

## *Lecture: - 7*

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### **Components of Genetic Variation: Heritability and Genetic Advance**

**7.1 Genetic variance:-**It refers to the heritable portion of total variance or phenotypic variance.

- It is most useful variability and exploitable by the breeder.
- It is measured in terms of genotypic variance .
- It consist of additive, dominance and epistatic components ( $G=D+H+I$ )
- According to Fisher(1918):- It is of 3 types, such as;Additive variance, Dominance variance, Epistatic variance.

**7.2 Additive variance:-**It refers to that portion of genetic variance which result due to average effects of genes on all segregating loci.

- Arises of from difference between two homozygotes for a gene i.e. AA and aa.
- It is generally represented by 'd'.
- It is due to lack of dominance.

#### **Features:**

- It is a measure of additive gene action. The additive gene show lack of dominance,i.e. intermediate expression.
- Additive genetic variance is associated with homozygosity and therefore, it is expected to be maximum in self-pollinating crops and minimum in cross pollinating crops.
- Additive variance is fixable and therefore selection for traits governed by such variance is very effective.
- Additive variance is required for estimation of heritability in narrow sense and response t selection is directly proportionate to narrow sense heritability.
- Breeding value of an individual is measured directly by the additive gene effect. The GCA effect of a parent is a measure of additive gene effects.
- Transgressive segregation is the result of additive gene action.

**7.3 Dominance variance:**-It is due to the deviation of heterozygote (Aa) phenotype from the average of phenotypic values of the two homozygotes (AA and aa) it is represented by 'h'.

- It is otherwise called as Intra allelic interaction
- It is due to incomplete or over-dominance.
- Selection for traits controlled by dominance variance is not effective.
- Heterosis breeding may be rewarding.

**Features:-**

- It is a measure of dominance gene action. Such gene show incomplete dominance, complete dominance or over dominance. In other words the heterozygote (Aa) does not represent mean value of two parent(AA and aa). It approaches more closely to one of the two parents for a particular character.
- Dominance variance is associated with heterozygosity and therefore it is expected to be maximum in cross pollinating crops and minimum in self-pollinating species.
- Dominance variance is not fixable and, therefore selection for traits controlled by such variance is not effective.
- Dominance variance is the chief cause of heterosis or hybrid vigour.
- Specific combination ability variance is the measure of dominance variance in diallele, partial diallele and line in to test cross analysis.
- Dominance variance gets depleted through Selfing or inbreeding.
- In natural breeding populations, dominance variance is always lesser than additive variance.

**7.4 Epistatic variance:-** It refers to the deviation from additive scheme as a consequence of inter-allelic interaction i.e. interaction between alleles of two or more different genes or loci.

- It is otherwise called as inter allelic Interaction.
- It is represented by 'e'.

**Features:**

- Epistatic variance includes both additive and non additive components.

- Hayman and Mather partitioned the epistatic component into three types of interactions – viz., is of three type viz, AA, AD and DD
- **additive x additive (AA)**:- it refers to interaction between two or more loci each exhibiting lack of dominance individually. It is denoted as A \* A and is fixable.it comes under additive gene action.
- **additive x dominance(AD)**:-It refers to interaction between two or more loci, one exhibiting lack of dominance and the other dominance individually. It is denoted as A\*D and is non fixable.
- **Dominance x dominance(DD)**:- It refers to interaction of two or more loci, each exhibiting dominance individually. It is represented as D\*D and is non-fixable.
- First type of epistatic is fixable and therefore, selection is effective for traits governed by such variance. The last two type of epistatic variances are unfixable and therefore heterosis breeding may be rewarding for traits exhibiting such variance.
- In the natural plant breeding population, epistatic variance has the lowest magnitude.

**7.5 Heritability**:-It is the ratio of genotypic variance to the phenotypic variance. Heritability denotes the proportion of phenotypic variance that is due to genotype i.e., heritable.

- It is generally expressed in percent (%)
- It is a good index of transmission of characters from parents to their offspring.

**Broad sense heritability**: - According to Falconer, broad sense heritability is the ratio of genotypic variance to total or phenotypic variance .

- It is calculated with the help of following formula where ,  $V_g$ = genotypic variance  $V_p$  = phenotypic variance  $V_e$  = error variance
- Heritability ( $h^2$ ) =  $V_g / V_p \times 100 = V_g / V_g + V_e \times 100$
- Separates genotypic from environmentally induced variance:  $h^2 = V_g / V_p$ .
- It can be estimated from both parental as well as segregating populations.
- It express the extent to which the phenotype is determined by the genotype , so called degree of genetic determination .
- It is most useful in clonal or highly selfing species in which genotypes are passed from parents to offspring more or less intact.

- It is useful in selection of superior lines from homozygous lines

**Narrow sense heritability:** - In outbreeding species evolutionary rates are affected by narrow- sense heritability.

- It is the ratio of additive or fixable genetic variance to the total or phenotypic variance Also known as degree of genetic resemblance .
- It is calculated with the help of following formula where VA or D = additive genetic variance VP or VP = phenotypic variance Heritability ( $h^2$ ) = VA / VP x 100 or  $\frac{1}{2} D / VP$
- It plays an important role in the selection process in plant breeding
- For estimation of narrow sense heritability , crosses have to be made in a definite fashion
- It is estimated from additive genetic variance.
- It is useful for plant breeding in selection of elite types from segregating populations.

**7.5 Genetic advance:**-Improvement in the mean genotypic value of selected plants over the parental population is known as genetic advance. It is the measure of genetic gain under selection

- The genetic advance is calculated by the following formula where ,  
K = standardize selection differential,  $h^2$  = heritability of the character under selection,  $\delta p$  = phenotypic standard deviation

$$h^2 (ns) GS = K \times h^2 \times \delta p$$