

### 3.6: One-Way ANOVA Greenhouse Example in Minitab

#### Step 1: Import the data

The data ([Lesson 1 Data](#)) can be copied and pasted from a word processor into a worksheet in Minitab:

	C1	C2	C3	C4
	Control	F1	F2	F3
1	21.0	32.0	22.5	28.0
2	19.5	30.5	26.0	27.5
3	22.5	25.0	28.0	31.0
4	21.5	27.5	27.0	29.5
5	20.5	28.0	26.5	30.0

Figure 3.6.1: Worksheet in Minitab of Lesson 1 data.

#### Step 2: Run the ANOVA

To run the ANOVA, we use the sequence of tool-bar tabs: **Stat** > **ANOVA** > **One-way...**

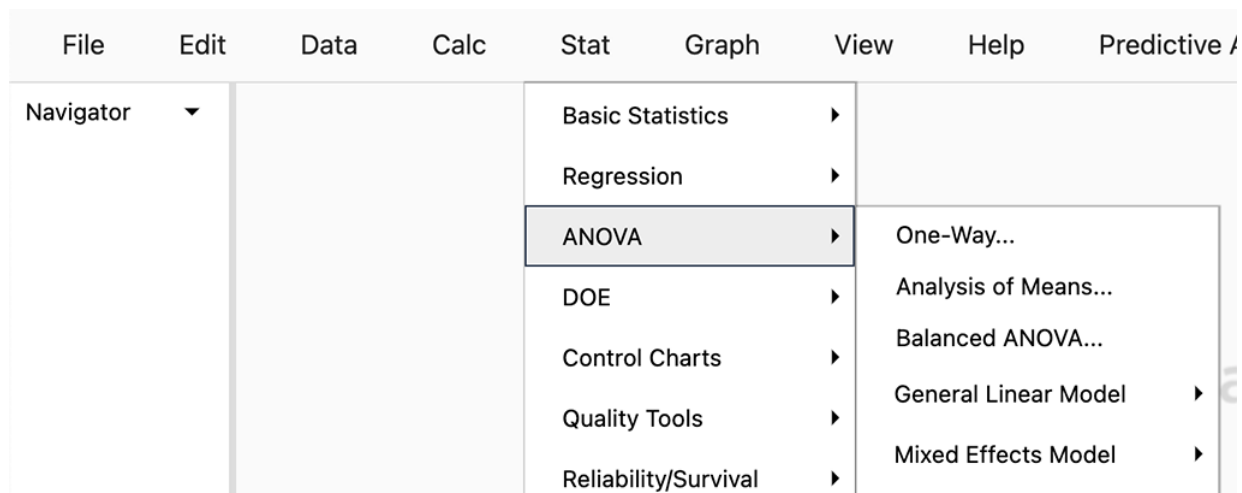


Figure 3.6.2: Selecting toolbar tabs in Minitab.

You then get the pop-up box seen below. Be sure to select from the drop-down in the upper right, "Response data are in a separate column for each factor level":

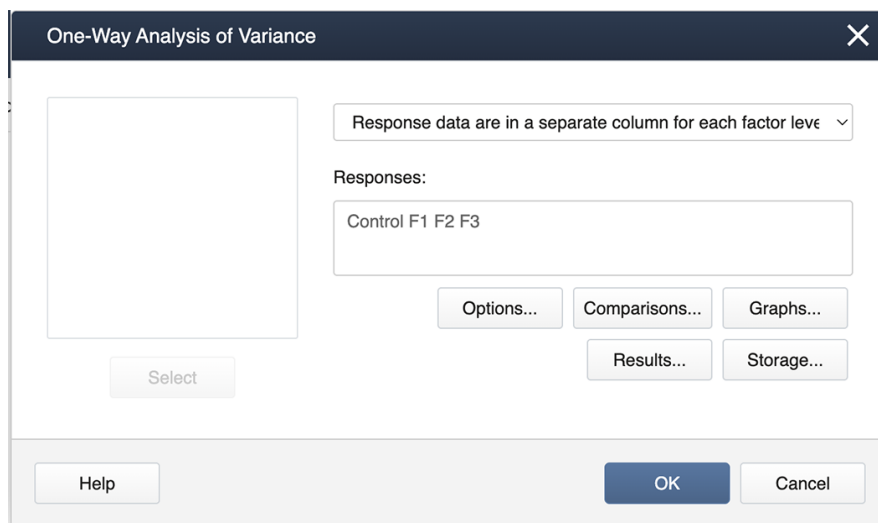


Figure 3.6.3: ANOVA pop-up window in Minitab.

