

MATH 204 – Exercises 2: Solutions

1. Soil.sav Analysis

(a) Under the Randomized Block Design, with soil as the blocking factor

Tests of Between-Subjects Effects

Dependent Variable: Sulphur content (ppm)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35.586(a)	7	5.084	6.327	.003
Intercept	270.333	1	270.333	336.460	.000
solvent	1.621	3	.540	.673	.585
soil	33.965	4	8.491	10.568	.001
Error	9.642	12	.803		
Total	315.561	20			
Corrected Total	45.228	19			

a R Squared = .787 (Adjusted R Squared = .662)

- Therefore a significant difference between soils, but not solvents
- Parameter estimates and summary statistics below

Parameter Estimates

Dependent Variable: Sulphur content (ppm)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	5.166	.567	9.112	.000	3.930	6.401
[solvent=1]	-.078	.567	-.138	.893	-1.313	1.157
[solvent=2]	-.348	.567	-.614	.551	-1.583	.887
[solvent=3]	.444	.567	.783	.449	-.791	1.679
[solvent=4]	0(a)	.	.	.	.	.
[soil=1]	.098	.634	.154	.880	-1.283	1.478
[soil=2]	-2.490	.634	-3.929	.002	-3.871	-1.109
[soil=3]	-3.065	.634	-4.836	.000	-4.446	-1.684
[soil=4]	-2.010	.634	-3.171	.008	-3.391	-.629
[soil=5]	0(a)	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Sulphur content (ppm)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
CaCl	5	3.5940	1.24380	.55624	2.0496	5.1384	2.34	5.07
NH4OAc	5	3.3240	1.45986	.65287	1.5113	5.1367	2.07	5.29
Ca(H2P04)2	5	4.1160	2.43956	1.09100	1.0869	7.1451	1.09	7.09
Water	5	3.6720	1.12782	.50437	2.2716	5.0724	2.35	4.98
Total	20	3.6765	1.54286	.34499	2.9544	4.3986	1.09	7.09

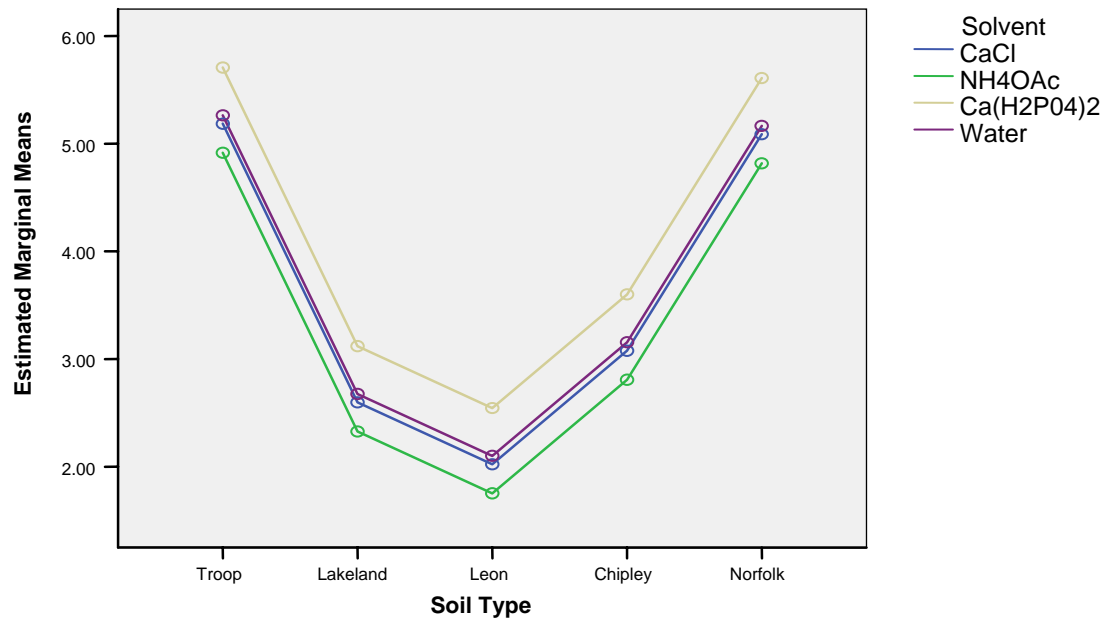
Levene's test confirms that there is no reason to suspect different variances.

