Course Name: Basics of Crop Breeding and Plant Biotechnology

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Lecture-12: Modifications of Mass Selection

Welcome back, so we will continue again. Now, let us discuss about the different modifications of mass selection. So, why modifications are needed? In mass selection we are doing selection based on the morphology. Now onwards we are gradually moving to the cross-pollinated species solely. So, let's assume a cross- pollinated field is there, a maize crop is being grown, so 5000 plants are there. So, any one of this plant can produce pollen grains to fertilize another plant in the field and we are initially selecting based on the morphology at the early stage we are selecting these plants.

So, we do not have any control over the pollen producing plant. So, pollen may come from an inferior plants also, so some modifications are needed. So, first modification, in early stage only superior plants are selected and rogging out the inferior plants, means we can remove the inferior plants from the field, only the superior plants will be grown over there. So, the pollen grains from the inferior plants will not come within the superior plant.

In next generation the inferior allele could be minimized. Next, manually the pollen grains from superior variety is provided through bagging. Over here first suppose these are the different plants growing in the maize field, first we need to select some plants based on phenotype. Once selection is done then we have to bag the plant, so that the pollen grains from other plants cannot come over here. Then we have to collect the pollen grains from this plant specifically and after collecting the pollen grains from this plant, will do fertilization in this plants means no outside pollens are allowed.

But what we are doing first, we are collecting a pollen grains from the superior plants, we are putting it in a bag and then bag is used for pollination of female flowers in those plants, in those corn plants. Next one that is very important thing that is stratified mass selection ok! So, before discussing the stratified mass selection first thing that in normal mass selection, different corn plants are being grown in the field ok! We are identifying some of them based on their phenotype. In this field over here the irrigation is being provided, irrigation channel is available in this side.

So, the plants over here they are getting proper irrigation while the plants which is growing in this side, they are getting less amount of water. You know that in maize a huge water is needed. So the plants in this side, they may perform better; our selection process may be dependent on the environment right? So, the stratified mass selection is conducted. In stratified mass selection basically the field is divided into different grids ok!

Suppose a field is divided into this type of grid ok! So, after making the grid ok… we have to.. we have to create some environmental variations. Suppose irrigation is given from here ok! So, this plants will be getting maximum irrigation, this line, this line will be getting moderate irrigation and this line will be getting less irrigation ok! Suppose we are applying nitrogen also in different dose, in these lines maybe we are getting high nitrogen, these lines are given moderate nitrogen and these lines are given low nitrogen ok!

In this way we can make a stratified field, we can make a grid. Then we are growing our maize seeds over here. We are growing different maize seeds over here in each and every grid and we have to select from each and every grid. Our selection should be done from each and every grid. So, that the environmental factor could be minimized through stratified mass selection.

So, it is done to increase the selection efficiency using stratified mass selection, a plant population is divided into groups according to features or characteristics and mass selection is then applied independently within each group. It assists breeder in maintaining genetic diversity while concentrating on particular features or adaptations. So, here from

adaptations will be improved isn't it. The plants what we are selecting they can be adapted for lower nitrogen, they can be adapted for low irrigation, they can be adapted for high nitrogen as well as for high irrigation. So, the adaptation will be more.

Now this is another method of modification of mass selection without progeny testing. Here inclusion of checked variety could be done. In mass selection, different maize plants were being grown in the field. So, according to this modification maybe after 10 to 50 rows in this way we have grown maize lines. Similarly after 10 to 50 rows we have to grow a check variety.

So, check variety will be highly suitable at that particular agro-climatic condition, its yield will be maximum. So, based on this check variety we have to do selection. Again we will be growing our targeted maize maybe in 10 to 50 rows, thereafter again we will show another check variety in a particular row; our check variety will be used. So, in this way after sowing the seeds of few rows we can put a check variety in the field. So, whatever we are selecting we have to compare it with the check variety. Whether it is better or not?

