



Accelerated Plant Breeding: Need of the Moment

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A plant breeding program typically consists of three stages (i) development of line or cultivar (ii) Multi location yield and field trials and (iii) Release of line as variety. Line development means developing a homozygous and stable line which usually takes several years (8-10 years). So generally to develop a new line or cultivar and bringing them to fields for cultivation it takes a lot of time period or we can say it's a very lengthy process. The major bottle neck in a breeding program is prolonged line development stage. Accelerated plant breeding means involving techniques which accelerates lengthy breeding cycles and in short time period they can be completed.

Need For Accelerated Plant Breeding

The recent trends in population boom showing that till 2050 the human population will reach the mark of 10 billion, to feed them all will be a major challenge. The land area under cultivation is also stable and predictions show that it won't increase in future. Crop yield productions are increasing but not at the rate of which it should be. Frequent climatic fluctuations also arising a major question in attaining global food security. All these challenges mark a big question mark in front of plant breeders as they have to develop high yielding and resistant cultivars in short time period, but the conventional breeding programmers take a long time to develop a cultivars so plant breeders had a major task to develop such techniques that can hasten the breeding cycles and program.

Techniques of Accelerated Plant Breeding

There are several techniques whose implementation speed up the prolong stages of cultivar development. Those techniques are as follows.

Shuttle Breeding

- It means in a same year at two different locations two successive generations are grown.
- This technique was developed at CIMMYT and later on popularized by Dr N.E. Borlaug.
- Shuttle breeding allows an additional generation of a crop in a year.

Doubled haploidy

- DHs (Double Haploids) are produced by doubling chromosomes in any haploids.
- Doubled haploidy is the method which immediately produces completely homozygous stable lines. It is the most rapid method of developing stable homozygous genotypes and significantly shortens the breeding program time period.
- There are several methods of producing double haploids such as anther and pollen culture, ovule culture, Bulbosum technique, Chromosome Elimination method.
- Wheat - maize system was used for developing first DH variety of wheat i.e., Him-Pratham in India by Dr. H. K. Choudhary.

Speed breeding

- Speed breeding is a technique to enable rapid generation cycles by shortening breeding cycles which mainly involves growing crop plant in an extended photoperiod and controlled growing conditions.
- The concept of SB was inspired by NASA's technique of crop cultivation in space research station in constant light.
- SB techniques accelerate reproductive process in plants which enables rapid development of new cultivars.
- SB techniques mainly manipulate light intensity, photoperiod, temperature, humidity, plant density, CO₂ concentration and soil moisture levels which leads to faster plant growth, induction of early flowering and early seed ripening which results in short life cycles of a plant and like this SB shortens the breeding cycles of crop plant.
- This technique allows us to get several generation of crop in a single year whereas only one or two generations we can get in traditional breeding methods.

MAS (Marker assisted Selection)

- Breeding program based on markers is called marker assisted selection. In MAS, desired genes or QTLs are selected on the basis tightly linked markers.
- MAS allow quick recognition of genes and QTLs and introgression of those genes QTLs in minimal crosses which hasten breeding programmes.
- The major merits of MAS are as they can be used at any stage (non stage specific), won't affected by environment, also reduces the number of lines or individuals as only desired ones are selected and others are discarded and will fast track the breeding programmes and thus more generation per year can be attained.

Genomic Selection

- GS is a specific type of MAS in which genetic worth of an individual is predicted on the basis of markers distributed over whole genome.
- In GS method the genetic worth of an individual is estimated or predicted by estimation of GEBVs (Genomic Estimated Breeding Values) with the help of genomic selection models. After estimation of GEBVs only those lines or individuals are selected who's having high genetic gain or genetic worth and it will reduces the time needed for selection process and also increases the efficiency of selection.
- From breeder's equation it is known that more the genetic gain will be less the time or generation cycles. So like this GS will reduce the number of generations and accelerates the breeding program.

Conclusion

As the population is increasing rapidly day by day to feed them all with good nutritive and sufficient amount of food and to achieve global food security we have to boost up our production levels and plant breeding always played a major role in it. These techniques will induce rapid development of resistant and high yielding varieties to ensure food security and meet our increasing needs. These techniques not only shorten breeding cycle but will also improve selection efficiency so that in very short period superior genotypes can be developed. Moreover breeders have to develop and implement new advance methodologies and techniques to meet up all the requirement and challenges.

References

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