Course Name: Basics of Crop Breeding and Plant Biotechnology

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Lecture-14: Reciprocal Recurrent Selection

Welcome back. So, we will continue again. So, now coming to the reciprocal recurrent selection i.e. another important part or i.e. the mostly exciting part also. Ok! So, reciprocal, what is reciprocal cross? So, in reciprocal cross suppose plant 1 and plant 2, these two plants are being crossed. Plant 1 is used as a female and plant 2 is used as a male. Ok! This is normal cross.

In reciprocal cross one cross will be like this, in another cross plant 1 will be used as a male while, the plant 2 is used as a female. This type of things is done, i.e. normally the reciprocal cross. Anyway so, we will be discussing about the reciprocal recurrent selection. Ok! So, in reciprocal recurrent selection is a breeding method, that improves both general combining ability i.e. GCA and specific combining ability for a trait.

So, for a particular trait wherever we have to go to reciprocal recurrent selection, then the trait will be applicable for the, means, our selection will be done for general combining ability as well as for specific combining ability. Both things will be controlled together. Ok! So, it uses two heterozygous testers. In recurrent selection for GCA you can recall, we had one tester having broad genetic base. In recurrent selection for SCA we had one tester having inbred population, narrow genetic base.

But over here we have to use two different testers, ok, and two heterozygous testers having broad genetic base. And the alternating roles are there and selective breeding is done to enhance populations genetic potential for desired trait. So, that the desired trait

could be achieved. The selective breeding methods is done. It is very specific method we would like to discuss.

So, this method was introduced by Comstock and his colleagues, two of his colleagues were involved there also, and it was discovered in 1949. So, what are the main features of reciprocal recurrent selection? First of all reciprocal recurrent selection is used for improving polygenic characters. Ok! Polygenic characters mean, a particular character i.e. controlled by more number of genes. Ok! If you think about the simple recurrent selection then it is controlled for those characters which is highly heritable. They are mostly oligogenic or monogenic character.

Over here in case of reciprocal recurrent selection it is used for improving polygenic characters. Ok! Again, here also selection is based on test cross performance. Here two types of test cross are done, later on we will be coming to it. Then two heterozygous populations are used here. Two heterozygous populations, population 1, population may be termed as population A another one is population B will be heterozygous populations they serve as tester.

It enhance both GCA and SCA, we have just discussed few minutes before for a specific trait. Then reciprocal recurrent selection is effective with various type of, various types of dominance, ok, genetic gene dominance like incomplete dominance, complete dominance, over dominance. Ok! Under all these conditions, this reciprocal recurrent selection could be useful. It is used for traits influenced by both additive and non-additive gene action i.e. another important thing. It is used for those traits which are influenced by both additive gene action, as well as non-additive gene actions.

And each selection cycles requires three seasons or years like recurrent selection for GCA, recurrent selection for SCA. There also three seasons or three years are needed in RRS, reciprocal recurrent selection also, three years are needed. So now, let us discuss about the reciprocal recurrent selection. So, first of all, we need two population over here ok. Both the population will be having broad genetic base, will be highly heterozygous

in nature and heterogeneous is nature also.

So let us assume, one population is population A and one population is population B. We have two different populations. Ok! In first year, two populations are being grown in two different fields. So then based on the phenotypic performance, we need to identify some plants from here. Let us assume, we are identifying A_1, we are identifying A_2, we are identifying A_1 from here.

These three plants have been identified based on its morphology. While from here we need to select some plants like B_1, B_2, B_3 we need to select from here also. Then in these plants what we will be doing? First, we need to bag it, so that the selfing could be done in this plant. We, should be, means, we have to make sure that selfing should be done in the selected plants. In addition, to that basically the pollen grains of A_1 plants will be used to cross a number of plants over here, while the pollen grains of B_1 also will be used to cross a number of plants over here.

So based on that, we will be having test cross progeny for population A, and the test cross progeny for population B. Ok! Once we will be getting the test cross progeny for separately, for population A and for population B, in next year we have to grow this test cross progeny. We have to make separate field trials for A and for B test cross progeny. Ok! So based on this test cross evaluation, we need to identify parents. If you just recall the recurrent selection for GCA or SCA you can understand that, based on test cross how we need to identify the parents. Ok!

Then once we will identify suitable parents suppose, A_1 is better, A_3 is better while, from here suppose we got B_1 is performing better, B_2 is performing better, then therefrom we will identify those lines. In next generation, the selfed seed of those plants A_1 and A_3 will be grown over here, while the B_1 and B_2 will be grown over here, in this way. Ok! And here the separate inter cross block is developed for population A and for population B. So, once this separate inter cross block is made, then all possible inter-crossing is done between the plants available over here while, in population B also all possible inter-cross

is done. So, in 3 years, our initial cycle is being completed.

