

13. QUALITATIVE AND QUANTITATIVE CHARACTERS

The phenotype of any individual can be classified into two types:

1) Qualitative characters and 2) Quantitative characters

1. Qualitative characters: The characters that show discontinuous variation and which cannot be measured easily are known as qualitative characters. These are also known as classical mendelian traits.

Eg: Corolla colour – Red white or pink \longrightarrow no continuous variation

Seed shape – Round wrinkled \longrightarrow variation is not continuous

2. Quantitative characters are those showing continuous variation and

Which can be measured easily. These characters are also known as metric traits. The data obtained from such characters is known as quantitative data. This data can be subjected to statistical analysis and the branch of science which deals with such analysis is known as quantitative genetics or biometrical genetics.

Eg: Yield, Plant height

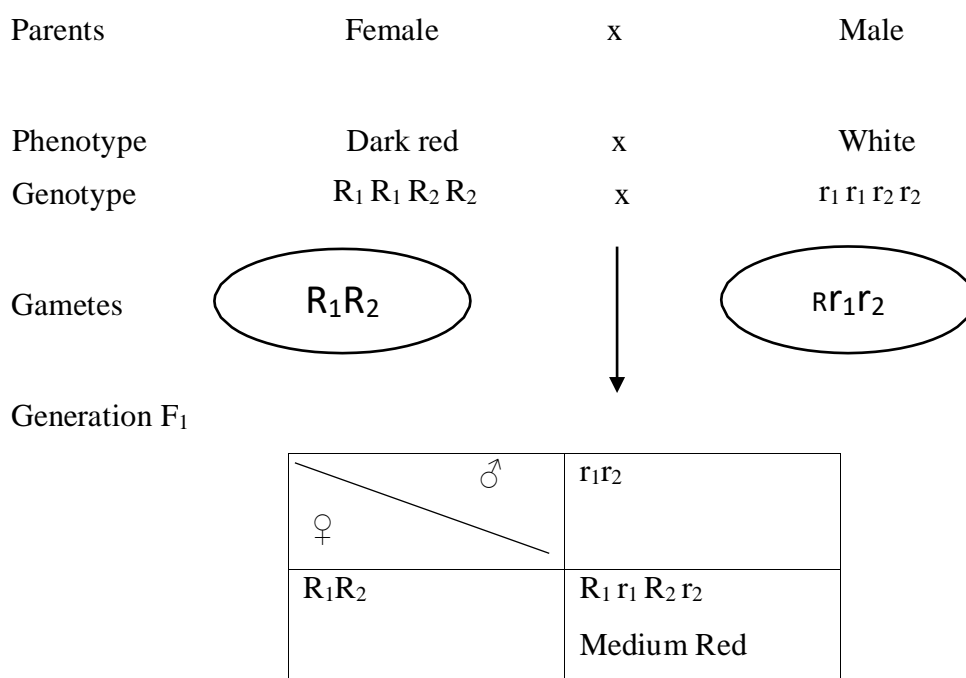
Differences between quantitative and qualitative characters

	Quantitative characters	Qualitative characters
Deals with	Traits of degree Eg: Plant height, seed weight, yield etc.	Traits of kind Eg: Corolla colour, seed shape, appearance etc
Variation	Continuous	Discontinuous
Effect of individual gene	Small and undetectable	Large and detectable
No. of genes involved	Several (polygenic)	one or few (mono /oligogenic)
Grouping into distinct Classes	Not possible	Possible
Effect of environment	High	Low
Metric measurement	Possible	Not Possible
Statistical analysis	Based on mean, variance, standard deviation etc	Based on ratios and frequencies
Stability	Low	High
Transgressive segregation of F ₂	Yes	No
Dominance effect	No	Yes
Cumulative effect of each gene	Yes	No

