Lab #9.

For the Citrus tree variety/Insecticide example, we need three variables: yield (the response variable), variety (factor A variable) and pesticide (factor B variable).

An experiment was conducted to determine the effects of four different pesticides (B_1, B_2, B_3, B_4) on the yield of fruit from three different varieties (A_1, A_2, A_3) of a citrus tree.

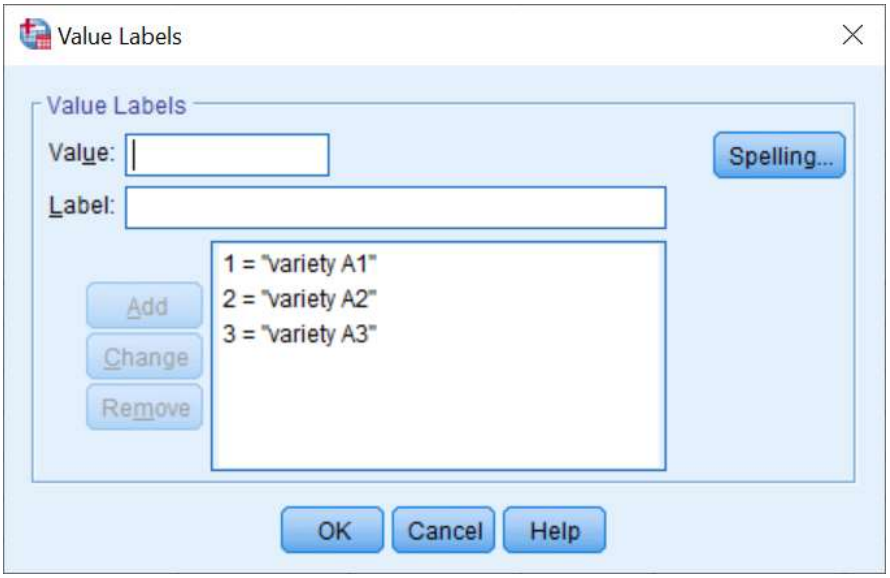
Experimenter decided to use 24 citrus trees (8 of each variety) and randomly assigned 2 trees to each factor-level combination.

The Table of Observations is given below:

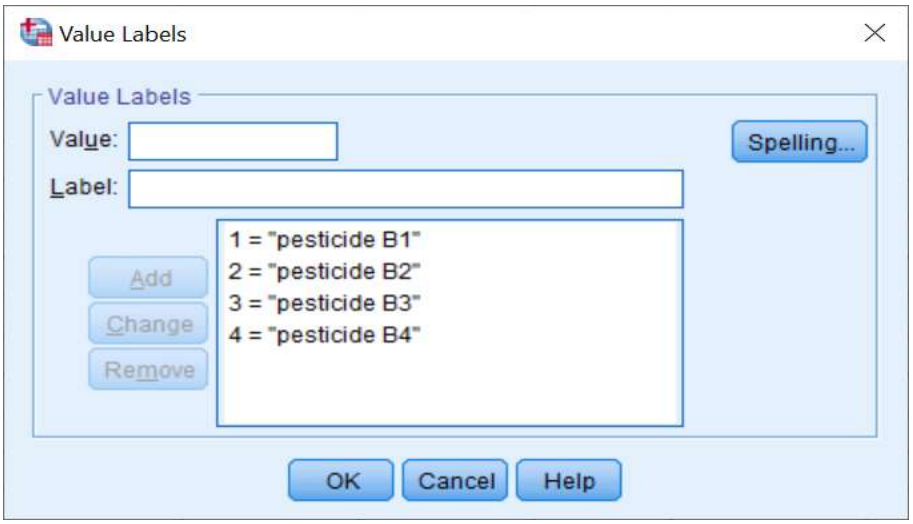
	Pesticide				
Tree Variety	B_1	B_2	B_3	B_4	*Totals*
A_1	49, 39	50, 55	43, 38	53, 48	375
A_2	55, 41	67, 58	53, 42	85, 73	474
A_3	66, 68	85, 92	69, 62	85, 99	626
Totals	318	407	307	443	1 475

Enter the name of the variable in the field labelled “Name”, in the “Type” keep the default option ‘numeric’. Next you can choose the “Width” of your variable and how many decimals it should have under “Decimals” (it is set by default to width=8 and decimals=2). The “Label” and “Values” fields are filled for treatment variable, so skip them for the response variable. The last field that should be filled is “Measure”. Since the lifetime is the response variable of quantitative type, set it to ‘scale’.

