CHI - Square test and its Significance:-

The chi - square test was 1st of all applied to the quantitative measurement of the Mendelian ratio. Although this method is also applied for bacterial colonization. In biological experiments & field survey. a part from quantitative data we have to deal with quantitative characters in genetical studies. The variable like seed colour & flower colour fall under a category, which has numerical value.

There are many such problems in which we are interested simply in counting the number of cases that fall into special categories. For eg., in tossing coins, we count the number, the heads in 20 tosses; in the study of genetics we count the number of progeny (F2 - generation). which inherits certain characters in public opinion polls. we count the number of favourable vote in a simple in quality controls where we count the number of defective items. in sample, in a study of performance we count the number passing & failing.

If we ~~count the number~~ campaign the actual results of a genetic cross with the expected results. They would rarely come out in exact agreement. In the actual experiment we donot expect to get results exactly equal to our expectation and degree of deviation is usually seen (observed).

To test the agreement between the hypothesis and observation, chi-square test are used.

(2)

Mendel in his crosses get 100 or 1000 of individuals but his result always were not equal to expectation. To record such deviation of results from the expectation chi-square test (χ^2 - test) has been used. The chi square test has can be understand well by the following of examples—

If we toss a coin 100 times & gets 46 head & 54 tails, we do think such an occurrence to be unusual. But supposed we get 40 head & 60 tails, this deviation is great enough to indicate that perhaps something other than chance is operating. The question arises how much deviation from the expected result can be purely due to the chance. & "obtained ratio" (observed ratio) fits the expected ratio" is called chi-square (χ^2) or goodness of fit".

definition

The formula for calculating chi-square is—

$$\chi^2 = \sum \left\{ \frac{(O - E)^2}{E} \right\}$$

where, χ → the greek letter chi - from which the chi-square test gets its name.

O → observed number or frequency.

E → Expected number or frequency

Σ → is the greek capital letter sigma but in the present context is called ~~as~~ a summation sign.

It has several application in statistical analysis such

1) To test the deviation of observed frequency from the expected frequency

2) To test the goodness of fitness.

3) To determine association between two or more ~~attrib~~ attributes, which are ~~important~~ important in biological

χ^2 $O_1 - E_1$ $O_2 - E_2$ $O_3 - E_3$

experiments & field survey.

The possible value of chi-square (χ^2) ranges upwards from zero. If the deviation between observed & expected frequency are large then the square deviation of $(O-E)^2$ is also large. The large ratio of $(O-E)^2/E$ occurs when actual & expected value differ considerably & make the size of χ^2 large.

EXAMPLES – 1) In the sample of 400 progeny the expectation is of 200 individuals in each category. If the observed frequencies give an excess of 5 individuals in one class and corresponding frequency of 5 individuals. Seconds class –

400 (A+B)

A 200, B 200

obs 205, 195

In this case –

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

$$= \frac{(205-200)^2}{200} + \frac{(195-200)^2}{200}$$

$$= \frac{25}{200} + \frac{25}{200} = \frac{50}{200} = 0.25$$

DEGREE OF FREEDOM

The chi-square result and the degree of freedom are calculated from the number of classes or categories that involve in the study. The degree of freedom of choice is always less than the total number of classes or categories.

For example, if there are two classes (male and female sex ratio), the degree of the freedom will be $2-1=1$

If there are 3 – classes or categories, the degree of freedom will be $3-1=2$

In the above example, the degree of freedom is one.

Now the Calculated value of x^2 for one degree freedom is matched with the value from x^2 - table.

d.f.	P_{95} at 5% level	$P_{97.5}$	P_{99}	$P_{99.5}$
1	3.84	5.02	6.63	7.88
2	5.99	7.38	9.21	10.6
3	7.81	9.35	11.3	12.8
4	9.49	11.1	13.3	14.9
5	11.4	12.8	15.1	16.8

Fig - chi - squire table

I/ In the x^2 - table ~~fore~~ for one degree of freedom value of chi - squire is 3.84 (at the 5% level of significance). The observed value of $x^2 = 0.25$ is not large enough to reject the hypothesis.

II/ In the F_2 - population breeds observes 603 plants of grey coloured seeds & 217 plant of red coloured seeds. Now you find in the test that the population of plant will be in agreement of monohybrid ratio.

Total no. of plants, 603 + 217 = 820

Monohybrid ratio = 3:1

Plant having grey coloured seed —

$\frac{3}{4} \times 820 = 615$ } Expected plant

red coloured seed $\frac{1}{4} \times 820 = 205$

$$x^2 = \Sigma \frac{(O-E)^2}{E}$$

$$= \frac{(603-615)^2}{615} + \frac{(217-205)^2}{205}$$

$$= \frac{(-12)^2}{615} + \frac{(12)^2}{205}$$

$$= \frac{144}{615} + \frac{144}{205}$$

$$= \frac{144 + 432}{615} = \frac{576}{615} = 0.936$$

.68
.005
.63
3.84
.49
3.84
0.96
0.5
10
0.5
.05
9
10
diffe
10
0.5
x
10
0.5

5

(5)

In this cross the value of chi-square for one degree of freedom is 0.93, which is less than the value of x^2 for one degree of freedom at 5% level. Thus, it is an agreement with Mendelian Monohybrid ratio.

3/ The varieties of plants are crossed and 4 types of plants are seen in seconda generation. The total number of plants are 880. Among them 502 Small/red, 159 Small/Grey, 171 - Large/red & 48 Large/grey.

Now you find the quantitative inheritance in the plant within MENDALIAN dihybrid ratio

MENDEDIAN ~~DH~~ DIHYBRID RATIO = 9:3:3:1

	Expected (E)	observed (O)	O-E
9/16 × 880 -	495	502	+7
3/16 × 880 -	165	159	-6
3/16 × 880 -	165	171	+6
1/16 × 880 -	55	48	-7

$$x^2 = \frac{(+7)^2}{495} + \frac{(-6)^2}{165} + \frac{(+6)^2}{165} + \frac{(-7)^2}{55}$$

$$= \frac{49}{495} + \frac{36}{165} + \frac{36}{165} + \frac{49}{55}$$

$$= \frac{49 + 108 + 108 + 441}{495}$$

$$= \frac{706}{495} = 1.426$$

In this example, the degree of freedom is ~~4-1~~ 4-1 = 3. For three degree of freedom the value of chi-square is 7.81 (at 5% level of significance). In this example the ~~the~~ value of x^2 is ~~Ka~~ 1.426 which is less than 7.81. Thus, quantitative inheritance is according to Mendelian dihybrid ratio of this example is in agreement with hypothesis. to