Then we double-click from the left-hand list of factor levels to the input box labeled "Responses", and then click on the box labeled **Comparisons**.

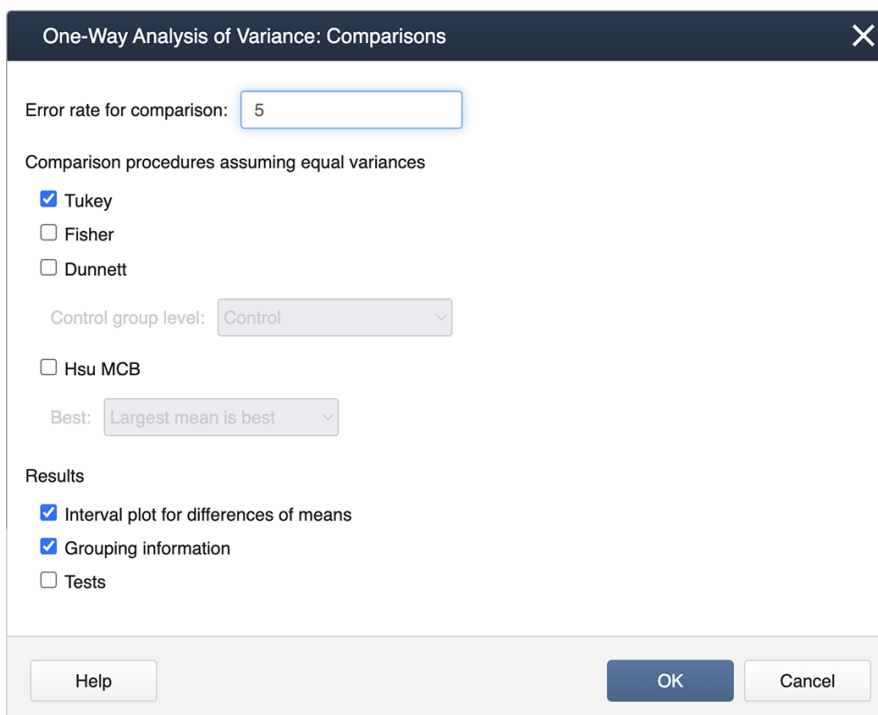


Figure 3.6.4: ANOVA: Comparisons pop-up window in Minitab.

We check the box for Tukey and then exit by clicking on **OK**. To generate the Diagnostics, we then click on the box for **Graphs** and select the "Three in one" option:

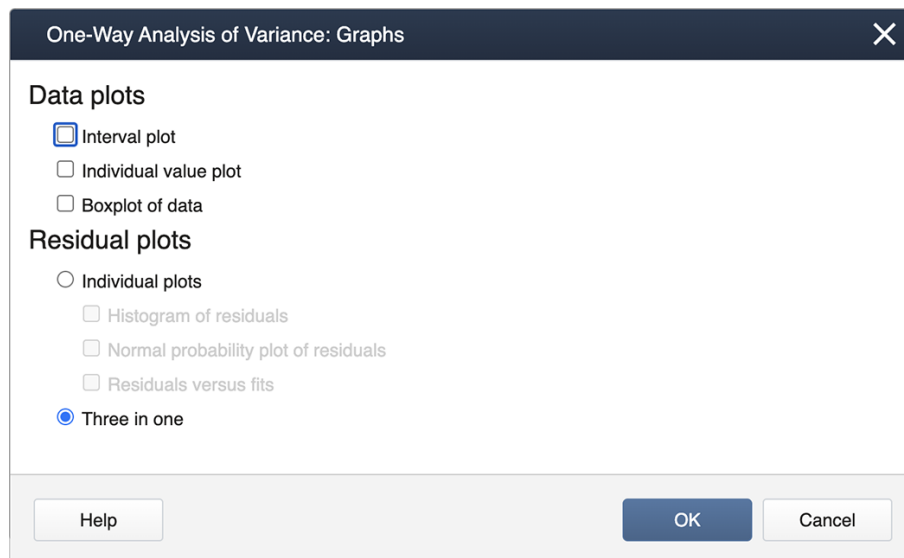


Figure 3.6.5: ANOVA: Graphs pop-up window in Minitab.