So, thereafter, once we will get the inter-cross seeds then we can pool the inter-cross seeds coming from here, the equal amount of inter-cross seeds is taken from here to develop the population, a new population A will be developed. While, if we pool the seeds coming from the inter-crossing, from here then you will get the new population B. Ok! In this way, in 3 years first selection cycle could be completed and thereafter, we can repeat this cycle once again to improve the efficiency. And finally, if you see carefully here, we are doing analysis for GCA means, one plant is being crossed with a multiple tester, then another plant is being crossed with multiple tester. So, some average performance we will be getting.

So, now let us compare among different recurrent selection schemes. So, first of all, in the absence of epistasis and multiple allele linkage. Now, what is epistasis? Suppose A is a gene available in chromosome number 5, while, B is another gene available in chromosome number 7. Ok! Suppose if a substrate is available in our system, then, first the A enzyme works on this, then it makes an intermediate product. On this intermediate product, the B gene works or B enzyme works and thereafter, we get the final product.

So, if we have to get the final product, these two genes might be available means, for this trait it may be an epistasis kind of things means, the function of these two genes are needed to finally, get this product ok! So, this is an epistatic scenario. Suppose, if capital A and capital B both genes are available maybe we can see black color. If small a small a capital B is available then also, we can see black color. If small a small a small b small b is available then we can see white color.

It is an epistatic character. Here, we may put any alleles ok, we may put capital A capital A capital B capital B or capital A small a capital B small b it could be black. While for A gene, if it is homozygous recessive small a small a, if it stays with capital B then also, we can see black. Yeah, I am just providing an example. Ok! And if small a small a small b small b is there, then we can see white color. Ok!

Means, two genes are governing a particular phenotype together ok, but they are located at a different place they are not at all allele of a particular gene ok, their loci are different. So, this is the epistasis. So, let us discuss over here. So, when dominance is incomplete means, incomplete dominance is there. Ok! Then reciprocal recurrent selection and recurrent selection for GCA would be comparable means, these two will be almost similar and they will be superior to recurrent selection for SCA.

This two will be superior if dominance is incomplete. Now when the dominance is complete ok, then it was found that the recurrent selection for GCA, the recurrent selection for SCA, as well as reciprocal recurrent selection all of these were equally effective. Ok! While, when the over dominance is there, when there is over dominance. So, initially we have discussed about incomplete dominance or partial dominance. So, when over dominance is there then, the reciprocal recurrent selection and reciprocal and recurrent selection for specific combining ability would be comparable means, RRS and recurrent selection for specific combining ability. This two will be comparable and this two will be superior to recurrent selection for GCA. Ok!

Now, in presence of epistasis and multiple allele linkage earlier we have discussed, wherever, the epistasis was not present, epistasis was absent. Now, we are coming to, in presence of epistasis and multiple allele linkage. Ok! So, in case of epistasis, reciprocal recurrent selection is superior to both recurrent selection for GCA, as well as recurrent selection for SCA means, RRS will be more beneficial if A and B gene are showing epistasis. Ok! Next one, the reciprocal recurrent selection could be considered superior in certain practical situations especially, when dealing with complex genetic scenarios a lot of genetic interactions are there, at that particular circumstances the reciprocal recurrent selection will be beneficial rather than going for recurrent selection for GCA or SCA. Ok!

So, when there is a lot of epistasis is there, when multiple allele linkage is there, then RRS will be beneficial, and in nature mostly this type of things is available. Ok! In cross-pollinated species also this type of non-allelic linkage or epistasis factors might find

means, they are mostly finding to play crucial role. Now, let us discuss, what are the different advantages of recurrent selection? First of all, genetic improvement it allows for continuous genetic improvement of a population for specific traits over multiple generations means, you have seen that within 2 years or within 3 years, one selection cycle could be completed, right? So, the continuous genetic improvement in a cross-pollinated species, we can do through this type of recurrent selection for multiple generations maybe, we have done a selection for 3 years thereafter, we can do the same selection for another 3 years, or for another 6 years. So, that the favorable allele will be more in our population. Ok! Next the adaptation, it can enhance the adaptability of a population to local or changing environmental conditions. If we repeat the selection process suppose, after 3 years again we are doing such type of recurrent selection. So, what will be happening? You know that due to global warming the average day temperature is increasing Ok! So, for this increase, in average day temperature in certain crops we are facing pollen sterility, ok! the lack of seed production the seed production is getting minimized. Ok!

