Managing segregating populations
Aim of the module

At the end of the module, we should be able to:

• Apply the general principles of managing segregating populations generated from parental crossing;

• Describe how the segregating populations are managed according to the particular type of crop;
Introduction

• A segregating population can be defined as “the genetically diverse progeny from crosses between parents that differ for one more traits that are under genetic control”

• Confirmation of crosses is critical to success
  – Easily observable phenotypic traits such as cotyledon color of the purported hybrid seed is a common approach.
  – Comparisons of the F1 hybrids grown in the presence of the parental plants
  – molecular markers can be used if facilities are available

• maintaining the identity of parental plants and parental seed is a must for a successful pre-breeding program
Introduction

Breeding methods may differ depending on whether you are working with:

• self-pollinating species
  – Goal: select stable true-breeding self-pollinating populations that clearly have the genes from the wild and exotic germplasm source in a stable genetic background.

• cross-pollinating species
  – Goal: populations of plants that intercross at random and that clearly have the intended genes and traits from the wild and exotic germplasm source; or

• clonal or apomictic species
  – Goal: early generation selections from crosses can be propagated as uniform heterozygous populations
Managing segregating populations of self-pollinating species

Pedigree selection also known as line breeding

- is one of the earliest breeding methods to be used following controlled crossing.
- requires record keeping for each of the plants selected in each generation – so method is labor intensive
- Method is not amenable to large populations.
- Has the advantage of being able to focus the breeding program on specific traits.
- May not be suitable for the relatively wide crosses of exotic germplasm with cultivated germplasm as in pre-breeding.
Managing segregating populations of self-pollinating species

Pedigree selection

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Managing segregating populations of self-pollinating species

Pedigree selection also known as line breeding

Advantages

• Easier to select families – eliminate bad plants early
• Select types you want - discard others
• Look back on several years data
• Screen characters in greenhouse and field
• Plant breeders can practice their art and science
• Excellent for highly heritable traits

Disadvantages

• Costly - time, labor - space - $$$$$
• Space planting not the same as farmers
Bulk population breeding

- Often the method of choice when
  - large population sizes are needed to combine a number of genes for a particular trait, and
  - where the goal is to combine genes for several traits.

- Goal is to inbreed the segregating population to homozygosity
  - After homozygosity is reached (F4 or later generation), intensive selection is practiced for the traits of interest

- With the procedure, seed used to grow each inbreeding generation is a sample of that harvested from plants the previous generation

- Advantage of minimal record keeping and can be used for rapid generation advance.
Bulk population breeding
Relies on natural selection

Advantages
• Less record keeping
• Easy to handle large numbers
• Natural selection effective (winter-hardiness, disease/insect resistance)
• Little effort needed (cheap)

Disadvantages
• Selected may not be high yielding
• Environment changes each year
• Little use of plant breeding skills
Backcross breeding

• Often the method of choice for introgressing genes from wild and exotic germplasm sources

• Backcrossing is a well-known breeding strategy that ensures the efficient transfer of the gene of interest from the donor parent to the genetic background of the recipient parent

• In doing so, the genetic makeup of the donor parent is greatly reduced while the genetic makeup of the recurrent parent is recovered
Managing segregating populations of cross-pollinating species

- Goal is improved populations of plants that can maintain the genes transferred from the wild and exotic germplasm source through cross pollination from one generation to the next.
  - heterogeneous populations of heterozygous plants that intercross at random

- The improved populations are an effective means of transferring pre-bred material to conventional breeders.

- Improved populations of cross-pollinating species are sometimes referred to as synthetics.
  - A synthetic is a population developed by intermating selected genotypes and is propagated from one generation to the next by open pollination.
Managing segregating populations of cross-pollinating species

- Methods for cross-pollinating species involve some form of population improvement that can be best described as a form of **recurrent** selection.
Managing segregating populations of clonal and apomictic species

- Some very important crops such as potato, sugarcane and many tree fruits are clonally propagated.

- Another group of crops, especially some of the forage grasses are propagated through apomixis (seed production without pollination).

- With these methods of propagation, highly uniform populations in early generations following crossing can be developed.

- In cases of apomictic species including some grasses, uniform populations of heterozygous plants can be developed and put to immediate use as improved cultivars.