26%). The determination of a positive correlation between the heterochromatin rate and the increase in number of B chromosomes in triticales.

Finally the richness en heterochromatin (sequences CG) and the presence of B chromosomes plays an important role in the adaptation of plant to difficult environmental conditions.These are the factors adaptation.

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