

EXPERIMENT NO. 3.

AIM OF THE EXPERIMENT - Chi square analysis/ test for determining the goodness of fit of dihybrid ratio.

THEORY -

To test whether the dihybrid F_2 ratio obtained by performing tests using models are near or good enough to be regarded as Mendelian ratios, statistical analyses are performed. The best statistic used in such cases where we see the goodness of observed ratios or values with that of expected ratios is a Chi Square test, developed by Karl Pearson.

Statistically, any observed value having more than or equal to 95% similarity to expected values is regarded as good enough to conclude that the observed values are not deviations of the expected values.

In case of Mendelian dihybrid ratios, expected values for the character combinations in F_2 generation are Round-Yellow : Round-Green : Wrinkled-Yellow : Wrinkled-Green :: 9 : 3 : 3 : 1.

This is taken as our baseline, and called as Null hypothesis (H_0): The hypothesis of no variance. The Alternative hypothesis (H_a) is

that the observed values are deviations from the expected values. To conclude, we find Chi square statistic, and if it is more than the critical statistic for the given degree of freedom (d.f. = $n-1$) for p value of 0.05, the Null hypothesis is rejected, indicating a deviation of over 95%. Degree of freedom refers to the possible number of outcomes (here, 4 outcomes, viz Round-Yellow, Round-Green, Wrinkled-Yellow, Wrinkled-Green) minus 1.

On the other hand, if the Chi statistic is less than the critical value, the Null hypothesis is accepted, and we conclude that there is no variation between the observed and the expected values. The critical value is obtained from Chi square distribution table.

Materials required.

Chi square distribution table,
supplied data, Pen, Pencil, Notebook,
Calculator.

The supplied data :

Data Sets	Round-Yellow	Round-Green	Wrinkled Yellow	Wrinkled Green.
Observed Data 1	9	3	2	2
Observed Data 2.	315	106	101	34

Procedure :

(A) Degree of Freedom - Since, we have 4 variables, degree of freedom (d.f) = $n-1$
 $= 4-1$
 $= 3$

(B) Chi square Critical value - For d.f = 3, and p value of 0.05, the critical Chi square value is 7.815, as obtained from Chi square distribution table.

(C) The formula - Chi square value is calculated using the following formula.

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

; χ^2 = chi squared.
 O_i = Observed value
 E_i = Expected value.

④ Calculation and Tabulation :

DATA SET 1 :

The ratio of F_2 individuals as observed by in dihybrid cross of pea plants using models.

Table 1 : Calculation for Data set 1

Phenotype	Observed value (O)	Expected value (E)	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$	Chi Square
Round-Yellow	9	9	0	0	0	1.333
Round-Green	3	3	0	0	0	
Wrinkled Yellow	2	3	1	1	0.333	
Wrinkled Green	2	1	-1	1	1	

Inference-

Since our calculated Chi square value is less than this critical value, we accept the null hypothesis. That is, we did not exceed the respective critical value. Thus we conclude that the minor deviation is not

Significant, and the ratios obtained are good enough to fit the expected ratio of F_2 generation.

DATA SET 2:

The ratio of F_2 individuals as observed by G.J Mendel in dihybrid cross of pea plants.

For the given data, we first calculate the expected values. Since our total number of pea plants is 556, at which number the expected values at 9:3:3:1 ratio will be:

$$\text{Round-Yellow} = (556 \times 9) / 16 = 312.75$$

$$\text{Round-Green} = (556 \times 3) / 16 = 104.25$$

$$\text{Wrinkled-Yellow} = (556 \times 3) / 16 = 104.25$$

$$\text{Wrinkled-Green} = (556 \times 1) / 16 = 34.75$$

Table 2 : Calculation for Data set 2.

Phenotype	Observed value (O)	Expected value (E)	O-E	(O-E) ²	$\frac{(O-E)^2}{E}$	Chi Square
Round-Yellow	315	312.75	-2.25	5.06	0.016	0.163
Round-Green	106	104.25	-1.75	3.06	0.029	
Wrinkled-Yellow	101	104.25	3.25	10.56	0.101	
Wrinkled-Green.	34	34.75	0.75	0.56	0.016	

Inference -

Here, again the Chi square critical value at d.f = 3, and p value of 0.05, as obtained from the Chi square distribution table (7.815) is less than the Chi square value we have obtained (0.16307), the Null hypothesis is accepted. This means that there is no variance between the observed and the expected values.