Centurion University

Steps in development of inbred lines and hybrids varieties

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- Populations of cross pollinated crops are highly heterozygous as well as heterogeneous.
- When inbreeding is practiced they show severe inbreeding depression. So to avoid inbreeding depression and its undesirable effects, the breeding methods in the crop is designed in such a way that there will be a minimum inbreeding.
- The breeding methods commonly used in cross pollinated crops may be broadly grouped into two categories.

1. **Population Improvement:** Here mass selection or its modification are used to increase the frequency of desirable alleles, thus improving the characteristics of populations.
2. **Hybrid and synthetic varieties:** In this case a variable no. of strains are crossed to produced a hybrid population; the strains that are crossed are the selected on the basis of their combining ability.

Hybrid Varieties:

Hybrids varieties are the first (F1) generation from a cross between two or more purelines (rice, tomato), **inbreds** (maize, jowar, bajara, S. bicolor), clones or other genetically dissimilar populations / lines is used for commercial cultivation.

History

- Hybrid varieties were first commercially exploited in maize.
- **Beal in 1878** suggested that heterosis can be exploited by growing hybrids in maize (heterosis upto 52%).
- Later **Shull in 1909** suggested that inbreds can be developed from open pollinated varieties by continuous self fertilization and then inbreds could be combined to produced superior hybrids **(single cross hybrid).**

- Shull scheme could not be exploited commercially because of the following reasons :

1. Superior inbreds were not available in those days.
2. Since the female parent was an inbred hybrid seed produced per acre was low (30-40% low).
3. The male parent was also was an inbred so there is poor pollen availability

- **Double cross scheme** proposed by **Jones** in 1918.
- First double cross hybrid in U.S.A. was **Burr Leaming Dent** (1922) in maize.
- In India hybrid maize began in 1952 under AICRP on maize improvement. In collaboration with **Rock Feller Foundation**.
- Four maize hybrids were released **in 1961 Ganga -1, Ganga-101, Rangit and Deccan.**
- The first hybrid Jowar was released in 1964 i.e. **CSH-1** while that of Bajra **HB-1**.

Main Features of Hybrid Varieties

1. Productivity
2. Genetic constitution
3. Adaptability
4. Application
5. Resistant

Types of Hybrid

1. Intraspecific hybrid/ Intervarietal hybrid
   a) Single cross hybrid
   b) Three way cross hybrid
   c) Double cross hybrid
2. Double top cross
3. Multiple cross
4. Polycross
5. Interspecific hybrid/ Intrageneric hybrid
6. Intergeneric hybrid

Development of Hybrid

The production of hybrid varieties in maize consists of 3 steps

Development of Inbreds

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Evaluation and Selection of Productive Inbred Lines

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Production of Hybrid Seeds

Inbreed: An inbred is a nearly homozygous line obtained through continuous inbreeding of a cross pollinating species with selection accompanying inbreeding; it is maintained by close inbreeding, preferably by self pollination.

- **First cycle inbred:** Isolated from **open pollinated variety**, which may or may not subjected to population improvement.
- **Second, third or fourth cycle inbred:** Isolated from the **hybrid varieties**, depending on the no. of improvement cycle

Procedure for development of inbred lines and their evaluation

1. Development of inbred lines:

- By two methods; first by **continues self fertilization** of a cross-pollinated species and second **by doubling of haploids**
- Inbreeding of an OPV leads to many deficiencies like loss of vigour, reduction plant height, plants become susceptible to lodging, insects and pests and many other undesirable characters appear.
- After each selfing desirable plants are selected and self pollinated or sib pollinated. Usually it takes **6-7 generations** to attain near homozygosity.
- An inbred line can be maintained by **selfing or sibbing**.
- The purpose of inbreeding is to fix the desirable characters in homozygous condition in order to maintain them without any genetic change.

- The original selfed plants is generally referred as **So** plant and the first selfed progeny as **S1** second selfed progeny as **S2** as so on.
- The technique of inbreeding requires careful attention to prevent natural crossing. The inbred lines are identified by numbers, letters or combination of both.
- In India inbred lines are developed are released through co-ordinate maize improvement scheme & are designated as **CM (Co-ordinate maize), CS (Co-ordinate sorghum)** etc.

CM-100-199 - Yellow flint

CM-200-299 - Yellow Dent

CM-300-399 - White Flint

CM-400-499 - White Dent

CM-500-599 - Yellow

CM-600-699 - White

2. Evaluation of inbred lines:

- After an inbred line is developed, it is crossed with other inbreds and its productiveness in single and double cross combination is evaluated.
- The ability of an inbred to transmit desirable performance to its hybrid progenies is referred as its **combining ability**.

GCA : The average performance of an inbred line in a series of crosses with other inbred lines is known as GCA.

SCA : The excessive performance of a cross over and above the excepted performance based on GCA of the parents is known as specific combining ability.

Thus GCA is the characteristic of parents and SCA is characteristic of crosses or hybrids.

The inbreds are evaluated in following way.

1. Phenotypic evaluation: It is based on phenotypic performance of inbreds themselves. It is effective for characters, which are highly heritable i.e. high GCA. Poorly performing inbreds are rejected. The performance of inbreds is tested in replicated yield trials and the inbreds showing poor performance are discarded.

2. Top Cross test: The inbreds, which are selected on phenotypic evaluation, are crossed to a tester with wide genetic base e.g.. An OPV, a synthetic variety or a double cross. A simple way of producing top cross seed in maize is to plant alternate rows of the tester and the inbred line and the inbred line has to be detasselled.

3.Single cross evaluation: Out standing single cross combinations can be identified only by testing the performance of single cross. The remaining inbred lines after top cross test are generally crossed in diallel or line x tester mating design to test for SCA.

Number of single crosses with reciprocals = n (n-1)
Number of single crosses without reciprocals = n (n-1)/2

Prediction of the Performance of Double Cross Hybrids

- In a double cross hybrid, four inbred parents are involved
- Therefore, based on the procedure of testing of the breeding value of inbreds, the performance of a double cross hybrid can be predicted through any of the four methods indicated by Jenkins (1934). Starting with the simplest procedure these methods are:

a) Top-cross testing (one cross per inbred) to know the breeding value to each of the four inbreds (total 4 top-crosses per double cross).

b) Mean of the four non-parental single crosses involved in (AXB) X (CXD) double cross, viz., (AXC), (AXD), (BXC) and (BXD) (total 4 non-parental single crosses per double cross).

c) Average yield performance of all possible six crosses [n(n-1)/2], namely AXB, AXC, AXD, BXC, BXD and CXD (total six crosses per double cross).

d) **Average progeny-performance of each inbred** can be determined by the mean performance of each inbred in all possible single crosses where it occurs (n-1 crosses per inbred). For instance, the mean performance of AXB, AXC and AXD will determine the average breeding value of the inbred A. Similarly, the mean of AXB, BXC and BXD will indicate the potential of the inbred B and so on (total 12 crosses per double cross).

SYNTHETICS AND COMPOSITES VARIETIES

Synthetic variety: A variety which is developed by intermating in all possible combinations a number of inbred lines with good general combining ability (GCA) and mixing the seed of F1 crosses in equal quantity is referred to as synthetic variety.

- The use of synthetic variety for commercial cultivation was first suggested in maize by **Hayes and Garber (1919).**
- After release synthetic varieties are maintained by open pollination.

Main features of synthetic variety

1. Relevance
2. Base material
3. Genetic concept
4. Geneticconstitution
5. Adaptation
6. Disease resistance
7. Reconstitution
8. Yield level
9. Designation