So, in those crop species, the based-on means, if we repeat this type of selection process again and again. So, it is adaptability will be more. Ok! So, in the… in the current scenario in the present agro-climatic conditions whatever, the cross combinations will be suitable we can take it to the next generation. We can use those parents for preparation of synthetics or preparation of hybrid varieties. Ok! So, our adaptability will be more and it will be based on the environmental changes.

Then maintains genetic diversity i.e. true in case of cross-pollinated crop, it helps to maintain the genetic diversity by avoiding extreme selection pressure. Ok! Means, here within the population we are selecting, not our target is to get a homozygous individual, ok! So, sufficient heterozygosity should be maintained within the population. Next, non-additive effect, it can capture non additive gene effects, that are important for some traits. For some traits non-additive gene effects are highly important. Ok!

We have discussed earlier also. So, the recurrent selection could be useful for those

traits also. Now, let us discuss, about the different disadvantages of recurrent selection. First of all, time consuming it is a time-consuming process. Although in 3 years our selection process could be finished for recurrent selection for GCA, recurrent selection for SCA, but there is a chance of further improvement, right? We are not.. we are not getting a population or we are we are not getting a particular inbred lines within 3 generation.

So, maybe we have to repeat this process for a couple of generations. So, several generations are needed to achieve significant improvements. Ok! To achieve minute improvements, for improvements are observed in each and every generation ok, each and every cycle, but to achieve significant improvement maybe we have to repeat the process for at least 3 - 4 recurrent selection, could be done 3 - 4 cycles could be done. Then resource intensive i.e. a very important point. Recurrent selection programs can be costly in terms of time, labor and resources.

If you recall the recurrent selection for GCA, if you recall the recurrent selection for SCA or reciprocal recurrent selection, we have to identify the plants at the early stage. Then we need to self those plants, we need to collect the pollen grains from those plants and we have to cross different tester plants ok! So, it is a huge process ok, lots of times are needed, a skillful labor, skilled labors are needed and they have to do the experiment meticulously. Otherwise in test cross generation we may identify some undesirable parent ok! because our selection will be based on the test cross. So, i.e. the very important thing we have to make the cross properly.

Then we have to maintain the selfed seeds also. So, that in third year we can grow the selfed seeds in row and we can make all possible inter-crossing. Ok! Then third disadvantage is that the complex management, the managing and tracking multiple generations and populations can be logistically challenging. If a breeder, plan to play with 4 - 8 different combinations, different combinations of heterozygous populations, suppose he is planning to attempt 4 different reciprocal recurrent selection. So, it could be next to impossible, it could be very challenging, very complex scenario ok, to

maintain all these processes, to make selfed progeny, to utilize different labors for doing these things, it is very challenging. Then it is limited to specific traits, it may not be suitable for all stress, all traits especially, those with low heritability. Ok!

Although the epistatic factors are controlled over there, but if a trait is very less heritability means, environment has a big impact over there, then we may face some problem. Suppose, we have grown the suppose, we are doing for some specific disease resistance and that disease occurs only in the hot and humid condition ok, maybe in the hot and humid condition that disease occurs. So, we are doing the, we are doing the trial of the checks means, of the test cross, we are checking the test cross in a particular year, on that year the hot and humid scenario was not prevailed. Ok! It was extremely dry heat, maybe the rainfall was low on that particular area on that particular year.

So, our selection process could be impacted. Ok! So, if the traits are having very low heritability, then we may face problem over here also. Then potential for inbreeding, ok! So, without careful management, it can lead to increase level of inbreeding in the population. As the self progenies are grown and we are trying to make crosses between the self progenies of different lines. So, again in next generation we are mixing those seeds.

So, some amount of inbreeding is understood, it will be done. But until and unless we take proper care and the level of inbreeding could be more. Because if we go to the next selection cycle, definitely some of the plants will be having same parenting. So, the inbred they will be gradually becoming in-breeds. Ok!

So, highest level of inbreeding should be minimized. Other than selfing, we should minimize the level of inbreeding also in the population. Then uncertain outcomes, the success of recurrent selection depends on genetic architecture of the traits and the breeding goals. Ok! Outcome, can be unpredictable for some traits. Maybe we are thinking for a particular trait that are highly heritable, it is fine. But along with that some non-specific trait means, that was not in our mind that unfavorable trait may come in the

product also. Ok!

So, these are the reference of this particular course. You guys are enjoying. So, thank you. Thank you.