

1

An introduction to analysis of variance

1.4 The fertiliser dataset: an example of one-way ANOVA

In this first example, we wish to compare the efficacy of three fertilisers. A field experiment has produced the yield of a crop from 30 plots, each fertiliser having been applied to 10 of these plots. Which fertiliser produces the greatest yields?

Step 1: The data

Minitab will require the data in columns as illustrated in Table 1.2 in the main text; that is, with levels of fertiliser represented as subscripts 1 to 3 in one column called `FERTIL`, and the yields from each plot in a second column called `YIELD`. These text names must be entered at the top of each column, so that when you enter commands, these names can be used to refer to those columns.

Step 2: The question

The relevant command is `ANOVA`, followed by the model formula. This may either be entered into the command window, or via menus.

MINITAB COMMANDS FOR BOX 1.1a Analysis of variance

Commands	<code>Anova YIELD = FERTIL.</code>
Menu route	<code>Stat > ANOVA > Balanced ANOVA</code> <code>YIELD → Response</code> <code>FERTIL → Model</code>

However these commands will only give you the analysis of variance table. In this particular example, we also wanted the confidence intervals for the three fertiliser means. This can be done in Minitab by using the very similar command `ONEWAY` which stands for ‘oneway ANOVA’.

MINITAB COMMANDS FOR BOX 1.1b Analysis of variance	
Commands	Oneway YIELD FERTIL
Menu route	Stat > ANOVA > One-way ANOVA YIELD → Response FERTIL → Factor

This should then give you the following output which falls into two parts. The first part is the ANOVA table, and the second part is a table of sample sizes, means and standard deviations for each of the three treatment groups. Minitab also calculates the 95% confidence intervals for each group mean. The details of how these values are calculated from first principles are explained in the text.

MINITAB OUTPUT FOR BOX 1.1 Analysis of the <i>fertiliser</i> dataset: One-way ANOVA						
One-way ANOVA: YIELD versus FERTIL						
Analysis of Variance for YIELD						
Source	DF	SS	MS	F	P	
FERTIL	2	10.823	5.411	5.70	0.009	
Error	27	25.622	0.949			
Total	29	36.445				
Individual 95% CIs For Mean Based on Pooled StDev						
Level	N	Mean	StDev	-----+-----+-----+-----		
1	10	5.4450	0.9760	(-----*-----)		
2	10	3.9990	0.9718	(------*-----)		
3	10	4.4870	0.9747	(------*-----)		
-----+-----+-----+-----						
Pooled StDev =		0.9742		4.00	4.80	5.60

Basic descriptive statistics may also be obtained, which are useful for having a preliminary inspection of the within group variances. Note that if typing your commands, you need to spread them over two lines, separated by a semi-colon. The second line is a subcommand of the first, and must be ended with a full stop. The menu route involves moving response and explanatory variables into boxes (which can be done by double clicking on the variable concerned, or simply by typing it in the box). The 'By Variable' box needs to be activated by checking it (✓), before it will accept the variable FERTIL.

MINITAB COMMANDS FOR TABLE 1.5 Descriptive statistics

Commands	Describe YIELD; By FERTIL.
Menu route	Stat > Basic Statistics > Display Descriptive Statistics YIELD → Variable <input checked="" type="checkbox"/> 'By Variable' FERTIL → By variable

MINITAB OUTPUT FOR TABLE 1.5 Descriptive statistics for the *fertiliser* dataset

Descriptive Statistics

Variable	FERTIL	N	Mean	Median	TrMean	StDev
YIELD	1	10	5.445	5.220	5.405	0.976
	2	10	3.999	3.845	3.830	0.972
	3	10	4.487	4.540	4.293	0.975

Variable	FERTIL	SE Mean	Minimum	Maximum	Q1	Q3
YIELD	1	0.309	4.070	7.140	4.725	6.300
	2	0.307	3.070	6.280	3.255	4.360
	3	0.308	3.530	7.000	3.770	4.572

1.7 Exercises

Melons

This experiment compares the yield from four melon varieties. It was designed so that each variety was grown in six plots—but two plots growing variety 3 were accidentally destroyed. There is just one categorical explanatory variable. It would therefore be analysed as follows:

MINITAB COMMANDS FOR TABLE 1.7 Descriptive statistics

Commands	Anova YIELDM = VARIETY.
Menu route	Stat > ANOVA > Balanced ANOVA YIELDM → Response VARIETY → Model

Which would produce the following output.

MINITAB OUTPUT FOR TABLE 1.7 Analysis of variance for melons						
ANOVA: YIELDM versus VARIETY						
Factor	Type	Levels	Values			
BEAN	fixed	4	1	2	3	4
Analysis of Variance for YIELDM						
Source	DF	SS	MS	F	P	
VARIETY	3	1115.28	371.76	23.80	0.000	
Error	18	281.19	15.62			
Total	21	1396.47				

Note that Minitab states the levels of any categorical variable, before producing the ANOVA table.

Dioecious trees

See Minitab output for this exercise in the answers to exercises in Chapter 14.