

The coefficient of variation (CV)

The coefficient of variation (CV) is defined as the ratio of the standard deviation to the mean. It shows the extent of variability in relation to the mean of the population.

The coefficient of variation should be computed only for data measured on a ratio scale, that is, scales that have a meaningful zero and hence allow relative comparison of two measurements (i.e., division of one measurement by the other).

To calculate the coefficient of variation (CV) for the previous example:

$$\text{Total mean } (\bar{y}) = \frac{Y_{..}}{N}$$

$$(\bar{y}) = \frac{446}{13} = 34.31$$

$$\text{CV} = \frac{\sqrt{MSe}}{\bar{y}} \times 100 = \frac{\sqrt{3.32}}{34.31} (100) = 5.31\%$$

*The CV affects the degree of precision with which the treatments are compared and is a good index of the reliability of the experiment. It is an expression of the overall experimental error as percentage of the overall mean; thus, the higher the CV value, the lower is the reliability of the experiment. The CV varies greatly with the type of experiment, the crop grown, and the characters measured. An experienced researcher, however, can make a reasonably good opinion on the acceptability of a particular CV value for a given type of experiment. Experimental results having a CV value of more than 30 % are to be viewed with caution.

Methods of multiple comparisons

The purpose of this section is to describe various multiple comparisons methods for testing hypotheses after the analysis of variance has been done.

1) Fisher's Least Significant Difference (LSD):

Fisher's LSD (to be written as LSD, henceforth) is a technique used for making comparison between the population mean of one treatment effect with the population mean of the other treatment effect. This test is needed to discover and compare the effects of the treatments after the analysis of variance has rejected the null hypothesis that all the treatment effects are same (or equal). The LSD test does not make any correction for multiple comparisons. The only difference between a set of t tests and LSD is that t tests compute the standard error from the two treatments being compared. The LSD test considers the square root of the error (residual), mean square from the analysis of variance as the pooled standard error. LSD should be used only when null hypothesis about equality of treatment effects through ANOVA is rejected.

To calculate the Fisher's LSD value is as follows:

- 1) Calculate the mean of treatments.
- 2) Estimate the value of LSD using the following equation:

$$LSD_{0.05} = \frac{\sqrt{2MSe}}{r} \times t_{0.05}$$

- 3) The means should Arrange ascending and descending (by table), and calculate the difference between the two means.
- 4) Compare the LSD value with the value of the difference between the treatments means. If the value of the difference between the two treatments is higher than the value of LSD, this means that there is a significant difference between the two treatments.

For more clarification on this subject, we will use the previous example to find the most effective treatments, as follows:

treatment	R1	R2	R3	T_i	mean
T1	29	28	29	86	28.67
T2	33.5	31.5	29	94	31.33
T3	26.5	30	-----	56.5	28.25
T4	48.5	46.5	49	144	48.00
T5	34.5	31	-----	65.5	32.72
Total				(Y..) 446	

$$LSD_{0.05} = \frac{\sqrt{2(3.32)}}{3} \times 2.13 = 3.17$$

LSD 3.17	T3 28.25	T1 28.67	T2 31.33	T5 32.72	T4 48.00
48.00 T4	* 19.75	* 19.33	* 16.67	* 15.28	00
32.72 T5	* 4.47	* 4.05	1.39	00	
31.33 T2	3.08	2.66	00		
28.67 T1	0.42	00			
28.25 T3	00				

*This means, that the (T4) and (T5) treatments gave the most significant effect, but the (T1, T2 AND T3) treatments have no significant effect.

2) Duncan test multiple-range test

This was found The test by researcher Duncan, Due to the determination of the use of the LSD test, the need for more accurate methods of making comparisons, and Especially the comparisons are not correlated (if the number increases The coefficients are about ten). In 1955 Duncan developed this test and called it the Duncan multiple-range test. It is counted once when the number of transactions is large (more than 15-20 transactions) and is calculated As follows:

1) Extract the standard deviation of any observation in the experiment with the root of the following:

$$S_{yi} = \sqrt{\frac{MSe}{r}}$$

2) Extracting **short significant range (SSR)** values from Duncan tables and their number is less than the number of transactions by one, which depends on the number Input transactions by comparison, according to the number of means included in the comparison.

3) Extracting **lowest significant range (LSR)** values from the product of the previous two steps through the following equation:

$$LSR = S_{yi} \times SSR$$

4) The treatments means and LSR values are arranged in descending and vertical order the means are ascending and horizontal and in both cases the last mean is left. Then, we take the difference between each two means and compare it with LSR value, if the difference between the two averages is higher than the LSR value, so the difference between the two means is significant. But if the difference is less than the LSR, it is not significant.

We will use the previous example to find the most effective treatments, as follows:

Source of variation	Degree of freedom	Sum of squares	Mean square	F cal	F table 5%
Treatment	4	762.69	190.67	57.38*	3.84
Error	8	26.58	3.32		
Total	12	789.27			

$$S_{yi} = \sqrt{\frac{3.32}{3}} = 1.04$$

SSR = 3.26 3.39 3.47 3.52 (Duncan table)

$$LSR = S_{yi} \times SSR$$

	2	3	4	5
SSR	3.26	3.39	3.47	3.52
S_{yi}	1.04			
LSR	3.39	3.52	3.61	3.66

LSR	3.39	3.52	3.61	3.66
	T3 28.25	T1 28.67	T2 31.33	T5 32.72
48.00 T4	* 19.75	* 19.33	* 16.67	* 15.28
32.72 T5	* 4.47	* 4.05	1.39	00
31.33 T2	3.08	2.66	00	
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*This means, that the (T4) and (T5) treatments gave the most significant effect, but the (T1, T2 AND T3) treatments have no significant effect.