Randomized Complete Block Designs

Randomized complete block designs differ from the completely randomized designs in that the experimental units are grouped into blocks according to known or suspected variation which is isolated by the blocks. Variation such as fertility, sand, and wind gradients, or age and litter of animals can be isolated by appropriate blocking. Therefore, within each block, the conditions are as homogeneous as possible, but between blocks, large differences may exist. In the attached figure 4 blocks have been established which subdivide the gradient into smaller segments. This results in relatively small gradients within each block so that the treatments may be compared under relatively homogeneous conditions. The treatments are assigned within the individual blocks at random with a separate randomization for each block. The analysis of variance table indicates that the error term now has 9 df rather than 12 df as in the CR design. These 3 df were removed for the block effect which removed the variation due to the gradient from the error variance. This will result in a more precise test of the treatment effects since the mean square for error will be smaller and the F value for treatment should be larger.

Advantages of randomized complete block designs

1. Complete flexibility. Can have any number of treatments and blocks.
2. Provides more accurate results than the completely randomized design due to grouping.
3. Relatively easy statistical analysis even with missing data.
4. Allows calculation of unbiased error for specific treatments.

Disadvantages of randomized complete block designs

1. Not suitable for large numbers of treatments because blocks become too large.
2. Not suitable when complete block contains considerable variability.
3. Interactions between block and treatment effects increase error.

Appropriate use of randomized complete block designs

1. When there is a known or suspected source of variation in one direction.

   Orient the blocks to have minimum variation within the block and orient plots to sample the entire range of variation within the block.

The randomized complete block design is one of the most widely used designs. If it will control the variation in a particular experiment, there is no need to use a more complex design.

RANDOMIZED COMPLETE BLOCK DESIGNS

An experiment with 4 treatments (A, B, C, D) and 4 blocks.

Blk 1	1 B	2 A	3 D	4 C
Blk 2	1 D	2 B	3 C	4 A
Blk 3	1 C	2 D	3 A	4 B
Blk 4	1 D	2 B	3 A	4 C

Number in upper left-hand corner are plot numbers.
Letters are treatments

Analysis of Variance

Source of Variation		df
Blocks	r-1	3
Trts	t-1	3
Error	(r-1) (t-1)	9
Total	(rt)-1	15

Mathematical Model

$$Y_{ij} = \overline{Y}_{..} + T_i + B_j + e_{ij}$$

Where: Symbols are the same as identified previously and

B_j = the block effect

j = a particular block