

Chi Square Analysis

Chi Square analysis is used to determine if there are variations from expected values.

1. The 3:1 ratio found in monohybrid (one trait crosses) and the 9:3:3:1 found in dihybrid crosses (two trait crosses) are rarely found in real life.

Chi square is used to determine if these variations are significant. Significant differences are observed values that are different from what is normal (expected). Non-significant values are values within the expected range.

2. The formula for calculating Chi Square is $X^2 = \sum (d^2/e)$

Definitions:

Σ = sum of values

d = difference between the expected value (3:1 or 9:3:3:1) and the actual observed value found in real life. (Subtract expected value from actual).

e = expected value

c = number of phenotypes

o = observed number

3. Calculate X^2 in this example. A monohybrid (one trait cross) involves flowers. The flowers with the dominant trait (P) are purple. The flowers with the recessive trait (p) are green.

160 flowers are picked from a field. Separate the flowers by color (phenotype) and find that 44 are green and 116 are purple. These are the observed values. Since this is a monohybrid cross, expect to find a 3:1 phenotypic ratio.

To determine the expected value start with the total number of flowers picked, 160. Since we are testing a 3:1 ratio, we have a total ratio number of 4 (3+1=4). Divide the total number of flowers picked by the total ratio number (160/4). This equals 40. This number is $\frac{1}{4}$ the total or 1 in the 3:1 ratio. This stands for the number of recessive-colored flowers expected to be found in the field. To get the dominant number of flowers expected to be found, multiply the 40 by 3, from the 3 in the 3:1 ratio (40 X 3). This equals 120. These are all the numbers we need to determine X^2 . $X^2 = \sum (d^2/e) = .400 + .133 = .533$.

Phenotype	O	E	d (o-e)	d ²	d ² /e
Purple	116	120	-4	16	16/120 = .133
green	44	40	4	16	16/40 = .400
					$\Sigma = .533$

4. To determine if these variations are significant use the following chart.

To use the chart, first decide from which line to read. This is determined by the number of phenotypes. In this example there are 2, purple and green. Insert this number into the formula $C-1$ where c = number of phenotypes. The result is $2-1 = 1$. Therefore, read from line 1.

Next look for where the X^2 number lies on this line. Our $X^2 = .533$ falls between the p values of .50 and .30. Therefore, the variation found is insignificant. This means that the observed values are not different from the values that were expected.

Had our X^2 value been 5.412, the p value would be .02 and the differences would be significant.

If $p > .10$, our hypothesis test verifies our observation and we can draw out conclusions with confidence.

If $p < .10$, our hypothesis test denies our observation and research methods may need to be revised or further explanation of our observation is needed.

Values of Chi-Square										
	<i>Hypothesis Is Supported</i>					<i>Hypothesis Is Not Supported</i>				
	Differences Are Insignificant					Differences Are Significant				
<i>P</i>	0.99	0.95	0.80	0.50	0.30	0.20	0.10	0.05	0.02	0.01
<i>C - 1</i>										
1	0.00016	0.0039	0.064	0.455	1.074	1.642	2.706	3.841	5.412	6.635
2	0.0201	0.103	0.446	1.386	2.408	3.219	4.605	5.991	7.824	9.210
3	0.115	0.352	1.005	2.366	3.665	4.642	6.251	7.815	9.837	11.341
4	0.297	0.711	1.649	3.357	4.878	5.989	7.779	9.488	11.668	13.277
5	0.554	1.145	2.343	4.351	6.064	7.289	9.236	11.070	13.388	15.086

Chi-Square Worksheet