For the factor A variable, we repeat: “Name” = variety, we have no need for decimals here since the bulbs are numbered 1,2,3. Next we click on “Values” and here we can label/code each insecticide as we wish.



For the factor B variable, we repeat: “Name” = pesticide, we have no need for decimals here since the bulbs are numbered 1,2,3,4. Next we click on “Values” and here we can label/code each plot as we wish.



To enter the data, we switch to **Data View** tab and start entering the values.

First, we enter our axb factorial model. To do so:

Select ‘**Analyze**’ → ‘**General Linear Model**’ → ‘**Univariate**’. Then select yield as ‘Dependent Variable’ and variety and pesticide as ‘Fixed Factors’. Next select ‘include the model intercept’, if it is not selected. To obtain the ANOVA table for our axb factorial, click “**OK**”.

Univariate Analysis of Variance

Between-Subjects Factors

		Value Label	N
variety	1	variety A1	8
	2	variety A2	8
	3	variety A3	8
pesticide	1	pesticide B1	6
	2	pesticide B2	6
	3	pesticide B3	6
	4	pesticide B4	6

Tests of Between-Subjects Effects

Dependent Variable: yield

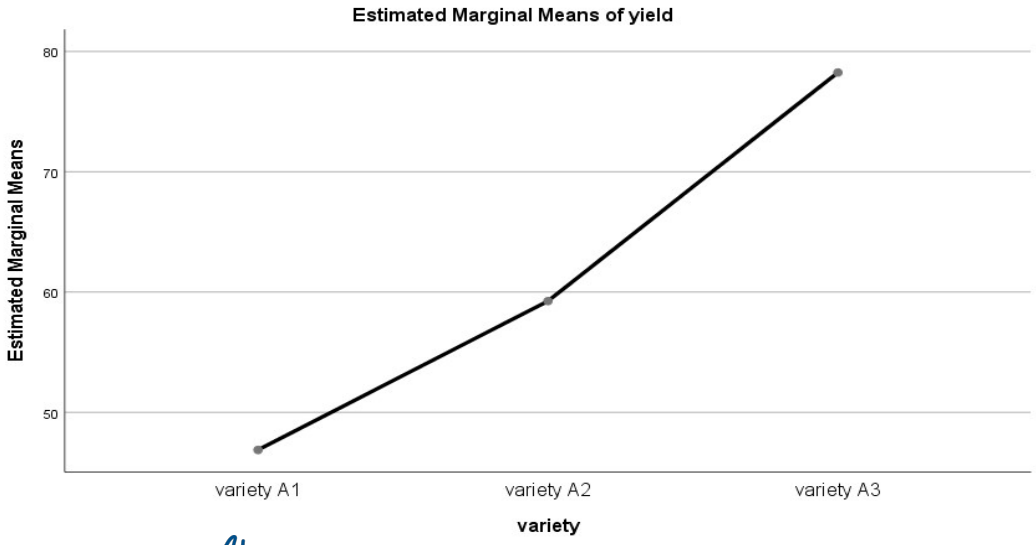
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6680.458[a]	11	607.314	14.360	.000
Intercept	90651.042	1	90651.042	2143.473	.000
variety	SSA 3996.083	2	MSA 1998.042	F_A 47.244	.000
pesticide	SSB 2227.458	3	MSB 742.486	F_B 17.556	.000
variety * pesticide	SS(AB) 456.917	6	MS(AB) 76.153	F_{AB} 1.801	.182
Error	SSE 507.500	12	MSE 42.292		
Total	97839.000	24			
Corrected Total	TSS 7187.958	23			

a. R Squared = .929 (Adjusted R Squared = .865)