If it is better, then only we will do the selection. So, selection will be done based on the performance compared to the check variety. This strategy contributes to both preserving genetic variability and strengthening the breeding program. So, that ultimately whatever we will be getting that would be superior to our check variety. So, now gradually we are moving to the modifications of mass selection with progeny testing.

So, so far, whatever we have discussed different modifications of mass selection we have discussed no progeny testing was done that is one of the demerits of mass selection because we are selecting based on the phenotype. So, capital A capital A could be there and capital A small a could be, there based on phenotype we cannot discriminate it. So, if we go to progeny testing then we can know which one is more beneficial, which one is better right? So, progeny testing is important. So, modifications of mass selection with progeny testing involves combining mass selection with the evolution of progeny or offspring in the next generation.

So, why it is done? To enhance the efficacy and precision of the breeding process. Next it helps in maintaining the genetic potential of chosen parents, the genetic potential of the chosen parent is maintained and their capacity to pass on the desired qualities to their progeny is also maintained. This based on phenotype we cannot tell, whether that trait will be converted, will be transferred to next generation or not? So, the progeny testing is highly beneficial. So, this is one important modification of mass selection with progeny testing that is "ear to row" method.

You know that most of the breeding strategy in a cross-pollinated species was initially developed by considering maize plant as a model ok! So, this "ear to row" method was discovered at that time. So, what is done in "ear to row" method? So, here first 1000 to 5000 plants are being grown and there from 50 to 100 number of plants are selected on the basis of their phenotype; that is similar to the mass selection.. normal mass selection. They are allowed to open pollinate, also we are selecting 50 to 100 plants they are allowed to open pollinate. The seeds from individual plants are selected and harvested separately.

In earlier we were pulling the seeds, we are harvesting the seeds in bulk, but here we need to select it separately, their seeds will be harvested separately. Then in next generation a single row of 10 to 50 plants, i.e. progeny row is grown from each of the selected plants. The progeny rows are evaluated for desirable characters and superiors are identified. Then several phenotypically superior plants are selected from the superior progenies and selected plants are permitted to open pollinate. And the small progeny rows are again grown from the selected plants and the process of selection could be repeated.

So, in this way a number of generation could be done for improving the selection process. So, this is the scheme, two different schemes are followed in "ear to row" method. According to first scheme the scheme 1; the open pollinated plant progenies grown from the selected plants, here from we need to select some plants, it will be open pollinated in next generation, will grow progeny ok! From this progeny row we need to identify some of the individuals. Some of the individuals are identified again, we can grow plant to

progeny row or they will be allowed to open pollinate and in next generation, it will be grown.

So, over here open pollination could be done and in next generation again plant to progeny row could be grown. So, it could be repeated for one or more times this is one scheme. According to second scheme, in first generation we are identifying some plants based on its phenotype those plants are being open pollinated in the field. So, whatever the seeds are being produced from this plants we are just dividing the seeds into two parts. So, first 50 percent seeds will be grown in next generation and we are evaluating the seeds of plant 1, the seeds coming from plant 2… in this way we are evaluating it.

And this is plant 5, this is plant 9 in this way different plants are being evaluated. Suppose over here this progeny is found better, this progeny is found better. So, in next generation we had the 50 percent seed of this plant, in next generation the seeds from those selected individuals, their 50 percent seeds will be bulked together and it will be grown. So, in this way the here over here… different plants will be grown, the bulked seeds of the selected individuals from here. So, basically seed was collected in the first generation based on this performance, we are selecting the previous generation seed.

And finally, we are growing it in third generation and we are allowing to open pollinate and then again we can grow to the plant to progeny row again, selection could be done over here. So, in this way the scheme "ear to row method" is followed. Now let us discuss about the different modifications of mass selection with progeny testing. From "ear to row" method we are dealing with the progeny testing, progeny rows are being made ok! Ear means the maize cobs, are known as ear ok! Ear to row method the name has been derived in that way.

