

Nullisomics

The cell, tissue or organism in which both the homologues of a chromosome are missing from the somatic chromosome complement is called nullisomic ($2n-2$), and the condition is called nullisomy. If two pairs of homologous chromosomes are absent, the cell, tissue or organism is known as double nullisomic ($2n-2-2$). Normally, nullisomics do not survive in diploids; but they survive in polyploid species.

Origin:

Nullisomics are obtained in the selfed progeny of monosomics where “ $n-1$ ” type male and female gametes fuse to form “ $2n-2$ ” zygote. Monosomic plants produce two types of gametes, (n) and ($n-1$).

Phenotype:

Nullisomics are weaker and less vigorous as compared to normal disomic plants. They show reduced size, vigour and fertility. All the 21 possible nullisomics in wheat were developed by Sears.

Uses of Nullisomics:

1. Nullisomics can be used to identify the groups of homoeologous chromosomes. In allopolyploid species like wheat {In $\sim 6x = 42$) the effects of nullisomy for particular chromosome may be compensated by tetrasomy for a specific chromosome of the complement.

For example, effects of nullisomy for chromosome 20 (= 2D) in the variety Chinese Spring were compensated by the tetrasomy for chromosome 2 (= 2B) or chromosome 13 (= 2A), while effects of nullisomy for chromosome 17 (= 1D) was compensated by chromosome 1 = 1B) or 14 (= 1A).

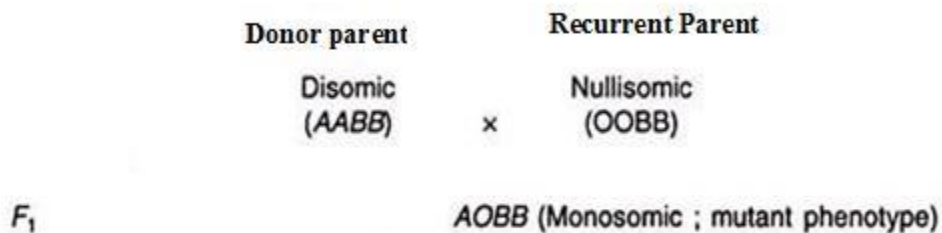
By making all possible combinations of nullisomics and tetrasomics, and selecting those where compensation occurred, Sears in 1954 and Sears and Okamoto in 1957 could classify all the homoeologous chromosomes in the three genomes (A, B and D), viz., (i) 1A to 7A, (ii) 1B to 7B and (iii) 1D to 7D.

2. Nullisomics are used to locate genes on particular chromosomes.

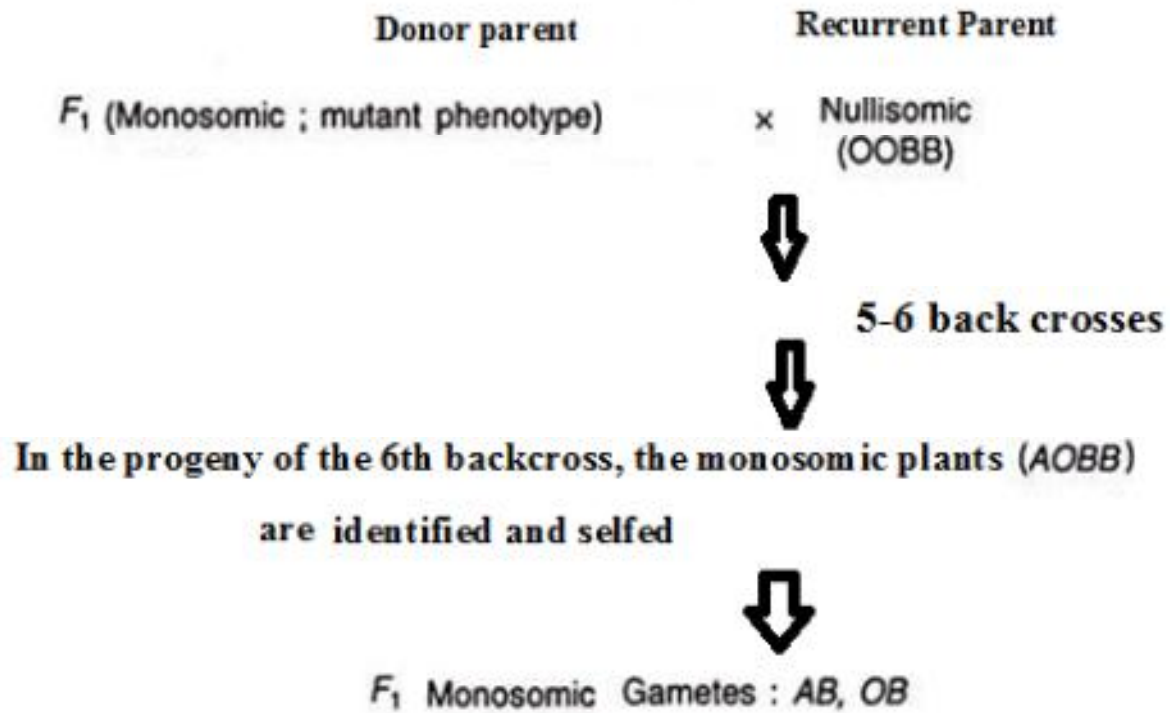
3. Production of substitution lines:

The production of substitution lines using nullisomics requires a good fertility and reasonable vigour in the nullisomic for the chromosome to be substituted. In wheat, nullisomic-7B and nullisomic-7D have reasonable fertility, while nullisomics for the other chromosomes are very low in vigour and fertility. The following is a generalised procedure for the production of substitution lines.

