

**Detection of Haploids:** Haploids can be identified by the following

**1. Morphological Approach:**

The vegetative and floral parts and the cell sizes of haploid plants are relatively reduced when compared to diploid plants. By this way haploids can be detected in a population of diploids. Morphological approach, however, is not as effective as genetic approach.

**1. Genetic Approach:**

Genetic markers are widely used for the specific identification of haploids. Several markers are in use to screen at seedling stage.

i. 'a<sub>1</sub>' marker for brown coloured aleurone and their corresponding dominant marker being 'A' marker for purple colour.

iii. 'lg' marker for liguleless and its corresponding dominant marker being 'Lg' marker for liguled character.

If the female parent carries 'a' or 'lg', then the monoploids are will be recognized by lack of purple colour or ligule character when crossed with male parent carrying 'A' or 'Lg'. The above markers have been used for the development of haploids of maize. Maize haploids can be used to develop inbrelines in hybridization programme. The other markers are

**3. Chromosomal Counting:** Haploids have gametic chromosome number of that species.

**Phenotypic effects of Haploidy:**

- A. Monohaploid plants are weaker, smaller and less vigorous than the diploids. However in Pepper, haploids may be comparable in size and vigour to its diploids
- B. Their leaves, flowers and other parts are smaller compared to those of diploids.
- C. Their stomatal size is smaller bur the number of stomata per unit area is higher than that of diploids.

**Meiosis and breeding behavior in haploids (x)**

- 1. In a monoploid, all the chromosomes present in a nucleus are non-homologous. Therefore, only univalents are expected at MI. These univalents are distributed

throughout metaphase-I and Anaphase-I because of univalents inability to localize at equatorial plane. Sometimes bivalents due to non-homologous pairing along with univalents are seen resulting in non viable gametes and thus there is a complete sterility.

2. Non-homologous chromosome pairing (of small chromosomal segments) has been assigned to small duplication and genetic redundancy. In 1983, Kasha and Seguin-Swartz made the following three main observations regarding chromosome pairing and chiasma formation in barley monoploids.

(i) Chiasma formation is mainly dependent on duplication of chromosomes segments and their location on the chromosomes rather than on the large content of highly repetitive DNA sequences (over 70%) in the barley genome.

(iii) The very low frequency of association, e.g., 0.03-0.05 bivalent per PMC, could be due to random breakage and crossing over.

3) In some species, all the chromosomes present at MI and AI may be included in a single restitution nucleus following the telophase I; this nucleus undergoes a normal second meiotic division to produce two normal haploid spores. Therefore, after pollination by a diploid plant the monoploid may produce diploid progeny.

4) Chromosome pairing and crossing over in the duplicated region of non-homologous chromosomes of the monoploid will lead to the diploid progeny carrying a heterozygous translocation. Studies in *Zea mays* revealed occurrence of repeated interchanges (translocations) due to crossing overs in the duplicated segments.

#### ***Breeding behaviour in Polyhaploids:***

In auto-polyhaploids, homologous chromosome pairing is a common feature. In auto-dihaploids, mostly bivalents with very few univalents are observed. However, fertility and vigour of these auto-polyhaploids are often lower than those of their polyploid counterparts, possibly due to inbreeding.

In case of allopolyploids such as wheat (*T. aestivum*), there should be no chromosome pairing since the chromosomes are not homologous. But a low frequency of chromosome pairing occurs in the same homoeologous group (A,B,D) due to the absence of chromosome 5B. This is expected since the gene *ph* present in 5B is known to suppress homoeologous chromosomes pairing. **Secondary association:** Secondary association of univalents is also observed in haploids; the association may be side-to side, end-to-end or end-to-side. The reasons for secondary association may be duplication, homoeology and the presence of highly repetitive DNA sequences.

#### **Uses of Haploids in plant breeding:**

- 1. Rapid production of homozygous lines in the shortest possible time:** This is achieved by treating haploids with colchicines and subsequent chromosome doubling of such haploids to generate doubled haploids or homodiploids. These doubled haploids can be used directly as cultivars or as inbred lines in breeding programmes (maize). Hap gene in barley is used for both production of haploids as well as spontaneous doubled haploids (SDH). In SDH, the doubling of chromosomes occurred naturally without colchicines treatment.
- 2. Use of haploids in species with polysomic inheritance such as potato.** The dihaploids in potato can be used for chromosome doubling to increase tuber size. This is known as analytical breeding.
- 3. Mutation breeding:** mutation breeding can be effectively carried out at haploid level as both dominant and recessive mutations are expressed in the M1 generation itself. Desirable mutations can be selected from among haploid cells cultured in vitro or from haploid plants and from them fertile doubled haploids with all desirable mutations can be obtained through chromosome doubling.
- 4. In cytogenetic studies haploids are used as sources of aneuploids:** In wheat, haploids as female when pollinated with hexaploid wheat, chine spring variety gave rise to monosomics and selfing of monosomics gave nullisomics and trisomics. Selfing of trisomics gave tetrasomics. Thus E. R. Sears developed aneuploid stocks as well as translocation stocks from wheat haploids.
- 5. Haploids are used in evolutionary studies:** Homoeologous chromosome pairing in the haploids of different allopolyploid species provide information on ancestry of the species and evolution of different genomes in these allopolyploids.
- 6. High yielding heterotic hybrids are generated in *Asparagus officinalis*:** *Asparagus* has XX-XY system of sex determination where XX is female and XY is male. Androgenetic haploids obtained through anther culture of *asparagus* male plant (XY) produced super males with YY line and homozygous female (XX). When super males (YY) were crossed to its female XX, all F1 are male population that are commercially superior in yielding abilities than the conventional "50% male + 50% female populations".
- 7. Haploids can be used in genetic studies.** Haploids used to study chromosome behavior during meiosis. Pairing in monohaploids indicates presence of duplications in the chromosome complement. Ex: potato.