So, let us discuss the first modification of mass selection with progeny testing. Over here instead of open pollination, caging of the selected plants are done and seeds collection, seeds is collected from them separately means over here different plants are being grown. We are not conducting open pollination it is a modification. So, suppose this plant is

selected this plant is selected.

So, we can cage this plant. So, only selfing will be done over here ok! Through selfing its progeny will be coming in next generation, will grow plant to progeny row, then again we can start the selection and those things. Next coming to another modification of mass selection with progeny testing, that is half-sib method that is very important. The breeding process can be made more effective and efficient by incorporating the half-sib approach with mass selection. Rather than selecting individual plants based on their performance in mass selected population we can form different half-sib families by deliberately controlling the pollination process.

What I will discuss! Next, the different male plants that is the pollen donors are suitable testers, means as a pollen donors suitable tester are used having broad genetic base to pollinate the female parent. Now, first what does the name means? Half-sib means among two individuals if one parent is common then it is known as half-sib ok! If one parent is common in 2 individuals then these 2 are known as half-sib. Over here suppose the maize plants are being grown in the field we have to do selection from here. What we are doing earlier in the just previous slide in the last modification we have selected some plants based on its phenotype and we bagged it.

We allowed for selfing right. Over here, we are selecting some plants and we are crossing this plant with a tester male plant. In tester male plant it is a population also having broad genetic base ok! Means different maize lines are being produced having broad genetic base. So, from this tester parent which is used as a male parent, first we need to collect the pollen grains. We need to collect the pollen grains. That collected pollen grains will be used to fertilize each and every selected plant in our original population. And after fertilization we will grow the plant to progeny row.

So, in this plant if you see about the progeny of this plant ok! Here this mother plant is common over here. So, in this way we can do the half-sib method of selection. Next we can discuss about the full-sib method that is another modification of mass selection with

progeny testing. So, in full-sib method, it is the breeding strategy that involves controlled pollination to create families of plants, here different plant families are generated where all offspring within a family share the same male and female plants. Over here first we need to identify some plants.

Suppose we have identified plant number 1, we have identified plant number 2, this is plant 3, this is plant 4 then we will do bagging and we will do crossing in such a way, 1 will be crossed with 2, 1 will be crossed with 2, 3 will be crossed with 4 and in next generation we will get the progeny of 1 crossed with 2, 3 crossed with 4. So, among these plants both the parents are common right, all of these individuals will be having both the parents common. So, the full-sib method of breeding strategy involve controlled pollination to create families of plants where all offspring within a family share same male and female plants. Within this family, all is having, all is sharing same male and female plants. This method is commonly used in plant breeding particularly for species where controlled pollination is necessary. Then each family represents a distinct set of offspring from the specific cross.

So, it represents 2 and 1 cross 1 and 2 cross only, it represents only 3 and 4 cross. So, based on that we can identify in this 2 crosses, if once the cross was made between 3 and 4 it could be better compared to 1 and 2. So, our selection will be more beneficial and the best performing full-sib families, best performing full-sib families those with most desirable traits are selected for further breeding ok! Which one is better over here that is selected for further breeding, these selected families are maintained as separate breeding lines. The full sib method is often used in plant breeding when breeders want to maintain specific combinations of genes ok!

Specific genetic combinations will be coming from here, plant 3 and plant 4 their genetic constitutions are different compared to plant 1 and 2. So, specific genetic combinations will be there and it is commonly employed in the development of hybrid varieties. So, later on we will discuss about the recurrent selection. Through recurrent selection gradually we can develop the inbred lines. Once the inbred lines are observed then also we have to

follow the full-sib method to develop the hybrid variety, suitable hybrid varieties. So, that our performance could be predicted, what could be the final performance, we can predict based on this type of full-sib analysis.