Test of Homogeneity of Variances

Sulphur content (ppm)

Levene Statistic	df1	df2	Sig.
2.080	3	16	.143

Estimated Marginal Means of Sulphur content (ppm)



(b) Under the CRD, with no blocking factor

ANOVA

Sulphur content (ppm)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.621	3	.540	.198	.896
Within Groups	43.606	16	2.725		
Total	45.228	19			

- One-way ANOVA appears to confirm the RBD analysis. But we know that this analysis is not valid as there is definitely a block structure due to soils. For example, parameter estimates will be unreliable.

Post Hoc Tests from the one way ANOVA

Multiple Comparisons

Dependent Variable: Sulphur content (ppm)

	(I) Solvent	(J) Solvent	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	CaCl	NH4OAc	.27000	1.04411	.994	-2.7172	3.2572
		Ca(H2P04)2	-.52200	1.04411	.958	-3.5092	2.4652
		Water	-.07800	1.04411	1.000	-3.0652	2.9092
	NH4OAc	CaCl	-.27000	1.04411	.994	-3.2572	2.7172
		Ca(H2P04)2	-.79200	1.04411	.872	-3.7792	2.1952
		Water	-.34800	1.04411	.987	-3.3352	2.6392
	Ca(H2P04)2	CaCl	.52200	1.04411	.958	-2.4652	3.5092
		NH4OAc	.79200	1.04411	.872	-2.1952	3.7792
		Water	.44400	1.04411	.973	-2.5432	3.4312
	Water	CaCl	.07800	1.04411	1.000	-2.9092	3.0652
		NH4OAc	.34800	1.04411	.987	-2.6392	3.3352
		Ca(H2P04)2	-.44400	1.04411	.973	-3.4312	2.5432
Scheffe	CaCl	NH4OAc	.27000	1.04411	.995	-2.9846	3.5246
		Ca(H2P04)2	-.52200	1.04411	.968	-3.7766	2.7326
		Water	-.07800	1.04411	1.000	-3.3326	3.1766
	NH4OAc	CaCl	-.27000	1.04411	.995	-3.5246	2.9846
		Ca(H2P04)2	-.79200	1.04411	.900	-4.0466	2.4626
		Water	-.34800	1.04411	.990	-3.6026	2.9066
	Ca(H2P04)2	CaCl	.52200	1.04411	.968	-2.7326	3.7766
		NH4OAc	.79200	1.04411	.900	-2.4626	4.0466
		Water	.44400	1.04411	.980	-2.8106	3.6986
	Water	CaCl	.07800	1.04411	1.000	-3.1766	3.3326
		NH4OAc	.34800	1.04411	.990	-2.9066	3.6026
		Ca(H2P04)2	-.44400	1.04411	.980	-3.6986	2.8106
Bonferroni	CaCl	NH4OAc	.27000	1.04411	1.000	-2.8710	3.4110
		Ca(H2P04)2	-.52200	1.04411	1.000	-3.6630	2.6190
		Water	-.07800	1.04411	1.000	-3.2190	3.0630
	NH4OAc	CaCl	-.27000	1.04411	1.000	-3.4110	2.8710
		Ca(H2P04)2	-.79200	1.04411	1.000	-3.9330	2.3490
		Water	-.34800	1.04411	1.000	-3.4890	2.7930
	Ca(H2P04)2	CaCl	.52200	1.04411	1.000	-2.6190	3.6630
		NH4OAc	.79200	1.04411	1.000	-2.3490	3.9330
		Water	.44400	1.04411	1.000	-2.6970	3.5850
	Water	CaCl	.07800	1.04411	1.000	-3.0630	3.2190
		NH4OAc	.34800	1.04411	1.000	-2.7930	3.4890
		Ca(H2P04)2	-.44400	1.04411	1.000	-3.5850	2.6970

2. Lympho.sav: Under the Randomized Block Design, with litter as the blocking factor

Tests of Between-Subjects Effects

Dependent Variable: Lymphocyte level (mm)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.249(a)	7	1.178	22.198	.000
Intercept	711.625	1	711.625	13405.799	.000
drug	1.846	3	.615	11.589	.001
litter	6.403	4	1.601	30.155	.000
Error	.637	12	.053		
Total	720.510	20			
Corrected Total	8.886	19			

a R Squared = .928 (Adjusted R Squared = .886)

- We conclude that there is a significant difference between the treatments (drug) ($p = 0.001$, row 3) and also that there is a significant difference between the blocks (litter) ($p < 0.001$, row 4)
- To estimate the treatment differences consistently, we need to average the differences between treatments across the blocks, that is to estimate $\mu_1 - \mu_2$, we use the average across litters

$$((X_{11}-X_{12})+(X_{21}-X_{22})+(X_{31}-X_{32})+(X_{41}-X_{42})+(X_{51}-X_{52}))/5$$

Estimated Marginal Means of Lymphocyte level (mm)

