A randomized block example

A farmer wishes to compare the growth times of four different varieties of daffodil under a range of different conditions. She decides to use a randomized block design where six fields are split into four equally sized plots and then the varieties are randomly assigned to these plots. The response is the number of days until half of the daffodils are ready for cutting.

Var	1	2	3	4	5	6	Mean
			Field				
A	43	46	46	42	40	37	42.33
B	34	30	33	25	32	22	29.33
C	36	35	38	27	29	28	30.50
D	37	43	40	33	39	35	37.83
Mean	37.5	38.5	36.75	31.75	35.0	30.5	35.0

The data were entered into MINITAB and the twoway ANOVA program was run.

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MTB > set c1
DATA> 43 34 36 37 46 30 35 43 46 33 28 40 42 25 27 33
DATA> 40 32 29 39 37 22 28 35
DATA> end
MTB > set c2
DATA> 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
DATA> end
MTB > set c3
DATA> 1 1 1 1 2 2 2 2 3 3 3 3 4 4 4 4 5 5 5 5 6 6 6 6
DATA> end
MTB > Name c4 "RESI1" c5 "FITS1"
MTB > Twoway c1 c2 c3;
SUBC>    Residuals 'RESI1';
SUBC>    Fits 'FITS1';
SUBC>    Additive;
SUBC>    Means c2 c3.


Two-way ANOVA: C1 versus C2, C3

Source  DF      SS        MS      F       P
C2       3    685.0   228.333   31.28  0.000
C3       5    209.5    41.900    5.74  0.004
Error   15    109.5     7.300
Total   23   1004.0

S = 2.702   R-Sq = 89.09%   R-Sq(adj) = 83.28%
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- There are significant differences among the varieties ($P \approx 0$)
- There are also significant differences among the fields ($P = .004$)
- The variety effect estimates are $\hat{\alpha}_1 = 7.33$, $\hat{\alpha}_2 = -5.67$, $\hat{\alpha}_3 = -4.5$ and $\hat{\alpha}_4 = 2.83$
- There are 6 possible comparisons among the varieties, and the Bonferroni correction for simultaneous inference uses $\alpha_* = .05/6 = .0083$.
- The width of confidence intervals for the variety differences $\alpha_i - \alpha_k$ is

$$t^{15}_{.05/12}\sqrt{MSE}\sqrt{\frac{2}{6}} = 3.0363(2.702)(.5774) = 4.74$$

- The confidence intervals are

i	k	Interval	
1	2	8.26	17.74
1	3	7.10	16.57
1	4	-.24	9.24
2	3	-5.91	3.57
2	4	-13.24	-3.76
3	4	-12.07	-2.59

- We conclude that variety A is not significantly different from variety D, and variety B is not significantly different from variety C. The other comparisons are significant at the $\alpha = .05$ level.