MULTIPLE FACTOR HYPOTHESIS

In early days of mendelian genetics it was thought that there was a fundamental difference in inheritance pattern of quantitative and qualitative traits. One of the

examples which helped to bridge the gap between these two kinds of traits is “multiple gene model” developed by Swedish Geneticist H. Nilsson Ehle in 1910 to explain inheritance of kernel colour in wheat. In studies on inheritance of kernel colour in wheat and oats, he obtained 3:1, 15:1 and 63:1 ratio between coloured and white seeds from different crosses. It is clear from these ratios that the seed colour was governed by one (3:1 ratio in F₂), two (15:1 ratio in F₂) or three (63:1 ratio in F₂) genes. Nilsson-Ehle found that in crosses showing 15:1 ratio in F₂ kernel colour is governed by two genes. However, on a closer examination of the coloured seeds, he found that there was a marked difference in the intensity of their colour. When he crossed a dark red strain to a white strain (or variety), he observed that all the F₁s were medium red (intermediate between the parental types). But in F₂ generation only one out of the sixteen were of parental types. He interpreted the results in terms of two genes, each with a pair of allele sexhibiting cumulative effects. Each of the dominant alleles R₁ and R₂ adds some red colour to the phenotype, while the recessive alleles r₁ and r₂ add no colour to the phenotype. Thus, dark red genotypes contain only R₁ and R₂ alleles while the white genotype contains none of these alleles.



On selfing

Parents	Female	x	Male
Phenotype	Medium Red	x	Medium Red
Genotype	$R_1 r_1 R_2 r_2$	x	$R_1 r_1 R_2 r_2$
	$R_1 R_2$		$R_1 R_2$
	$R_1 r_2$		$R_1 r_2$
	$r_1 R_2$		$r_1 R_2$
	$r_1 r_2$		$r_1 r_2$

Generation F₂

$\begin{matrix} \text{♂} \\ \diagdown \\ \text{♀} \end{matrix}$	$R_1 R_2$	$R_1 r_2$	$r_1 R_2$	$r_1 r_2$
$R_1 R_2$	$R_1 R_1 R_2 R_2$ Dark Red	$R_1 R_1 R_2 r_2$ Red	$R_1 r_1 R_2 R_2$ Red	$R_1 r_1 R_2 r_2$ Medium Red
$R_1 r_2$	$R_1 R_1 R_2 r_2$ Red	$R_1 R_1 r_2 r_2$ Medium Red	$R_1 r_1 R_2 r_2$ Medium Red	$R_1 r_1 r_2 r_2$ Light Red
$r_1 R_2$	$R_1 r_1 R_2 R_2$ Red	$R_1 r_1 R_2 r_2$ Medium Red	$r_1 r_1 R_2 R_2$ Medium Red	$r_1 r_1 R_2 r_2$ Light Red
$r_1 r_2$	$R_1 r_1 R_2 r_2$ Medium Red	$R_1 r_1 r_2 r_2$ Light Red	$r_1 r_1 R_2 r_2$ Light Red	$r_1 r_1 r_2 r_2$ White

Phenotypic ratio: 1 Dark Red: 4 Red: 6 Medium Red: 4 Light red: 1 white

Genotypic ratio: 1 $R_1 R_1 R_2 R_2$: 2 $R_1 R_1 R_2 r_2$: 1 $R_1 R_1 r_2 r_2$

: 2 $R_1 r_1 R_2 R_2$: 4 $R_1 r_1 R_2 r_2$: 2 $R_1 r_1 r_2 r_2$

: 1 $r_1 r_1 R_2 R_2$: 2 $r_1 r_1 R_2 r_2$: 1 $r_1 r_1 r_2 r_2$

S.No.	No. of Alleles for red colour	Phenotype	Frequency	Genotype	Frequency
1.	4	Dark Red	1	R1 R1 R2 R2	1
2.	3	Red	4	R1 R1 R2 r2	2
				R1 r1 R2 R2	2
3.	2	Medium Red	6	R1 R1 r2 r2	1
				R1 R1 r2 r2	4
				r1 r1 R2 R2	1
4.	1	Light Red	4	R1 r1 r2 r2	2
				r1 r1 R2 r2	2
5.	0	White	1	r1 r1 r2 r2	1

