Solution to Exercise 3.7 (Version 1, 22/09/14)

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Exercise 3.7

A field experiment was set up to investigate how invertebrate abundance is affected by the spatial structure and species composition of weed patches (Smith, 2007). Small weed patches were formed from three pots of plants in a tray. Species composition was varied by using different numbers of mayweed (M) or thistle (T) plants in the patch, i.e. 3M, 2M+1T, 1M+2T or 3T. Spatial structure was varied by changing the distance between patches (12 m or 6 m). Five blocks of two whole plots were set up, with the two spacings allocated at random to whole plots within blocks. Each whole plot contained 16 patches laid out in a 4 × 4 array with the designated spacing, with patches allocated to four replicates of each of the four species compositions according to a Latin square design. A different randomization was used within each whole plot. Write down the explanatory and structural components for this design.

Solution 3.7

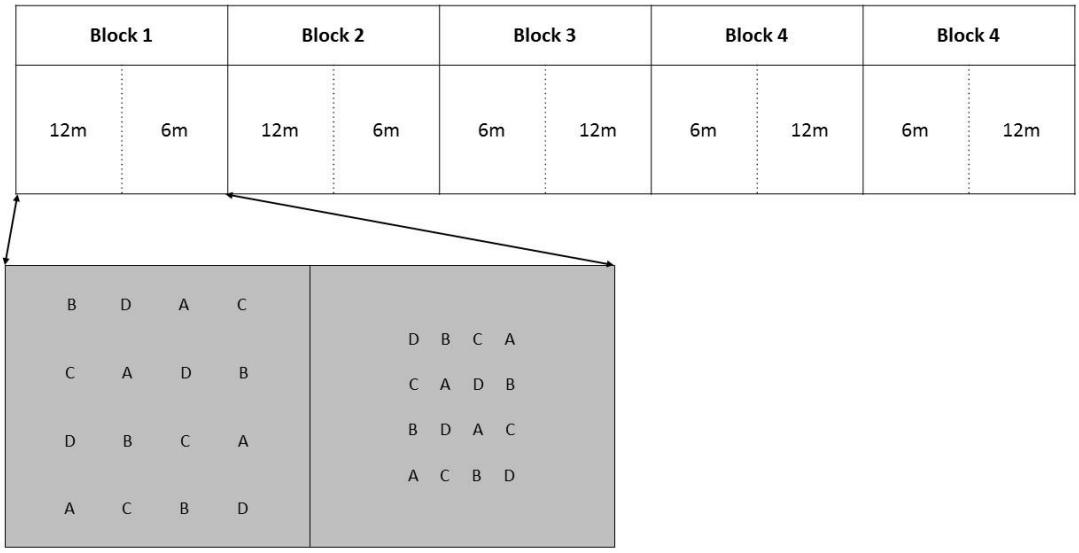

Figure S3.7.1. Layout of weed patch experiment in field, showing detail of allocation of weed patches within whole-plots in block 1 only, with A = 3M, B = 2M+1T, C = 1M+2T and D = 3T.

Figure S3.7.1 shows how this design might be laid out in practice. To define the structure, we require factors to label the blocks (factor Block with 5 levels), the whole plots within each block (factor WholePlot, two levels) and then the patches within each whole plot, which are themselves structured. We will define factors Row and Column (both four levels) to label the four rows and columns of the Latin square layout of patches within each whole plot. Whole plots are nested within blocks, as we

assume no association between whole plots with the same label. Similarly, we regard the Latin squares to be nested within whole plots, as we expect no association between rows belonging to squares in different whole plots, or between columns belonging to squares in different whole plots. This structure can be written as

Structural component: Block / WholePlot / (Row * Column)

which expands to give five terms:

Structural component: Block + Block.WholePlot + Block.WholePlot.Row
+ Block.WholePlot.Column + Block.WholePlot.Row.Column

The term Block.WholePlot.Row.Column labels the individual patches.

The explanatory component relates to the treatments applied, namely the spacing and composition of the patches. We define factor Spacing (with two levels, 12m and 6m) to label the spacing applied and factor Composition (4 levels, 3M, 2M+1T, 1M+2T, 3T) to label the composition for each tray. These treatment factors have a crossed structure and the explanatory component can be written as

Explanatory component: Spacing * Composition

which expands to give three terms:

Explanatory component: Spacing + Composition + Spacing.Composition

The design uses a balanced 2 × 4 factorial structure, with each spacing tested with each composition four times within each block. The experimental unit for spacing is whole plots, and there are five replicates of each spacing. The experimental unit for composition is the patches within the whole plots, and each composition has 40 replicates (four within each whole plot). The spacing × composition combinations have 20 replicates (four within each block).