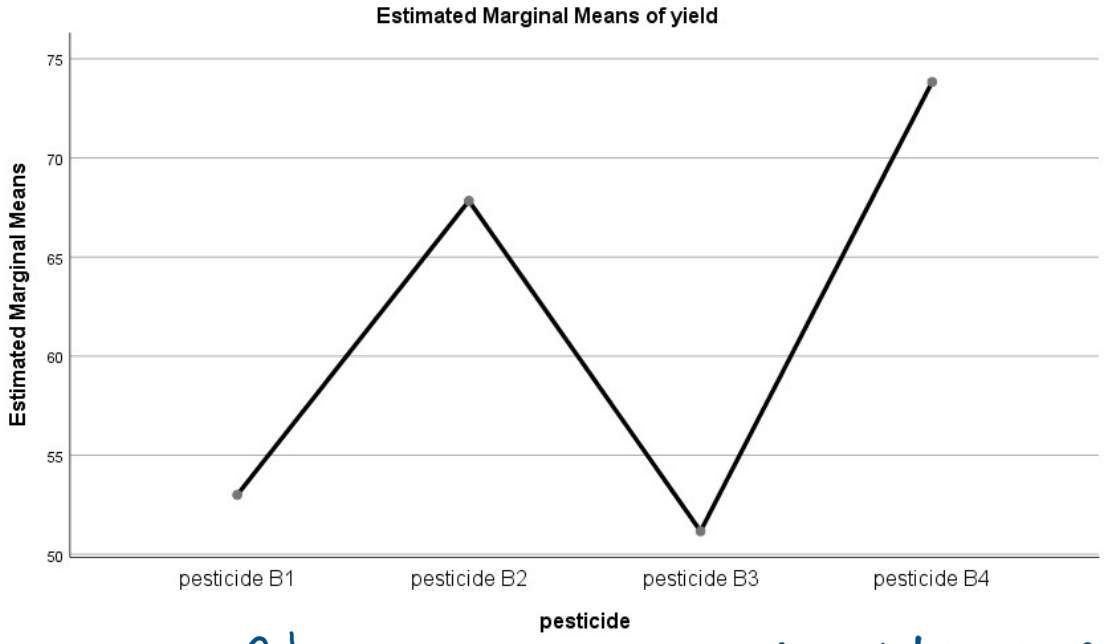
To do *Interaction plo*t (i.e treatment mean plot):

Select **Analyze**' → '**General Linear Model**' → '**Univariate**'. Select seedlings as 'Dependent Variable" and insecticide and plot as 'Fixed Factors'. Then select "**Plots**" and add the factors you want to plot on horizontal axis (you may want to plot each factor individually or you may want to plot the treatment mean plots, in that case put one factor on horizontal axis and another factor in separate lines box. You may want to plot them in reverse order). Each plot is followed by "**add**" Once you selected all the plots, click "**continue**" and then click "**OK**".