So, this is last modification of mass selection with progeny testing. Over here first we need to grow the plants. There are no bagga… no bagging is done we have to select based on the morphology and we will do open pollination. After open pollination in next year in spite of growing in rows, will grow in replicated yield trial, will grow in replicated trial in multi-location conditions, means in different locations we will use the seeds of this particular process. Suppose its seed will be grown over here, over here, over here.. these are 3 different locations. In this way its seed also will be grown in 3 locations. So, in this way the replicated yield trial will be done and here from will identify the suitable plants based on the yield data. So, the plants which will be showing best yield data… it will be pooled and will allow to cross in all possible combination in next generation.

Suppose this is the plant 1 product, the plant 2's product were being grown over here, the plant 3's product was being grown over here. If plant was found to perform better in 3 different locations in 3 replications then will pool the seeds of the plant 1's product and over here those seeds will be grown and it will be open pollinated again. So, let us discuss the merits and demerits of mass selection. In merits the varieties developed will be having more adaptability since each plant is genotypically not similar. They have buffering action, means we are having capital A capital A capital B small b, we are having capital A small a capital B small b… this different genetic combinations will be available in the population.

So, some buffering action is available over there. If (some) under certain circumstances new races come, new stresses arise; then the plant can sustain because the genetic base become broad. Then… time taken for release of a variety is less. If you recall the pedigree method, if you recall the backcross method, over there you had to do at least 10 to 12 generation of selection, then preliminary yield trial, replicated yield trial those things ok! Because we need to get a pure homozygous line, but over here we are just selecting either

based on phenotype or we are doing plant to progeny testing for a couple of generations.

So, the time taken for release of a variety is less. Next one, the genetic variability present in the original population is maintained. In the original population whatever the genetic variability is available we are maintaining it, because mostly we are discussing about cross-pollinated species right? We are trying to reduce the inferior allele, but under heterozygote condition those alleles will be available. So, the variability present in the original population could be maintained.

Now let us discuss about the demerits of mass selection. First compared to pure line variety they may not be uniform, because at the end of mass selection we will be having this, will be having this also right? So, their features might be different. So, they may not be uniform. It may be little bit taller ok!

These plants, their seeds may be little bit bold ok! This type of features may be raised. Next in absence of progeny test we are not sure whether the superiority of the selected plant is due to environment or genotype. So, if you consider the initial mass selection, so progeny testing is not done over there. So, until and unless we do progeny test we cannot tell that the plants what we have been selected whether the phenotype is due to environment or it is due to the genetic factor because, if it is growing close to the irrigation source, the nutrient source it may perform better, the environment may have big impact. So, in next generation we have to confirm it through plant to progeny testing.

Next may not be as uniform as that of pureline variety and certification is difficult. It is true in mass selection in case of self-pollinated crops also will be getting capital A capital A small b small b or small a small a capital B capital B. Both the things will be available at the end of mass selection right. It will be homozygous in nature, but it will be a mixture of different pure lines… kind of thing. So, it is.. as it will be a mixture so the plants will not be look alike it will not be uniform.

So, the seed certification will be difficult over there. Now what are the different

applications of mass selection? It can be done for improvement of the local variety. Suppose a local chickpea variety is being grown in a farmer's field for last 20 years. So, we can purify it through mass selection, some inferior types will be removed and the superior will be aggregated together. Next the purification of the existing pureline. Suppose existing pureline variety is there, it is true for the cross-pollinated… it is true for the self-pollinated one.

Suppose the existing pureline variety we are having ok! And due to course.. means during the course of the time some mutation has been occurred over there. Initially genotype was this and due to some mutation this allele has been formed the small b allele has been formed as it is a self-pollinated crop. So, due to selfing for again and again, ultimately we are having this, we are having this after the end of 5 to 6 generation of selfing. So, from this its progeny will be pureline, its progeny will be pureline right?

The homozygous self-pollinated crop its progeny. So, we can purify it from here through the mass selection process. So, these are the references of the mass selection what we have discussed mostly today. In next class we will discuss about the recurrent selection.