You can now "back out" by clicking on **OK** in each nested panel.

### Step 3: Results

Now in the Session Window, we see the ANOVA table along with the results of the Tukey Mean Comparison:

#### One-Way ANOVA: Control, F1, F2, F3

##### Method

Null Hypothesis: All means are equal

Alternative Hypothesis: Not all means are equal

Significance Level:  $\alpha = 0.05$

Equal variances were assumed for the analysis.

##### Factor Information

Factor	Levels	Values
Factor	4	Control, F1, F2, F3

##### Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	3	251.44	83.813	27.46	0.000
Error	20	61.03	3.052		
Total	23	312.47			

(Extracted from the output that follows from above.)

##### Grouping Information Using Tukey Method

	N	Mean	Grouping		
F3	6	29.200	A		
F1	6	28.600	A	B	
F2	6	25.867		B	
Control	6	21.000			C

Means that do not share a letter are significantly different.

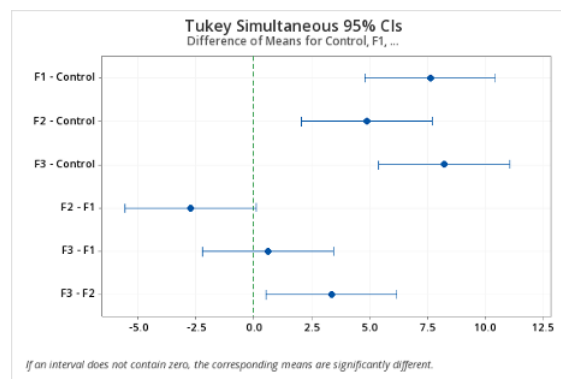


Figure 3.6.6: Minitab difference in means plot.

As can be seen, Minitab provides a difference in means plot, which can be conveniently used to identify the significantly different means by following the rule: if the confidence interval does not cross the vertical zero line, then the difference between the two associated means is statistically significant.

The diagnostic (residual) plots, as we asked for them, are in one figure:

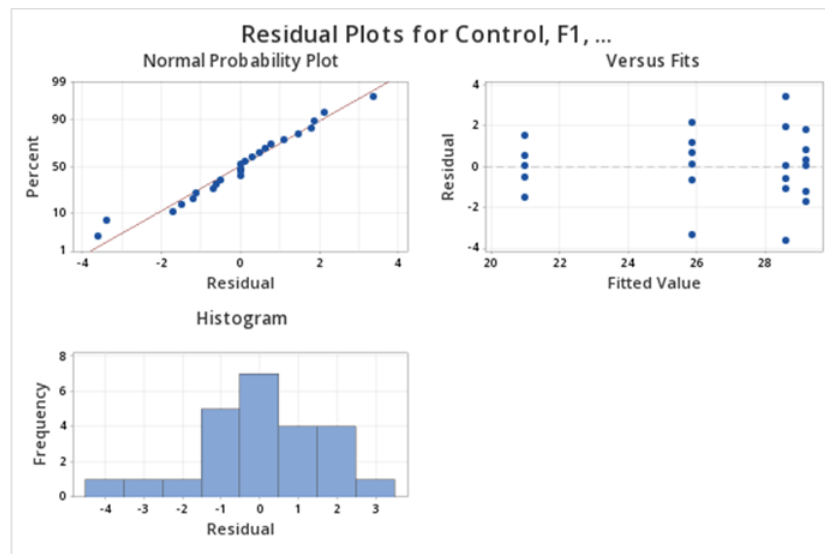


Figure 3.6.7: Residual plots generated by Minitab.

Note that the Normal Probability plot is reversed (i.e, the axes are switched) compared to the SAS output. Assessing straight line adherence is the same, and the residual analysis provided is comparable to SAS output.

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