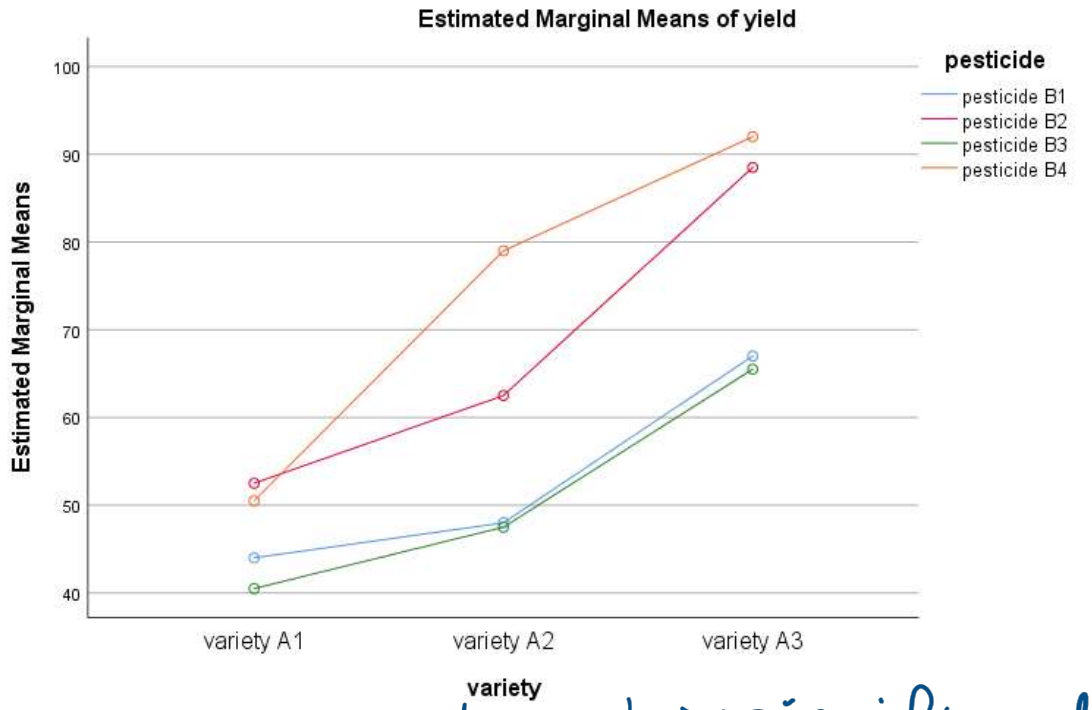
Profile Plots



differences in variety means



differences in pesticide means



- very slight, almost insignificant interactions

<u>Obtaining Simultaneous C.I.'s</u> (i.e. doing Multiple Comparisons) **<u>to compare treatment means</u>**:

Choose '**Analyze**' → '**General Linear Model**' → '**Univariate**'. Select seedlings as 'Dependent Variable" and insecticide and plot as 'Fixed Factors'. Then select "**Options**" and you can select what you wish to obtain e.g. if you want means and std. deviations, click on descriptive statistics. To get C.I.'s click on "**Post Hoc**"

<u>NOTE</u>: In case of unequal sample sizes, C.I.'s will need to be calculated by hand.

Post Hoc Tests

Variety

Multiple Comparisons

Dependent Variable: yield

			Mean Difference			95% Confidence Interval	
	(I) variety	(J) variety	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Tukey HSD	variety A1	variety A2	-12.38*	3.252	.007	-21.05	-3.70
		variety A3	-31.38*	3.252	.000	-40.05	-22.70

	variety A2	variety A1	12.38*	3.252	.007	3.70	21.05
		variety A3	-19.00*	3.252	.000	-27.67	-10.33
	variety A3	variety A1	31.38*	3.252	.000	22.70	40.05
		variety A2	19.00*	3.252	.000	10.33	27.67

Based on observed means.

The error term is Mean Square(Error) = 42.292.

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

yield

			Subset		
	variety	N	1	2	3
Tukey HSD[a,b]	variety A1	8	46.88		
	variety A2	8		59.25	
	variety A3	8			78.25
	Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 42.292.

a. Uses Harmonic Mean Sample Size = 8.000.

b. Alpha = 0.05.

pesticide

Multiple Comparisons

Dependent Variable: yield

			Mean Difference			95% Confidence Interval	
	(I) pesticide	(J) pesticide	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Tukey HSD	pesticide B1	pesticide B2	-14.83*	3.755	.009	-25.98	-3.69
		pesticide B3	1.83	3.755	.960	-9.31	12.98
		pesticide B4	-20.83*	3.755	.001	-31.98	-9.69
	pesticide B2	pesticide B1	14.83*	3.755	.009	3.69	25.98
		pesticide B3	16.67*	3.755	.004	5.52	27.81
		pesticide B4	-6.00	3.755	.416	-17.15	5.15
	pesticide B3	pesticide B1	-1.83	3.755	.960	-12.98	9.31
		pesticide B2	-16.67*	3.755	.004	-27.81	-5.52
		pesticide B4	-22.67*	3.755	.000	-33.81	-11.52
	pesticide B4	pesticide B1	20.83*	3.755	.001	9.69	31.98

		pesticide B2	6.00	3.755	.416	-5.15	17.15
		pesticide B3	22.67*	3.755	.000	11.52	33.81
		pesticide B2	-16.67*	3.755	.005	-28.50	-4.83
		pesticide B4	-22.67*	3.755	.000	-34.50	-10.83
	pesticide B4	pesticide B1	20.83*	3.755	.001	9.00	32.67
		pesticide B2	6.00	3.755	.816	-5.84	17.84
		pesticide B3	22.67*	3.755	.000	10.83	34.50

Based on observed means.

The error term is Mean Square(Error) = 42.292.

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

yield

			Subset	
	pesticide	N	1	2
Tukey HSD[a,b]	pesticide B3	6	51.17	
	pesticide B1	6	53.00	
	pesticide B2	6		67.83
	pesticide B4	6		73.83
	Sig.		.960	.416

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 42.292.

a. Uses Harmonic Mean Sample Size = 6.000.

b. Alpha = 0.05.