(i) The nullisomic line is crossed to the donor variety. The F₁ progeny will be monosomic, and the monosomic will be contributed by the donor variety.



(ii) The F₁ (monosomic) is back crossed to the nullisomic line (used as female). Monosomic plants are selected from the back cross progeny and are back crossed to the nullisomic lines; this is repeated till 5-6 back crosses have been made. In the 6th backcross generation, the genotype of the recurrent parent would be almost completely recovered (Figure below).



(iii) In the progeny of the 6th backcross, the monosomic plants are identified and selfed, and disomic plants (AABB) are selected from the F₂ progeny as shown below. These plants will possess the substituted chromosome from the donor variety in the background of the nullisomic variety.

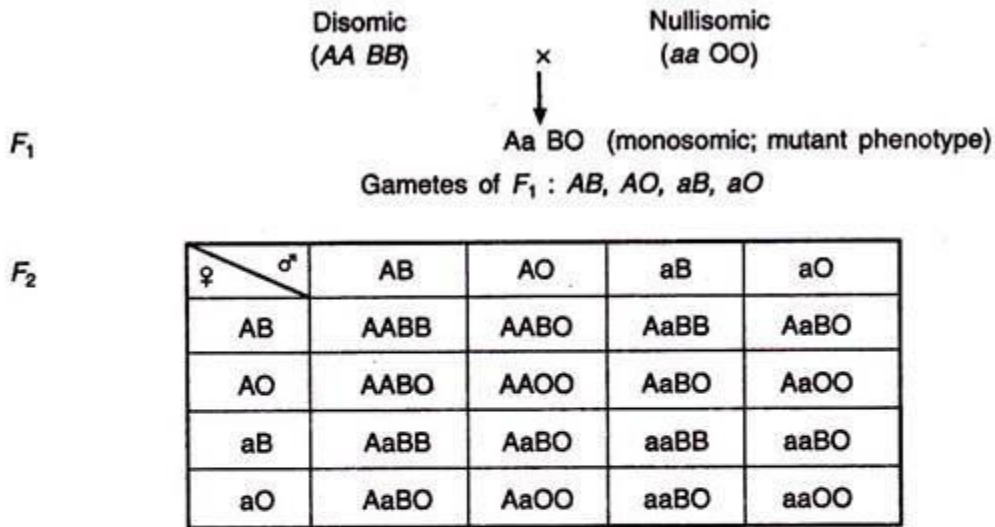
F_1 Monosomic Gametes : AB, OB

F₂	<table border="1" style="border-collapse: collapse; text-align: center;"> <tr> <td style="padding: 5px;">♀ \ ♂</td> <td style="padding: 5px;">AB</td> <td style="padding: 5px;">OB</td> </tr> <tr> <td style="padding: 5px;">AB</td> <td style="padding: 5px;">AABB</td> <td style="padding: 5px;">AOBB</td> </tr> <tr> <td style="padding: 5px;">OB</td> <td style="padding: 5px;">AOBB</td> <td style="padding: 5px;">OOBB</td> </tr> </table>	♀ \ ♂	AB	OB	AB	AABB	AOBB	OB	AOBB	OOBB
♀ \ ♂	AB	OB								
AB	AABB	AOBB								
OB	AOBB	OOBB								

Use of nullisomics in locating genes on chromosomes

Nullisomics are used to assign genes to particular chromosomes. If the dominant mutant gene (A) to be located is present in the chromosome of a disomic parent, then a cross between this disomic line (AABB) and nullisomic line for gene (B) but disomic for gene A will produce all monosomic F₁ plants. The F₁ monosomic plants are selfed and the segregation for the concerned gene (A) is studied in F₂.

If the concerned gene (A) is located in the chromosome of anullisomic parent (in other words, if the nullisomic parent is disomic for the concerned mutant gene), then in F₂ both (Fig. 16.8) mutant and nonmutant phenotypes will appear in all the types of F₂ plants, viz., disomic, monosomic and nullisomic plants. In case of nullisomics, the frequency of mutant and nonmutant phenotypes will be 3: 1.



- (i) Ratio of mutant (A) and nonmutant (a) phenotypes = 3 : 1.
- (ii) Both mutant and nonmutant phenotypes found in disomics, monosomics and nullisomics.
- (iii) Nullisomics show mutant phenotype in higher frequency than nonmutant phenotype.

Fig. 16.8. F₂ segregation for a dominant mutant gene (A) located in the chromosome for which the plant is disomic. Genes A and B are located in nonhomologous chromosomes; the aneuploid plant is nullisomic for the chromosome carrying the gene B.

On the other hand, if the dominant mutant gene is located in the chromosome of a disomic parent when crossed to parent nullisomic for the concerned gene (A) (That is, the nullisomic line lack the concerned dominant gene but disomic for the other gene) (Fig. 16.9), all the nullisomics will show the non-mutant phenotype in the F₂, while all the other types of plants, viz., disomics and monosomics will exhibit the mutant phenotype.

Disomic (AABB) × Nullisomic (OOBB)

F_1 AOBB (Monosomic ; mutant phenotype)

Gametes : AB, OB

F_2

♀ \ ♂	AB	OB
AB	AABB	AOBB
OB	AOBB	OOBB

- (i) All the plants, except the nullisomics, have the mutant phenotype.
- (ii) All the nullisomics have the nonmutant phenotype.

Fig. 16.9. Segregation in F_2 for a dominant gene *A* located in the chromosome for which the aneuploid parent is nullisomic. Genes *A* and *B* are located in nonhomologous chromosomes; gene *A* located in the critical chromosome for which the aneuploid stock is nullisomic.