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

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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

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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.